



University of Wollongong

Electrical Services Design Standards
Version 1.10 – 25 November 2010



QUALITY SYSTEM

Reason for Issue:	Client Review
Client:	University of Wollongong
Director Responsible:	Chris Hewitt
Director's Signature:	
Primary Consultants:	
Issue:	Version 1.10 – 25 November 2010

CONFIDENTIAL

This document contains confidential information solely for use by the University of Wollongong. All reasonable precautionary methods in handling the document and the information contained herein should be taken to prevent any third party from obtaining access without the approval of the University of Wollongong.



VERSION CONTROL SYSTEM

Section Modified	Description of Modification	Version	Organisation	Representative	Date
4.8	Life Cycle Costings moved to section 4.9	1.03	Asset Technologies Pacific	Tom Poyner	20/11/06
4.8	Warranty periods added	1.03	Asset Technologies Pacific	Tom Poyner	20/11/06
Throughout	UOW Logo added to headers	1.03	Asset Technologies Pacific	Tom Poyner	28/11/06
4.2	Add risk assessment activity to conceptual design process.	1.03	Asset Technologies Pacific	Tom Poyner	1/12/06
4.4	Insert OH&S reference link	1.03	Asset Technologies Pacific	Tom Poyner	1/12/06
4.7	Equipment	1.04	University of Wollongong	Chris Hewitt	1/6/07
4.7.3	Emergency & Exit Lighting	1.05	University of Wollongong	Chris Hewitt	9/12/08
4.3.6.2	Emergency & Exit Lighting	1.05	University of Wollongong	Chris Hewitt	16/12/08
4.6.3.2	Distribution Boards	1.06	University of Wollongong	Chris Hewitt	11/02/09
4.3.1	Functional Design Requirements – General	1.07	University of Wollongong	Chris Hewitt	25/05/09
4.3.1	Update Sub-station Listing	1.08	University Of Wollongong	John Hazelton	24/8/2009
4.3.4	Metering and connection to UMMS	1.08	University of Wollongong	John Hazelton	24/8/2009
4.3.6.1	Amended general lighting control	1.08	University of Wollongong	John Hazelton	24/8/2009
4.6.3.2	Added reference to 4.3.4	1.08	University of Wollongong	John Hazelton	24/8/2009
4.6.5.1	Added reference to 4.3.6.1	1.08	University of Wollongong	John Hazelton	24/8/2009
4.6.7	Amended meter labelling	1.08	University of Wollongong	John Hazelton	24/8/2009
4.3.6.2	Amended Emergency and Exit Lighting section	1.09	University of Wollongong	Chris Hewitt	19/3/2010
4.7.3	Amended Table 4.7	1.09	University of Wollongong	Chris Hewitt	19/3/2010
4.7.3	Amended Table 4.9	1.09	University of Wollongong	Chris Hewitt	19/3/2010
4.3.1, 4.6.2.2, 4.6.5.5	Amended Table 4.1. Added information re conduits to 4.6.2.2. Added information re cable size to 4.6.5.5	1.10	University of Wollongong	Chris Hewitt	24/11/2010



TABLE OF CONTENTS

4.1	OVERVIEW	3
4.2	DESIGN PROCESS.....	4
4.3	FUNCTIONAL DESIGN REQUIREMENTS	5
4.3.1	General.....	5
4.3.2	Reticulation.....	6
4.3.2.1	Sub-mains	6
4.3.2.2	Final Sub-Circuit.....	6
4.3.3	Switchboards.....	6
4.3.3.1	Main Switchboard.....	6
4.3.3.2	Distribution Boards.....	7
4.3.4	Metering and UMMS connection.....	7
4.3.5	General Power.....	8
4.3.6	Lighting.....	9
4.3.6.1	General Lighting	9
4.3.6.2	Emergency and Exit Lighting	9
4.3.6.3	Security Lighting	10
4.3.6.4	External Lighting	10
4.3.6.5	Specialist Lighting	10
4.3.7	Interfaces.....	10
4.4	STANDARDS.....	10
4.5	MINIMUM PERFORMANCE STANDARDS.....	14
4.6	INSTALLATION GUIDELINES.....	14
4.6.1	General.....	14
4.6.2	Reticulation.....	14
4.6.2.1	Sub-Mains.....	14
4.6.2.2	Final Sub-Circuits	15
4.6.3	Switchboards.....	15
4.6.3.1	Main Switchboard.....	15
4.6.3.2	Distribution Boards.....	16
4.6.4	General Power.....	16
4.6.4.1	General Purpose Outlets	16
4.6.4.2	Skirting Duct.....	17
4.6.4.3	Motors	17
4.6.4.4	Isolating Switches	17
4.6.5	Lighting.....	17
4.6.5.1	General Lighting	17
4.6.5.2	Emergency Lighting.....	17
4.6.5.3	Exit Lighting	18
4.6.5.4	Security Lighting	18
4.6.5.5	External Lighting	18
4.6.6	Communications	18
4.6.7	Labelling	18
4.7	EQUIPMENT	19
4.7.1	Power Supply.....	19



