SECTION 7: ELECTRICAL SERVICES, POWER AND LIGHTING

CONTENTS

DESIGN STANDARDS CHANGE LOG FEBRUARY 2013

7.3.3 Main Electrical Switchboard 9
Switchboard colours amended and approved manufacturers added.

7.3.4 Lighting and Power Distribution Boards 10
Approved manufacturers added.

7.3.8 Wiring Accessories 13
Floor box requirements and approved manufacturers added.

7.4 Lighting 14
General update of the whole section with LED's as the preferred lighting source.

7.4.10 Emergency and Exit Lighting System 18

Manufacturers Technical Assistance
Requirement for an independent commissioning agent added.

Log Book / Database / Acceptance Criteria
Requirement for the correct information to be entered into the system controller database and the successful completion of a 2 hour testing prior to occupation. Delete requirement for a printout of the 90 minute test.

Installation of System and Equipment
New schedule required showing the location, manufacturer, catalogue number, circuit and switchboard origin, serial number and sequence number to the independent commissioning agent and the University.

7.9 Material Selections 24
Floor boxes added, Emergency and Exit lighting updated.

7.10.3 Emergency Lighting Database Information Sheet 29
New emergency lighting database information sheet added.

7.1 INTRODUCTION

This section provides details of minimum requirements for the design, installation and operation of electrical services. The Designer is expected to produce their own specification incorporating the elements of the following information and submit all designs to the University's Manager (Engineering and Infrastructure) for review prior to any works commencing on site. This design standard sets out the University's minimum requirements and shall be considered an adjunct to all relevant statutory regulations having jurisdiction over the works. In particular AS/NZS 3000, AS/NZS 1680, AS/NZS 2293 and the Building Code of Australia National Construction Codes.

The Designer must approach and obtain written approval from the University's Manager (Engineering and Infrastructure) for any departure from any clause in this design standard.

All works, irrespective of the nature of the installation, shall incorporate value engineering in respect to energy saving, cost saving in ongoing maintenance, etc.

The Designer shall read this Electrical Design Standard with the other sections of the University's Design Standards document.

7.2 GENERAL DESIGN CRITERIA

7.2.1 Standards and Regulations

The electrical design shall meet all the requirements of national and local authorities, building permit conditions, and shall be in accordance with the following, and any other relevant standard.

Standard	Title
AS/NZS 1158	Lighting for roads and public spaces
AS/NZS 1680	Interior Lighting
AS/NZS 1768	Lightning protection
AS/NZS 2053	Conduits and fittings for electrical installations
AS/NZS 2293	Emergency escape lighting and exit signs for buildings
AS 2676	Installation and maintenance of batteries in buildings
AS/NZS 3009	Electric installations - Emergency power supplies in hospitals
AS 3011	Electrical installations - Secondary batteries installed in buildings
AS/NZS 3000	Electrical installations (also known as the Australian/New Zealand Wiring Rules)
AS/NZS 3008.1.1	Electrical installations – Selection of cables – Cables for alternating voltages up to and including 0.6/1kV – Typical Australian installation conditions
AS/NZS 3013	Electrical installations – Classification of the fire and mechanical performance of wiring systems
AS/NZS 3017:2007	Electrical installations—Verification guidelines
AS/NZS 3019:2007	Electrical installations—Periodic verification
AS/NZS 3080	Telecommunications installations - Generic cabling for commercial premises
AS/NZS 3084	Telecommunications installations - Telecommunications pathways and spaces for commercial buildings
AS/NZS 3100	Approval and test specification – General requirements for electrical

Standard	Title
	equipment
AS 3439.1	Low Voltage Switchgear and Control Gear Assemblies
AS/NZS 3947.3	Low-voltage switchgear and control gear - Switches, disconnectors, switch-disconnectors and fuse-combination units
AS/NZS 5000	Electric cables – Polymeric insulated
AS 60529—2004	Degrees of protection provided by enclosures (IP Code)
AS/ACIF S008	Requirements for customer cabling products
AS/ACIF S009	Installation requirements for customer cabling (wiring rules)
ASC 168	Fluorescent lamp ballasts
BS 5042	Specification for lampholders and starter holders.
EIA/TIA 569	Commercial building standard for telecommunications pathways and spaces
EN 55015:2006	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
EN 55022	Information Technology Equipment - Radio Disturbance Characteristics - Limits and Methods of Measurement
EN 61347	Lamp control gear
EN 60929	AC-supplied Electronic Ballasts For Tubular Fluorescent Lamps - Performance Requirements
IEC 60038	Standard Voltages
IEC 60044.1	Instrument transformers - Part 1: Current transformers
IEC 60051	Direct acting indicating analogue electrical measuring instruments and their accessories
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 61000	Electromagnetic compatibility (EMC)
IEC 61547	Equipment for general lighting purposes - EMC immunity requirements
IEC 62052	Electricity metering equipment (AC) - General requirements, tests and test conditions
BCA	Building Code of Australia
SIR	Supply Authority Service Installation Rules
--	Work cover requirements
--	All Health Authority Requirements
--	State Fire Brigade requirements
--	All Local Council regulations
--	Electricity Safety (Installations) Regulation

7.2.2 Electrical Services Noise and Vibration Limitations

The Designer shall select and locate equipment to achieve the acoustic performance required by these Design Standards. Particular attention shall be paid to noise generating equipment such as luminaires, UPS, generator sets, transformers and the like.

7.2.3 Services Fit-out Zone

The designer/contractor is requested to discuss this issue with the design team.

7.2.4 Building Services Penetrations

The designer/contractor is requested to discuss this issue with the design team. Allowance shall be made for the appropriate sealing of all electrical services penetrations for all fire rated and acoustic walls and partitions.

7.2.5 Energy Efficiency and Harmonics

All equipment specified for installation shall maintain a power factor not less than 0.90 lagging at half load. The installation shall achieve a nominal power factor of 0.95 lagging at the main incoming supply.

The electrical design shall achieve BCA Part J requirements as a minimum.

7.3 INCOMING SUPPLY AND LV DISTRIBUTION

7.3.1 Underground Cabling

Distribution of services to new buildings should be via crawl culverts or tunnels connected to adjoining existing buildings, where possible.

Drawings for existing underground services installed across the Parkville Campus are available from the Drawing Office in Property and Campus Services (PCS). All available documentation must be scrutinized by PCS prior to commencing any excavation.

Trenches shall be straight and parallel with the buildings, roadway, etc. Bitumen and concrete surfaces shall be cut prior to excavation by a concrete saw or similar. All surplus excavated spoil shall be removed from the site.

Underground cabling shall be installed in heavy duty non-metallic conduits in accordance with AS/NZS 3000 and the following additional requirements:

- The minimum depth of laying and protection for underground wiring shall be 600mm (cover) below finished ground level;
- Conduits shall be embedded in a layer of clean washed sand to a minimum cover of 100mm followed by premium grade crushed rock or premium top soil in garden areas;
- Marker tape shall be provided laid between 100mm and 200mm above the conduits. Trenches shall be allowed to remain open for the minimum length of time required for laying the conduits and cabling with due allowance for inspection;
- Backfilling shall not commence until the laying of the conduit has been approved by the Manager (Engineering and Infrastructure). The backfilling shall be compacted to 95% AASHO.

