



UNIVERSITY  
OF WOLLONGONG  
AUSTRALIA

# University of Wollongong

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Electrical Services Design Standards  
Version 4.2 – 23 July 2019

## VERSION CONTROL SYSTEM

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## **4. ELECTRICAL SERVICES**

Electrical services involve the supply and reticulation of electricity to a facility. The main factors involved are:

- Reticulation
- Switchboards
- Metering
- General Power
- Lighting
- Site Generated Power

### **4.1 OVERVIEW**

This design standard outlines the functional, installation and technical requirements for electrical services at UOW.

The designer shall use these standards as the basis for the system design, however it is incumbent upon the designer to ensure that the design satisfies site specific operational, logistical and performance requirements and meets UOW's demand requirements for electrical services for the facility.

Where the designer considers that an alternate equipment type is preferred to the equipment type specified in the design standard, the designer will advise the principal of the functional, performance or cost benefit that will be achieved through the use of the alternate equipment type.

In determining the most appropriate electrical equipment for a particular installation, the designer shall consider the long term energy efficiency, maintenance implications, operational efficiency and life cycle costs as well as the initial capital costs.

## 4.2 DESIGN PROCESS

This section overviews the design process. The process shall be followed to achieve UOW's desired outcomes.

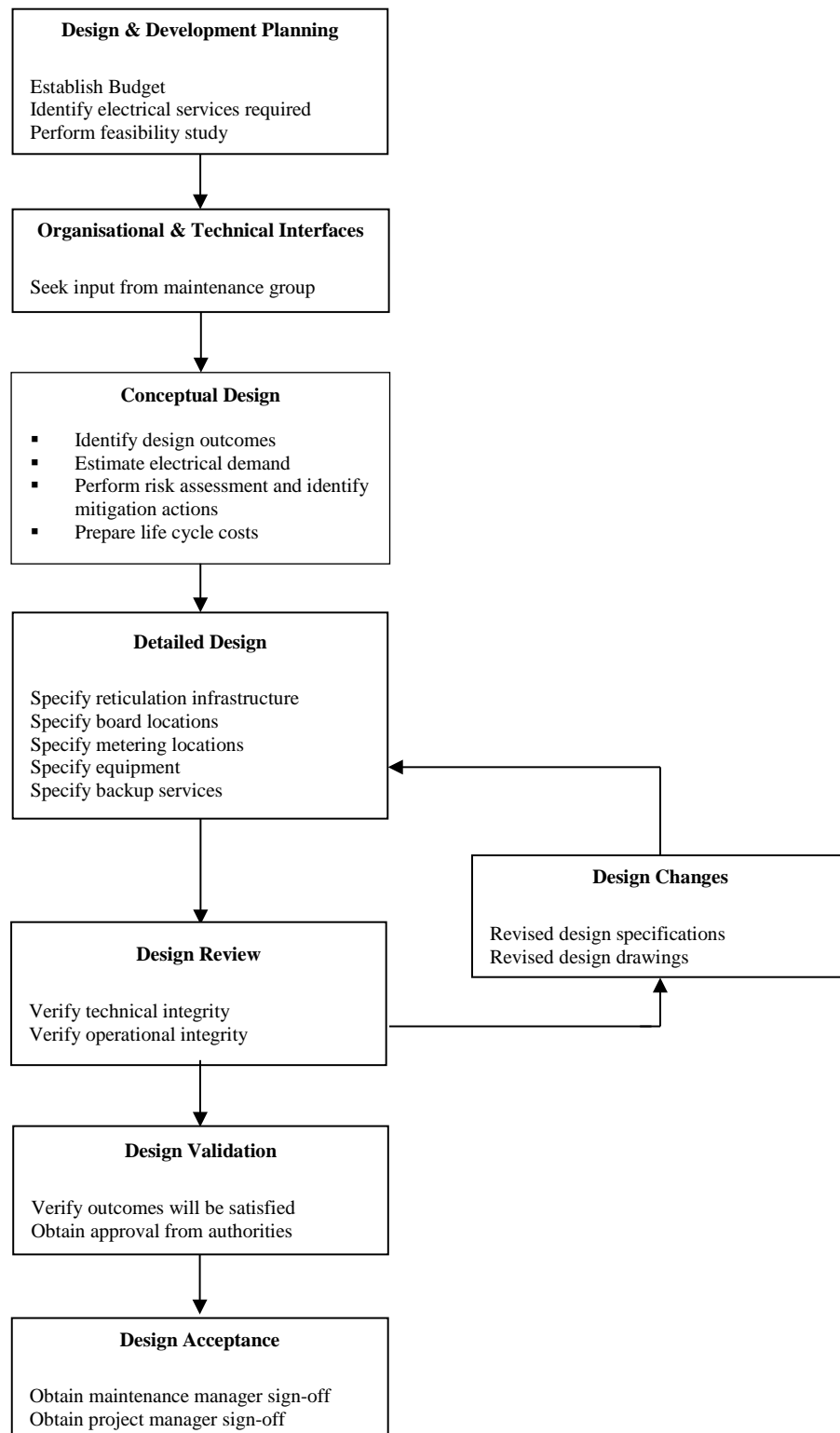


Figure 4.1 - Process Flow

## **4.3 FUNCTIONAL DESIGN REQUIREMENTS**

### **4.3.1 General**

The design of all alternations, additions and modifications to the Electrical Services at the University of Wollongong shall comply with the followings:

- Workplace Health and Safety legislation
- NCC/BCA
- Relevant Australian Standards (current version)
- This standard and all other University of Wollongong standards.

This document sets out the minimum requirements for design, documentation, construction and maintenance of Electrical Services. In addition, the design shall provide flexibility and the ability to accommodate changes and expansion of services over the life of the building.

Due to the diversity of requirements and built environments, this document is not intended to cover every application. Where specific requirements or applications are identified in the design process the designer shall seek clarification and approval of their design solutions from the University.

At the 80% point of the tender documentation process the Electrical Consultants shall submit the following documentation:

- Lighting calculation
- AS/NZS3000 maximum demand calculations
- Submain calculations including voltage drop, spare capacity and fault levels
- NCC/BCA Section J6 calculation

At the commencement of each project, the Electrical Consultant/designer shall seek confirmation of when a Safety In Design workshop will be scheduled with the relevant stakeholders.

Where required by the Project Manager the designer shall prepare life cycle costing as part of the conceptual system design. A ten-year period of financial interest shall be used as the basis of the life cycle analysis. These costs will include:

- Initial cost of electrical equipment
- Installation costs
- Maintenance costs
- Energy operating costs.

### **4.3.2 Electrical Supply**

The University of Wollongong campus is fed from three (3) dedicated underground feeders from Mt Ousley Zone substation with additional back-up supplies from domestic overhead feeds located in Madoline and Dallas Street. There are sixteen (16) substations located throughout the main campus (refer to drawing “Substations Power Distribution, latest version”. Electricity from the substations is supplied at 415V, 50Hz, 4 wire, 3 phase and neutral, maintained within commercial limits. Details of the substations are provided in the following table.