4.7.2	Switchboards.....	21
4.7.3	Emergency and Exit Lighting	22
4.7.4	External Lighting	24
4.7.5	Internal Lighting	26
4.7.6	Cabling.....	28
4.7.7	Conduits	28
4.8	WARRANTY	29
4.9	LIFE CYCLE COSTING.....	29



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.

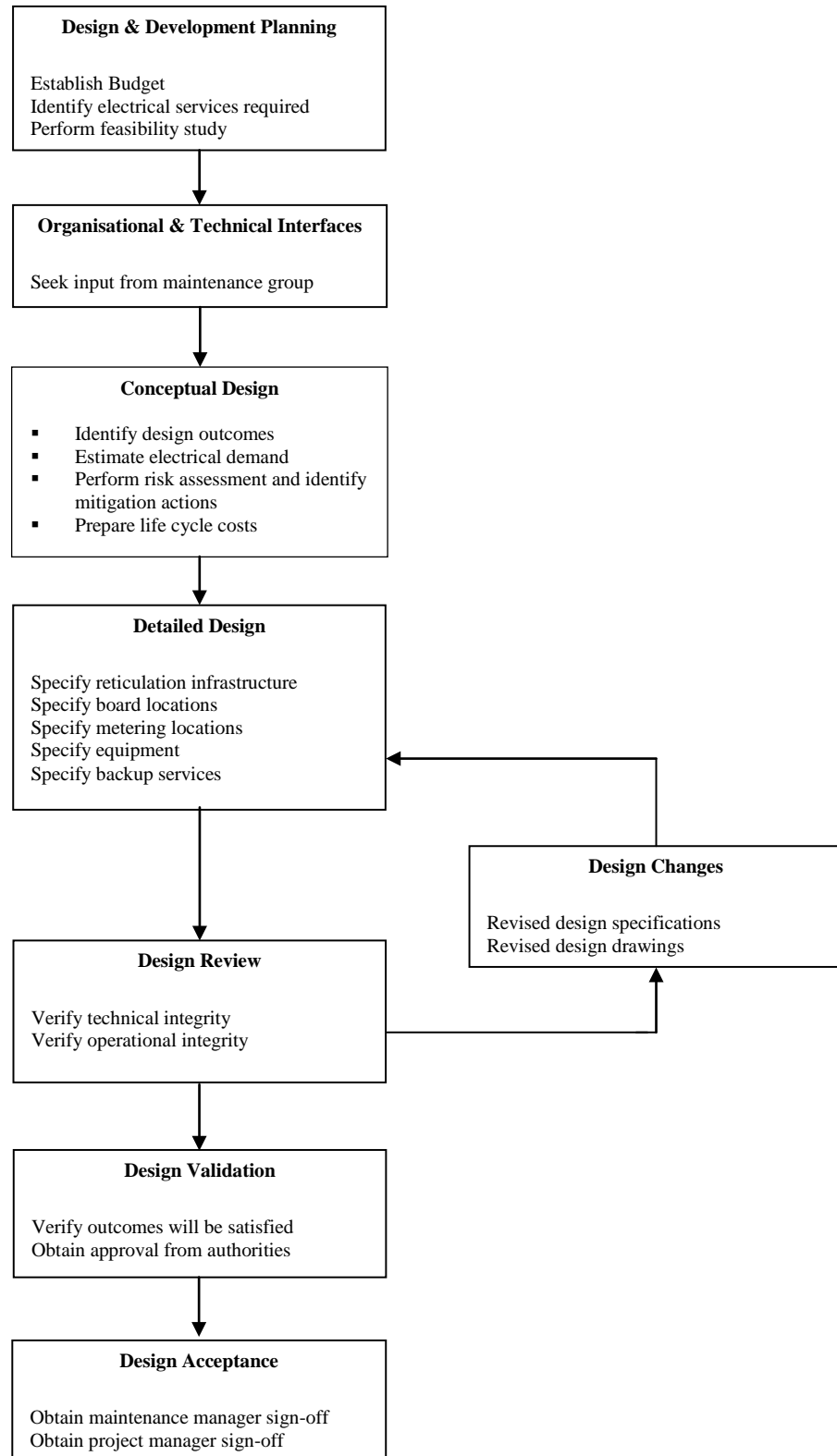




Figure 4.1 - Process Flow

4.3 FUNCTIONAL DESIGN REQUIREMENTS

4.3.1 General

The University of Wollongong campus is fed from two (2) dedicated underground feeders from Mt Ousley Zone substation with additional back-up supplies from domestic overhead feeds. There are thirteen (13) substations located throughout the main campus (refer to drawing "Substations Power Distribution, March 2009". 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	Location	Provides Power To The Following buildings
1	North West B25	28
2	B16 Basement	11,12,16,17
3	South end of central wing of B19	19,24, 40
4	South West corner of B25	21,22,23,25,27,29,31,36,38,67
5	South East corner of B6	3
6	West side of Printery B32	41
7	South end of B4	1,2,4,5,8,10,14,15,32,35,42 and the east end of building 11
8	North West of B30	30 and the demountable buildings
9	South East corner B6	39
10	North West B42	32
11	South West Corner B20	18,20
12	South West corner B13	13,9
14	East of B70	70

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.

The design shall provide flexibility and the ability to accommodate changes and expansion of services over the life of the building.

The electrical services design philosophy shall take into consideration the life cycle operational and cost efficiency of the equipment and the environmental impacts and energy performance of the equipment.



4.3.2 Reticulation

4.3.2.1 Sub-mains

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

4.3.2.2 Final Sub-Circuit

Cabling used for general lighting and power sub-circuits shall be a minimum of 2.5mm² type V75. Power and lighting circuits shall be designed to accommodate the predicted loads plus spare capacity for an additional 20% future load.

4.3.3 Switchboards

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

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

4.3.3.1 Main Switchboard

For sites that require a new main switchboard (MSB), the MSB shall be of modular construction 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 100%. Power factor correction equipment shall be provided to maintain near unity power factor.

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 changeover switches to control the switching of electrical loads when an alternate power supply is active.

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



4.3.3.2 Distribution Boards

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