Cables specified for underground wiring shall generally be elastomer or thermoplastic insulated with elastomer or thermoplastic sheathing (double insulated) complying with the relevant Australian Standard for underground cables, be enclosed in heavy duty rigid UPVC conduit and installed in Category A wiring system.

Cable markers shall be provided where trenches change direction and where cables enter/exit buildings. Markers shall be selected from the Gatic range or as otherwise approved in writing by the University's Manager (Engineering and Infrastructure). PVC marker tape complying with AS2648 part 1 shall be specified for cable trenches.

The Contractor shall be responsible for the proper disposal (from the site) of all spoil and associated waste materials excavated during the project. The Contractor shall allow under the Contract to keep the Works Area clean and tidy and shall regularly remove from the site rubbish and surplus material arising from the execution of the work.

The Contractor shall produce drawings/revised existing drawings to accurately describe services distribution upon completion of the installation works.

7.3.2 Supply and Metering

The electrical supply distribution system for the Parkville Campus is 3 phase, four wire 415/240 volts, 50 Hz. The supply originates from Supply Authority sub-stations distributed around the Campus.

Early in the Design Stage, the Designer shall calculate the Maximum Demand (MD) and energy consumption for each project or installation, and agree with Property and Campus Services (PCS) the selection of the appropriate tariff and load management techniques.

On request the Designer shall submit to the University's Manager (Engineering and Infrastructure) a detailed report for each project. The report shall include the Maximum Demand calculations and recommended tariff selection, recommended metering arrangements and any easements required for the Supply Authority. The Designer shall liaise with the Supply Authority and assist the University with negotiations, including submission of applications, relating to reinforcement of existing and new electrical supplies.

The Designer shall prepare Single-line diagrams for the entire distribution system. Calculations shall be prepared to support the correct operation and discrimination of protective devices.

The Designer shall prepare fault level calculations estimating the fault level at all parts of the electrical distribution system. The fault withstand of the distribution equipment shall be specified in accordance with the results of the calculations.

Metering arrangements shall conform to the requirements of the Supply Authority and the requirements of the nominated NABERS / Green Star rating.

The Designer shall observe appropriate segregation of circuits at different voltages for safety and avoidance of electromagnetic interference.

The installation of switchboard instrumentation is a complex issue. Design discussions with relevant University representatives shall take place at an early stage.

Consideration shall be given to the following:

- Electronic energy meter;
- Maximum Demand (MD) ammeters;
- Voltmeter;
- The type of current transformers compatible with the Building Automation System (BAS);
- Test links for current transformer secondary terminals;
- Fused potential terminals for connection of portable recording equipment;
- Indicating lights (LED type: Red = Off, Cream = On, Blue = BAS)

Busbar links shall be provided for current transformers.

7.3.3 Main Electrical Switchboard

The main electrical switchboard shall be specified as a custom-built type-tested assembly and shall be designed to comply with the requirements of AS/NZS 3000, AS/NZS 3439, AS/NZS 3947 and the additional requirements of the University as set out in this Design Standard.

Main switchboard enclosures shall meet the requirements of the relevant Australian Standard for the degree of protection. Generally the Form of Segregation for a switchboard with ratings of 800A and above shall be Form 3b; for smaller switchboards it shall be Form 2.

Adequate support shall be provided for all busbars and the like to withstand the stresses caused by a prospective maximum fault current of not less than 45 kA for one second.

Tenderers shall submit full details of the switchboard with their tender, together with the name of the testing authority and relevant information regarding the fault current rating of the switchboard. A type test certificate shall be provided. Approved main switchboard manufacturers are Aline, Nilsen and PSG Elecraft.

Prior to manufacturing the switchboard, comprehensive shop drawings, together with all relevant data relating to a proposed main switchboard, shall be submitted to and approved by the University's Manager (Engineering and Infrastructure).

Main Switchboard Design

Switchboard design shall incorporate the following:

- The Designer shall confirm the University's requirement for spare capacity for future combined fused switches (CFS) and / or alternate current breaker (ACB) units (Note that the use of Moulded Case Circuit Breakers are permitted upon review and consultation with the University);
- All busbars and busbar assemblies shall be designed to limit the rise in temperature to no more than 40°C above the ambient temperature when carrying the maximum current rating of each and all associated items of switchgear;
- All busbar supports shall be capable of supporting busbars for a temperature range of 15°C to 110°C in continuous service;
- Neutral busbars shall have the same current carrying capacity as the phase conductors;
- Readily removable busbar links shall be provided for specified current transformers;
- Busbars for the red, white and blue phases shall be colour coated. Colouring shall be by means of full length heat shrink (Thermoshrink or as otherwise approved in writing by the University's Manager (Engineering and Infrastructure)). Strips or bands of heat shrink shall be utilised to identify the neutral and earth conductors;
- All joints, terminations and fixings shall be fully accessible;
- Provision shall be provided for future expansion of the main busbar system; all junctions associated with the installation of copper busbar shall be established using full lap-joints or compression joints. Lap joints shall be secured using torqued bolt fasteners. Clamp joints will not be accepted;
- The main switchboard shall be of a front connected design;
- All 'live' sections of a main switchboard, within wiring chambers, etc. shall be fully insulated to prevent contact with live parts;

- The main switchboard shall be free-standing, dust and vermin proof;
- Control of outgoing supplies shall be as follows:
  - up to 800 amps - CFS unit;
  - 800 amps and over - ACB unit;
- Installation of Moulded Case Circuit Breakers shall be avoided, where these are required confirmation of the University's Manager (Engineering and Infrastructure) shall be obtained;
- The minimum capacity for any CFS unit shall be 200 amps;
- Each CFS assembly shall be withdrawable from the body from the front of the switchboard;
- CFS and ACB units shall be by University approved manufacturers;
- Provide a minimum of one ACB lifting truck in each main switch room;
- The provision of a positive air ventilation system for the main switchboard room to minimise dust entry shall be considered;
- Internal switchboards shall be provided with protection to AS 1939 IP42;
- External switchboards shall be provided with protection to AS 1939 IP56;
- Provide glanded cable entries for cables entering a switchboard (one gland per cable) to ensure IP rating of MSB is maintained;
- All cable ends shall be identified by clip on markers;
- Lift-off hinges shall be supplied for all hinged doors;
- Doors shall be supplied with lockable latches; lock cylinders shall be keyed to CL-001 keys;
- Removable panels shall be supplied with:
  - Suitable lifting handles;
  - Captive knurl-headed fixing screws;
- Removable panels shall be supported by locating dowels or pins to provide support for the panel when the fixing bolts are removed;
- The design shall incorporate adequate space for:
  - Supply authority metering equipment;
  - University BAS connections;
  - Termination of incoming and outgoing circuits;
  - University kWh check metering;
  - Future extensions or additions.
- A separate, wall-mounted, steel, lockable cabinet, keyed to a B2.3 key shall be provided in a suitable location in the main switchboard room;
- The cabinet shall be labelled 'Spare Fuses and Equipment';
- The cabinet shall contain spare parts, tools and a full set of spare HRC fuse cartridges for all CFS units installed on the main switchboard.

The Contractor shall install a copy of the schematic wiring drawing in a suitable enclosure inside the main switchboard room.

The contractor shall provide switchboards in line with the University's preferred colouring scheme, i.e:

- Electrical Main Switchboards and Distribution Boards: Grey;
- Mechanical Main Switchboards and Distribution Boards: Orange.

