13 Artificial Lighting

13.1 Background
Artificial lighting accounts for a considerable portion of the energy consumption in Defence. It is imperative that lighting systems and their associated controls meet the engineering performance requirements and achieve optimal energy usage and that high efficiency lighting systems and robust control strategies be realised.

Emphasis is on the provision of the best through life performance and this policy addresses both the lighting systems and lighting control applications. For the purposes of this policy, lighting systems encompasses the entire lighting system including luminaires, fixtures, fittings and control systems.

The areas of application covered by this policy include:

a) Interior Lighting;
b) Exterior Lighting such as flood, apron, road & car park;
c) Security Lighting;
d) Cleaning Lighting;
e) Emergency Lighting; and
f) Lighting Control.

13.2 Performance Objective
The objective of this policy is to:

a) facilitate the suitable performance of lighting installations;
b) facilitate optimal lighting control strategies;
c) facilitate optimal energy efficiency, and
d) ensure the economics of the design on a through life basis.

13.3 Referenced Documents

13.3.1 Standards and Codes
All materials and workmanship shall be of the best standard and shall comply with the relevant legislation and Australian Standards, or if such do not exist with relevant International Electro-technical Committee (IEC), International Standards (ISO) and International Commission on Illumination (CIE) standards.

Irrespective of status and any requirements shown in these documents the installation as a whole shall comply with:
Australian Standards

- AS/NZS 1158  *Road Lighting series*
- AS/NZS 1680  *Interior Lighting series*
- AS/NZS 2293  *Emergency evacuation lighting for buildings series*
- AS 2467  *Maintenance of Electrical Switchgear*
- AS 2560  *Sports Lighting series*
- AS 3595  *Energy Management Programs - Guidelines for financial evaluation of a project*
- AS/NZS 3827  *Lighting System Performance*
- AS/NZS 61000  *Electromagnetic capability series*
- AS/NZS CISPR  *Electromagnetic compatibility - Requirements for household appliances electric tools and similar apparatus - Immunity - Product family standard*
- HB 49.1  *Sports Lighting*
- HB 264  *Power Quality*

International Standards

- International Commission on Illumination (CIE) 129  *Guide to the lighting of exterior work areas*

Defence Requirements and Standards

- Defence Energy Management Strategy  *Promulgates Defence energy management policy guidance.*

Other Standards

Building Code of Australia (BCA)

Civil Aviation Safety Authority (CASA) Manual of Standards Part 139 (MOS Part 139)

International Civil Aviation Organisation (ICAO) Annex 14 Aerodrome Design and Operations and Design Manuals

Regulatory Authority requirements in each state

Technical References

Australian Greenhouse Office Best Practice Guidelines

Green Building Council of Australia, Green Star rating tool and Best Practice Guidelines

13.4 Other Agency Guidance
Adequate consideration is required on the policy and guidance published by other government agencies and other recognised organisations. Where the provisions containing the guidance published by these agencies cannot be implemented or where it is found impracticable the matter is to be raised in the design report for Defence agreement. Some of these agencies and their policy and guidance are listed below.

Australian Greenhouse Office
The Australian Greenhouse Office (AGO) is a government agency responsible for government energy management that provides policy and guidelines on reducing power consumption and greenhouse gas emissions. The policy requirements are to be implemented for all Defence installations.

Green Building Council of Australia
The Green Building Council of Australia has developed a new rating tool for commercial office buildings. The tool, known as Green Star, evaluates new and refurbished office design based on a number of environmental criteria including energy and water efficiency, indoor environment quality, waste avoidance and resource conservation. There are also additional tools available such as as-build and interiors.

Department of Industry, Tourism & Resources
The Department of Industry, Tourism & Resources is a government Department that encourages the efficient use of energy. To this end, the Department monitors and produces a report on the ‘Energy Use in Commonwealth Operations’ & ‘Measures for Improving Energy Efficiency in Commonwealth Operations’.

13.5 Financial Assessment
Financial assessment is required to justify the selection and economic basis for the chosen design solution. Financial assessment is also required when considering the merit of upgrading an existing installation or implementing energy efficiency measures in existing facilities.

Financial assessment must be undertaken on a through life basis and must include the lighting system installation costs and all recurring costs such as energy usage, energy impacts to other services such as HVAC and the ongoing operating and maintenance costs.