Substation	Substation No.	Location	Provides Power To The Following buildings
1	24829	North West B25	28
2	41520	B16 Basement	11,12,16,17
3	41252	South end of central wing of B19	19,24, 40
4	40535	South West corner of B25	22,23,25,27, <del>29</del> ,31,36,38,67
5	27871	South East corner of B6	3,6
6	43236	West side of Printery B32	41
7	43356	South end of B4	1,2,4,5,8,10,14,15,32,35 and the east end of building 11
8	32529	South End B21	30 and P4 Car Park
9	26059	South East corner B6	39
10	26060	North West B42	32
11	26058	South West Corner B20	18,20
12	27375	South West corner B13	13,9
14	26453	East of B70	70,71
15	32530	South End B21	21
16	33486	North End B43	43
18	29797	West of B69	68,69

Table 4.1 - Substation Details

All parts of the system shall be sized and designed to withstand the prospective fault level current for a minimum of one (1) second.

Where a new substation is required, it shall be of the pad mounted type, located external to the building.

### 4.3.3 Reticulation

#### 4.3.3.1 Sub-mains

Sub-mains shall be sized to accommodate current maximum demand requirements plus spare capacity for an additional 30% future demand.

Full size neutral cables shall be used as a minimum.

#### 4.3.3.2 Final Sub-Circuit

Cabling used for general lighting and power sub-circuits shall be a minimum of 2.5mm<sup>2</sup> type V75 and shall be sized in accordance with AS3008. Power and lighting circuits shall be designed to accommodate the predicted loads plus spare capacity for an additional 30% future load.

### 4.3.4 Main Switchboards and Distribution Boards

Switchboards shall be designed to the following standards in accordance with AS 3439:

- 250A or less and less than 10kA: Form 1
- Greater than 250A or 10kA: Form 3A
- Main Switchboards greater than 1000A: Form 4

All MSBs and Distribution Boards shall be located in dedicated, exclusive rooms and cupboards.

The following shall be complied with:

<b>Main Switchboard</b>	<b>Distribution Boards</b>
Internal: Metal External: Double skin marine grade stainless steel Complete with plinth.	Internal: Metal External: Double skin marine grade stainless steel
Floor mounted	Wall mounted
IP43 Protected (internal) IP67 Protected (external)	IP42 Protection (fully smoke sealed)
Back connected / totally enclosed	Front connected / totally enclosed. Fully smoke sealed.
Hinged, lift off escutcheons	Hinged, lift off escutcheons
Labelled	Labelled
Painted – gloss enamel Exterior: Orange Interior: Orange	Painted – gloss enamel Exterior: Orange Interior: Orange
Surge Protection – 120 kA 8/20 $\mu$ S	Surge Protection – 80 kA 8/20 $\mu$ S
Cable entry from underside	Cable entry from underside

*Table 4.2 - Switchboard Details*

Test blocks for meters on all switchboard shall be located at the front of the switchboard, and not behind a panel to facilitate maintenance.

To facilitate thermographic testing, it shall be possible to either open the panels of the switchboard and distribution boards without disrupting operations or alternatively glass panels shall be provided to allow this testing to be undertaken.

Signage shall be provided on all switchboards and distribution boards identifying:

- Manufacturer
- Year of Manufacture
- Fault Level
- Point of Supply
- Arc Flash rating

#### **4.3.4.1 Main Switchboard**

For sites/buildings that require a new main switchboard (MSB), the MSB shall be of fully welded construction and modular in design to facilitate change and expansion. The MSB shall be designed for minimum disruption when regular or reactive maintenance is being undertaken.

The MSB shall be sized to meet predicted loads over the next twenty (20) years and be expandable to 30%, including the addition of a future PV system. The main switchboard shall have provision



to cater for any known future expansion of the building. Space shall also be provided adjacent to the MSB for future expansion.

The main switchboard shall consist of an essential and non-essential section and the busbars for all sections shall be sized to accommodate fault levels.

The switchboard fault rating shall be based on the predicted final transformer capacity.

The MSB shall be complete with PLC control of multiple changeover 'make-before break' switches to control the progressive switching of electrical loads when a (future) alternate power supply is active.

The strong preference is for main switchboard to be back connected with appropriate access to the front and rear of the MSB. This configuration needs to be included in the spatial provisions.

All sub-mains shall be protected by an air circuit breaker unit and moulded case circuit breakers appropriately sized for the sub-mains.

To ensure reliability of supply, surge filters shall be provided at the main switchboard.

For sites/buildings that require a new MSB, a generator link box shall be provided on the perimeter of the building to facilitate the connection of a standby generator supply to the building. The rating of the connection box and the associated cabling to the MSB shall match the normal power supply to the building. The generator link box shall be complete with flags and removable gland plates at the bottom to allow for connection.

#### **4.3.4.2 Distribution Boards**

New DBs shall be

- NHP/Terasaki Concept PLUS or above switchboards to suit Din-T circuit breakers.

The DB shall be of the "dead front" type with circuit breaker toggles exposed and operating in the horizontal plane.

The DB shall be fitted with NHP Rapid test units - Wi-Fi Master Module connected to Channel Module/s (up to 10 Channel Modules per Master can be used, enabling a total of up to 240 RCD's tested).

The DB shall be fitted with a hinged lockable and removable door fitted bi-locks keyed to the University standard keying system. Maximum height shall be 1200mm.

A cable management system shall be provided to ensure cables can be maintained in a secured and orderly fashion. Cable entries shall be insulated to protect cables from mechanical damage.

DBs shall be complete with cable entry glands.

DB ratings shall be designed to meet the capacity of the sub-mains. The busbars and isolator ratings shall meet the maximum rating of the DB.

Distribution boards shall be divided into separate lighting and power sections with separate metering facilities in accordance with Section J of the BCA.

Each DB shall be sized to accommodate the predicted load plus an additional 30% spare capacity for future loads.

Each section of each DB shall be protected by its own top centre mounted main isolator switch. There shall be a minimum of one DB per floor. Sub-distribution boards where the supply to the DB is dependent on the supply to another DB will be avoided.

Where required, DBs shall include contactors for automation of lighting circuits. Controls (e.g. lighting, BMS interface, test switches, emergency lighting test buttons etc.) shall be housed in a dedicated section of the distribution board. Allow all required cupboard space to ensure these requirements are accommodated.

Where the predicted load requires the provision of power filters, the distribution board design will accommodate the necessary space.

Circuit breakers with integrated residual current devices shall control all final sub-circuits.

Each distribution board shall be complete with a typed switchboard schedule mounted in a frame on the inside of the switchboard door.

#### **4.3.5 Power Factor Correction.**

Supply and install a Power Factor correction unit in the Main Switchboard room, as close as possible to the MSB. Power factor correction equipment shall maintain near unity power factor and shall be complete with cooling fans. Automatic capacitor banks shall comply with AS1013.

The capacitor unit shall be able to operate at 10% over voltage for long periods, at 20% over voltage for 15 minutes and at 30% overcurrent continuously due to harmonics.

All equipment shall be housed in a proprietary enclosure.

#### **4.3.6 Metering**

The metering of electrical power shall comprise the following separate systems:

1. Building/Department energy consumption
2. NCC/BCA Section J8 metering
3. Main Switchboard analogue ammeters.

The contractor shall liaise with UOW during the design phase to agree and obtain UOW approval on the quantity of meters required.