The proposed colour scheme for main electrical equipment shall be presented to the University's Manager (Engineering and Infrastructure) prior to ordering for approval.

Switchboard Labelling

All switchgear, apparatus, terminal strips and controls shall be labelled in accordance with the Supply Authority's requirements and to the satisfaction of the University's Manager (Engineering and Infrastructure).

The following guidelines shall be observed.

Lift-off panels shall be labelled to identify their location on the main switchboard;

Labels shall be provided for Safety/Essential Services, which are deemed to include the following:

- Fire protection equipment;
- Fire indicating panel;
- Passenger elevators;
- Circuits supplying computer LAN, WAN or computer equipment;
- Circuits controlling emergency luminaires;
- Circuits controlling security or building access control equipment;
- Main switches controlling safety services shall be identified to indicate the equipment that they control and be marked 'IN THE EVENT OF FIRE, DO NOT SWITCH OFF'.

All incoming and outgoing circuits shall be adequately labelled, including all essential supply circuits. The contractor shall provide typed circuit schedules for generic light and power distribution boards. These shall be located in the vicinity of equipment and protected with Perspex covers.

Traffolyte labels shall be installed on the front doors and shall be fixed with chrome-plated screws. The labels shall indicate the capacity of the unit, the rating of installed protective devices and the outgoing cable reference. Labels shall also be installed adjacent to the load terminals.

All essential safety services are to be colour coded separately. Labelling colours are defined as follows:

- GENERAL: Black lettering on white background;
- MAIN SWITCH AND CAUTION: Red lettering on white background;
- DANGER/WARNING LABELS: White lettering on red background.

Meters and Instruments

Fuses with Enclosed Fuse Links

All fuse cartridges shall be of the high rupture capacity (HRC) type. Fuses shall be suitable for the fault current of the installation and shall discriminate properly with other protective equipment.

The installation of motor start fuse cartridges shall be avoided.

All fuse cartridges (excluding those installed in CFS units) shall be held in a fully enclosed fuse base with shrouded fuse contacts. Glow lamps for each HRC fuse assembly shall be specified.

Schematic Wiring Diagram

The Designer shall prepare a schematic wiring diagram of the complete switchboard. The wiring diagram shall include, but shall not be limited to, the following information:

- Circuit breaker capacities and trip settings;
- Fuse sizes;
- Capacity of CFS units installed;
- Size and capacity of installed busbar;
- Capacity of incoming supply;
- Capacity of outgoing circuits;
- Destination of subman supplies;
- Size of main earth conductor and location of main earth electrode;
- Type test rating of the Main Switchboard.

The Contractor shall install a copy of the above drawing in a suitable enclosure inside the main switchboard room.

7.3.4 Light and Power Distribution Boards

Distribution boards shall generally be proprietary type panel boards constructed to Form 1 specifications and shall be from an approved manufacturer (Eaton or NHP) or unless otherwise approved in writing by the University's Manager (Engineering and Infrastructure).

Distribution boards shall be installed in common areas which are fully accessible without the need to enter offices or secured areas. Distribution boards shall not be located in escape routes.

100% spare capacity shall be provided for all distribution boards (i.e. 50% full).

Circuit breakers controlling final sub-circuits shall be NHP, Schneider, Eaton Quicklag Series or other equal and approved equivalent. Installation of lock dogs for all circuit breakers controlling computer outlets or special equipment shall be specified.

The installation of Duplex circuit breakers shall not be permitted.

NHP, Schneider, Cutler-Hammer circuit breakers from the ELQ2 or QELDO range, or as otherwise approved in writing by the University's Manager (Engineering and Infrastructure), shall be specified for all laboratory power outlets (earth leakage applications).

Installation of a centre mounted main switch, to control each distribution board, shall be specified. All busbar tee-offs shall be fully insulated.

7.3.5 Control Panels and Control Equipment

Sprecher and Schuh contactors and panel-mounted control switches, unless otherwise approved in writing by the University's Manager (Engineering and Infrastructure), shall be specified. Contactors, relays, control switch etc. shall be DIN-Rail mounted. 100% spare capacity shall be provided on the panel for future expansion (i.e. 50% full).

Control panels shall meet the following criteria:

- All cables shall be identified by numbered ferrules at each termination including field terminations;
- Equipment within the panel shall be logically laid out and labelled;
- LED 24 Volts;
- There shall be sufficient space between items to permit safe maintenance - a minimum of 50mm between contactors;
- Automatic controls shall be mounted external to the switchboard in a separate cabinet containing only extra-low voltage wiring; control wiring entering the switchboard shall be insulated to the appropriate rating;
- There shall be adequate cabinet ventilation to ensure against temperature rise and thermal overload operation.

Circuit breakers are preferred in lieu of HRC fuses. Where HRC fuses are specified, they shall be complete with glow lamps.

Schematic diagrams, complete with wire numbers, shall be installed at each control panel.

7.3.6 LV Cables and Containment

All cables shall be stranded copper conductors, PVC insulated 0.6kV, V75 grade conforming to the relevant Australian Standard.

Aluminium conductors shall not be specified.

Insulation colour code shall be as follows:

- Active phase A RED
- Active phase B WHITE
- Active phase C BLUE
- Neutral BLACK
- Earth GREEN / YELLOW

Double insulated colour code shall be as follows:

- Lighting WHITE
- Power BLACK
- Fire services RED

General power circuits shall be wired in not less than 2.5mm2 (Cu PVC/PVC or TPS minimum).

General light circuits shall be wired in not less than 2.5mm2 (Cu PVC/PVC or TPS minimum).

Note that mixed power and lighting sub-circuits are not permitted.

Control cabling shall conform to the specification in Section 6: Building Controls.

PVC Cable

Cables shall be concealed wherever possible. Cables installed as surface wiring shall be enclosed in PVC mini ducting in lieu of PVC conduit. The duct shall be fixed to the wall with suitable fixings, not double-sided adhesive tape.

Metal Cable Duct

Where permitted to specify, metal duct shall be selected from the Dencol range, unless otherwise approved in writing by the University's Manager (Engineering and Infrastructure).

Cable Tray and Cable Ladder

Cable tray and cable ladder shall be specified from the Burndy or Dencol range, unless otherwise approved in writing by the University's Manager (Engineering and Infrastructure). Fifty-percent (50%) spare space shall be provided for future installation of cables. All parts of cable tray or ladder shall be galvanised, including hangers and support brackets.

Skirting Wall Duct

Skirting wall duct shall be specified from the Clipsal Moduline range or other equal and approved suppliers.

Chasing-in of Cables

Any cables chased into masonry shall be installed in suitable PVC conduit.

Flexible Conduit

Flexible conduit including corrugated conduit shall only be installed between rigid conduit and equipment which is subject to vibration or movement. The overall length of flexible conduit shall be kept to a minimum and in no case shall exceed 1200mm.

7.3.7 Ducting – Communication Cabling

Adequate future provision shall be made for both vertical and lateral ducting to accommodate computer cables and telephone cables. This also applies to cabling for audio-visual equipment.

Ducts shall be easily accessible so that the covers can be easily removed and reinstated.

Consideration must be given to the suitable radii for the current high level data cables to minimise transmission losses through corners.

Refer to Section 13: Communications for further specification of computer cabling and ducting. Where communication cabling is installed in a shared skirting duct with power and Audio Visual (AV) service appropriate segregation between each service shall be provided. Where required three channel skirting ducts shall be provided.