Financial assessment must demonstrate:

a) Payback period for the works is within 5 years. Defence uses $70 per tonne when considering green house gas reductions;

b) Chosen solution offers the lowest through life costs;

c) Best environmental and/or ESD performance;

d) Through life costs including SCADA maintenance, energy costs, lamp replacement, luminaire cleaning and control system management;

e) Compliance with current Standards; and
f) Operational considerations that overrides the economic consideration.

13.5.1 Economic Analysis
The payback period is the time required for the lighting installation to redeem the cost of installation. The cost benefit analysis needs to consider the through life costs of the PFC installation against the reduced energy costs or savings in the reticulation system construction costs.

There are two fundamental methods accepted:

a) Simple Payback: this doesn’t normally take into account future value of monies today but can be used as a basic check of the feasibility of a project.

b) Net Present Value (NPV): this does take into account future value of monies today. NPV is very useful in comparing options over the time frame considered.

13.5.2 Energy Performance Contracting (EPC)
EPC can be considered to minimise the cost of installation to Defence by using the energy savings. EPC is a form of contracting for energy efficiency services. The contractor guarantees a level of energy consumption savings, upgrades the facility using equipment at its own expense to achieve the consumption targets and is repaid over a number of years from the resulting stream of energy cost savings.

Energy Performance Contracting provides access to private sector capital, technology and technical expertise at minimal up-front cost to the Commonwealth.

Any EPC proposal must be formally agreed by Director Engineering Services and Technical Regulation (DESTR).

13.5.3 New lighting System Assessments
Financial assessment is required to confirm the selection of the most suitable lighting design and lighting control system. The financial assessment is to consider the through life cost of the lighting system (including energy usage for both the lighting and impacts to other services such as HVAC and the ongoing management and maintenance costs). Assessment must also consider greenhouse gas emissions and measures to reduce them.

New lighting systems when comparing the merit of suitable options must use NPV.

13.5.4 Existing Lighting Systems
The purpose of replacing older lighting systems or installing new lighting control systems is to improve the energy efficiency of the building in which it is applied. If this isn’t achieved through the proposed modifications, justification will be difficult unless it is required to bring the installation into conformance with the required lighting levels.

Financial assessment is necessary to determine the merit of replacing existing lighting systems on the basis of energy savings or through life savings. It is imperative that these proposals achieve a financial payback within 5 years where being justified on economic
grounds alone. Note that for greenhouse gas reductions a Figure of $70 per tonne shall be used in estimating the savings.

13.5.5 Energy Audit: Watts/m² lighting consumption
To establish a base line for existing energy/power consumption, a preliminary load profile can be established for an installation by one/all of the following methods:

a) Power Measurement where a suitable temporary three phase power recorder should be installed at the switchboard supplying the floor(s) to be upgraded;

b) Electricity accounts can be review to determine the electricity consumption, and
c) Building Management System can be investigated to determine the availability of data from the Defence Building Management System or Digital Power Analyser on the Main Switchboard (MSB) to determine power consumed.

Following these preliminary investigations, a watts/m² can be determined for each area and can be compared against the anticipated design watts/m². The difference can be used to calculate the cost savings.

13.6 Energy Efficiency
Defence energy performance requirements are provided below. Where a lighting system cannot achieve these requirements or it is considered impractical to comply, the reasons need to be justified as an alternate design solution as detailed in Chapter 6 – Certification and Verification.

a) The target power densities for Defence all indoor lighting applications is 10 watts/m².
b) Electric lighting levels must not be over designed. Maintain levels for office applications at not more than 400 lux for 95% of the net floor area.

Fluorescent Lighting Ballasts - Minimum Energy Performance Standard (MEPS)
AS/NZS 4783.2 specifies the MEPS requirements for lighting ballasts (e.g. Class A1 to Class B2). The designer is to determine the most appropriate ballast based on merit, cost effectiveness and energy efficiencies. Detail in the design report suitable justification of the chosen solution showing the option considered and the basis for selection.

13.7 Developing and identifying specific project lighting requirements
Generally, lighting system performance requirements are adequately defined by the required standards; however, in some instances there may be unique Defence requirements where alternate lighting systems solutions are needed. Examples include rooms used for night vision training and simulator complexes.

Normally, specific project requirements will be identified in the FDB or other project requirement documentation together with the performance requirement. However, where the FDB does not include the performance requirement the designer will be required to
investigate and make recommendations on suitable lighting installations as part of the design process.

13.7.1 Maintenance and Lamp Replacement
When determining the lighting system maintenance requirements and light loss factors, the designer shall consider AS/NZS 1680.4, the anticipated lamp life and the required CMS cleaning intervals in deciding on the most cost effective design solution. The designer shall detail the design basis including the required lamp replacement and cleaning intervals in the design report.