Unless otherwise agreed by UOW in writing all the electricity meters shall be EDM1 Mk10E and shall:

- Be mounted in an approved, accessible area but if this is outside an electrical or mechanical plantroom they should be enclosed in a separate lockable panel.
- Be labelled with load name and CT ratio.
- Current Transformers shall be class 1 and of the split core type where possible. They shall be installed in an approved manner and the installation shall include test blocks and appropriate fusing.

The design, manufacture and installation of main switchboards and distribution boards shall allow the correct and effective integration of the electricity meters.

The supply, installation and commissioning of the electricity meters will be conducted by the University's Electricity Metering Agent.

The electrical services contractor shall liaise with the University and with the University's Electricity Metering Agent to organise the installation and commissioning of the electricity meters. The University will provide the contact details of the Electricity Metering Agent to the electrical services contractor.

The cost of supplying, installing and commissioning the electricity meters will be passed on to the University directly by the Electricity Metering Agent and no costs for these services shall be passed on to the University by the electrical services contractor.

All meters shall utilise current transformers (CTs). Whole current meters shall not be used. All meters shall be connected via test blocks, to facilitate their testing and replacement without impacting on the operation of the building so that testing and replacement can be done without interrupting the electricity supply to any load or any part of the building.

The meters shall be suitable for connection to a future SCADA system.

#### **4.3.6.1 Building/Tenancy Energy Consumption**

The electricity meter shall be installed on the main switchboard such that the total building interval electricity consumption can be monitored.

If there are areas/tenancies within the building that are to be used for commercial purposes metering shall be provided to enable these spaces to be individually monitored.

The contractor shall request feedback from the University at the design stage to define the specific areas/loads that are required to be measured and monitored.

#### **4.3.6.2 NCC/BCA Section J8 metering**

Meters shall be installed for compliance with the NCC/BCA to measure all substantive energy uses within the building as required by Section J8 of the NCC/BCA.

#### **4.3.6.3 Main Switchboard Analogue Ammeters**

All MSBs shall incorporate maximum demand indicating ammeters on each phase of the incoming supply in addition to the metering listed above.

#### **4.3.7 General Power**

General purpose outlets for general purpose or office equipment shall be protected by RCDs in accordance with AS/NZS 3000. Circuits shall not be loaded to more than 67% of their capacity. Where appropriate, the requirements of AS 3003 are also to be met.

Open area workstations shall be soft wired and where required starter sockets shall be compatible with the soft wiring system (to be supplied and installed by the workstation installer).

The Electrical Consultant is to consider the need for USB charging outlets integrated into GPOs on each project.

Vertical and horizontal cable pathways shall be sized for an increase of 100% in the number of sub-main cables.

All sub mains shall be supported on galvanised ladder tray.

All external cable enclosures including MSB, distribution boards and junction boxes shall be marine grade stainless steel.

## **4.3.8 Lighting**

### **4.3.8.1 General Lighting**

The designer shall seek to limit the number of different types of luminaires used on each project.

The internal lighting design should comply with the requirements of AS/NZS 1680 and relevant sections of the NCC/BCA for artificial lighting including Section J. All components of the lighting design and installation shall comply with all relevant Australian Standards.

Only LED technology will be used throughout all projects (including exit and emergency lighting). The luminaires selected shall be fit for purpose, high quality, cost effective, energy efficient and low maintenance. Fittings and components shall be readily available in Australia.

All luminaires shall have complete thermal and photometric (IES electronic format) test data. Tests shall be performed by an independent and accredited NATA laboratory. All luminaires shall be permanently marked with the Regulatory Compliance Mark (RCM) to certify that they do not cause electromagnetic interference. Where custom luminaires are to be provided, this information shall be obtained prior to manufacture.

The lighting installation is considered to be a long term asset and all fittings shall have a track record of quality and service.

### **4.3.8.2 LED Luminaires**

Luminaires that are already approved by IPART for their use under the NSW Energy Savings Scheme (ESS) will be preferred.

LED luminaires shall comply with the following criteria:

- Have completed the following tests:
  - Thermal and photometric (IES electronic format) test.
  - Lamp circuit power (LCP) and power factor test.
  - IES LM-80-08 test and IES TM-21-11 test for light output degradation.

All these tests shall be performed by an independent NATA accredited laboratory. Evidence of these tests as well as evidence of the laboratory's accreditation with NATA shall be provided to the University. Where custom luminaires are to be provided, this information shall be obtained prior manufacture.

- Comply with NSW electrical safety requirements.
- Meet the Electro Magnetic Compatibility (EMC) requirements of the Radio Communications Act 1992.
- High luminous efficacy (aim for > 100 lm/W).
- Lumen depreciation criteria: L80B50 (at 50,000 hours, only 50% of LEDs in a luminaire will be below 80% of initial output) unless otherwise specified by UOW.

- UGR<19.
- Rated life of 50,000, failure rate <0.1% after 50,000 hours.
- All luminaires will be flex and plug type.
- Minimum 5 year warranty on all equipment and labour.
- Manufactured by a reputable manufacturer with proven track record and experience in LED production and proven long term financial stability.
- Colour Rendering Index (CRI) >80. Colour rendition shall be measured on the TM-30-15 scale.
- The luminaire manufacturer shall comply with all requirements of the LED manufacture.
- LED module mounting shall be designed to ensure the junction temperature of any LED does not exceed the manufacturer's recommended maximum operating temperature. Thermal dissipating of the module shall be designed for the operating temperature and wattage of the unit.
- LED luminaires shall be thermally tested to ensure maximum junction temperature is not exceeded whilst operating in any environment between -10°C to +38°C.
- LED batches shall be from the same colour bin, no greater than 5 mm wide.
- LED supplier shall provide LED batch bin number, recording luminous flux, wavelength/colour and forward voltage of LED. Batch information to be included as part of the operation and maintenance manual or as part of the fixture's order/serial number.
- Drivers shall match optimum and maximum current to suit the LED over the whole range of input voltages.
- Dedicated constant current (max: 500 - 750mA ) drivers shall be provided with the following features as a minimum:
  - automatic reset in the event of a fault
  - isolation between the primary and secondary sides
  - dimming (where required) with linear characteristics
  - operation in ambient temperatures of -20oC to +50oC
  - low power loss
  - integral electronic overload protection circuitry
  - integral electronic over temperature protection circuitry
  - integral electronic short circuit protection circuitry.
  - DALI electronic dimming ballast where dimming is required

The use of custom built or modified special luminaires is not recommended due to the capital and recurrent cost premium. Formal approval from the University is required before incorporating these into the design. Where approved, such fittings shall undergo thermal and photometric performance testing by a NATA-accredited laboratory and this information shall be obtained and provided to the University prior to manufacture.

All light fittings shall be approved by UOW prior to ordering the fittings. If required by UOW samples of light fittings shall be submitted for approval.

## Lamp Colour Temperature

Unless otherwise specified by UOW:

- In Teaching, laboratory and office areas, a colour temperature of 4000K is to be provided.
- In retail and entertainment areas, a colour temperature of 3000 K is to be considered and is subject to client approval.
- For external lighting, the colour temperature shall be consistent with similar fittings used elsewhere on the campus. Where facades are being illuminated, consideration shall be given to the colour of the façade when selecting the colour temperature.