7.3.8 Wiring Accessories

General Power Outlets

General power outlets (GPOs) shall be selected from the Clipsal 2000 Series range unless otherwise approved in writing by the University's Manager (Engineering and Infrastructure)and shall be specified from the standard Clipsal colour range unless otherwise approved in writing by the University's Manager (Engineering and Infrastructure). Double outlet combinations shall be specified throughout an installation. Clipsal IP56 Series, unless otherwise approved in writing by the University's Manager (Engineering and Infrastructure), shall be specified for wet areas, mechanical services,

hydraulic services within the ceiling void or under floor. The circuit current load shall be no more than 60% of the respective circuit breaker rating.

Allow for sub-circuit protection and RCD circuit breaker to each individual sub-circuit as required by AS/NZS 3000.

Emergency stop buttons shall be installed for safety control for laboratory power outlets.

Light Switches

Light switches shall be selected from the Clipsal 2000 Series range, unless otherwise approved in writing by the University's Manager (Engineering and Infrastructure), and shall be specified from the standard Clipsal colour range, unless otherwise approved in writing by the University's Manager (Engineering and Infrastructure). All light switch mechanisms to be rated at 15 Amp minimum and suitable for fluorescent loads. Clipsal 30-FLM-15 Amp mechanisms shall be specified for all standard light switches, unless otherwise approved in writing by the University's Manager (Engineering and Infrastructure).

Floor Boxes

Floor boxes shall be selected from a University approved Moduline or Electric Cable Duct Systems (ECD) range (Refer to Section 7.9). All floor boxes shall come complete with a rubber flap cable access to all sides of the lid apart from the hinged side thus providing protection of the cords/cables when the lid is closed and avoiding potential electric shock due to wear and table of the cable.

The main aspect of the University's approved floor boxes is that the lid comes complete with a rubber flap cable access (see image below) to all sides of the lid apart from the hinged side. The main reason for this is to provide protection of the cords/cables when the lid is closed thus avoiding potential electric shock due to damage to the cable insulation.

7.4 LIGHTING

7.4.1 Lighting Design

The University's goal in the management of lighting is to gain maximum benefit from lighting systems whilst minimising energy waste. The Designer shall calculate installed lighting loads as required by the Energy Impact Statement.

The level of illumination shall be in accordance with the requirements of AS/NZS 1158, AS/NZS 1680 and the recommendations of the Lighting Guides published by CIBSE. Excess illumination shall be discouraged. Task lighting shall be used where practical rather than overall illumination techniques which may require an unnecessarily high-level of illumination. Refer to Section 3: Sustainable Design.

Each luminaire shall be corrected to a minimum power factor of 0.9 lagging

The Design Team shall consider incorporation of the following to minimise energy consumption:

- Use of LED light fittings (or approved equivalent) with LED drivers.
  - Warranty shall be minimum of 5 years
  - Provision of minimum 90 lm/W for linear LEDs (replacement for T5/T8)
  - Provision of minimum 70 lm/W for LED modules that are installed in downlights
  - Impact of forward current on LED minimum lamp life:

Forward Current	Lamp Life to 50% Lumen Output of Original Output
350 mA	50,000 hours
700 mA	50,000 hours
1005 mA	20,000 hours
1400 mA	20,000 hours

- The balance between task and building illuminance;
- Availability of daylight lighting;
- Provision of switching controls to enable electric lighting to respond to daylight variations;
- Controls of lighting: photocell, occupancy, automatic switching, dimming;
- Use and maintenance of high surface reflectors;
- Mounting height of luminaries;
- Colour Rendering Index (CRI) – LEDs shall have a CRI >85;Standardisation of light fittings to suit the University's current stock;
- Efficient exterior lighting.

The design of lighting systems shall achieve the following:

- Enable tasks to be performed quickly, accurately and easily;

- Enable building occupants to work in and move around the building safely;
- Achieve the desired character of the interior.

The lighting system in a building can consist of daylighting combined with electric lighting, or electric lighting only.

Installations shall conform to IEC 61547 for minimum radio interference.

7.4.2 Luminaire and Lamp Selection

LED's are the University of Melbourne preferred light source unless approved otherwise. The consultant/lighting designer shall nominate the type of light fittings include suppliers details and shall obtain University of Melbourne approval before tender.

Luminaires and lamp type shall be selected as appropriate for the area to be served and as required for compliance with BCA Part J and relevant Australian standards.

Luminaires shall be selected for ease of lamp changing and cleaning and have adequate mechanical and electrical features to ensure durability and resistance to deterioration. Reflectors shall be manufactured from high purity aluminium.

Light fittings selected for computer laboratories or VDU applications shall be of the low brightness type. Prismatic diffusers for public or common areas shall be K12; for office rooms K19 (only where there is no screen-based task application); and for special purpose rooms K19 with silver tint. Diffusers shall be strong and of rigid construction and UV stabilized.

Where entire floor levels are being documented, the installation of 24-hour light fittings at strategic locations for general security lighting shall be discussed with PCS. These fittings shall be disconnected from bulk switching lighting zone controls to allow 24/7 operation.

Designers shall consider the following:

- Where LED luminaires cannot be used, T5 light fittings are to be used for all linear fluorescent fittings;
- Co-efficient of utilisation - the efficiency of a fixture in space;
- Visual comfort - the importance of having a low glare system in areas such as terraced lecture theatres etc;
- Resistance to dirt built up and appropriate IP ratings;
- Diffusers - the University's preference is for acrylic prismatic lenses; opal or other type of diffuser that significantly reduces light output should not be used;
- Low-glare diffusers should be used when appropriate;
- Where screen-based equipment is used the recommendations of AS 1680.1, regarding the minimum shielding angle of the luminaires, shall be followed;
- Heat removal - use of heat removal or air handling fixtures may permit specification of smaller and more efficient cooling systems to maintain equivalent comfort levels.

The following criteria shall be considered before specifying the most efficient lamp suitable for the application:

- Colour Rendering Index (CRI) – LEDs shall have a CRI >85
- Lamp lumen depreciation;
- Lamp shape;

-
- Ease of lamp removal for changing;
- Cost.

The Designer shall specify LED luminiares in lieu of compact fluorescent tubes. Fluorescent lamps are not to be used without written permission of PCS.

Timer control to be provided in open office areas with occupancy sensor and bypass switch override function

Dichroic (ELV) luminaires shall not be used. =

Each light fitting shall be supplied with a fixed terminal block. The terminal block shall accommodate three 2.5mm^2 (7/.067) cables. Each terminal block shall incorporate a spare 'loop' terminal.

7.4.3 Lighting Control

Switching shall be arranged to provide for 50% illuminance. Where possible, all light fittings shall be installed using the plug-in method.

The installation shall be designed so that additional light fittings can be easily added to the circuit. The current load of the initial circuit when installed should not be more than 50% of capacity. Unswitched active conductors shall terminate in each light fitting. This will allow for simple future alterations, should they occur. Ceiling pull cord switches are not acceptable.

Refer to 'Section 9: BMS and Controls' of the PCS Design Standards for lighting control system BMS interfacing requirements.

7.4.4 Fluorescent Light Fittings

The use of fluorescent luminaires is discouraged unless LED luminaires are not practical for use and written permission is obtained with the University's Manager (Engineering and Infrastructure).

The following items shall be taken into account when specifying fluorescent light fittings.