Where the designer proposes an alternate maintenance regime to current CMS requirements this shall be clearly detailed in the design report together with justification for the alternate arrangement.

Where no CMS maintenance requirements are available, the designer shall base the maintenance cycles on the recommendations of AS/NZS 1680.4 using bulk lamp replacement, manufacturers published lumen output/lamp life and allowing for luminaries to be cleaned at the same time as the replacement of lamps (e.g. for T5 luminaires: not less than 80% of manufacturers published lumen output and allowing for luminaries to be cleaned not more regularly than 5 yearly intervals).

All new luminaires shall be constructed for ease of maintenance and cleaning and to suit the ceiling system. Attention is drawn to AS 2946 for luminaire and ceiling compatibility.

13.7.2 Lighting Circuitry
New lighting circuits shall be designed to a maximum circuit utilisation of 66 percent (i.e. 33 percent spare capacity). The capacity of lighting circuits may be determined by factors other than normal current rating. RCD protected lighting circuits may have a much lower limit to the number of light fittings which may be reliably connected to the same circuit, due to the leakage current to earth inherent in electronic ballasts within the light fittings.

13.7.3 Power Factor
All fluorescent and high intensity discharge lighting systems are to be power factor corrected (to at least 0.9pf). The Designer shall consider both individual equipment/luminaire correction and centralised correction based on the best through life performance.

13.7.4 Equipment
In industrial or commercial areas the designer is to ensure that the colour rendition of the lighting system is suitable for the tasks performed. Where lights are installed in areas that could be exposed to mechanical damage (e.g. plant rooms) the fittings shall be provided with suitable wire guards or or impact resistant lens.
Discharge lighting installed in hangars or other sensitive areas shall have fail safe type control gear that will automatically de-energise the igniters’ circuit in the event of lamp failure to prevent any failure condition from causing a potential fire hazard.

All fluorescent lights are to have electronic starters or electronic ballasts. Electronic ballasts shall be selected with the operating conditions and design life in mind. Longer design life types will generally provide a whole of life cost benefit.

13.7.5 Luminaire Standards
The base or region may have lighting standards which will need to be addressed by the designer in the development of new works. The designer will need to consider these and adopt them where they comply with the requirements outlined in this policy and offer practical and cost effective solutions.

Where a regional standard is identified but is not proposed for adoption the reasons why is to be addressed in the design report for Defence agreement.

13.7.6 Lamps Selection

Lamp choice shall take account of whole of life cost as well as operational requirements.

13.7.7 Harmful Effects of Lamps
Where lamps pose a hazard in normal/failed operation or when damaged, the designer must ensure suitable safeguards are applied. To this effect suitable UV filter or similar should be installed with the fittings that emit UV radiation. The designer must address, in the design report, any lighting system that has the potential for harmful effect and the proposed treatment strategies.

13.8 Lighting Design Criteria
The following requirements are provided to further define Defence requirements. The main objective is to ensure lighting system designs achieve the required performance whilst also achieving optimum energy efficiency.

13.8.1 Interior Lighting
The levels of artificial lighting shall accord with the recommendations of AS/NZS 1680 series for the various tasks to be undertaken in the facility. The lighting installation shall comply with the energy limitation requirements of Section J of the BCA regardless of the State or Territory in which the installation resides. Lighting layouts and switching patterns are to be arranged to make best use of the available daylight and the tasks being undertaken in the facility.

Consideration shall be given to intelligent automatic daylight compensation where appropriate and cost effective. The preferred method of daylight compensation is by automatic perimeter dimming using individual sensors per luminaire, particularly the lighting
installed adjacent to window areas. Where implemented adjacent window areas, the daylight compensation dimming system shall only control the first row of luminaires.

Existing lighting systems to be modified as part of building refurbishment shall be assessed for compliance with current standards and suitability for retention. The existing lighting shall only be retained where justified by a business case against modern energy efficient lighting systems.

Luminaires in office areas shall generally incorporate fluorescent lamp sources. High efficiency lamp types and luminaires are to be specified and the selected light arrangement and lamp type shall be on the basis of achieving the best through life performance.

13.8.2 Daylighting
The use of daylighting within a building can increase the occupant’s amenity. This needs to be balanced against the potential for increased glare from daylighting.