Each DB shall be protected by its own main switch. There shall be a minimum of one DB per floor. Sub-distribution boards where the supply to the DB is dependant on the supply to another DB will be avoided.

Where appropriate, DBs shall incorporate contactors for automation of lighting circuits. Where the predicted load will require 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 supplying laboratories.

4.3.4 Metering and UMMS connection.

Maximum demand and kilowatt hour meters shall be installed on the main switchboard and/or DBs such that the electricity consumption can be monitored for the following functions:

- Total building consumption.
- General Light and Power consumption.
- Heating Ventilating and Air Conditioning consumption
- Other special systems with significant consumptions.

Sub-metering of these consumptions types shall be provided to enable each department within the building to be individually monitored.

All private electrical meters shall be of the digital smart meter type (PRI ICM-400, Sprint or Premier or their approved equals) and shall:

- Be approved for sale in the Australian market and be of an accuracy of +/- 2% of the variable measured value.
- Be supplied with communication ports permitting networking via RS232 or 485 interface to data concentrators compatible with the Utility Metering and Management System (UMMS), currently in operation for the University of Wollongong campuses.
- Store a minimum of 80 days load profile and provide time of use metering.



- 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 (if applicable)
- Current Transformers (where required) 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 electrical services contractor shall engage Utiligy Pty Limited (www.utiligy.com.au, Phone +61 3 86998799) to supply, install and commission the equipment and configurations required for any new electricity, water and gas meter data to be automatically collected, communicated and then incorporated into the existing Utility Metering and Management system.

Utiligy Pty Limited work scope shall include transmission of the consumption data to both the Utiligy User-online and the University of Wollongong Performance Indicator Project.

The integration to UMMS of the water and gas meters provided under the hydraulics section of the works will include:

- Pulse loggers which shall be connected to water and gas meters pulse voltage free contact outputs. These pulse loggers should be capable of counting pulse widths of 40 milliseconds or less, at frequencies up to 10 Hz. Loggers shall incorporate de-bounce input filtering.
- The system should be able to transmit hourly consumption data and have the capability to store 24 hours of consumption data.
- Pulse logger communications to concentrator units shall be compatible with the Coronis based 433 MHz system currently installed on campus.