Ballasts, High Frequency Electronic

Separate ballast shall be specified for each fluorescent lamp. Ballasts shall be complete with quick-connect terminals. They shall have an energy-efficiency index (EEI) of A3 or better unless otherwise approved in writing by the University's Manager (Engineering and Infrastructure).

1149 mm Lamps T5 Triphosphor

The colour temperature of the lamps shall be 4,000 degree Kelvin (Triphosphor lamps). Lamp colour should be confirmed with the University's Manager (Engineering and Infrastructure) prior to ordering. The minimum lumen output at 100 hours shall be 2600 lumens. Lamps shall be selected from the GE, Sylvania, Osram, Philips range, unless otherwise approved in writing by the University's Manager (Engineering and Infrastructure).

Lamp Holders

Tombstone lamp holders, suitable for T5 or similar, shall be specified. Lamp holders shall be made from non-flammable materials and shall not be starter / lamp holder combined type.

Lamp holders with snap-in wiring terminals shall only be accepted if solid conductor (1/0.80) wiring is utilized

Fuse Protection

Each light fitting shall be provided with a fuse of a suitable rating to isolate the fitting in the event of a fault within the light fitting.

Such fuses shall be readily accessible.

Fixings

Cadmium plated loxins, dyna bolts or approved metal expansion devices shall be used for securing light fittings to concrete ceilings. Wooden or plastic plugs will not be accepted. The minimum number of fixings per light fitting shall be as follows:

- 1 x 28 Watt fluorescent light fitting - 2 fixings;
- 2 x 28 Watt fluorescent light fitting - 4 fixings.

General

Diffusers, reflectors, etc. shall be installed just prior to practical completion so as to limit dust build up.

7.4.5 Incandescent Light Fittings

Installation of incandescent light fittings shall be avoided. This clause may not apply to lecture theatres; in these cases the Designer shall discuss this issue with the University's Manager (Engineering and Infrastructure). Incandescent light fittings shall only be considered where there are no other possible solutions.

Where permitted, incandescent light fittings shall be supplied with long-life 250 volt lamps and the lamp holders shall be porcelain.

7.4.6 Down Lights

Light fittings shall be selected from the range which incorporates LEDs. Down lights with incandescent lamps will not be accepted.

LED drivers shall be provided and a suitable label shall be located as a means of identification of the required lamp wattage. Power factor shall be maintained at or better than 0.90 lagging.

Reflectors should be of high purity aluminium.

Where LED cannot be used and fluorescents are required, electronic ballasts shall be installed as default for all fluorescent type luminaries.

7.4.7 External Light Fittings

External light fittings shall be specified from the HID range and shall conform to the following:

- Self-ballasted lamps will not be accepted;
- HID ballasts shall be of energy efficient design;
- Capacitors for each light fitting shall maintain the Power Factor at or better than 0.90 lagging.

Light fittings which incorporate the following types of lamps will not be accepted:

- Quartz Iodide lamps;
- Incandescent lamps;

- Dichroic (halogen) ELV lamps.

External light fittings shall be individually protected by HRC fuses, have adequate ventilation and degree of protection (IP rating) as required. Reflectors should be manufactured from high quality (purity) aluminium.

Luminaires shall be selected for ease of lamp changing and cleaning and have adequate mechanical and electrical features to ensure durability and lack of deterioration. They shall be treated to prevent corrosion.

7.4.8 Bollard Luminaires

Bollard light fittings shall be selected from the University directive materials in section 7.9: Material Selection.

7.4.9 Pole-Top Luminaires

Pole-top light fittings and poles shall be selected from the University directive materials in section 7.9: Material Selection.

In general, underground circuits are wired in 16mm2 cables. Each light fitting shall be protected by a HRC fuse installed at the base of the pole. The HRC fuse shall be accessible from the pole inspection plate.

Circuits shall be controlled by a suitable contactor (see section 7.10: Schematic Drawings). The installation of time clocks shall not be accepted.

Light Poles

Poles shall be galvanised after manufacture and shall be painted with one coat of metal primer, one undercoat, plus two top coats of enamel paint. The colour shall be in accordance with the Landscape Elements Report and to the approval of the University's Manager (Engineering and Infrastructure).

Poles shall be rag-bolt mounted and be provided with an inspection plate at the base of each pole to facilitate maintenance. Double luminaire poles shall be situated at right angles to the road or walkway wherever possible.

They shall be provided with a suitable HRC fuse assembly, complete with a 10 amp fuse cartridge, at the base of each to protect individual light fittings. The HRC fuse shall be accessible from the inspection plate.

For dual post-top luminaires, the top cross arm shall swivel 360 degrees.

Exit conduits shall be installed at the last pole for future installations.

Each pole shall be provided with a Traffolyte label attached to the rear of the inspection plate cover as a means of identification. The information shall be transferred to the 'as-built' drawings by the Contractor.

Please refer to drawing number 00095004 available from the Drawing Office at the Property and Campus Services Division for details of the standard University light pole.

7.4.10 Exit and Emergency Lighting System

General Requirements

This section of the Design Standard applies to the provision of a self contained computer monitored Emergency Lighting installation throughout the University's new buildings. The objectives of this Standard are:

- To enable the Maintenance Manager to remotely access the system, to command testing, to determine the result of the tests and to enable repairs to be carried out;

- To enable extensions to the system to be carried out in way that minimises disruption to the University community;
- In order to achieve these objectives, the University has selected the Legrand Commander wired system.

The Designer shall specify the wired version of the Legrand Commander system. Wireless systems shall not be specified without the written consent of the University's Manager (Engineering and Infrastructure).

The Exit and Emergency Lighting system shall be designed, installed and commissioned in accordance with the manufacturer's recommendations and this specification.

Compliance with Standards

The Emergency luminaires and exit signs shall comply with this Design Standard, the latest revisions and Amendments of Building Code of Australia, AS2293, AS/NZS 3000, AS3009, and other relevant local regulations.

System Description

The wired Legrand Commander System comprises single point luminaires each fitted with an internal microprocessor and communications system communicating through a dedicated communication cable looped through each luminaire from a self contained supervising Control Unit. The system shall be connected through a dedicated LAN System. The Contractor shall supply and install a Terminal Server and Area Controllers including all associated hardware, equipment and cabling required for a fully functioning and complete computer monitored Exit & Emergency lighting system.

Manufacturer's Technical Assistance

The contractor shall allow, in the tender price, for the system to be commissioned and technical assistance to be provided to the contractor during installation, by an independent commissioning agent chosen by the University. This technical assistance shall extend to support during the warranty period.

Software

The Contractor shall supply, install, update and commission the latest Aegis software on the remote Maintenance Manager head end PC (provided by others) at the Maintenance Manager's office. Provide electronic plans for incorporation into the software Graphical User Interface. Allow for all software and programming of the system as required.

Terminal Server (Communications Interface Unit)

The Contractor shall supply and install a Lantronix UDS 1100 Terminal Server (RS232 to TCP/IP to enable remote control and monitoring of the Computer Monitored System by the Maintenance Manager. Provide all additional equipment, software, hardware, cabling between devices a complete functioning installation.

Supply and install a shelf in main comms room for mounting of the Terminal Server.

Provide double 10A GPO supplied from a clean 240V AC power supply adjacent the shelf.

Provide single Cat6 data outlet adjacent the shelf. Arrange for one of the outlets to be configured / connected to the dedicated PCS LAN by the University.

