E.3.2 LIGHTING – TABLE OF CONTENTS

UNSW DESIGN & CONSTRUCTION REQUIREMENTS – WEB ENTRY PAGE

SECTION A – INTRODUCTION

SECTION B – DEVELOPMENT & PLANNING

SECTION C – ARCHITECTURAL REQUIREMENTS

SECTION D – EXTERNAL WORKS

SECTION E.1 – HYDRAULIC SERVICES

SECTION E.2 – MECHANICAL SERVICES

SECTION E.3.1 – ELECTRICAL SERVICES

E.3.2 LIGHTING – SCHEDULE OF CHANGES – REVISION 4.1

E.3.2. LIGHTING

E.3.2.1. External Lighting

E.3.2.1.1. General Requirements

E.3.2.1.2. Lighting Fixtures

E.3.2.1.3. Type Of Luminaire

E.3.2.1.4. Light Sources

E.3.2.1.5. Lighting Levels

E.3.2.1.6. Control System

E.3.2.1.7. Connection Of Control System

E.3.2.1.8. Environment, Trees And CCTV

E.3.2.2. Internal Lighting

E.3.2.2.1. Scope

E.3.2.2.2. Verification

E.3.2.2.3. Design verification

E.3.2.2.4. Construction Verification

E.3.2.2.5. Installation Verification

E.3.2.2.6. General Requirements

E.3.2.2.7. Light Sources

E.3.2.2.8. Luminaires

E.3.2.2.9. Low voltage and mains voltage tungsten halogen fittings

E.3.2.2.10. Glare Control

E.3.2.2.11. Control Gear

E.3.2.2.12. Quality of Luminaires

E.3.2.2.13. Preselection of Luminaires

E.3.2.2.14. General Luminaire Quality

E.3.2.2.15. Surface mounted Luminaires with wraparound prismatic diffuser.

E.3.2.2.16. Recessed luminaire with prismatic refractor panel

E.3.2.2.17. Recessed luminaire with semi specular reflector

E.3.2.2.18. Decorative Fittings

E.3.2.2.19. Illuminance

UNSW Design and Construction Requirements (Rev 4.1)
E.3.2.2.20. Avoid over-illumination  18
E.3.2.2.21. Lighting Control  18
E.3.2.2.22. Switching  20
E.3.2.2.23. Multifunction Spaces  20
E.3.2.2.24. Dimming  21
E.3.2.2.25. Integration  21
E.3.2.2.26. Daylight integration  21
E.3.2.2.27. Scheduling of Lighting Controls  22
E.3.2.2.28. Installation  22
E.3.2.3. Emergency Lighting  28

SECTION E.3.3 – SPECIAL SYSTEMS

SECTION E.3.4 – HIGH VOLTAGE

SECTION E.4 – COMMUNICATIONS

SECTION E.5 – LIFTS

SECTION E.6 – FUME CUPBOARDS

SECTION F – SPECIFIC AREA REQUIREMENTS

APPENDIX 1 – BUILDING AUTOMATION AND CONTROL SYSTEMS
SPECIFICATION

APPENDIX 2 – CONCRETE FOR STRUCTURES

APPENDIX 3 – UNSW CONTROL SYSTEM STANDARDS HVAC

APPENDIX 4 – DOCUMENT REQUIREMENTS

APPENDIX 5 – UNSW STANDARD PRELIMINARIES

APPENDIX 6 – SECURITY SYSTEMS
E.3.2 LIGHTING – SCHEDULE OF CHANGES – REVISION 4.1

As a guide only, attention is drawn to changes that have been made in the following clauses since the last revision

<table>
<thead>
<tr>
<th>Clause</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>General revision</td>
<td></td>
</tr>
<tr>
<td>E.3.2.2.22</td>
<td>August 2004</td>
</tr>
<tr>
<td>E.3.2.2.19</td>
<td>November 2004</td>
</tr>
</tbody>
</table>
E.3.2. LIGHTING

E.3.2.1. External Lighting

E.3.2.1.1. General Requirements

External lighting shall provide an elegant, interesting environment at night as well as a safe and secure environment for people to move about.

A design for external lighting shall ensure that the following parameters are met:

Highlighting building features and entrances
Provision of appropriate lighting for pedestrian walkways between buildings and car-park facilities.
Provision for appropriate lighting for Roadways.
Compliance with all relevant lighting standards and Occupational Health and Safety Act.
Conformity with existing campus installations and control systems.
Maintainability of the installation.

Highlighting of buildings or points of interest shall be carefully considered in accordance to their relative importance and shall be combined in a harmonious fashion between the visual interests and the needs of pedestrians.

Appropriate lighting for pedestrians shall be provided to ensure their safety and a secure environment.

In the selection of components making up an installation for external lighting the following shall be assessed:

a) Energy efficiency of the light fittings or luminaires.
b) Maintenance of the light fitting (easy access for any future need for spare part)
c) Type of appropriate lamps
d) The method for the control system.

E.3.2.1.2. Lighting Fixtures

Any lighting fixture or luminaire chosen shall be from a well-known manufacturer, preferably made in Australia.

The selection of luminaires shall be based on the following:

UNSW Design and Construction Requirements (Rev 4.1)
a) Vandal resistant  
b) UV stability of component  
c) Resistant to corrosion  
d) Weather proof  
e) Easy access for maintenance of lamp  
f) Energy management provision and controls

Glare from the fitting shall be carefully controlled for comfort; indirect type luminaire could be applied. However, luminaire with direct optical control (with shielded lamps) should be considered if more appropriate.

Luminaires using unshielded HID lamps shall not be visible to the public at normal viewing angles.

The external lighting design shall utilise the building whenever practical for mounting of luminaires. The provision for access and maintenance shall be included in all such designs.

In any installation, the choice and type of luminaire and its location shall be compatible with the Security CCTV Surveillance cameras.

Post top lanterns shall generally be used for most of pedestrian areas.