4.3.5 General Power

General purpose outlets for general purpose or office equipment shall be protected by RCDs. The following maximum circuit loadings shall apply:

- Five 10A General Purpose Outlets in non air-conditioned areas;
- Ten 10A General Purpose Outlets in air-conditioned areas;
- Twenty 10A General Purpose Outlets serving IP racks;
- Individual circuit for each permanently connected equipment;
- Individual circuit for each 15A GPO.

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).



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

4.3.6 Lighting

4.3.6.1 General Lighting

General light fittings shall be energy efficient, low maintenance and use long life lamps such as compact fluorescent, metal halide or other high efficiency lamps. Triphosphor lamps shall be used in fluorescent light fittings.

External lighting shall comply with the recommendations of CIBSE LG6, the outdoor environment and be highly resistant to salt air.

Lighting in offices, lecture theatres and laboratories shall be locally switched with light sensing devices installed in perimeter offices. Where feasible, light level sensing Passive Infrared Detectors will be utilised to turn lights off when areas are unoccupied or subject to adequate levels of natural light. Local switches will be capable of overriding ON the PIR/light level switching. 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 either be time scheduled through the BMCS and operated by either an after hours button or passive infra red motion detector(s). Low brightness compact fluorescent or other energy efficient lighting shall be used in toilet and other staff utility areas. DB mounted, access restricted, auto-off-manual switches shall be provided to override the BMCS.

Each lighting circuit is to be initially loaded to no more than 67% capacity.

4.3.6.2 Emergency and Exit Lighting

Emergency and exit lighting shall be provided 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. 2293.1 clause 2.2.1.

The UOW is progressively changing all buildings to the Legrand Axiom computerised system and has a preference to use this system in all new buildings, extensions to buildings and refurbishments.

On completion of works the installing contractor must provide the UOW with:

- As built drawings consisting of:
 - Location of all communication and data gathering equipment.



- Position of individual lighting units including their allocated numbers.
- Complete and updated emergency lighting register (to be provided in both soft and hard copy).
- Copy of the initial 2 hour test report.

4.3.6.3 Security Lighting

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.

4.3.6.4 External Lighting

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.

Key operated switches shall be provided to override both BMCS and photo-electric devices.

4.3.6.5 Specialist Lighting

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 and provide good colour rendering.

4.3.7 Interfaces

The electrical services interface with the building monitoring and control system (BMCS).

System to be Interfaced	Interface Type	Interface Responsibility
BMCS	Low level	Electrical Contractor

Table 4.2 – Interfaces

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
CIBSE	LG6:1992	Chartered Institution of Building Services Engineers. The outdoor environment
Standards Australia	AS/NZS CISPR 14.1:2003	Electromagnetic compatibility - Requirement for household appliance, electric tools and similar apparatus - Emission
Standards Australia	AS/NZS CISPR 15:2002	Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
Standards Australia	AS/ACIF S009:2006	Installation requirements for customer cabling
Standards Australia	AS 1125	Conductors in insulated electric cables and flexible cords
Standards Australia	AS 1158	Road lighting
Standards Australia	AS 1170.4	Earthquake loads
Standards Australia	AS 1201	Tubular fluorescent lamps for general lighting service
Standards Australia	AS 1345	Identification of the contents of pipes, conduits and ducts
Standards Australia	AS 1367:2000	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	Interior lighting
Standards Australia	AS 1768	Lightning protection
Standards Australia	AS 1882	Earth and bonding clamps



Issuing Body	Document Number	Title
Standards Australia	AS 1930	Circuit-breakers for distribution circuits (up to and including 1000 V a.c. and 1200 V d.c.)
Standards Australia	AS 1939	Degrees of protection provided by enclosures for electrical equipment.
Standards Australia	AS 2053	Conduits and fittings for electrical installations
Standards Australia	AS 2220	Emergency warning and intercommunication systems in buildings
Standards Australia	AS 2293	Emergency evacuation lighting for buildings
Standards Australia	AS 2325	Tungsten filament lamps for general service – Performance requirements
Standards Australia	AS 2643	Fluorescent lamp ballasts of reactive type - Performance requirements
Standards Australia	AS 2644	Capacitors for use in discharge lamp circuits
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
Standards Australia	AS 3008	Electrical installations - Selection of cables
Standards Australia	AS 3015	Electrical installations - extra low voltage D.C. power supplies within public telecommunications networks
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.