Area Controllers

The contractor shall supply and install all Industrial computer / Microprocessor based Area Controllers as required to provide a complete functioning installation.

A minimum of one (1) Area Controller shall be provided per floor of the building to monitor the computer monitored exit and emergency lights. Additional Area controllers shall be provided as required where the number of emergency luminaires exceeds eighty (80).

The first Area Controller shall be configured as the Master building Area Controller. As such, it shall be installed in the building main communications room and be appropriately interfaced to the Terminal Server (Communications Interface Unit) to provide remote monitoring.

Area controllers shall be connected together via 10 core flat communications cable to Legrand specifications.

Emergency and Exit Luminaires

The Designer shall select exit signs and emergency luminaires listed in Section 7.9. Written approval from the University's Manager (Engineering and Infrastructure) is required for any departure from directive materials. A schedule of exit signs and emergency luminaires shall be provided and locations shall be indicated on the layout drawings, in consultation with the Building Surveyor and / or Architect.

Emergency and exit luminaire coverage shall comply with the BCA and AS/NZS 2293.

Fittings shall be selected to suit the environment in which installed.

Fittings shall be either non-maintained (typically emergency lights) or maintained (typically exit lights). Sustained / combined fittings shall not be specified (i.e. Emergency lighting shall always be provided separate to the normal lighting and not be combined).

New and modified exit signs shall be of pictograph 'running man' type as required by AS/NZS 2293.

Communications Cable

The Contractor shall supply and install communications cable and connections to the Area Controllers in each area as specified by the manufacturer of the Legrand Commander System. Riser cables shall be run on cable trays or ducts. Where cables run vertically they shall be securely fixed at 1.2 meter intervals to ensure the weight of the cable is distributed evenly along the cable.

Communications cable used shall have passed the AS/NZS 60950:2000 for electrical impulse and electrical strength test requirements with the latter having a voltage of 1500V 50 Hz AC RMS between the outer casing and the electrical conductors.

The Communications cable used shall comply with the relevant requirements detailed in AS/ACIF S008 and be correctly terminated at each end.

Typically 10 core flat cables shall be used between Area Controllers and 6 core flat cables between Area Controller and field emergency luminaires. All cables shall be to Legrand specifications and terminated utilizing Legrand cable connectors.

The Designer shall minimise the possible incidence of electrical interference by minimizing the incidence of running communications cable alongside high voltage cable and ensuring that each area is fed by only one supply and feeder. Should there be more than one earthing system in the areas, and then the individual earthing system shall be bonded together using a method laid down in AS 3000.

The installing Contractor shall seek advice from the relevant local authorities on the subject of safety standards and compliance with wiring regulations should he have any doubt, prior to installation of the system.

Samples

One sample luminaire and exit sign of each type to be installed in the project shall be submitted to the University's Manager (Engineering and Infrastructure) prior to commencement of the luminaire installation.

Log Book / Database / Acceptance Criteria

The Contractor shall be responsible for correct collection of data to be entered into the electronic database and logbook by the commissioning agent and shall allow for this in the tender price.

The Contractor shall allow, in the tender price, to obtain certification of the installed Emergency luminaires and exit sign compliance with the BCA and local authority requirement.

The Contractor is responsible for ensuring that the personnel installing the system are adequately trained to install its communications wiring:

- To install, connect and configure Terminal Servers;
- To install, connect and configure Area Controllers;
- To generate hard copy information on location, sequence and wiring details of each Area Controller;
- To enter correct information on each Area Controller into System Controller database. The minimum acceptance criteria of the system shall be:
  - The successful completion of 2 - hour testing of SPU's once they have been connected to the satisfaction of the Inspecting authority to ensure occupancy can take place;
  - Subsequent confirmation that all SPU's are on the system and communicating with the Area Controllers by submitting to the Engineer;
- Maintenance period is concurrent with the Defects Liability period and during that period the installing contractor shall commission himself, or others, to:
  - Carry out periodic inspections and maintain the emergency lighting installation in a condition to meet the specified performance;
  - Promptly rectify faults; replace faulty materials and equipment without charge provided that the fault was not caused by the actions of other contractors on site;
  - Replace all failed lamps, starters, broken diffusers and also re-lamp all emergency exit systems at 12 monthly intervals or sooner if lamp end are black and light output is affected;
  - 6 and 12 monthly after the emergency luminaries and Exit signs have been connected to the system make an inspection of the installation;
  - Perform 6 and 12 monthly tests as specified in AS/NZS 2293 and upon satisfactory completion certify in writing that the installation is operating correctly. Similarly, just prior to the end of the liability period, replace or repair all units that fail to operate for the required period, before the end of the manufacturer's warranty period. Replace or repair units shall be similarly tested in situ;
  - Provide the specified number of copies of manufacturers installation and operating manuals, written in clear concise English and containing a title page listing the suppliers name, Project / Building name, Proprietors name, installing sub-contractors, Architects, Consulting Engineers, names addresses, telephone

and fax numbers and a table of contents. Printed or typed on durable printing paper neatly bound in durable vinyl or similar hard covers;

- Provide an equal number of A3 sized copies of all floor and Area plans depicting location, catalogue number, circuit, switchboard, serial number, initial sequence number and accurate communications cable path in each area;
- Provide maintenance and testing equipment as recommended by the manufacturer.

Installation of System and Equipment

All Emergency luminaires and Exit sign shall incorporate Legrand Commander System control gear.

All emergency luminaires shall be connected to their own dedicated unswitched AC circuit off the local AC circuit in the area they serve. The circuit wiring for monitoring and sensing of supply shall be suitable for microprocessor operation, and in accordance with the manufacturer's recommendations.

Locations of the luminaires shall be approximately as shown on the drawings and shall be wall or ceiling mounted as indicated. Exit lights shall be suspended from the ceiling as necessary to comply with AS/NZS 2293. Submit for approval suitable support brackets details.

Installing Contractor shall provide mounting brackets for ceiling mounting, surface wall mounting and cantilevered wall mounting as required.

Mains cabling to each luminaire shall be TPS, installed on cable trays and for tied to catenaries together with other TPS cabling. Cables between cable support trays and luminaires shall be supported via fixing to the building structure.

Labels shall be provided on each emergency luminaire in accordance with serial number and in accordance with the building and area numbers, this labelling shall reflect the database information.

A schedule shall be provided of all emergency luminaire and exit signs depicting location, manufacturer, catalogue number, circuit and switchboard origin, serial number and sequence number to the commissioning agent and to the University maintenance manager. See section 7.10.3 for example schedule.

Installing Contractor shall provide work as executed drawings of the emergency lighting system installation including the following:

- Construction details and manufacturers part number for each type of emergency luminaire;
- Serial number and initial sequence number;
- Accurate location of all emergency light SPU's;
- Accurate wiring layout and route of the communications wiring between Area Controllers;
- Accurate wiring layout and route between the Area Controllers and each emergency luminaire;
- Clearly identify on each floor the location of the End Of Line emergency luminaire.

7.5 OTHER ELECTRICAL INSTALLATIONS

7.5.1 Clocks

University policy is to install battery-operated wall clocks. Where a master clock system currently exists in a building, additional clocks installed in the building shall not be connected to the master clock system. Wall clocks specified for lecture theatres shall be silent in operation.