High mast luminaires or roadway luminaire shall be used at campus entrance only.

**E.3.2.1.3. Type Of Luminaire**

The types of luminaire, which are to be used with external lighting, are as follows:

**Post Top Luminaire**

This type of luminaire is mounted on a 3.5 m height painted galvanized steel pole. The preferred mounting method is by separate pole bolted to a ragbolt assembly. The luminaire shape is a clear spherical lens. As conformity with any existing luminaire is crucial for the aesthetic of the campus, the 500-mm size is recommended to the 600 mm. The type of lens should PMMA acrylic material. Generally direct optical systems comprising lamp is preferred to an indirect system as it provides a better uniformity at a reasonable spacing (20m).

**Wall Mounted Luminaires**

This type of fitting is mainly used to illuminate walls for visual orientation only.

**Bollards**

This type of luminaire shall be used to delineate the boundaries of walkways. This luminaire provides a low level of lighting just enough for people to move about. Bollards do not provide the level of safety a post top luminaire will provide. Therefore use of bollards shall be limited to provide guidance for a walkway.
Uplighters
These fitting are to be used only after consultation and approval of Engineering Services the Project Officer. They are generally used for aesthetic reasons. However they are inefficient in providing useful illuminance on pathways and create interference with CCTV surveillance system.

**E.3.2.1.4. Light Sources**

Lamps for external lighting luminaire shall be appropriately selected from the following:

**Incandescent Lamps**
Generally this type are not suitable for external lighting except for selected application and shall not be used unless approved by Engineering Services the Project Officer. These lamps are inexpensive and do not require any control gear; they have a good colour rendering, instantaneous switching, but are very inefficient and have a very short service life.

**Fluorescent Lamps**
Fluorescent lamps are low-pressure mercury discharge lamps, certain type of lamps have an excellent colour rendering (triphosphor type). These lamps have a low luminance source producing low glare, and have a very high efficiency. Fluorescent lamps are suitable for many applications such as covered ways, under awnings.

**High Intensity Discharge (HID) Lamps**
Due to the initial high cost and the delay to start up, HID lamps shall only be used in certain selected application where appropriate. These lamps are discharge lamps and request appropriate control gears. The HID lamps are excellent for their high efficiency and very long service lives.

**Mercury Vapour (MV) Lamps**
MV are low efficiency and suffer significant lumen depreciation such lamps shall be used mainly where fitting are difficult to be accessed. MV lamps are cheap, reliable and have an exceptional long service life. The characteristics of MV lamps are the blue-white light.

**Metal Halide Lamps (MH)**
These lamps shall be the preferred source for pedestrian lighting. They have an excellent colour rendering. Most of MH lamps are highly efficient and have a long service life. Lumen maintenance is good.

**High Pressure Sodium Lamps (HPS)**
This type of lamps, where appropriate, shall be used for floodlighting building façade, roadway and in some security applications. HPS lamps have a high lighting level, long service life and stability of light output. However the colour rendering is poor.
E.3.2.1.5. Lighting Levels

Any design for external lighting shall comply with the Australian Standard AS1158.1. 1986.

The recommended lighting level shall be as follows:

<table>
<thead>
<tr>
<th>Area</th>
<th>Min. Average Illuminance (Lux)</th>
<th>Minimum Illuminance (Lux) at any Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service roads</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Entrance and nodes</td>
<td>50</td>
<td>10</td>
</tr>
<tr>
<td>Shared zones and formal Walks</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Steps</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Informal walk</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Covered lighted Ways</td>
<td>10-25</td>
<td>8</td>
</tr>
</tbody>
</table>

It has to be noted that for compatibility with the CCT Surveillance Cameras, lighting should be as uniform as possible with a maximum of 10 lux.

E.3.2.1.6. Control System

The control system shall be a centralised system, which will control all light fittings that provide lighting for pedestrians. This system shall be controlled via the External Lighting Automatic Control. This control is a native BACNet system and any controller shall be BTP Modbus type from Alerton and shall be part of the whole Building Automation and Control System (BACS)

E.3.2.1.7. Connection Of Control System

The distribution board for the control system for all external lighting in any building shall be located at the main switchboard for that building.

E.3.2.1.8. Environment, Trees And CCTV

Where required for security and/or practical consideration, planting including trees shrubs etc… shall be kept pruned regularly so as not to impair the effectiveness of campus external lighting

UNSW Design and Construction Requirements (Rev 4.1)
As with other visual task, external lighting for security is a complex requirement

Refer: Section B - PLANNING CONTROLS - Crime Prevention Through Environmental Design (CPED Principles)

As previously mentioned Security CCTV Surveillance Cameras lighting shall be totally uniform with maximum illumination to about 5-10 lux and shall have a predominantly downward directionality

**E.3.2.2. Internal Lighting**

**E.3.2.2.1. Scope**

This document outlines the University’s minimum requirements for:

- a) The extent and quality of lighting that is to provided in each space
- b) The quality of the lighting equipment to be used
- c) The energy efficiency of the installation
- d) Lighting control

The requirements shall apply to all new, refurbished and modified installations on University property.

**E.3.2.2.2. Verification**

As part of the design and installation process the following verification shall be provided throughout the various stages of the project:

**E.3.2.2.3. Design verification**

The consultant, designer or design and construct contractor shall document the equipment and control that will be provided, prior to construction commencement and submit a *statement of design compliance* to the “Manager – Engineering ServicesProject Officer” stating that the documents comply with these requirements. If there are any deviations from these requirements they shall be attached as a schedule listing how it does not comply, and the extent of the non-compliance. The written approval by the Manager Engineering Services the Project Officer for each non-compliance, shall be attached to the schedule prior to any proposed departures being implemented.