Issuing Body	Document Number	Title
Standards Australia	AS 3112	Approval and test specification - Plugs and sockets-outlets
Standards Australia	AS 3168	Approval and test specification - Fluorescent lamp ballasts
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 3439	Low voltage switchgear and control gear assemblies
Standards Australia	AS 3947	Low voltage switchgear and control gear
Standards Australia	AS 4251	Electromagnetic compatibility (EMC) – Generic Emission Standard
Standards Australia	AS 4252	Electromagnetic compatibility - General immunity standard
Standards Australia	AS 4282	Control of the obtrusive effects of outdoor lighting
Standards Australia	AS/NZS 5000.1:2005	Electric cables - Polymeric insulated - For working voltages up to and including 0.6/1 (1.2) kV
Standards Australia	AS 60269.2.0-2005	Low-voltage fuses - supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application)
Standards Australia	AS/NZS 60598.1:2003	Luminaries - General requirements and tests
Standards Australia	AS 61000	Electromagnetic compatibility (EMC)
UOW	OHS064	OH&S Consideration for Design http://staff.uow.edu.au/workingsafely/design/OHS064-OHS_Design_Guidelines.pdf

Table 4.3 - Codes and standards



4.5 MINIMUM PERFORMANCE STANDARDS

The minimum performance standards as outlined in the documents specified in Section 4.4 shall apply. In addition, the services shall be designed to meet or exceed the following:

Lamp Type	Lamp Life (hours)
Fluorescent	8,000
Halogen	2,000
High Pressure Mercury Vapour	9,000
Incandescent	1,000
Low Voltage	2,000
Metal Halide	6,000

Table 4.4 - Minimum Performance Standards

4.6 INSTALLATION GUIDELINES

4.6.1 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.

4.6.2 Reticulation

4.6.2.1 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. 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.



4.6.2.2 Final Sub-Circuits

All cabling shall be mechanically protected and enclosed in not less than 20mm diameter conduits or supported by cable trays, except where installed in accessible roof or false ceiling spaces and in stud partition walls where 0.6/1kV grade TPS cables may be used.

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.

4.6.2.2 Conduits and Cable Trays

All conduits and cable 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.

Cable 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.

4.6.3 Switchboards

4.6.3.1 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 be either front connected or back connected and all sub-mains shall be protected by an air circuit breaker unit or CFS unit appropriately sized for the sub-mains.

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 heatshrink and coloured ties as follows:

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

4.6.3.2 Distribution Boards

DB construction shall be equal to Eaton Quicklag style of switchboards. The DB shall be of the "dead front" type with circuit breaker toggles exposed and operating in the vertical plane.

The DB shall be fitted with a hinged lockable door fitted L & F locks keyed to the University standard keying system.

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 that supply mechanical services shall be installed with provision for sub-metering of major mechanical plant (Refer also, section 4.3.4).

4.6.4 General Power

4.6.4.1 General Purpose Outlets

General purpose outlets shall be 10A 3 pin with flat earth pin and white in colour. Special purpose outlets shall be 15A or 20A depending on their purpose and be grey in colour.

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.



4.6.4.2 Skirting Duct

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

- 3 channel ducting;
- Equal to GKN standard.

4.6.4.3 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.

4.6.4.4 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.

4.6.5 Lighting

4.6.5.1 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 (refer also, section 4.3.6.1).

Connection to luminaires 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 or on catenary wires in the ceiling space.

4.6.5.2 Emergency Lighting

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.

4.6.5.3 Exit Lighting

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

4.6.5.4 Security Lighting

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 minimum lux levels and to reduce perceive security risks.

4.6.5.5 External Lighting

External lighting shall be installed to meet minimum lux levels, provide uniform lighting on walkways and stairs and to reduce the likelihood of accidents in areas where external risks may occur.

All underground external lighting shall be supplied with a cable size of 16mm.

4.6.6 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.

4.6.7 Labelling

Labelling on the switchboards 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.

All labelling on switchboards and meters shall be traffolyte with black lettering on a white background. The labels shall be securely attached using double sided adhesive tape.

The origin of final sub-circuits shall be identified by labelling the general purpose outlet or switch plate by means of standard number inserts.