Daylighting is to be used with the appropriate use of sun shading or internal to prevent the entry of direct sunlight and control glare. The fundamental measure of the quantity of daylight at a point indoors (the daylight factor), is the ratio of the inside daylight horizontal illuminance to the horizontal illuminance simultaneously existing under an unobstructed sky and expressed as a percentage. The daylight factor is approx 2-5% of the externally available light. AS/NZS 1680.1 – 1990 table 9.1 provides a table of the illuminance available from the sky for major Australian cities. From this table, illuminance within a space can be determined.

13.8.3 Artificial
Artificial lighting is lighting required to illuminate the interior of a building if no daylight was available. The provision of artificial lighting comes in many forms and is further detailed below.

13.8.4 Task
Task lighting is local illumination related to a workstation or specific task. It can be used as secondary lighting, where the primary lighting is provided by lights from the ceiling and task lighting provided by a local luminaire that can be moved by the occupant. This will provide higher levels of light than the primary lighting. For example office lighting is generally 320 lux but task lighting can increase the local illumination to 600-1000 lux. Task lighting is a more cost effective alternative than trying to increase the office illumination from the primary lighting source to 600-1000 lux.

The disadvantage with task lighting is that it cannot be easily controlled by an automated system and therefore has the possibility of increasing the lighting energy consumption for the building. This aspect will need to be addressed in any proposed task lighting application.
13.8.5 Perimeter
Perimeter lighting are the luminaires adjacent the external windows of a building. Light sensors built into each luminaire can reduce the level of light when there is adequate daylighting. At night, the sensors drive the luminaire to full brightness.

13.8.6 Cleaning Lighting
Building cleaning can be conducted after hours at night. Where cleaning is undertaken at night, there must be a system where the cleaner can activate egress path lights and suitable limited office space lighting to enable for them to carry out their cleaning duties without the need to energise entire lighting system. This can be a key system or other suitable arrangement at the entrance to the building or each area. When the cleaner leaves, they de-energised the lights through the key again or by time control.

13.8.7 Security Patrol Lighting
Where a building is routinely patrolled by security staff, a similar lighting system to the cleaning lighting above is required to enable the security patrols to be undertaken without the need to energise the entire lighting system. Security lighting can be achieved by movement sensor, by a key system or other suitable arrangement.

13.8.8 Emergency Lighting and Exit Signs
Emergency lighting and illuminated exit signs shall comply with the requirements of AS/NZS 2293 and be provided in the areas as required under the BCA.

Emergency luminaires shall be connected to a computerised automatic testing system, consisting of a central control unit located in a suitable location. The computerised testing system shall be incorporated onto the site wide or regional monitoring, where existing. Please note that Defence intends to implement centralised site/regional monitoring at all establishments and therefore consideration is required on standardising equipment to achieve this requirement, whether such a system is already installed or not.

Luminaires for emergency lighting should incorporate the following general features:

a) Plant areas and switchboards – Non maintained lamp, integral with general lighting luminaire;

b) General floor areas – Recessed non-maintained type;

c) Exit signs – Two (2) lamp with one lamp being non maintained; and

d) Install emergency lights over Fire and Security Alarm panels.

Existing emergency lighting and illuminated exit signs in buildings to be refurbished or modified are to be upgraded as necessary to comply with AS/NZS 2293 and provided in the areas as required under the BCA. Where the expense of the above requirements for monitoring and lighting types cannot be justified, additional or relocated emergency lighting and illuminated exit signs shall comply with AS/NZS 2293 and can be single point, self-contained, battery operated type. The newly configured system should satisfy the following criteria:
a) install single point emergency luminaries and illuminated exit signs at locations in accordance with the BCA,
b) emergency luminaries shall generally be non-maintained type and recessed mounted,
c) illuminated EXIT signs shall operate in a dual-lamped sustained mode, and
d) install emergency lights over Fire and Security Alarm panels.
e) Where there is no computer monitoring, lights shall be provided with a test facility at the local distribution board complying with the requirements of AS/NZS 2293.

### 13.8.9 Building Exterior Lighting
External lighting is to be provided to suit the tasks involved and to allow safe access and usage of the building particularly after hours. The design of the external lighting shall be suitable for the purpose and meet all applicable OH&S requirements. The luminaires shall be of robust construction, weatherproof and high efficiency lamp sources (preferably either sodium, metal halide or fluorescent lamp sources).

### 13.8.10 Building Security Lighting
The requirement for security lighting is to be investigated by the Design Consultant after consultation with the Base Security Agency to meet Operation Safe Base (OPSB) passive defence augmentation requirements. Generally in the majority of instances, only building perimeter lighting is required and the requirements for this lighting system follow. Where an alternate security lighting system is required such as perimeter fence lighting seek DEEP guidance for the additional engineering requirements for these lighting systems.