**E.3.2.2.4. Construction Verification**

The Builder or Design and Construct Contractor shall provide a *statement of specification compliance* stating that the specified equipment is to be installed. If **UNSW Design and Construction Requirements (Rev 4.1)**
approved deviations are proposed, the statement must clearly identify each deviation and be accompanied with evidence that Manager Engineering Services the Project Officer approval has been given. Deviations without approval will not be accepted. Equipment that is installed contrary to the statement of specification compliance shall be replaced, within 12 weeks of notification, at no cost to the University.

E.3.2.2.5. Installation Verification

At the completion of the installation, and before payment is made the Consultant or Design and Construct Contractor shall provide a statement of installation compliance stating that the specified equipment and approved variations (if any) has been installed.

E.3.2.2.6. General Requirements

The lighting design shall meet all the applicable requirements of the Building Code of Australia and other statutory requirements.

The lighting design shall provide the visual conditions required for the task with minimal energy usage and without excessive maintenance. The lighting design shall meet the qualitative and quantitative recommendations of AS1680 Interior lighting code.

The following guide sets out the minimum requirements for the design of interior lighting within the University. Deviations will only be allowed in circumstances where the specific function of the building requires an exceptional lighting solution.

Before any deviations from these requirements are incorporated into the documentation or installed, written approval is required from the Manager – Engineering Services the Project Officer.

Requests for a departure or variations of the requirements shall be in writing and provide the following information:

- The nature of the proposed departure or relaxation of the requirements
- The extent that it applies to the project
- An assessment of the impact to long-term energy consumption and maintenance
- The reason the proposed departure or relaxation of the requirements is required.

E.3.2.2.7. Light Sources

The University’s preferred light source is low pressure mercury fluorescent. Fluorescent lamps shall have tri-phosphor coating and low mercury content. Lamps shall have a maximum mercury content of 4mg.

Fluorescent light sources shall be used for all internal applications except in the following situations:

- Metal Halide luminaires may be used in areas with high ceilings or where high illuminance is required
Where strongly directional lighting is specified
Downlights and Wallwash luminaires may be fluorescent or metal halide depending on the lighting function required

Display lighting

In most situations where dimming is required it is only required to dim to 10% output. In these situations fluorescent lamps with dimmable electronic ballasts shall be used. Where the function of the space requires uniform dimming to and from extinction (e.g. a performance auditorium) tungsten halogen lighting may be used.
### E.3.2.2.8. Luminaires

Luminaires shall be high efficiency, quality luminaires with the following minimum performance:

<table>
<thead>
<tr>
<th>Luminaire type</th>
<th>Minimum Light Output Ratio</th>
<th>Minimum Downward Light Output Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Mounted Linear Fluorescent</td>
<td>0.82</td>
<td>0.72</td>
</tr>
<tr>
<td>Recessed Linear Fluorescent - Prismatic</td>
<td>0.80</td>
<td>0.80</td>
</tr>
<tr>
<td>Recessed Linear Fluorescent – Low Brightness</td>
<td>0.65</td>
<td>0.65</td>
</tr>
<tr>
<td>Recessed Linear Fluorescent – Suspended Fittings</td>
<td>0.65</td>
<td>0.45</td>
</tr>
<tr>
<td>Recessed Compact Fluorescent</td>
<td>0.45</td>
<td>0.45</td>
</tr>
<tr>
<td>Wall Wash fittings</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Recessed Metal Halide</td>
<td>0.55</td>
<td>0.55</td>
</tr>
<tr>
<td>High Bay Luminaires</td>
<td>0.8</td>
<td>0.75</td>
</tr>
<tr>
<td>Low Bay Luminaires</td>
<td>0.75</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Table 4.6.1 Minimum Light Output Ratios

Where a fitting is built into an enclosure, the light output ratio for comparison with the table above shall be adjusted to include the effect of the enclosure as well as the luminaire.

### E.3.2.2.9. Low voltage and mains voltage tungsten halogen fittings

Low voltage (and extra low voltage normally referred to as low voltage) and 240 Volt tungsten halogen fittings, including spotlights, downlights and directional downlights may be used where there is the need to highlight specific objects or areas, or to create a special lighting effect.

Tungsten halogen lamps are not to be used for general illumination unless there is a specific requirement in the brief to dim to extinction, or for display lighting. Tungsten halogen or incandescent fittings are not to be on the same circuit as other light sources.

All circuits with tungsten halogen or incandescent fittings shall have a dimmer with a soft start and an upper limit set to 85% of mains voltage.
Tungsten halogen fittings shall be provided with UV shields and glass covers unless low pressure, UV-stop lamps are used.

Dichroic lamps shall be minimum 5000-hour rated life and be manufactured and branded as one of the following brands:

BLV
GE
Osram
Philips
Sylvania

Luminaires for low voltage tungsten halogen shall be manufactured with a heat sink area to remove the heat from the back of the lamp. The heatsink shall be made of cast aluminium and shall have minimum overall dimensions equivalent to 50mm diameter and 20mm deep.

E.3.2.2.10. Glare Control

Luminaires shall be selected to achieve the appropriate glare control specified in Table 5, while still illuminating the vertical surfaces. Supplementary lighting in the form of wall washing should be used to reduce gloom rather than increasing the illumination over the entire area.

Glare control shall be achieved by reflector and refractor design rather than methods that significantly reduce the light output of the luminaire.

Low brightness fittings shall use semi-specular, high purity aluminium reflectors

Prismatic fittings shall combine an acrylic extruded of injection moulded lens panel of K12 or K19 pattern, with a high reflectance internal reflector.

“Soft tone” luminaires maybe used provided that they achieve the required light output and glare control

Eggcrate and silvertint refractor panels are not acceptable.

The Glare Index values specified in Table 5 shall be calculated as specified in AS1680.1 Internal Lighting Part 1: General principles and recommendations. The reference points for calculation shall be confined to locations where students or staff are reasonably expected to be located to undertake the task required in the room. The glare will not be calculated for lecterns, daises or positions where lecturers or performers normally occupy.