### 4.3.8.3 Lighting Design

Lighting design should comply with the AS1680 and Section J of the BCA. Calculations indicating compliance with AS1680 and Section J of the BCA for all the areas/rooms of the building shall be submitted to the University. These shall include as a minimum the average lux levels and the lighting power density.

Unified Glare Rating shall not exceed the maximum values specified in the AS/NZS 1680 for each specific area/room and in no case shall the UGR be higher than 19.

Specialist lighting shall be provided to areas such as lecture theatres, teaching areas and laboratories.

Where decorative or feature lighting is required, light fittings shall compliment the interior design.

Maintenance considerations shall be incorporated into the lighting design: The design shall minimise the number of different fitting types and approval shall be sought where a lift or scaffolding is required for maintenance purposes.

Design parameter	Calculation requirement
Reflection factors	White ceilings: 70% (use an appropriate lower figure for darker ceiling). Walls: 50% Carpeted Floors 15% (carpet), 20% (tiles and concrete)
Work plane height	Desks: 0.75m Benches: 0.9m Circulation areas: Floor level Other areas: as defined by the relevant Australian Standard or appropriate for the space use.
Effective work area	0.5m from walls for enclosed spaces
Light loss factor	0.8

### 4.3.8.4 Lighting Controls

#### *Lecture Theatres & Teaching spaces*

Lighting to be DALI controlled via a Dynalite control system and shall be interfaced to the AV system. Appropriate dimming/switching/scenes to be provided in lecture/teaching spaces to ensure that projection images are not compromised by stray light, while maintaining appropriate illumination levels to the student areas.

#### *Offices, store rooms and cleaner's rooms*

Lighting in office areas and meeting rooms shall be controlled by occupancy sensing devices.

Sensors shall incorporate dual technology (PIR & Microphonic) to automatically turn the lights off when areas are unoccupied.

PIR sensors shall be installed in store rooms and cleaners' rooms.

Individual rooms with occupancy sensors shall be configured with local manual switches capable of overriding OFF the occupancy sensors so lights are either off or controlled by the sensor. All the sensors shall be adjusted and commissioned so that the sensitivity and time settings of each sensor are adequate for each area.

#### *Laboratories and plant rooms*

Lighting in shall be locally switched.

#### *Dimming*

Where dimming is functionally required to foyers, meeting rooms, lecture theatres and teaching space, DALI protocols shall be used.

#### *Circulation spaces*

Lighting to be controlled via the BMS with 24 hour security lighting provided at intervals sufficient to allow for the safe movement through the space.

#### *Stairwells and toilets*

Lighting to incorporate presence sensors, and to dim down (e.g. to 10%) light output when the space is unoccupied.

#### *Façade lighting*

To be controlled via the BMS system. Lights to be turned on at dusk and off at a designated time during the evening.

#### *External circulation lighting*

To be controlled via the BMS system. Lights to be turned on at dusk and off at dawn.

### **4.3.8.5 Submissions**

The following documentation shall be submitted to the University for each Luminaire Type:

- A test report from a NATA accredited laboratory that evidences the LCP and power factor testing and results. Alternatively, a print out (screenshot) of the equipment's LCP as listed on the Lighting Council of Australia's website of registered products under the Solid State Lighting (SSL) Quality Scheme. This report shall include brand and model of the equipment.
- An IES LM 80-08 test report issued by a laboratory accredited by NATA.
- Evidence of the laboratory's accreditation with NATA including the name of the laboratory and showing that the laboratory is accredited to test against IES LM-80-08.
- An IES TM-21-11 test report using the results from the LM-80-08 report. This report is usually included as an appendix or section of the LM-80-08 report.
- A declaration from the lamp or luminaire manufacturer and/or a test report that states:
  - The brand and model of the lamp/luminaire and the brand and model of all the LED chips used in it



- The in situ case temperature and the in situ drive current of the LED chip in the product when it is installed in the lamp/luminaire and operating normally
- A Certificate of suitability issued by NSW Fair Trading or another certification body listed as a REAS. Alternatively, a JAS-ANZ endorsed Certificate of Suitability that complies with JAS-ANZ's Policy 06/13 – Certification of Non-Declared Articles classified as Emerging Lighting Technologies in the ESS.
- An ACMA (Australian Communication and Media Authority) Declaration of Conformity for compliance with electrical safety and EMC regulations.

Lighting designers (including contractors where appropriate) shall undertake full lighting calculations using either AGI 32 or DIALux software and submit complete report comprising:

- Project details
- Summary of results
- Confirmation of code compliance
- Native calculation files
- PDF printouts all calculations
- Manufacturer confirmation of compliance with L80/B10 criteria.
- Average lux levels for each room/area
- Lighting power density for each room/area
- UGR

#### **4.3.8.6 Circuiting**

For rooms that require eight or more individual light fittings, a control strategy shall be adopted that enables 50% of the lighting to be switched to maintain desired light levels.

The lighting in public areas such as stairs, corridors, and foyers shall be time scheduled through the BMCS and operated by either an after-hours button or passive infra-red motion detector(s). DB mounted, access restricted, auto-off-manual switches shall be provided to override the BMCS.

In circulation areas and toilets security lighting shall be provided. Security lighting shall be installed in accordance with the objectives of the Security Master Plan for security lighting. The location of fittings shall be selected to meet or exceed the minimum illumination levels, to ensure the correct operation of the CCTV system and to reduce perceive security risks. All security lighting shall be connected to a security designated circuit and controlled by the BMCS. A local key operated switch shall be provided to override the BMCS.

Each lighting circuit is to be initially loaded to no more than 67% capacity. Lighting shall be installed on dedicated circuits and not mixed with general power or permanently connected equipment. Where required, separate contactor control of lighting circuit shall be provided at the DB to switch appropriately zoned lighting circuits.

Connection to luminaries to be by flexible cable and plug top. Plug bases shall be located adjacent to each luminaire and securely fixed to either the underside of the slab with appropriate sized plugs and screws or on catenary wires in the ceiling space.

The external circulation lights ('lollypop' lights) are circuited using three phase supplies with the phases alternating between every third fitting.

#### **4.3.8.7 External Lighting**

External lighting shall be installed to meet minimum illumination levels, provide uniform lighting



on walkways and stairs and to reduce the likelihood of accidents in areas where external risks may occur.

External light fittings shall be designed to avoid light being directed upwards.

All underground external lighting cabling shall be sized for voltage drop and future load growth on the circuit (50%).

External lighting to colonnades, footbridges, entrances, etc. shall be controlled by a photo-electric device with day omitting "time" switch with provisions to interconnect to the BMCS for time scheduling.

Manual/off/auto override switches shall be provided for both BMCS and photoelectric controls, installed in a suitably locked IP67 stainless steel enclosure.

External lighting shall comply with the recommendations of CIBSE LG6, AS 4282, shall be low in copper content and be highly resistant to salt air.

#### **4.3.8.8 Emergency and Exit Lighting**

Emergency and exit lighting shall be a Legrand Axiom self-contained computer monitored wireless system with automatic testing facilities. The system shall be designed with a minimum operational time of not less than 2 hours in accordance with A.S. 2293. The exit and emergency lighting system shall be designed, installed and commissioned in accordance to the manufactures recommendation and this specification. The system shall allow for remote access by both the UOW and the external contractor engaged by UOW to undertake regular testing.