Labelling of switchboards shall include:

- Building name and number



- Level number
- Size of submains supplying the distribution board
- Origin of submains

4.7 EQUIPMENT

4.7.1 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
Industrial Power Filters - Series Connected	Surge protection	Powerware	SPFi series	100A - 315A
Industrial Power Filters - Shunt Connected	Surge protection	Powerware	VSD series	40kA - 120kA
Lightning Protection	Lighting protection	Eritech	System 2000	N/A
3 Channel Skirting Duct	Skirting duct	Skirtec	C15035	N/A
Conduit	Conduit	Various	Various	Various
Rotary Cam Switch	Rotary cam switch	HPM	7GNX	Various
Architectural Switch Range MM Curved Series	Switch	HPM	MM770	240V 10A
Architectural Switch Range Architrave	Switch	HPM	MA770	240V 10A
Double Powerpoints	Socket outlet	HPM	777	240V 10A
Single Powerpoints	Socket outlet	HPM	787	240V 10A



Device	Function	Make	Model	Rating
Chemically Resistant Powerpoints	Socket outlet	HPM	777CH	240V 10A
Junction Boxes	Junction boxes	HPM	413	240/415V 30/40/50A
Insulated And Earth Connectors	Insulated and earth connectors	HPM	401	40/50A
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
Automatic Light Switch	Automatic light switch	HPM	XL632	600VA
Ceiling Sweep Fans	Ceiling sweep fans	Mistral	M1831-0	N/A
Domestic Exhaust Fan	Exhaust fan	Airflow	iCON15S	230V
Portable Products And Plug In Products	Portable products and plug in products	Various	Various	Various
Hot Water Units	Hot drinking water	Zip	Various	Various
Hot Water Domestic	Domestic hot water	Rheem	Various	Various
Motor Control Gear	Motor control gear	Cutler Hammer	Various	Various
Motor - Electrical	Motor	Crompton	Various	Various

Table 4.5 - Power Supply



4.7.2 Switchboards

Table 4.6 below contains a list of switchboard components.

Device	Function	Make	Model	Rating
Miniature Circuit Breakers	Miniature circuit breakers	Cutler Hammer	Quicklag	Various
Residual Current Devices	Residual current devices	Cutler Hammer	ELQ	Various
Chassis	Panel boards	Cutler Hammer	Quicklag	N/A
Cabinet	Panel boards	Cutler Hammer	QCC	N/A
CFS Units	CFS unit	Socomec	Various	Various
Fuse Switches	Fuse switches	Socomec	Various	Various
Contactors	Contactors	Cutler Hammer	Freedom	Various
Meters	Analogue meters	I.M.E.	Various	Various
Meters	Digital meters	PRI	Various	Various
Timers	Timers	Carlo Gavazzi	Various	Various
Electromechanical Timer	Timers	TimeMaster	GM40	Various
Relays	Relays	Finder	Various	Various
PLC	Programmable logic circuit	Siemens	Various	Various

Table 4.6 - Switchboards



4.7.3 Emergency and Exit Lighting

Table 4.7 below contains a list of communication devices.

Device	Function	Make	Model	Rating
Communication	Communications Interface Unit	Axiom	2231 85	
Communication	Modem Interface Unit	Axiom	682377	
Communication	Axiom Wireless Area Controller	Axiom	6822 98	
Communication	Axiom Aegis 8 Software	Axiom	6822 99	

Table 4.7 – Communication Devices

Table 4.8 below contains a list of batten devices.

Device	Function	Make	Model	Rating
Battens – Weatherproof	Non-Maintained Batten	Axiom	6822 91	1x18W
Battens – Weatherproof	Non-Maintained Batten	Axiom	6822 72	1x36W
Battens- Weatherproof	Maintained Batten	Axiom	6822 89	1x36W
Battens – Weatherproof	Maintained Batten	Axiom	6822 93	2x36W
Battens	Non-Maintained Batten Classification (D32/C32)	Axiom	6822 62	1x18W
Battens	Maintained Batten Classification (D32/C25)	Axiom	6822 61	1x18W
Battens	Maintained Batten Classification (D32/C40)	Axiom	6822 65	1x36W
Battens	Non-Maintained Batten Classification (D63/C63)	Axiom	6822 64	1x36W
Battens	Maintained Batten Classification (D63/C63)	Axiom	6822 63	1x36W
Battens	Maintained Batten Classification (D36/D20)	Axiom	6822 67	2x36W



Table 4.8 – Batten Devices

Table 4.9 below contains a list of exit signs.