7.5.2 Uninterruptible Power Supply Unit (UPS)

The Designer shall specify the installation of a suitable Uninterruptible Power Supply Unit (UPS) to protect critical computer equipment (e.g. switches, optical fibre repeaters, etc.). The UPS shall be rated to provide service for at least 15 minutes at the rated power plus 20%.

The battery shall be rated such that the design capacity shall be delivered at the end of 10 years. Ventilation to the battery shall be in accordance with the recommendations of AS 2676 and AS 3011.

7.5.3 Emergency Diesel Generator

The designer/contractor is requested to discuss this issue with the University's Manager (Engineering and Infrastructure).

7.5.4 Power Factor Correction

The designer/contractor is requested to discuss this issue with the University's Manager (Engineering and Infrastructure).

7.6 LABELLING

Each item of equipment (i.e. general purpose outlets, light switches, computer outlet plates, etc) shall be labelled by one of the following methods:

- IPA studs, unless otherwise approved in writing by the University's Manager (Engineering and Infrastructure), to indicate phase and circuit number;
- Dymo electronic label maker, unless otherwise approved in writing by the University's Manager (Engineering and Infrastructure);
- Brother electronic label maker, unless otherwise approved in writing by the University's Manager (Engineering and Infrastructure).

Supplementary information shall be provided at the rear of equipment. Traffolyte labels shall be specified for all switchboards, main and sub main feeders.

7.7 INSTRUCTION OF UNIVERSITY'S OPERATING PERSONNEL

The specification shall require the major Electrical Contractor to instruct University personnel in the operation and maintenance of each system installed.

7.8 AS-BUILT DRAWINGS, OPERATING AND MAINTENANCE MANUALS

As-built drawings and O&M Manuals are to be provided as described in the University of Melbourne Project Management Standards (available on request) or as per agreed scope of services on a project by project basis.

7.9 MATERIAL SELECTION

The Designer shall select products from this table; alternatives shall require written permission from the University's Manager (Engineering and Infrastructure) or their nominated delegate.

Item	Supplier	Model no.	Description	Notes
Wiring accessories	Clipsal	IP56 range	Weatherproof wiring accessories	Wet areas
Wiring accessories	Clipsal	2000 series	General purpose power outlet (GPO)	Dual outlet
Wiring accessories	Clipsal	2000 series	Light switch	Min 15A mechanism
Wiring accessories	Moduline	FFBSS1RF4PTD; FFBCTSS2RF8PTD	Floor Box	Complete with soft lid and lid supports
Wiring accessories	Electric Cable Duct system (ECD)	FFOB490SS/MU; FFOB490SS/MU/8P8D	Floor Box	Complete with soft lid
Lighting pole	Vicpole Pty Ltd		University of Melbourne standard light pole	University drawing number 00095004
Emergency Lighting System	Legrand	Commander		Wired type
Exit Sign (generally)	Legrand	AXLSC102RM	AXIOM LED SLIDE CONNECT FITTING, white body rim	Wired type
Exit Sign (theatres)	Legrand	AXLSC102B	AXIOM LED SLIDE CONNECT FITTING, green on black diffuser	Wired type
Emergency Lighting Unit	Legrand	AXSRLED102FP	AXIOM LED SATELLITE - WITH LARGE METAL SPINNING	Wired type
Emergency Lighting Unit	Legrand	To be from Axiom Computer monitored range. Please confirm for approval prior to order.	18WATT N/M BATTEN	Wired type
Emergency Lighting Unit	Legrand	To be from Axiom Computer monitored range. Please confirm for approval prior to order.	36WATT N/M BATTEN	Wired type
ELV dimmer units	Dynalite			
ELV dichroic halogen lamps	GE		[Use of this lamp is deprecated]	Average rated lamp life of 4,000 hours.

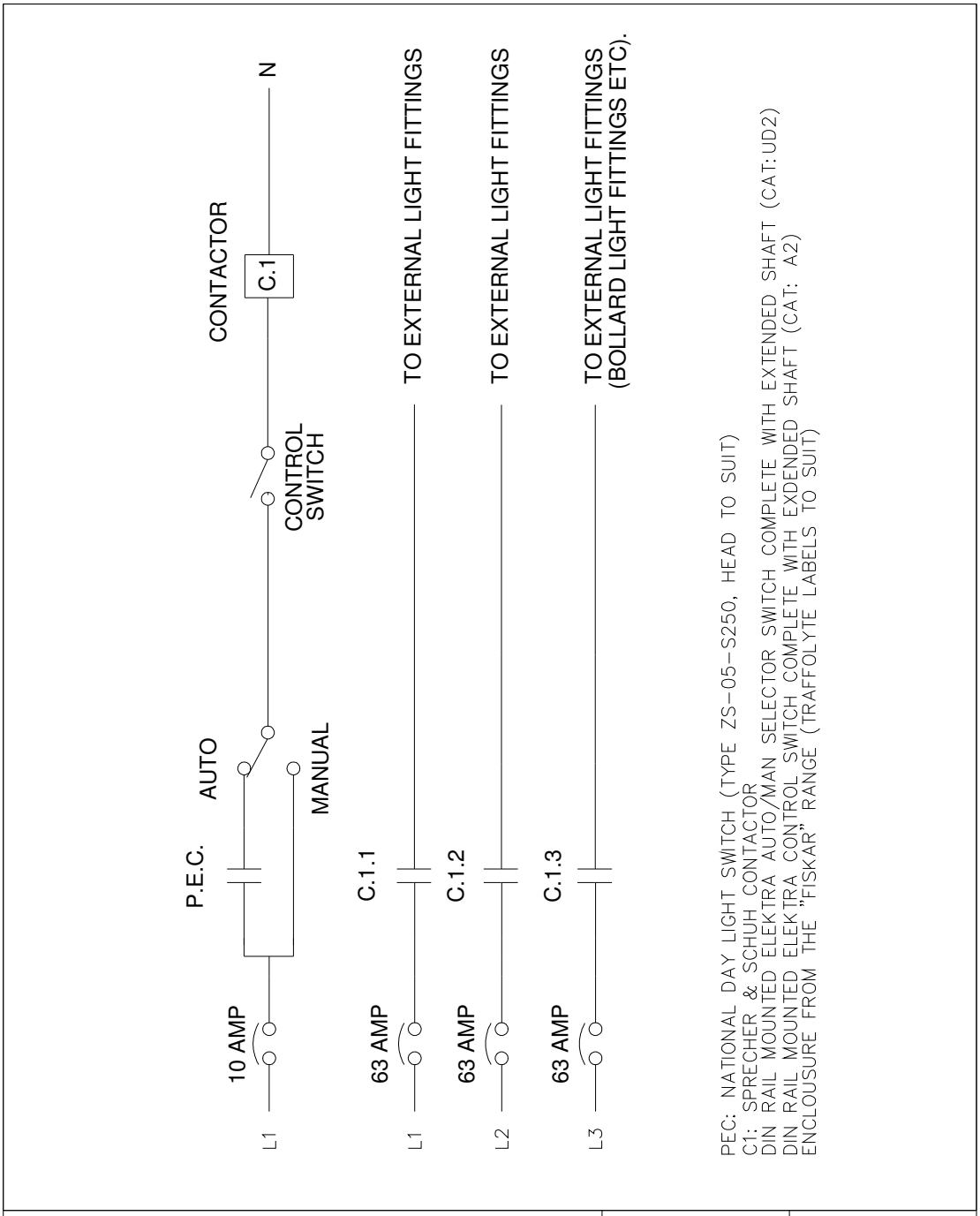
Item	Supplier	Model no.	Description	Notes
Bollard Luminaire	Associated Lighting Industries (ALI)	Catalogue number 630	Closed louver type complete with 50W mercury vapour lamp	
Bollard Luminaire	Associated Lighting Industries (ALI)	Catalogue number 616	Open lens type complete with 50W mercury vapour lamp	
Pole-Top Luminaires	Holophane / Unique Lighting Solutions	Caribe / Prismasphere	Complete with Plexiglas PR diffuser and 80 W mercury vapour lamp	Bracket or pole mounted for general grounds lighting
Energy meters, electronic	Nilsen	CALMU3 Plus Series	CALMU3 per the following specification: 3 Phase, 4 Wire, 240 volt, 50 Hz, Class 0.5 CT operated 5 amp CT, Imax = 6A LED display 1 X PACT Port 1 X D Port (RS232 Remote Interrogation) Pulse Outputs Battery Back-up ovram Pactlan P-Type 4 Way cable Netcomm Modem GPO for modem Telephone line for Modem;	[This meter is no longer in production – what is the University's current standard?]
Combined fuse switch (CFS)		Re-specify		
Air circuit breaker (ACB)		Re-specify		
Miniature circuit breaker (MCB)	NHP, Schneider, Eaton Quicklag	ELQ2 or QELDO for RCD applications		
Control gear	Sprecher + Schuh		Contactors, relays, panel-mounted control switches	