The wireless axiom Legrand system comprises single point luminaries, each fitted with an internal micro processor and commutations system communicating through an Arial connected from a self-contained supervising controlled unit. The system shall be connected through a dedicated LAN System. Supply and install a terminal server and area controllers including all associated hardware and equipment required for a fully functioning and complete computer monitored exit and emergency lighting system.

Supply and install all required equipment including but not limited to satellite devices and power packs.

All fittings shall be Legrand.

#### **4.3.9 Interfaces**

The following equipment and work will be supplied and/or carried out by other Trades/Authorities as follows:

<b>Work by Electrical Installer....</b>	<b>Work By....</b>
<b>in Connection with the Supply Authority</b>	<b>Supply Authority/Energy Retailer</b>
<ul style="list-style-type: none"> <li>▪ Application for meters</li> </ul>	<ul style="list-style-type: none"> <li>▪ Provision of Supply Authority/Energy Retailer meter.</li> </ul>
<b>in Connection with Mechanical Services</b>	<b>Mechanical Services Installer</b>
<ul style="list-style-type: none"> <li>▪ Supply and installation of sub-mains to the Mechanical Services Switchboard</li> </ul>	<ul style="list-style-type: none"> <li>▪ Supply and installation of Mechanical Services Switchboards, complete with suitable lugs, gland plates, connectors, isolators.</li> </ul>

<ul style="list-style-type: none"> <li>▪ Supply and installation of GPOs for distributed fan coil units</li> </ul>	<ul style="list-style-type: none"> <li>▪ Supply and installation of air conditioning equipment.</li> </ul>
<ul style="list-style-type: none"> <li>▪ All cables to be dressed, prepared and terminated.</li> </ul>	
<ul style="list-style-type: none"> <li>▪ BMCS interface cabling and connection of cabling to BMCS panel</li> </ul>	<ul style="list-style-type: none"> <li>▪ BMCS panels and associated terminals</li> </ul>
<b>in Connection with Lift Services</b>	<b>Lit Services Installer</b>
<ul style="list-style-type: none"> <li>▪ Provide supply to the lift services switchboards.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Supply and installation of lift switchboards and panels complete with suitable lugs, gland plates, connectors, isolators etc.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Dress and prepare all cables for termination and terminated as indicated on the drawings.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Final connection of power supplies to the lift switchboards.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Provide telephone cabling to Local Distributor box adjacent to the Lift Motor panels and terminate the cables at each end.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Connection to telephone Local Distributor panel from the lift machine control panels.</li> </ul>
<b>in Connection with Hydraulic Services</b>	<b>Hydraulic Services Installer</b>
<ul style="list-style-type: none"> <li>▪ Provide supply to hydraulic services equipment.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Supply and installation of hydraulic services equipment complete with suitable lugs, gland plates, connectors, isolators etc.</li> </ul>
<ul style="list-style-type: none"> <li>▪ All cables to be dressed, prepared and terminated.</li> </ul>	
<b>in Connection with the Ceilings</b>	<b>Ceiling Installer</b>
<ul style="list-style-type: none"> <li>▪ Set out all required penetrations in ceilings for Electrical Services (lights, exit and emergency lights etc.).</li> </ul>	<ul style="list-style-type: none"> <li>▪ Cut-outs and trimming of openings for light fittings.</li> <li>▪ Removal and replacement of ceiling tiles.</li> <li>▪ Openings in plasterboard ceilings and ceiling tiles.</li> <li>▪ Co-ordination of penetrations.</li> </ul>
<b>in Connection with the Doors</b>	<b>Door Installer</b>
<ul style="list-style-type: none"> <li>▪ Set out all required penetrations in doors for Electrical Services.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Cut-outs in doors and trimming of openings for electric locks and security sensors provided as part of Electrical Services Works.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Supply of electric locks and all cabling works.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Installation of electric locks supplied Electrical Works.</li> </ul>
<b>in Connection with Building Works</b>	<b>Builders Works</b>
<ul style="list-style-type: none"> <li>▪ Supply and install all lifting beams, building structure for securing electrical components.</li> <li>▪ Supply and install all platforms and walkways required for maintenance to equipment. Shop drawings indicating size and location to be provided Electrical Works.</li> <li>▪ Seal all fire rated penetrations using a system to AS4072.1.</li> <li>▪ Seal all non-fire rated penetrations around conduits and sleeves. Seal around cables within sleeves. If the building element is acoustic rated, maintain the rating.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Services trenches; excavation and backfilling.</li> <li>▪ All chasing, coring, cutting and making good.</li> <li>▪ Access doors and hatches for maintenance.</li> <li>▪ Bases and plinths for equipment.</li> </ul>

<ul style="list-style-type: none"> <li>▪ Undertake all coring, cutting and making good, subject to approval from the Structural Engineer.</li> <li>▪ Undertake all placing, casting in and protection of conduct sleeves and conduits.</li> </ul>	
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*Table 4.5 – Interface Table*

#### **4.3.10 Lightning Protection**

For all new buildings undertake a risk assessment of the impact of a lightning strike to the building in accordance with AS 1768.

Once this is undertaken, seek direction from the University with regards to the provision of a lightning protection system. Where such a system is to be installed, it shall be done in accordance with the requirements of AS 1768.

#### **4.3.11 Solar Photovoltaic (PV) Cells**

The inclusion of a solar PV system shall be considered on each new building project.

The building, structure and roof shall be designed to ensure that the building and roof structural integrity are able to support the installation of solar PV systems (including wind loads) on all the roof area and to comply with all relevant regulations including (but not limited to) AS/NZS 1170.2 - Structural Design Actions - Wind Actions.

The following factors shall also be integrated as part of the building design:

- Roof access, pitch and orientation shall be designed to maximise the sunlight gains of a future solar PV system
- Roof type and material shall allow the installation of a solar PV mounting system without the need for roof penetrations
- Objects on the roof (ventilation, air conditioning equipment etc.) shall be considered to be consolidated and located on the south side of the roof, far away from the centre of the roof and close to roof edge in order to maximise the roof space available and to minimise shading.
- The possible inverter location, cabling, connection to main switch board/distribution board, raisers, spare CB's and availability of spare capacity in the electrical board for the connection of a solar PV system shall be considered as part of the building design.

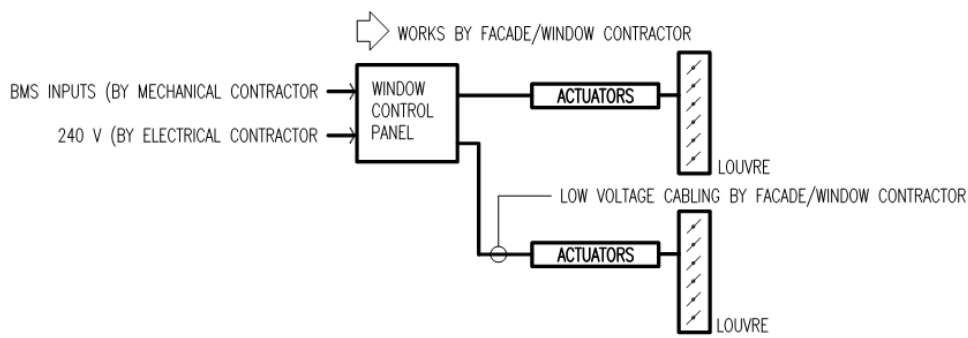
Feedback from UOW shall be requested at the design stage to:

- Provide input on the building and roof design
- Provide input about the requirements of a solar PV system to be potentially installed as part of the project

Where any of these requirements cannot be met then these matters shall be brought to the attention of UOW.