E.3.2.2.11. Control Gear
Electronic ballasts shall be used for all linear fluorescent lamps and compact fluorescent lamps greater than 11 Watts. Electronic ballasts shall have the following characteristics:

a) Warm or soft start period of > 0.8 seconds
b) Power factor > 0.95
c) Switch off of defective lamps and automatic restart after lamp replacement
d) Internal overvoltage protection
e) Dimming electronic ballasts shall only be used where dimming is required.

f) Electronic Ballasts shall be limited to the following brands:

Helvar
Osram
Philips
Tridonic-Atco
Vossloh-Schwebe

Conventional copper iron ballasts shall only be used where a specific luminaire is required that is only available with a conventional ballast or for high-pressure discharge lamps. All conventional ballasts shall be low loss.

The maximum power consumption and losses for ballasts are listed in Table 2

<table>
<thead>
<tr>
<th>Lamp controlled</th>
<th>Circuit power consumption at rated lamp flux</th>
</tr>
</thead>
<tbody>
<tr>
<td>T8 lamps</td>
<td></td>
</tr>
<tr>
<td>1 x18 Watt</td>
<td>22 W</td>
</tr>
<tr>
<td>2 x 18 Watt</td>
<td>40 W</td>
</tr>
<tr>
<td>3 x 18 Watt</td>
<td>58 W</td>
</tr>
<tr>
<td>1 x 36 Watt</td>
<td>37 W</td>
</tr>
<tr>
<td>2 x 36 Watt</td>
<td>72 W</td>
</tr>
<tr>
<td>3 x 36 Watt</td>
<td>105 W</td>
</tr>
<tr>
<td>1 x 58 Watt</td>
<td>57 W</td>
</tr>
<tr>
<td>2 x 58 Watt</td>
<td>108 W</td>
</tr>
<tr>
<td>T5 Lamps</td>
<td></td>
</tr>
<tr>
<td>14 Watt</td>
<td>17 W</td>
</tr>
<tr>
<td>2 x 14 Watt</td>
<td>33 W</td>
</tr>
</tbody>
</table>

**UNSW Design and Construction Requirements (Rev 4.1)**
<table>
<thead>
<tr>
<th>Watt</th>
<th>Control Gear Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>33 W</td>
</tr>
<tr>
<td>63</td>
<td></td>
</tr>
<tr>
<td>2 x 28</td>
<td>63 W</td>
</tr>
<tr>
<td>33 W</td>
<td></td>
</tr>
<tr>
<td>63 W</td>
<td></td>
</tr>
</tbody>
</table>

**Conventional Ballasts Hot Water Loss**

<table>
<thead>
<tr>
<th>Watt</th>
<th>Control Gear Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>6 W</td>
</tr>
<tr>
<td>36</td>
<td>5.5 W</td>
</tr>
<tr>
<td>58</td>
<td>8 W</td>
</tr>
</tbody>
</table>

**Linear Fluorescent**

<table>
<thead>
<tr>
<th>Watt</th>
<th>Control Gear Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;18</td>
<td>3.5 W</td>
</tr>
<tr>
<td>18</td>
<td>6 W</td>
</tr>
<tr>
<td>&gt;18</td>
<td>5.5 W</td>
</tr>
</tbody>
</table>

**Compact Fluorescent**

<table>
<thead>
<tr>
<th>Watt</th>
<th>Control Gear Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>9 W</td>
</tr>
<tr>
<td>70</td>
<td>14 W</td>
</tr>
<tr>
<td>150</td>
<td>20 W</td>
</tr>
<tr>
<td>175</td>
<td>16 W</td>
</tr>
<tr>
<td>250</td>
<td>20 W</td>
</tr>
</tbody>
</table>

**Metal Halide**

<table>
<thead>
<tr>
<th>Watt</th>
<th>Control Gear Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>9 W</td>
</tr>
<tr>
<td>70</td>
<td>14 W</td>
</tr>
<tr>
<td>150</td>
<td>20 W</td>
</tr>
<tr>
<td>175</td>
<td>16 W</td>
</tr>
<tr>
<td>250</td>
<td>20 W</td>
</tr>
</tbody>
</table>

Table 4.6.2 Maximum Control Gear Losses

**E.3.2.2.12. Quality of Luminaires**

All luminaires shall be good quality fittings with good quality control gear and fittings designed for a minimum life of 20 years.

All luminaires shall comply with the following standards

- AS/NZS 60698.1 – 2001 Luminaires – General requirements and tests
- AS/NZS 60698.2 – 1998 Luminaires – Particular requirements – Fixed general purpose luminaires
- AS/NZS 4251 and 4252 Electromagnetic compatibility.

Fittings used in damp or aggressive environments shall be manufactured of non-corrosive material, UV stabilised with an IP Rating appropriate for the area. All fittings used in external environments shall have a minimum rating of IP54, above and below the ceiling.

**E.3.2.2.13. Preselection of Luminaires**
The University has preselected luminaires for the common types of luminaires used throughout the University’s facilities. The luminaires covered by the preselection process are:

Surface mounted linear fluorescent luminaires
Recessed linear fluorescent fittings with refractive diffuser for t-bar and plasterboard ceilings.
Recessed linear fluorescent fittings with semi-specular low brightness reflectors for t-bar and plasterboard ceilings

The preselected luminaires are listed by brand and catalogue number in the Schedule of Preselected luminaires available from the University’s Engineering Services. There are multiple fittings listed in each category. The University has no preference for any fitting and the designer may select any appropriate fitting from the Schedule. The Electrical Contractor must install the luminaire selected by the designer.

E.3.2.2.14. General Luminaire Quality

Luminaire bodies shall be fabricated from zinc coated steel or pressure diecast aluminium.

Sheet steel bodies shall be folded to give rigidity. Ends shall be folded to give a minimum overlap of 20mm and shall be either spot or seam welded. The body shall be formed to exclude light leaks. All edges of all openings of the fittings shall be folded. Corners of the trim that are visible shall have mitred joints that are seam welded or fabricated in a manner that the joint cannot open or move out of alignment.