Building perimeter security lighting shall be designed to illuminate an area sufficient to detect an intruder. This area will depend on the surroundings of the site and the category of the area to be protected but should be at least an area of 3m from the building extremity. The distance to be illuminated will be provided by the Base Security Agency. The lighting shall be designed to achieve the following requirements:

a) Minimum vertical illuminance of 1 lux;
b) Uniformity of 5:1 (maximum: minimum);
c) Maintenance factor of at least 20 percent; and
d) Restrike and achieve 80 percent illuminance within 60 seconds after outage.

### 13.8.11 CCTV Security Lighting
Where camera security monitoring systems (e.g. CCTV) are installed, the designer of the security lighting system shall ensure that the performance of the system is appropriate for the type of monitoring system installed.

The illuminance requirements for security lighting installations can be compared with those for roads in so far as they are both designed for detection at night.

If closed-circuit TV cameras are used, higher levels of illumination may be required depending on the choice and sensitivity of the camera. Below is a guide:
Table 13.1: Illumination Levels for CCTV Systems

<table>
<thead>
<tr>
<th>Illuminance</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 lux</td>
<td>Minimum for security lighting</td>
</tr>
<tr>
<td>5 lux</td>
<td>Recommended average</td>
</tr>
<tr>
<td>10 lux horizontal</td>
<td>Recommended for areas adjacent roads</td>
</tr>
<tr>
<td>3 lux vertical</td>
<td>For CCTV camera’s.</td>
</tr>
</tbody>
</table>

The CCTV levels are as a guide and reference is needed with the manufacturer of the cameras to determine their recommended levels of light for human face recognition.

13.8.12 Road, Car Park & Pedestrian Lighting
The FDB will identify the outdoor areas to be lit. Where required the following shall apply.

Road, carpark, pedestrian, outdoor and street lighting where required is to be designed in accordance AS/NZS 1158. The design report is to detail the selected category and the proposed lighting system arrangement including a through life cost benefit analysis.

The luminaires shall be of robust construction, weatherproof and high efficiency lamp sources. The luminaires may be standardised on each site and the designer shall liaise with the Region to determine the required lighting system and incorporate the Regions Requirements.

All road lighting systems installed at or near aerodromes shall use aeroscreen type luminaires with zero tilt.

13.8.13 Flood lighting
Flood lighting requirements are to be developed by the designer in consultation with Defence using all applicable standards. Attention is drawn to CIE 129-1998 Guide to the Lighting of Exterior Work Areas. Where no applicable standards exist, either Australian or international, the designer shall make suitable recommendations based on the activities proposed for the facility. The lighting should be designed with appropriate illuminance for the activities to be undertaken and shall be arranged to meet the specific objectives sought. The design arrangement and objectives are to be detailed in the design report.

13.8.14 Sports Lighting
Sports lighting shall comply with the requirements and recommendations of AS/NZS 2560 series of standards.

13.8.15 Military Apron Floodlighting
Aircraft apron floodlighting shall comply with Civil Aviation Safety Authority (CASA) Manual of Standards Part 139 (MOS Part 139), International Civil Aviation Organisation (ICAO) Annex 14 and ICAO Design Manual 4. The lighting systems shall be designed with appropriate cut offs to prevent any spill light affecting aircraft operations.
13.8.16 Extraneous Lighting Control for External Lighting

All outdoor lighting shall comply with AS 4282.

Where any proposed outdoor or external lighting falls within the controlled areas as detailed in MOS Part 139 the lighting design shall comply with the requirements of MOS Part 139 Section 9.21.

Lighting installations complying with these requirements will in most instances be acceptable to aircraft operations. However, the suitability for aircraft operations cannot be ascertained without flight survey and ground survey that includes survey from the ATC Tower. The designer shall ensure that the necessary assessments and verification is included as part of the facility commissioning. If it is found during these assessments that the proposed lights endanger the safety of aircraft operations, the lighting shall be suitably modified.

On Defence airfields, all street lighting shall be provided by luminaires with no upward light component (e.g. aeroscreen type) to minimise potential conflict with aircraft operations irrespective of whether the lighting falls within the controlled areas. Consideration of no upward lighting component is required for all outdoor lighting on or near the aerodrome.

13.9 Lighting Control

After a decision has been made on the types of lighting to be used and in what applications, decisions need to be made on the method of control.