### 4.3.12 Motorised windows

The demarcation of works for motorised windows shall be as follows:



MOTORISED LOUVRE INTERFACE SCHEMATIC



Figure 4.2 – Motorised Windows

Systems that are based in the reticulation of 240V power through window frames are not acceptable. Ensure that the appropriate specification for the window controller nominates that the low voltage supplies to each set of windows is separately protected.

The control panel shall have the facility for local override of the BMS to control the lighting.

## 4.4 STANDARDS

The design shall comply with the latest versions of all relevant codes and standards in force at the time of specification. Where the designer considers a standard to be inappropriate to the circumstances, the designer shall advise the principal and seek direction. Table 4.3 below contains a list of the relevant codes and standards.

Issuing Body	Document Number	Title
AUSTEL	AUSTEL	Australian Telecommunication Authority requirements
BCA	BCA	Building Code of Australia requirements
Standards Australia	AS/NZS CISPR 14.1	Electromagnetic compatibility - Requirement for household appliance, electric tools and similar apparatus - Emission
Standards Australia	AS/NZS CISPR 15	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
Standards Australia	AS/ACIF S009	Installation requirements for customer cabling
Standards Australia	AS/NZS 1125	Conductors in insulated electric cables and flexible cords
Standards Australia	AS/NZS 1158	Road lighting
Standards Australia	AS 1170.4	Earthquake loads
Standards Australia	AS 1345	Identification of the contents of pipes, conduits and ducts
Standards Australia	AS 1367	Coaxial cabling systems for the distribution of analogue television and sound signals in single and multiple unit installations
Standards Australia	AS 1418	Cranes (including hoists and winches)
Standards Australia	AS 1680 series	Interior lighting
Standards Australia	AS 1768	Lightning protection
Standards Australia	AS 1882	Earth and bonding clamps
Standards Australia	AS 1939	Degrees of protection provided by enclosures for electrical equipment.

<b>Issuing Body</b>	<b>Document Number</b>	<b>Title</b>
Standards Australia	AS 2053 series	Conduits and fittings for electrical installations
Standards Australia	AS 2293	Emergency evacuation lighting for buildings
Standards Australia	AS 2700	Colour standards for general purpose
Standards Australia	AS 2946	Suspended ceilings, recessed luminaires and air diffusers - Interface requirements for physical compatibility
Standards Australia	AS/NZS 3000	Wiring Rules
Standard Australia	AS/NZS 3003	Electrical installations – Patient areas
Standards Australia	AS 3008	Electrical installations - Selection of cables
Standards Australia	AS 3080	Telecommunications installations - Generic cabling for commercial premises
Standards Australia	AS 3084	Telecommunications installations - Telecommunications pathways and spaces for commercial buildings
Standards Australia	AS 3111	Approval and test specification - Miniature overcurrent circuit breakers.
Standards Australia	AS 3112	Approval and test specification - Plugs and sockets-outlets
Standards Australia	AS 3190	Approval and test specification - Residual current devices (current-operated earth-leakage devices)
Standards Australia	AS 3191	Electric flexible cords
Standards Australia	AS 614396 series	Low voltage switchgear and control gear assemblies
Standards Australia	AS 60947	Low voltage switchgear and control gear
Standards Australia	AS 61000 series	Electromagnetic compatibility (EMC)
Standards Australia	AS 4282	Control of the obtrusive effects of outdoor lighting

Issuing Body	Document Number	Title
Standards Australia	AS/NZS 5000.1	Electric cables - Polymeric insulated - For working voltages up to and including 0.6/1 (1.2) kV
Standards Australia	AS 60269.2.0	Low-voltage fuses - supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)
Standards Australia	AS/NZS 60598.1	Luminaries - General requirements and tests
UOW	OHS064.9	WHS Consideration for Design <a href="http://staff.uow.edu.au/content/groups/public/@web/@ohs/documents/doc/uow017017.pdf">http://staff.uow.edu.au/content/groups/public/@web/@ohs/documents/doc/uow017017.pdf</a>

*Table 4.6 - Codes and standards*

## **4.5 INSTALLATION GUIDELINES**

### **4.5.1 General**

Where electrical services are installed as part of a large project involving multiple services, the installation shall be scheduled to occur at a logical time during the project. Cable runs should not be installed prior to the location planning of major plant and equipment or the provision of access points for other services.

All redundant cabling and equipment shall be disconnected, removed and made safe. For external works, all rubbish, spoil and excavated material shall be removed and all finished surfaces are to be made good.

### **4.5.2 Reticulation**

#### **4.5.2.1 Sub-Mains**

All sub-mains shall be identified at each end by approved labels fixed to cable sheaths or conduit and identifying the cable size, type and purpose, origin and destination.

The sub-mains shall be installed as one complete run without joints and with adequate air circulation around the cable to avoid overheating unless authorised by the UOW Electrical Works Supervisor. Where bends are necessary, the bend radii shall not exceed the manufacturer's recommended maximum.

Terminations shall be made using propriety type termination lugs where equipment has not been supplied with tunnel termination lugs.

#### **4.5.2.2 Final Sub-Circuits**

All cabling installed in accessible roof or false ceiling spaces shall be supported on catenary wire, run in orderly routes. Elsewhere the cabling shall be mechanically protected and enclosed in not less than 20mm diameter conduits or supported by cable trays.

Cabling shall not be supported off the ceiling grid supports.

Wherever possible, the cabling shall be installed so that it can be repaired or renewed without damaging the architectural finishes. The final sub-circuits shall be installed as one complete run without joints and with adequate air circulation around the cable to avoid overheating.

#### **4.5.2.3 Conduits and Ladder Trays**

All conduits and ladder trays shall be mechanically secured and concealed wherever possible. Directional changes to straight runs will be achieved through the use of bends, risers and curves supplied by the conduit or cable tray manufacturer.

Conduits that may be exposed to damage shall be rigid steel unless installed on structural elements that are subject to movement, where flexible steel shall be used.

Where external conduits will be exposed to harsh environmental conditions close to seawater, HDPE shall be used.

Ladder trays shall be supported by steel brackets and be free of sharp corners and edges. Where new cable trays are installed, a minimum of 30% free capacity shall be provided for future installations.



Underground conduits shall be minimum size of 50mm diameter and shall be complete with marker tape in accordance with AS/NZS 3000. Before commencing the installation of underground cables, undertake a complete survey of all other in ground services and ensure that the installation is coordinated with these.

All pre-formed pits for electrical services are to be industry standard pits where the pit body is made from concrete and the lid is made from concrete or infill type as appropriate. The pit lid is to be marked as “E” or “ELECTRICAL”.