Item	Supplier	Model no.	Description	Notes
Electronic time-switch clock	Sauter	ZDR102-F02	Dual Channel electronic time-switch clock	
Concrete fixings	Ramset, Hilti			

7.10 SCHEMATIC DRAWINGS

Refer to Section 9.6 in 'Section 9: BMS and Controls' of the PCS Design Standards.

7.10.1 CAMPUS EXTERNAL LIGHTING CONTROL



CAMPUS EXTERNAL LIGHTING CONTROL	SCALE: NTS	BR No:
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	DRAWN: DR	
	CHECKED:	
PROPERTY AND BUILDINGS DEPARTMENT ARCHITECTURAL AND ENGINEERING SERVICES	CLIENT:	Sheet No: 1/7
	DATE:	REV:

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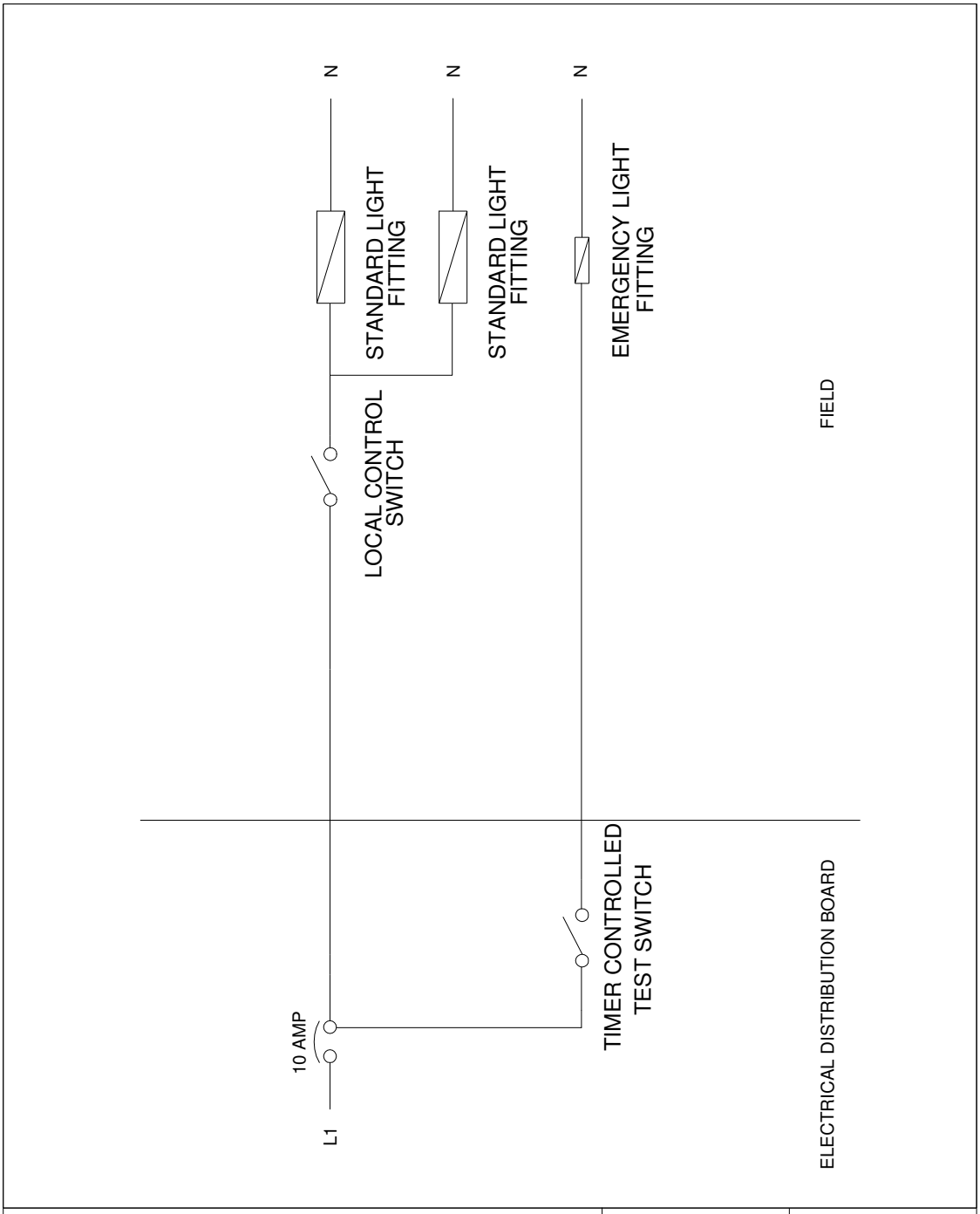
7.10.2 EMERGENCY LIGHTING TYPICAL CONTROL



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	DRAWN: DR	
	CHECKED:	
PROPERTY AND BUILDINGS DEPARTMENT ARCHITECTURAL AND ENGINEERING SERVICES	CLIENT:	Sheet No: 2/7
	DATE:	REV:

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7.10.3 EMERGENCY LIGHTING DATABASE INFORMATION SHEET

AREA CONTROLLER DATABASE INFORMATION SHEET

PROJECT BR AND NAME:.....

BUILDING NUMBER:..... BUILDING NAME:.....

AREA CONTROLLER (AC) SERIAL NUMBER:..... AC SEQUENCE NUMBER:..... AC LOCATION:.....

DATE: / / SHEET No. of

AC SEQ. No. 2 DIGITS		SPU SERIAL No. (6DIGITS)						SPU LOCATION (24 CHAR MAX)	DIST. BOARD No. (8 CHAR MAX)	CIRCUIT BREAKER ID (4 CHAR MAX)	DRAWING NUMBER (4 CHAR)
0	*1*	*1*	*2*	*3*	*4*	*5*	*6*	*LEVEL 4 EAST LAB*	*DB4AEAST*	*CB12*	*F100*