Luminaires shall either have a minimum thickness of 1.0mm or shall be double folded and ribbed to achieve rigidity.

The fittings shall not have more than 12 holes in the back of the body.

Following fabrication the fitting shall be degreased and powder coated inside and out. The inside of all fittings shall be white.

Fittings fabricated from pre-painted sheet will not be accepted. The powder-coat finish shall have a minimum thickness of 100µM. The inside surfaces shall have a minimum thickness of 80µM and reflector surfaces, 100µM.

E.3.2.2.15. Surface mounted Luminaires with wraparound prismatic diffuser.

The fitting shall be provided with a purpose made prismatic wraparound refractor panel of minimum 2.5mm thick acrylic. The base of the refractor shall be K12 or K19 pattern prisms and the sides shall be horizontally reeded. Of the refractor is injection moulded the side panels can be prisms.
The refractor panel shall be held in place by clips or springs. Fittings that rely on the end caps for retaining the refractor will not be accepted.

E.3.2.2.16. Recessed luminaire with prismatic refractor panel

The fitting shall have a lay in prismatic refractor panel. The panel shall be a clear acrylic with a minimum thickness of 2.8mm. The panel shall be a K12 or K19 panel. The fitting shall be constructed so that the fitting returns an all sides behind the t-bar so that the refractor panel is fully supported by the fitting body and not the t-bar lip. Recessed fittings shall be provided with a 1.5 metre lead and three pin plug.

Fittings designed for installation in plasterboard ceilings shall provide uniform pressure between the trim and the ceiling so that there is no sagging or gaps.

E.3.2.2.17. Recessed luminaire with semi specular reflector

The fittings shall have a specially designed semispecular reflector to provide a batwing type distribution while achieving a cut off above 35 degrees. The reflector and cross blades shall be fabricated from min 0.5mm high purity anodised aluminium manufactured specifically for luminaire reflectors by Alanod. The aluminium shall have the following minimum requirements:

- Purity >99.8%
- Total reflectivity >84%
- Diffuse reflectivity <70%, > 64%
- Anodising thickness >2.5 µm
- Low iridescence when used with triphosphor lamps

The reflector and cross blades shall be designed so that there is no visible image of the lamp in the reflector when viewed above the shielding angle.

E.3.2.2.18. Decorative Fittings

The use of decorative fittings will be limited to the following areas:

- Building entrance lobbies
- Foyers of auditoria or primary lecture theatres
- Board Rooms

All decorative fittings shall use lamps with a minimum efficacy of 65 Lumens per Watt, where the Watts are the circuit input watts. Decorative fittings shall have a minimum light output ratio of 0.45 and be designed so that the fitting does not collect dirt and insects on the inside of the diffuser. Fittings must be proprietary fittings from published catalogues. Specially designed and manufactured fittings shall not be used.

UNSW Design and Construction Requirements (Rev 4.1)
E.3.2.2.19. Illuminance

Lighting levels shall be designed to achieve the illumination levels specified in table 5.

There is a strong preference for direct illumination. However, an upward component may be used to improve the appearance of a space and to reduce gloom. In these circumstances, the total upward flux shall not exceed 20% of the downward luminous flux in a room. In any case up lighting should be avoided in areas with ceiling reflectances of less than 70%.

In spaces with large windows or where there is a potential for sky glare, measures should be taken to reduce the transmission of the glass and the direct penetration of sunlight. Vertical surfaces of the rooms should be specifically lit in preference to increasing the general illumination in the space to compensate for external glare sources. The room layout shall be arranged to minimise the affect of window glare.

Designers shall use the following light loss factors in their calculations:

<table>
<thead>
<tr>
<th>Luminaire Type</th>
<th>Light Loss Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recessed Fluorescent</td>
<td>0.75</td>
</tr>
<tr>
<td>Surface Mounted Fluorescent</td>
<td>0.7</td>
</tr>
<tr>
<td>Downlights</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Table 4.6.3 Design Light Loss Factors

Lighting designs should be based on the best information available. Lighting designs must be based on the photometric data for the specific luminaire and lamp combination proposed and reflectance of room surfaces based on the actual colours proposed.

Irrespective of the room colours used, the reflectance used in the calculations shall not be higher than the following unless approved by the University:

<table>
<thead>
<tr>
<th>Space</th>
<th>Maximum ceiling reflectance</th>
<th>Maximum wall reflectance</th>
<th>Maximum floor reflectance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Laboratories</td>
<td>0.75</td>
<td>0.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Meeting Rooms</td>
<td>0.75</td>
<td>0.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Offices</td>
<td>0.75</td>
<td>0.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Auditoria and Lecture Theatres</td>
<td>0.5</td>
<td>0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Lecture Rooms</td>
<td>0.75</td>
<td>0.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Laboratories</td>
<td>0.75</td>
<td>0.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Workshops and Plant Rooms</td>
<td>0.5</td>
<td>0.5</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Table 4.6.4 Maximum Design Reflectances

UNSW Design and Construction Requirements (Rev 4.1)
E.3.2.2.20. Avoid over-illumination

The lighting design shall avoid under or over-illuminance. While it is acknowledged that physical limitations require some tolerance in illuminance, excessive over-illuminance is not acceptable.

The acceptable range for the average illuminance in a space, after compensation for the light loss factor, is −5%, +10% or the minimum number of additional lights that can be added within the limitations of the luminaire layout, whichever is the lesser.

Where a relatively small portion of the space has higher illumination requirements, task lighting should be used rather than increasing the general illumination of the space.

E.3.2.2.21. Lighting Control

E.1.2.2.21.1. Motion Detection

Spaces indicated in Table 5 as requiring “Motion” detection, shall be fitted with a passive infrared, ultrasonic or microwave detector. The type of detector shall be selected to suit the space and application, in accordance with the following guidelines.