The design must consider the facility usage and determine the most appropriate control strategy. The performance of the control system must achieve the defined functionality and also optimise the energy usage, minimising wastage.

Consideration needs to be given to ongoing management of the lighting control systems. Aspects such as the ability to implement control changes, modifying or tuning operation may dictate the type of control system arrangement. Complex computer based control systems offer significant through life advantages for applications with high accommodation churn rates or where control changes are likely.

Guidance is provided in the following paragraphs on the Defence lighting control objectives. The designer must consider these objectives and detail the chosen control arrangement in the design report. The designer must demonstrate the chosen strategy offers Defence the best through life performance with minimal reliance on manual intervention.

13.9.1 Control Strategies

Manual switching alone is not acceptable because of the risk associated with users leaving lighting on. Consideration shall be given to a complete automated building lighting control system similar to ECS, Clipsal CBUS or BMS controlled system based on through life performance and cost effectiveness.

Additionally, where the light loss factors dictate that the initial lighting levels significantly exceed the required performance, consideration may be given to lighting controls
incorporating dimming functions to minimise energy usage particularly where electronic ballasts have been incorporated into the design. Any such dimming shall be controlled in a manner so as not to cause premature lamp failure due to the lamps being dimmed prior to the manufacturer’s lamp burn in time.

The control system shall be suitable for unskilled operation and shall not require training to achieve effective operation of the system. There shall be sufficient manual overrides and after hours initiation provided for each area to ensure that the lighting is available for extended occupations and also to allow occupant to turn off lighting in unoccupied areas. After hours lighting shall be regularly switched off to suit the intended use to prevent excessive unnecessary usage.

Areas shall be segregated into logical user defined work areas and the control switches shall be readily accessible to the users as they enter the work area. The control switches shall be clearly labelled to assist operation of the system and prevent unnecessary turning on of unoccupied areas. Where necessary include engraved two colour laminated traffolyte labels to clearly show the control.

Further guidance on control strategy application is provided in Table 13.2: Schedule of Lighting Control Applications Summary below.

Table 13.2: Schedule of Lighting Control Applications Summary

<table>
<thead>
<tr>
<th>Control Type</th>
<th>Conference</th>
<th>Meeting</th>
<th>Training</th>
<th>Single Occupant</th>
<th>Office Open Plan</th>
<th>Locker/change room</th>
<th>Exercise/weights</th>
<th>Lunch/tea</th>
<th>Toilets</th>
<th>Transit Corridors</th>
<th>Stores (small)</th>
<th>Warehouse</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual Switch</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<td>X</td>
<td>X</td>
<td>X*</td>
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<tr>
<td>Time delay</td>
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<td></td>
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<tr>
<td>Lighting Control</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Dimming</td>
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<td>X</td>
<td>X</td>
<td>X</td>
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<td>X</td>
<td>X</td>
<td></td>
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</tbody>
</table>

Note: X* manual override switch at the main switchboard or substation as appropriate

13.9.1.1 Meeting & Conference Rooms
All meeting and conference rooms shall be provided with separate on/off and dimming facilities. Dimming shall achieve 10 to 100 percent luminous output.
13.9.1.2 Building External Lighting
External lighting is to be controlled by photoelectric cell with a manual override provided at the building MSB. This may also be achieved through the BMS system or site wide control system such as DESN, however there must be a manual switch provided at the building main switchboard.

All external lighting is to be connected to the Base "Black Out" system where applicable.

13.9.1.3 Building Security Lighting
The building security lighting is to be controlled by photoelectric cell with a manual override provided at the building MSB. This switch shall be separate to any other external lighting control and the switch shall be suitably labelled "Perimeter Security Lighting". Security lighting can be controlled through BMS system or site wide control system such as DESN where agreed by the Base Security Agency.

13.9.1.4 Carpark, Street & Outdoor Lighting
Carpark, street and all other outdoor lighting systems are to be controlled by the site wide control system such as DESN where available otherwise by photo-electric cell with a manual override at the relevant substation. BMS system can also be used where no site wide system exists. Control for this lighting is generally to be separate to building service controls.

13.9.1.5 Flood Lighting
Control of the flood lighting needs to be specified as a particular to project requirement that will generally involve local on/off switching. For aircraft apron flood lighting, this may need to be achieved at a number of locations such as the flight line, ATC tower and local manual control to suit the operations at the airfield.