Device	Function	Make	Model	Rating
Exit Signs – Surface Mounted	TR body Classification (D5/D8)	Axiom	6822 03	2x8W
Exit Signs – Surface Mounted	TR body – Weatherproof	Axiom	6822 69	2x8W
Exit Signs – Surface Mounted	Large Weatherproof IP66	Axiom	6822 88	2x13W
Exit Signs – Surface Mounted	Slide Connect Exit – body only Classification (D32/E32)	Axiom	686203	3WLed
Exist Signs – Surface Mounted	Slide Connect Exit - LED – white body, RM legends	Axiom	6822 03	
Exit Signs – Recessed	Edgelight Exit Classification S(E1.6/E1.6) Classification D(E1.6/C2.0)	Axiom	684422	4x3WLed
Exist Signs – Recessed	Bladelight Exit Double-sided, sustained	Axiom	6822 05	2x8W

Table 4.9 – Exit Signs

Table 5.0 below contains a list of satellite devices.

Device	Function	Make	Model	Rating
Satellites	Polycarb satellite Classification (D20/D20)	Axiom	6822 56	1x10W
Satellites	Surface mounted Classification (D20/D20)	Axiom	6822 57	1x10W

Table 5.0 – Satellite Devices



Table 5.1 below contains a list of power pack devices.

Device	Function	Make	Model	Rating
Power Packs	Power Pack	Axiom	6822 13	18W
Power Packs	Power Pack	Axiom	6822 15	36W
Power Packs	Power Pack	Axiom	6822 16	58W
Power Packs	Power Pack	Axiom	6822 51	14W
Power packs	Power Pack	Axiom	6822 17	28W
Power Packs	Power Pack	Axiom	6822 18	35W

Table 5.1 – Power Pack Devices

4.7.4 External Lighting

Table 5.2 below contains a list of external lighting.

Device	Function	Make	Model	Rating
Floodlights	Floodlighting	Eye Lighting	EYE H573D	1000W
Floodlights	Floodlighting	Eye Lighting	EYE H373D	400W
Floodlights	Floodlighting	Eye Lighting	EYE H802	400W
Floodlights	Floodlighting	Eye Lighting	Mini Fontana	250W
Floodlights	Floodlighting	Eye Lighting	Leo SR	250W
Floodlights	Floodlighting	Eye Lighting	Kitty Hawk	75/150W
Reflector System	Floodlighting	Pierlite	Dakar IP65	1000W
Industrial Floodlight	Floodlighting	Pierlite	503 IP66	1000 - 2000W



Device	Function	Make	Model	Rating
Sports Floods	Floodlighting	Pierlite	Environ	1000 - 1500W
Aurora Dome Top	Bollard Lighting	Pierlite	ABD200	70W
Aurora Flat Top	Bollard Lighting	Pierlite	AB200	70W
Comet	Bollard Lighting	Pierlite	CB150	18-100W
Auris IP54	Post Top Lighting	Pierlite	AUR150INC	150W
Clima IP447	Post Top Lighting	Pierlite	422222-01	125W
Pulsar 150 (Asymmetric)	Floodlighting	Versalux	PULSAR150ASMHTS0150	150W
Pulsar 150 (Symmetric)	Floodlighting	Versalux	PULSAR150SMMHTS0150	150W
Pulsar 70 (Asymmetric)	Floodlighting	Versalux	PULSAR70ASMHTS0070	70W
Pulsar 70 (Symmetric)	Floodlighting	Versalux	PULSAR70SMMHT	70W
Merlin	Floodlighting	Versalux	M90.107.501 – M90.107.508	250-400W
Ranger	Floodlighting	Versalux	M90.107.301 – M90.107.316	250-400W
Whitenight	Floodlighting	Versalux	M90.107.601 / M90.107.603	1000W
Aerobeam (Forward Throw)	Floodlighting	Versalux	40.038.010 – 40.038.050	150-400W
Aerobeam (Standard)	Floodlighting	Versalux	40.033.010 – 40.033.050	150-400W
Prisma	Floodlighting	Versalux	PRISMA 1, PRISMA 1/B, PRISMA 1/C	250-1000W
Sportz	Floodlighting	Versalux	40.100.010 – 40.100.030, 40.101.010 – 40.101.030	1000 / 2000W



Device	Function	Make	Model	Rating
Ultralux	Floodlighting	Versalux	40.031.050 – 40.031.350	400-1500W
Silvia Z1	Bollard Lighting	Versalux	SILVIAALMHT0070	70W
Tosca	Post Top Lighting	Versalux	TOSCAALMHT0035	35W
Tosca	Post Top Lighting	Versalux	TOSCAALMHT0070	70W
Tosca	Post Top Lighting	Versalux	TOSCAALMHT0150	150W
Satellite	Post Top Lighting	Versalux	50.160.010 – 50.160.091	70-250W
Delta SBO	Post Top Lighting	Versalux	DELTAASSBO, DELTAWLSBO, DELTALXSBO	250-400W
Zeta SBO	Post Top Lighting	Versalux	ZETASBOMHTS0150	150W

Table 5.2 - External Lighting

4.7.5 Internal Lighting

Table 5.3 below contains a list of internal lighting.