The restrictions on use and application of load-ratings to cabling pits is as follows:

- Load rating for turfed areas, garden spaces and paths used solely for foot traffic. These areas can be fitted with pre-formed pits. Where constructed-in-situ pits are being fitted, the pit lids are to be rated as “Class C” as defined in AS-3996 and be able to sustain a load of 150k Newtons.
- Load rating for roads and vehicular paths. These areas are to be fitted with pit-lids rated as “Class D” as defined in AS-3996 and be able to sustain loads of 210k Newtons. Pre-formed cabling pits are not to be used in these situations.

Spare conduits shall have a draw wire installed

Trays installed external to a building shall be stainless steel.

### 4.5.3 Switchboards

#### 4.5.3.1 Switchboard Equipment

The detailed selection of equipment shall provide fully discrimination. Downstream circuit breakers shall isolate circuits in over current conditions without upstream circuit breakers including HV protection, under voltage or other protection devices affected by the voltage and over current disturbances operating.

Such discrimination shall occur for over current fault conditions from overload through to the maximum three phase bolted fault current at the circuit breaker line side terminals.

Device	Make
Miniature Circuit Breakers	NHP Din-T
Moulded Case Circuit Breakers	NHP - Terasaki
Chassis Panel boards	NHP - Terasaki
Cabinet Panel boards	NHP - Terasaki
Contactors	NHP Din-T, Sprecher + Schuh
Air circuit breakers	Terasaki TemPower

Table 4.7 – Switchboard Equipment

#### 4.5.3.2 Main Switchboard

The main switchboard shall be located as close as practical to the point for entry of the consumer mains and shall be provided with full automatic protection.

The main switchboard shall have provision to cater for any known future expansion of the building. Space shall also be provided adjacent to the MSB for future expansion.

The colour of the main switchboard shall be orange No X15. Busbars shall be identified by using colour bounded heat shrink and coloured ties as follows:

- A Phase: Red
- B Phase: White
- C Phase: Blue
- Neutral: Black

Loads shall be balanced on each phase.

Approved MSB manufacturers are as follows:

- Electrical Maintenance and Manufacture (EMM)
- KE Brown
- Tabulec

Supply and install a full sized schematic in a glazed frame in the Main Switchboard room

#### **4.5.3.3 Distribution Boards (DBs)**

Loads shall be balanced on each phase.

#### **4.5.4 General Power**

##### **4.5.4.1 General Purpose Outlets**

General purpose outlets shall be 10A 3 pin with flat earth pin and white in colour, unless instructed otherwise by the client. Special purpose outlets shall be 15A or 20A depending on their purpose.

Special purpose single phase plug sockets shall be as follows:

- ELV DC - two flat pin with each pin perpendicular to each other;
- ELV AC - two flat pin with each pin parallel to each other;
- LV DC - two round pin with flat earth pin;
- Process heating - two flat pin with round earth pin.

General purpose and special purpose outlets shall be flush mounted and installed in perimeter and partition walls. Each outlet shall be permanently labelled with a traffolyte label.

##### **4.5.4.2 Skirting Duct**

Ducted skirting will be installed throughout. The ducted skirting shall be provided with the following:

- Metal
- 150 mm high x 50 mm deep
- Locking cover – cover plates that rest in place are not acceptable
- Equal to Skirtec D15050.

##### **4.5.4.3 Motors**

High efficiency motors shall be used in all applications where appropriate. Motor exceeding 0.37kW (0.5HP) shall be three (3) phase, controlled by a contactor and protected by a thermal overload.

Motors for variable speed drives shall be rated such that they will not be loaded more than 83% at maximum rated speed and will not over heat at any speed up to maximum rated speed when driving a load.

All motors shall be fitted with PTC thermistors providing Class 1 protection matched to the motors insulation class and be able to withstand repetitive electrical surges.

#### **4.5.4.4 Isolating Switches**

A full current isolating switch shall be provided adjacent to all fixed equipment. For automatically controlled equipment, the isolating switches shall be three position, marked auto/test/off.

Isolating switches shall be lockable for maintenance purposes.

#### **4.5.4.5 Earthing**

Provide:

- Protective earthing in accordance with requirements for MEN system, current AS/NZS 3000 and Service and Installation Rules of NSW, Supply Authority requirements
- Technical/functional earthing systems in accordance with. Where there is a need for a separate technical earthing system, the technical earthing system should satisfy requirements of AS/NZS 3000, AS/ACIF S009 and shall be labelled appropriately. In all other instances, the communications earth terminal (CET), if required, shall be taken from the nearest distribution board on the floor. The comms equipment (and outlets) shall be supplied from this distribution board.
- Combined earthing systems in accordance with current AS/NZS 3000

Provide M.E.N and earth electrodes at main switchboards

Earth electrodes as required for each earthing system shall be provided, installed and labelled in accordance with the requirements of AS/NZS 3000 and the Supply Authority

All power cable ladder, cable trays and the like shall be continuously earthed. Abutting/overlapping lengths of tray shall be joined by earth straps.

#### **4.5.4.6 Floor boxes**

Floor boxes shall be recessed wherever practical, and shall be complete with metal frame and cover. Plastic covers and insets for carpet are not acceptable. Floor boxes shall have a minimum depth of 90mm.

Allow for spatial provisions and conduits are required for power, communications and AV services.

### **4.5.5 Lighting**

#### **4.5.5.1 General Lighting**

Lighting shall be installed on dedicated circuits and not mixed with general power or permanently connected equipment. Where required, separate contactor control of lighting circuit shall be provided at the DB to switch appropriately zoned lighting circuits.

Connection to luminaries to be by flexible cable and plug top. Plug bases shall be located adjacent

to each luminaire and securely fixed to the either the underside of the slab with appropriate sized plugs and screws or on catenary wires in the ceiling space.

#### **4.5.5.2 Submissions**

The following submissions are required by the Electrical Contractor at the commencement of the construction for each luminaire:

- A test report from a NATA accredited laboratory that evidences the LCP and power factor testing and results. Alternatively, a print out (screenshot) of the equipment's LCP as listed on the Lighting Council of Australia's website of registered products under the Solid State Lighting (SSL) Quality Scheme. This report shall include brand and model of the equipment.
- An IES LM 80-08 test report issued by a laboratory accredited by NATA.
- Evidence of the laboratory's accreditation with NATA including the name of the laboratory and showing that the laboratory is accredited to test against IES LM-80-08
- An IES TM-21-11 test report using the results from the LM-80-08 report. This report is usually included as an appendix or section of the LM-80-08 report.
- A declaration from the lamp or luminaire manufacturer and/or a test report that states:
  - The brand and model of the lamp/luminaire and the brand and model of all the LED chips used in it
  - The in situ case temperature and the in situ drive current of the LED chip in the product when it is installed in the lamp/luminaire and operating normally
- A Certificate of suitability issued by NSW Fair Trading or another certification body listed as a REAS. Alternatively, a JAS-ANZ endorsed Certificate of Suitability that complies with JAS-ANZ's Policy 06/13 – Certification of Non-Declared Articles classified as Emerging Lighting Technologies in the ESS.
- An ACMA (Australian Communication and Media Authority) Declaration of Conformity for compliance with electrical safety and EMC regulations.

#### **4.5.5.3 Exit and Emergency Lighting**

The Exit and Emergency lighting shall be provided to the installation in accordance with the BCA and AS 2293.