13.9.2 Methods of Control
There are a number of methods available to control a luminaire. The designer shall liaise with the users to determine the most suitable control arrangement where not adequately covered by the design brief. Control methods include:

Manual switching. Simplest form of control of a luminaire and comprises an on/off switch adjacent the entry to the room/building.

Time based switching. Timer functions are used that has pre-set times for turning luminaires on/off. Changes of times are manually done through DESN, BMS, specific lighting control systems or other suitable system.

Occupancy Sensors. Two main types, passive infrared and ultrasonic. They rely on movement of the building occupants. They are very effective in reducing power consumption for the capital installation cost.

BMS Control. Consists of time based control through the BMS. The BMS can also provide after hours operations and may allow global changes making modification easier to implement.
Lighting Control. Proprietary lighting control system incorporating similar controls to the BMS described above and possibly also the dimming or DALI functionality.

Dimming. Dimming control reduces the output from the luminaires depending on the level of available light. Dimming control requires the luminaires to have electronic ballasts for either 0-10 volt analogue or Digital Serial Interfacing (DSI) control. Electronic ballast provides better control and increases the life of the lamp.

Digital Addressable Lighting Interface (DALI). System which communicates with each luminaire individually. Most expensive and flexible form of luminaire control. If the space to be considered requires continual changes to the floor/workstation layout due to employee movements, this system can be considered as luminaires can be switched in any configuration through software changes avoiding expensive rewiring. Control can be from a single luminaire or any luminaire combination.

13.9.3 Location and Arrangement of Control Systems
The location of the control system varies depending on the type of control system employed and the user requirements. Generally a more sophisticated control system should be located in readily accessible areas for the responsible persons and, if possible, in the same location as other control systems such as the BMS. The designer is to liaise with the DSG Region Energy and Sustainability Manager and the user to determine the most suitable location and arrangement.

All manual switching is to be located adjacent entrances to the room/buildings.

13.9.3.1 Control System Application
Manual Switching
As a minimum, building lighting systems should have separately switched zones so that unoccupied parts of floors can be switched off. Switches should be placed at obvious positions at the entrance(s) to each zone. The use of a single switch to control multiple zones is not acceptable.

Consideration needs to be given to a convenient way to turn all lights through a suitable lighting control solution to turn light off after hours. Neither the last user out nor the cleaners can be relied upon to walk around and switch off multiple switches for lighting zones that will be invariably left on. A master off switch may be considered where automatic controls are not justified, linked to a control relay should be located in an obvious position near the main exit door. It should be clearly labelled.

Manual Time Delay Switches
These switches are typically wall mounted push button timers. They have application in certain installations such as accommodation facility communal areas.

The timing is usually preset in the range of 5-30 minutes, and a 15 minute setting should suit most applications. Appropriate applications include spaces subject to short-term occupancy
where there is no access to natural light or transit areas such as corridors. It may not be economical to retrofit timers if the total controlled load (including ballasts) is less than 400VA. Such timers must not be used to control HID lamps.

Safety is an issue and the situation where occupants can be suddenly plunged into darkness needs to be avoided. For larger spaces and corridors this can be achieved by installing a minimum of lighting on 24 hour operation. For specific smaller, infrequently used spaces installing an occupancy sensor with a 10 minute delay that keeps the lights on until the space has been safely vacated should provide the necessary safety without inefficient 24 hour operation.

**Automatic Time Switches**
Automatic time switches turn lights on and off at manually preset times. They are generally inflexible and not preferred. They are prone to get out of time due to such events as extended power failures, holidays, and day light saving. Their resetting requires manual intervention that all too often fails to occur as time switches are generally out of sight. As a result, lights come on when they shouldn’t or do not go off when they should.

In some cases, the manual override function is used as an easy way to overcome the inconvenience of the lights not functioning correctly. Consequently the device may be left in override mode and this negates the value of the original capital investment in controls. Therefore, time switch controls should be considered as a last resort for one-off cases where it is too costly or the load controlled too small to justify other better control methods. If used, they should be installed in or near switchboards or electrical distribution rooms so as to be accessible and not hidden away.

**Occupancy Sensors**
There are several types of movement sensors including:

a) Passive Infrared (PIR)
b) Ultrasonic
c) Microwave
d) Combinations of PIR and ultrasonic.

The purpose of these devices is to turn lights on/off as occupants enter/leave the room or as they access common areas such as corridors. These devices can be used alone or together with other control devices in a coordinated manner and are very effective in reducing energy consumption by approximately 30%. The units are available with photo-electric cells where there is ample natural light.