The detectors shall be a stand-alone, mains voltage unit designed specifically for the switching of lighting. The contacts in the detector shall either be rated to switch the inductive load connected, or the detector shall control a contactor rated for its duty.

The detector shall cover all locations where people may normally be expected to occupy. Additional detectors are to be provided where the room shape or obstructions will restrict the coverage of the detector.

The selection of detector types shall be based on the cost of the detectors and the coverage achieved.

Where ultrasonic and microwave detectors are to be used in laboratories the designer will check that the operating frequency of the emissions will not effect the laboratories function.

The detectors shall be as follows:

E.1.2.2.21.2. Passive infra red

To be used in small rooms and rooms that are subdivided with obstructions.

The detectors shall be selected based on the design range of the detector. Where a space requires more than three detectors to cover an open area a unit with a larger range should be specified.

PIR detectors should not be used in areas with areas of rapidly changing temperature.
Detectors may be ceiling mounted or corner mounted to achieve the best coverage of the room.

The location of the detectors should take into account permanent obstructions.

The detector shall be located so that it is not triggered by external activities.

The detector shall have a switch off delay between 15 and 25 minutes. If the delay is adjustable it shall not be able to be adjusted above 30 minutes.

The detector shall have a photoelectric switch incorporated into the sensor. The photoelectric switch shall switch off the lights when the illumination level exceeds a predetermined level. The level shall be adjustable between 50 and 2000 lux.

If the delay time is not adjustable there shall be a walk test setting with a rapid reset.

**E.1.2.21.3. Ultrasonic detectors**

Ultrasonic detectors shall be used in rooms that are of sufficient size to require more than three PIR detectors. They shall also be used in rooms with extensive divisions and obstructions. In some circumstances the ability for an ultrasonic detector to monitor the space immediately behind it will improve the coverage.

Ultrasonic detectors shall not be installed adjacent to air conditioning registers or in areas subjected to air movement or moving objects such as machines or ceiling fans.

The detector shall be located so that it is not triggered by external activities.

The detectors shall have adjustable sensitivity in the on and off mode.

The detector shall have a switch off delay between 15 and 25 minutes.

If the delay is adjustable it shall not be able to be adjusted above 30 minutes.

The detector shall have a photoelectric switch incorporated into the sensor. The photoelectric switch shall switch off the lights when the illumination level exceeds a predetermined level. The level shall be adjustable between 50 and 2000 lux.

Wide and narrow distributions shall be provided to suit special requirements of the room.

**E.1.2.21.4. Microwave detectors**

Microwave detectors to be used in large areas (typically detection distances between 15 and 60 metres) and areas medium areas with high air movement.

The detector shall be located so that it is not triggered by external activities including transmission.

*UNSW Design and Construction Requirements (Rev 4.1)*
The detectors shall have adjustable sensitivity in the on and off mode.

The detector shall have a switch off delay between 15 and 25 minutes.

If the delay is adjustable it shall not be able to be adjusted above 30 minutes.

The detector shall have a photoelectric switch incorporated into the sensor. The photoelectric switch shall switch off the lights when the illumination level exceeds a predetermined level. The level shall be adjustable between 50 and 2000 lux.

Wide and narrow distributions shall be provided to suit the special requirements of the room.

Microwave detectors should not be used in areas where the frequency of the emission may interfere with equipment in laboratories.

Microwave detectors should not be used in areas with lightweight walls or large expanses of glass as they can detect outside the area.

**E.3.2.2.22. Switching**

Irrespective of the presence of motion detection all rooms shall be fitted with switches at the door. Where a room is larger than 40m² the switching shall be subdivided so that there is no area >50m² per switch.

All switches shall be designed to switch inductive loads and shall switch no more than 70% of their rated current.

Consultation with the UNSW Facilities Project Manager is required prior to selection of light switches as some switches installed on campus have exhibited undue carbonizing and arcing resulting in minor electric shock when operated. Assurance must be given that the operating mechanism is robust enough to prevent arcing and carbonizing.

In lecture theatres and spaces that are likely to be blacked out, the switches are to be fitted with integral neon indicators or LEDs that illuminate when the switch is in the off position.

Separate lighting circuits and controls, including dimmer channels, shall be provided for all supplementary lighting schemes including demonstration areas, bio box, dais lighting and wall washing.

**E.3.2.2.23. Multifunction Spaces**

Where the multiple functions of a space require several lighting systems superimposed, the control shall be mutually exclusive so that only one system can be used at a time.
Lighting controls shall be clearly labelled to indicate the lighting function of each control. 

**E.3.2.24. Dimming**

Where dimming is required, the dimming shall be provided by centralised dimmer units in bundles of 4 or 12 dimmer channels of a rating to suit the loads. All dimmers controlling the one space shall be linked by a common control network. The dimmers shall be capable of a minimum of 4 programmed preset levels. The dimmer shall have a self-monitoring function for the activation of the emergency lighting in the case of dimmer failure. After re-energisation the dimmers shall revert to the levels prior to disconnection.

Dimming that is not required to dim below 10% of input voltage, shall use fluorescent fittings with dimmable electronic ballasts.

Dimming systems in auditoriums shall be operated by the local control network and DMX protocols.

The dimmer system shall have the following features:

- Capability of controlling fluorescent, low voltage tungsten halogen and incandescent loads
- Control of the output voltage of the dimmer to a maximum of 240 volts

**E.3.2.25. Integration**

Where required, integrate the lighting controls with other services:

- Interface with UNSW Cardex Security Services (refer Section B - Security) or Building Automation and Control System (BACS) to allow for programmable time of day operation (enabling room controls within defined time periods).

Lighting control systems shall be stand-alone systems with programming and presets being set and stored at the local level. Interface with the security and BACS systems shall be limited to the remote control of off and on commands and where required, selection of presets.