Device	Function	Make	Model	Rating
Fluorescent Lights T5	Recessed Troffers	Pierlite	T5 Futcha 5	28W
Clean Room Plaster (T5)	Recessed Troffers	Pierlite	CRF/DA236Q	2x28W - 2x54W
Compact Premium T-Bar	Recessed Troffers	Pierlite	CC418H/K12	4x18W
ET Economy T-Bar	Recessed Troffers	Pierlite	ET1218H	2x18W
Vandal Resistant Plaster	Recessed Troffers	Pierlite	CSVDT236	2x36W
Astro Diffused	Battens	Pierlite	ABD136H	1x36W
Compact Fluorescent Downlight	Recessed	EZ-Lite	AZL30FU	1x9W



Device	Function	Make	Model	Rating
Single Compact Fluorescent Lights	Recessed	Perlite	PLT	1x13W
Tungsten Halogen Dichroic Low Voltage Downlights	Recessed	Perlite	Elite	20W
Nova Recessed Fluorescent	Recessed	Versalux	NOVAR	1x14W, 2x14W, 3x14W, 4x14W, 1x28W, 2x28W
Inca Recessed T5 Fluorescent	Recessed	Versalux	10.102.010 – 10.102.040	2x14W, 3x14W, 4x14W, 2x28W
Florence Cleanroom Fluorescent	Recessed	Versalux	FLORENCE	2x28W, 2x36W, 4x14W, 4x18W
Aztec Specular Compact Fluorescent Downlight	Recessed	Versalux	AZTECSP	1x13W, 1x18W, 1x26W, 2x13W, 2x18W, 2x26W
Aztec Crossblade Compact Fluorescent Downlight	Recessed	Versalux	20.237.010 – 20.237.140	1x13 – 2x26W
Aztec Facetted Compact Fluorescent Downlight	Recessed	Versalux	20.238.010 – 20.238.140	1x13 – 2x26W
2EM Modular T5 Fluorescent System	Modular Fluorescent	Versalux	2EM	28W, 54W
2EM Modular T8 Fluorescent System	Modular Fluorescent	Versalux	2EM	36W, 58W
Hangar Industrial / Commercial Highbay Lighting	Industrial Lighting	Versalux	Hangar	250-400W
Versabeam Industrial / Commercial Highbay / Lowbay Lighting	Industrial Lighting	Versalux	30.040.010 – 30.040.140	175-400W



Device	Function	Make	Model	Rating
Multilux Industrial / Commercial Lowbay Lighting	Industrial Lighting	Versalux	MULTILUX, MULTILUXR, MULTILUXDPI, MULTILUXBON	175-400W
Rhino Industrial Fluorescent	Industrial Lighting	Versalux	RHINO2X24	2x24W
Rhino Mini Industrial Fluorescent	Industrial Lighting	Versalux	RHINOMINI2X11	2x11W
Rhino Round Industrial Fluorescent	Industrial Lighting	Versalux	RHINOROUND1X28	1x28W

Table 5.3 - Internal Lighting

4.7.6 Cabling

Table 5.4 below contains a list of cabling.

Function	Minimum Cable Size (mm ²)	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 5.4 - Cabling

4.7.7 Conduits

Table 5.5 below contains a list of conduits.

Device	Function	Make	Model	Sizing
UPVC Conduit	Conduit	Iplex	Various	> 20mm (diameter)
Rigid PVC Conduit	Conduit	Vinidex	Various	> 20mm (diameter)
HDPE	Conduit	Vinidex	Various	> 20mm (diameter)
Rigid Steel Conduit	Conduit	HPM	Various	> 20mm (diameter)



Device	Function	Make	Model	Sizing
Flexible Steel Conduit	Conduit	HPM	Various	> 20mm (diameter)

Table 5.5 - Conduits

4.8 WARRANTY

The designer shall ensure that all components are supplied with the following minimum warranty periods:

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

Table 5.6 - Warranty Periods

4.9 LIFE CYCLE COSTING

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