Emergency lighting shall also be provided adjacent at the main switchboard and all DBs.

The emergency evacuation lighting monitored system shall have an operating duration not less than 2 hours.

The tender price shall include for the UOW nominated exit and emergency lighting commissioning contractor to commission, provide technical support throughout the warranty period of the system and provide technical assistance both to the contractor in installing and commissioning the system and its communications.

#### **Software**

The UOW nominated exit and emergency lighting commissioning contractor shall supply, install, update and commission the latest AEGIS software on the remote maintenance managers PC at the maintenance manager's office. The contractor shall provide electronic plans for corporation into the software graphical user interface. Allow for all software and programming of the system as required.

### **Terminal server (Communications Interface Unit)**

Supply and install in conjunction with the UOW nominated exit and emergency lighting commissioning contractor 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 for a complete functioning installation.

The contractor shall provide a double 10A GPO supplied from a clean 240V AC power supply. Provide a single CAT6 Data outlet and the outlet is to be configured and connected to the dedicated PCS LAN by the university.

### **Area Controllers**

Supply and install all industrial computer I 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 interface to the terminal sever (communications interface unit) to provide remote monitoring.

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

### **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 axiom wireless system.

Riser cabled shall be run the 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 cabled used shall have passed the AS/NZS 60950.2000 for electrical impulse and electrical strength test requirements with the latter having a voltage of ISOOV 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 5008 and be correctly terminated at each end.

Typically 10 core flat cabled shall be used between area controllers. All cabled 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/NZS 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 I Database I Acceptance Criteria**

The contractor shall be responsible for correct collection and entry of data into the electronic database and logbook 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.

Installation personnel shall be 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 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
- Printout of a subsequent 90 minute test indicating the presence of all SPU's.

Maintenance period is concurrent with 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 if required at 12 monthly intervals or sooner if lamp ends are black and light output is affected;
- 6 and 12 monthly after the emergency luminaires 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 similar tested in situ;
- Provide the specified number of copies of manufacturer's installation and operating manual, 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 and addresses, telephone and fax numbers and a table of contents. Printed or typed on durable printing paper neatly bound in a 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 communication's cable path in each area;
- Provide maintenance and testing equipment as recommended by manufacturer.

## **Installation of System and Equipment**

All Emergency luminaires and Exit signs shall incorporate Legrand Axiom system control gear.

All emergency luminaires shall be connected to their own dedicated unstitched AC Circuit off the local AC circuit in the area they serve.

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.

Supply and install 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 centenaries 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.

'Work as executed' drawings of the emergency lighting system installation shall 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.

### **4.5.5.4 External Lighting**

All external luminaires shall be complete with manufacturer approved mountings.

Cabling to all underground external lighting shall be sized to meet the voltage drop and earth loop impedance requirements of AS/NZS 3000. The minimum cable size of 16mm<sup>2</sup> PVC/PVC.

Light posts shall be individually protected by circuit breakers mounted within the post within a weatherproof enclosure.

## **4.6 COMMUNICATIONS**

The communications system is an integrated voice data system complying with UOW's specification for Voice and Data at the University of Wollongong.

The provision of communications cabling, conduits, termination points and associated equipment shall be selected in accordance with this standard.

## 4.7 LABELLING

- All components shall be separately and clearly identified by labelling. All labels shall be manufactured from laminated Traffolyte with bevelled edges or as approved.
- Bar-coded labels shall be provided on each luminaire with details of the model number, manufacturer and installation date.
- Labels for GPOs shall not be fixed to removable covers.
- Each label shall be in the English language and mounted adjacent to their respective component.
- All labels except danger or warning labels shall be black lettering against a white background. Danger and warning labels shall be red lettering against a white background.
- Labels shall be screw or pin fixed in position using at least two (2) polycarbonate screws which permit ready replacement. The holes in the label shall be elongated to allow thermal movement. The use of double sided adhesive tapes will NOT be acceptable.
- Labels, when mounted, must not be obstructed by wiring, switchboard equipment, support brackets, etc.
- Main Switchboards: A main label shall be mounted in an approved position on the front of the switchboard. The label shall be metal, with 38 mm high embossed letters coloured white on a black background. The label shall include the switchboard reference and its function, and the building name and number.
- Labelling on the distribution boards shall include the origin, size and type of the consumer and sub-mains mains and the main control switch number and the source of supply.
- Sub mains shall be labelled at both the MSB and their destination distribution board. Labelling of sub mains shall include the cable size, type and origin/destination as appropriate.
- Labels shall also be provided outside the panels or on doors to identify the following in 3mm lettering.
- All instruments, protective relays, timers, switches, etc.
- All internal equipment circuit references, fuse base and cartridge sizes, current transformers, ratios and classification, etc.
  - Size and type of fuse cartridge inside each door of fuse switch unit.
  - Isolating switches.
  - Terminal strips.



## 4.8 EQUIPMENT

### 4.8.1 Power Supply

Table 4.5 below contains a list of power supply components.

Device	Function	Make	Model	Rating
Combination Switched Socket Outlets	3 phase socket	Clipsal	56 Series	500V 50A
Surface Socket Outlets	3 phase socket	Clipsal	56 Series	500V 50A
Lightning Protection	Lighting protection	Eritech	System 2000	N/A
3 Channel Skirting Duct	Skirting duct	Skirtec	D15050	N/A
Standard Mounting Clips	Mounting clip	HPM	711	N/A
Standard Size Mounting Brackets	Mounting bracket	HPM	143	N/A
Standard Wall boxes	Wall boxes	HPM	429	N/A
2hr Fire Rated Acoustic Standard Wall Boxes	Fireboxes	HPM	430	STC54
Surface Mounting Blocks	Mounting block	HPM	137	N/A
Chemically Resistant Mounting Block	Mounting block	HPM	137DCH	N/A

*Table 4.8 - Power Supply*

## 4.8.2 Emergency and Exit Lighting

Table 4.7 below contains a list of communication devices.

Device	Function	Make
Communication	Communications Interface Unit	Axiom
Communication	Modem Interface Unit	Axiom
Communication	Axiom Wireless Area Controller	Axiom
Communication	Axiom Aegis 8 Software	Axiom

Table 4.9 – Communication Devices

Table 4.8 below contains a list of satellite devices.

Device	Function	Make
Satellites	Polycarb satellite Classification (D20/D20)	Axiom
Satellites	Surface mounted Classification (D20/D20)	Axiom

Table 4.10 – Satellite Devices

## 4.8.3 Cabling

Table 4.9 below contains a list of cabling.

Function	Minimum Cable Size (mm <sup>2</sup> )	Model	Rating
Sub Main Cables	16	Cable Maker Australia - HPM	135A
Light Final Sub Circuit	2.5	Cable Maker Australia - HPM	15A
Power Final Sub Circuit	2.5	Cable Maker Australia - HPM	10 - 15A

Table 4.11 - Cabling

## 4.9 WARRANTY

All components shall be complete with the following minimum warranty periods, including all materials and labour:

System/Equipment	Warranty Period
Power Supply	12 Months
Switchboards	12 Months
Emergency and Exit Lighting	12 Months
External Lighting	5 years
Internal Lighting	5 years
Cables	12 Months
Conduits	12 Months

*Table 4.12 - Warranty Periods*