**E.3.2.26. Daylight integration**

Automatic integration of artificial lighting, using dimming or multilevel switching, shall only be used in spaces with skylights or windows on opposite sides of the room. The consultant shall demonstrate to the Project Officer the projected payback for the system and the sensitivity of the result to the accuracy of the daylight prediction, before the scheme is included in the project.

*UNSW Design and Construction Requirements (Rev 4.1)*

21/28
E.3.2.2.27. Scheduling of Lighting Controls

Where multi channel dimmers are used, the output circuits shall be included on the switchboard schedules as if they were circuits on the distribution board.

E.3.2.2.28. Installation

Where luminaires are mounted greater than 3.5 metres above the ground, or above an uneven floor or above fixed furniture or equipment, the design shall specify the method of lamp replacement. The method must be safe and efficient, not require the use of scaffolding or more than two people, and be in accordance with OH&S requirements.
Table 5
Schedule of Lighting Requirements

<table>
<thead>
<tr>
<th>Space</th>
<th>Area</th>
<th>Types of Liminaire</th>
<th>Designed Maintained Illuminance</th>
<th>Uniformity</th>
<th>Glare</th>
<th>Dimming</th>
<th>Maximum Power Density</th>
<th>Control</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Laboratories</td>
<td></td>
<td>Recessed Fluorescent with glare control</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>9 overall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Background</td>
<td>80</td>
<td>0.5</td>
<td>19</td>
<td>No</td>
<td>4</td>
<td></td>
<td>PIR or US</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workstations</td>
<td>320</td>
<td>0.6</td>
<td>N/A</td>
<td>no</td>
<td>N/A</td>
<td></td>
<td>Pir or Us</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meeting Rooms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conference and committee Rooms</td>
<td>&lt;50m²</td>
<td>320</td>
<td>0.5</td>
<td>19</td>
<td>&gt;10%</td>
<td>10</td>
<td>PIR</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;50m²</td>
<td>320</td>
<td>0.5</td>
<td>19</td>
<td>&gt;10%</td>
<td>9</td>
<td>PIR or US</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General meeting rooms</td>
<td>&lt;50m²</td>
<td>320</td>
<td>0.5</td>
<td>19</td>
<td>&gt;10%</td>
<td>10</td>
<td>PIR</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&gt;50m²</td>
<td>320</td>
<td>0.5</td>
<td>19</td>
<td>&gt;10%</td>
<td>8</td>
<td>PIR or US</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Offices</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Executive</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General</td>
<td>&lt;50m²</td>
<td>Enclosed</td>
<td>320</td>
<td>0.5</td>
<td>19</td>
<td>No</td>
<td>10 Overall</td>
<td>PIR</td>
<td></td>
</tr>
</tbody>
</table>

UNSW Design and Construction Requirements (Rev 4.1)
<table>
<thead>
<tr>
<th>Space</th>
<th>Area</th>
<th>Types of Liminaire</th>
<th>Designed Maintained Illuminance</th>
<th>Uniformity</th>
<th>Glare</th>
<th>Dimming</th>
<th>Maximum Power Density</th>
<th>Control</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>offices and academic rooms</td>
<td></td>
<td>fluorescent Recessed fluorescent</td>
<td></td>
<td>80</td>
<td>0.5</td>
<td>19</td>
<td>No</td>
<td>4</td>
<td>PIR</td>
</tr>
<tr>
<td>Background</td>
<td></td>
<td></td>
<td></td>
<td>80</td>
<td>0.5</td>
<td>19</td>
<td>No</td>
<td>4</td>
<td>PIR</td>
</tr>
<tr>
<td>Workstations</td>
<td></td>
<td></td>
<td></td>
<td>320</td>
<td>0.6</td>
<td>N/A</td>
<td>No</td>
<td>N/A</td>
<td>PIR</td>
</tr>
<tr>
<td>General offices and academic rooms</td>
<td>&gt;50m²</td>
<td>Enclosed fluorescent Recessed fluorescent</td>
<td>320</td>
<td>0.5</td>
<td>19</td>
<td>No</td>
<td>8</td>
<td>PIR or US</td>
<td></td>
</tr>
<tr>
<td>Background</td>
<td></td>
<td></td>
<td></td>
<td>80</td>
<td>0.5</td>
<td>19</td>
<td>No</td>
<td>4</td>
<td>PIR or US</td>
</tr>
<tr>
<td>Workstations</td>
<td></td>
<td></td>
<td></td>
<td>320</td>
<td>0.6</td>
<td>N/A</td>
<td>No</td>
<td>N/A</td>
<td>PIR or US</td>
</tr>
<tr>
<td>Corridors</td>
<td></td>
<td></td>
<td></td>
<td>160</td>
<td>0.4</td>
<td>22</td>
<td>No</td>
<td>6</td>
<td>PIR, US or Micro</td>
</tr>
<tr>
<td>Main entries and thoroughfares</td>
<td></td>
<td></td>
<td></td>
<td>160</td>
<td>0.4</td>
<td>22</td>
<td>No</td>
<td>6</td>
<td>PIR, US or Micro</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enclosed fluorescent Recessed fluorescent</td>
<td>80</td>
<td>0.4</td>
<td>22</td>
<td>No</td>
<td>4</td>
<td>PIR, US or Micro</td>
<td></td>
</tr>
<tr>
<td>Lecture Rooms</td>
<td></td>
<td></td>
<td></td>
<td>500</td>
<td>N/A</td>
<td>N/A</td>
<td>&gt;0%</td>
<td>N/A</td>
<td>PIR, US</td>
</tr>
<tr>
<td>Auditoria and Lecture Theatres – raked floor</td>
<td></td>
<td></td>
<td></td>
<td>320</td>
<td>0.4</td>
<td>19</td>
<td>&gt;10%</td>
<td>12</td>
<td>PIR, US or Micro</td>
</tr>
<tr>
<td>General Lighting</td>
<td></td>
<td></td>
<td></td>
<td>160</td>
<td>0.4</td>
<td>19</td>
<td>&gt;0%</td>
<td>25</td>
<td>PIR, US or Micro</td>
</tr>
<tr>
<td>Performance Venue (seating area)</td>
<td></td>
<td></td>
<td></td>
<td>500</td>
<td>N/A</td>
<td>N/A</td>
<td>&gt;0%</td>
<td>N/A</td>
<td>PIR, US</td>
</tr>
</tbody>
</table>