**Passive Infrared (PIR)**
PIR devices work on the principle of heat detection by detecting the difference between the human body and the ambient temperature. PIR devices are not as sensitive as the Ultrasonic devices.
**Ultrasonic/Microwave**

Ultrasonic detectors are more sensitive than PIR devices and are for short to medium range applications such as cellular offices or open plan where lights are controlled in linked groups which can be easily reconfigured to suit changes in office layouts. With greater sensitivity comes the change of spurious operation of the sensor, especially if there are large air movements from air conditioning registers in the ceiling.

Microwave devices are for long range applications and can be used for virtually any internal space. They are generally more expensive than the other types, so are only economical for larger areas.

**Dimming**

Dimming of a luminaire occurs when there are more than adequate levels of light (dimmed by PE cell) or where there is no occupant movement for a period of time (dimmed by occupant sensors). Dimming requires electronic control gear within the luminaire.

**Individual Light Dimming.** This is used in perimeter lighting as described above in Perimeter lighting. Photocells are installed in each luminaire that measure the illumination in that area and dims the light from the luminaire. The required levels of light after dimming are still to remain within the Australian Standards for levels of workspace illumination.

PE cells can be individually clipped to any existing luminaire that will sense the amount of natural light and adjust the luminaire light output accordingly. A sensor can be added to each light so as to provide local control. Changes in light conditions in one area will not effect the operation of lights in another area.

The existing luminaire is required to have an electronic dimming ballast (0-10V analogue) installed already for PE cells to work. If the existing fitting doesn’t have an electronic ballast, retrofit kits are available that consists of an electronic ballast, wiring, lamps holders and light sensor if required.

**Zone Dimming.** Zone dimming is the dimming of a number of luminaires in an area or zone.

**DSI**

Digital Serial Interface (DSI) is a digital protocol used for the control of high frequency ballasted luminaires. This gives the ability to control/dim a group of luminaires and requires a communication cable and power cable to be installed.

**DALI**

Digital Addressable Lighting Interface (DALI) is a common platform that enables equipment from different manufacturers to be connected together.

DALI is the most advanced method for controlling high frequency ballasted luminaires as each individual luminaire has an ‘address’ and can be controlled separately from every other
luminaire. Both the 0-10Volt analogue or DSI method of control for high frequency ballasts cannot achieve this level of control.

The luminaires can also be grouped with any other luminaire on a floor to provide maximum flexibility (max of 64 devices). This also means that any DALI motion sensor or PE cell or similar DALI device can be used to switch any light and up to 64 DALI devices can be on one communications cable.

Of the 64 devices, 16 groups can be formed and in each group, 16 lighting scenes can be set. A lighting scene is preset levels of light: for example: 50% light in a room for an audiovisual projector presentation. A site requiring more than 64 devices is implemented by having multiple separate DALI networks, each having 64 devices. These separate networks are then linked together with DALI gateways and a data backbone running a high level protocol.

This system also requires a communications cable and power cable to be connected to all the luminaires increasing the wiring costs.

Reconfiguring of the system is a software reconfiguration and is quick and inexpensive as no re-wiring is required. If an area has a history of changing workstations/room boundaries, this system should be considered.

Where replacement of ballasts is required under maintenance, there will be an extra cost of configuring the new ballast to have an address similar to the ballast to be removed.

Table 13.3: Dimmable high frequency ballast comparison

<table>
<thead>
<tr>
<th>Control type for HF ballast</th>
<th>Control cable</th>
<th>Polarity dependent</th>
<th>Individually addressable</th>
</tr>
</thead>
<tbody>
<tr>
<td>DALI</td>
<td>2 wire</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>DSI</td>
<td>2 wire</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>0-10Volt</td>
<td>2 wire</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Lighting Controller and BMS Control
The proprietary lighting controllers and BMS or similar system can provide a range of control options to turn lights on or off and to optimised lighting performance in conjunction with occupancy sensors, PE cells, DALI and dimming. This method of luminaire control could be considered for a retrofit situation.

The benefit of this control is the flexibility, occupants can press a manual switch adjacent their office/workstation to control light. The flexibility comes at a cost and where it can be demonstrated as a cost effective means, particularly for high churn rates, it should be installed.
Energy saving devices

Energy saving devices are available that operates by reducing the voltage to a luminaire and thereby reduces the power consumption by 30% for a 15% reduction in light output. These devices can be used in commercial, educational and warehousing.

The principle of operation is an autotransformer that can switch from full supply volts to 70, 80 and 85 % (user selectable) after 5 minutes of operation.