*UNSW Design and Construction Requirements (Rev 4.1)*

24/28
<table>
<thead>
<tr>
<th>Space Area Types of Lighting for</th>
<th>Designed Maintained Illuminance</th>
<th>Unifor mity</th>
<th>Glar e</th>
<th>Dimmin g</th>
<th>Maximum Power Density</th>
<th>Control</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ry lighting for bench or dias</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Lectern Lighting</td>
<td>100</td>
<td>N/A</td>
<td>N/A</td>
<td>&gt;20%</td>
<td>N/A</td>
<td>PIR, US or Micro</td>
<td></td>
</tr>
</tbody>
</table>

Lecture rooms and tutorial rooms - with audio visual provisions

| General lighting | >50m² | Enclosed fluorescent Recessed fluorescent | 320 | 0.5 | 19 | >10% | 9 | PIR, US or Micro |
| Supplementary lighting for bench or dias | 500 | N/A | N/A | >0% | N/A | PIR, US or Micro |
| General lighting | >50m² | Enclosed fluorescent Recessed fluorescent | 320 | 0.5 | 19 | >10% | 10 | PIR |

Lecture rooms and tutorial rooms – without audio visual provisions

<p>| General lighting | &gt;50m² | Enclosed fluorescent Recessed fluorescent | 320 | 0.5 | 19 | No | 9 | PIR, US or Micro |
| Supplementary lighting for bench or dias | 500 | N/A | N/A | No | N/A | PIR, US or Micro |
| General lighting | &gt;50m² | Enclosed fluorescent Recessed fluorescent | 320 | 0.5 | 19 | No | 10 | PIR |</p>
<table>
<thead>
<tr>
<th>Space</th>
<th>Area</th>
<th>Types of Liminaire</th>
<th>Designed Maintained Illuminance</th>
<th>Uniformity</th>
<th>Glare</th>
<th>Dimming</th>
<th>Maximum Power Density</th>
<th>Control</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratories</td>
<td></td>
<td>fluorescent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Practical Work Rooms (Teaching Laboratories)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>General lighting</td>
<td>&gt;50m²</td>
<td>Enclosed fluorescent Recessed fluorescent</td>
<td>320</td>
<td>0.5</td>
<td>19</td>
<td>No</td>
<td>12</td>
<td>PIR, US or Micro</td>
<td></td>
</tr>
<tr>
<td>General lighting</td>
<td>&lt;50m²</td>
<td>Enclosed fluorescent Recessed fluorescent</td>
<td>320</td>
<td>0.5</td>
<td>19</td>
<td>No</td>
<td>12</td>
<td>PIR</td>
<td></td>
</tr>
<tr>
<td><strong>Research Laboratories</strong></td>
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</tr>
<tr>
<td>General lighting</td>
<td>&gt;50m²</td>
<td>Enclosed fluorescent Recessed fluorescent</td>
<td>320</td>
<td>0.5</td>
<td>19</td>
<td>No Note 1</td>
<td>12</td>
<td>PIR, US or Micro</td>
<td></td>
</tr>
<tr>
<td>General lighting</td>
<td>&lt;50m²</td>
<td>Enclosed fluorescent Recessed fluorescent</td>
<td>320</td>
<td>0.5</td>
<td>19</td>
<td>No Note 1</td>
<td>12</td>
<td>PIR</td>
<td></td>
</tr>
<tr>
<td><strong>Workshops and Plantrooms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plantrooms</td>
<td></td>
<td>Dependant on environment</td>
<td>240</td>
<td>0.5</td>
<td>28</td>
<td>No</td>
<td>8</td>
<td>PIR, US or Micro</td>
<td></td>
</tr>
<tr>
<td><strong>Workshops</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*UNSW Design and Construction Requirements (Rev 4.1)*
<table>
<thead>
<tr>
<th>Space</th>
<th>Area</th>
<th>Types of Liminaire</th>
<th>Designed Maintained Illuminance</th>
<th>Uniformity</th>
<th>Glare</th>
<th>Dimming</th>
<th>Maximum Power Density</th>
<th>Control</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Dependant on environment</td>
<td>240</td>
<td>0.5</td>
<td>22</td>
<td>No</td>
<td>8</td>
<td>PIR, US or Micro</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workbench</td>
<td>Dependant on environment</td>
<td>To suit task</td>
<td>N/A</td>
<td>N/A</td>
<td>No</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes
1. Dimming may be used where it is a particular requirement of the research being carried out in the space.
2. Operating and clinical areas shall comply with the recommendations of AS1680.2.5 Interior Lighting Part 2.5 Hospital and medical tasks.
3. Lighting in workshops and production related areas shall comply with the recommendations of AS 1680.2.4 Interior Lighting Part 2.4 Industrial tasks and processes.

Designs should comply with the requirements of AS/NZS 2982.1 Laboratory design and construction - General requirements.

PIR = Passive infrared occupancy sensor
US = Ultrasonic occupancy sensor
Micro = Microwave occupancy Sensor
N/A = not applicable or no additional requirement
E.3.2.3. Emergency Lighting

Emergency and exit lighting shall be provided where required by the Building Code of Australia in accordance with the following:

Addressable, monitored single point luminaires, incorporating power line carrier controls and complete with associated network devices, Famco FMX series

Details of networking requirements to be discussed with the University The whole emergency lighting system shall be fully commissioned, updating existing computer system in B14a and in zone office, this shall be undertaken prior to final commissioning

Any new emergency and exit light fittings shall be Famco FMX. No other type will be considered. This condition shall apply even if existing fittings in the area are of a different type.