0951 Lighting

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0.01 Main considerations

It is a requirement to undertake the 00 PLANNING AND DESIGN/0001R - DESIGN REFERENCE and GLOSSARY OF TERMS information into all aspects of design, detailing and delivery when developing the content here within. Clear demonstration of adherence to these requirements is part of the services and will be called upon at key points in the project and during at the discretion of the Department of Education (DoE).

General lighting through the use of luminaires in schools are provided for three purposes:

- Access Lighting is intended to provide safe and comfortable illumination for movement around the school both during and after normal school hours.
- General Purpose Lighting is intended to allow the various areas to be used for their designed function.
- Emergency/Exit Lighting is provided in most areas to indicate exit routes and to maintain illumination in the event of a power failure.

The design principles, to be read in association with specification requirements, provides information and structure around the lighting and control systems that should be provided by designers for new build and refurbishment of NSW Public Schools.

Lighting and control technologies should provide an environment that promotes and enhances learning and personal development.

The National Construction Code (NCC), standards referenced, and other associated standards, set out the requirements for all three forms of lighting and therefore are to be complied with for the design and installation of lighting systems.

The design of the lighting systems and the selection of fittings is to be undertaken based on a Whole of Life approach to ensure that the completed system and selected fittings provide:

- Value for Money
- Fit for purpose
- Long term reliability
- Minimal maintenance requirements and low maintenance costs

Specifically, lighting equipment should:

- Support sustainable design principles including reducing energy consumption
- Use light sources lamps and control gear with a long life

- Consider long term maintenance of fittings and ensure that parts that require replacement are accessible. Establish the availability cycle of spares from manufacturers and if necessary, allow for extra complete products to be procured initially as a spare parts pool.

0.02 Relevant Standards

The provision of lighting and associated control systems and their installation must comply with all applicable Australian codes and standards. They are to include, but are not limited to, the following standards, including those referenced by them:

- The National Construction Code (NCC) (incorporating the Building Code of Australia or BCA)
- AS/NZS 3000:2007 and its amendments titled “Electrical installations (known as the Australian/New Zealand Wiring Rules)”
- AS 2946:1991 (R2013) titled “Suspended ceilings, recessed luminaires and air diffusers - Interface requirements for physical compatibility”
- ANSI/IES LM-80-15 titled “Approved Method: Measuring Luminous Flux and Colour Maintenance of LED Packages, Arrays and Modules
- IES TM-21-11 titled “Projecting Long Term Lumen Maintenance of LED Light Sources”
- IES LM-79-08 titled “Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products”
- AS/NZS 4417: 2012 and amendments titled “Regulatory compliance mark for electrical and electronic equipment”
- AS/NZS 60598 all applicable sections
- AS 2293 titled “Emergency escape lighting and exit signs for buildings”
- AS/NZS CISPR 15:2011 titled “Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment”
- AS/NZS 61347 all applicable sections
- AS/NZS 61347.2.13 titled “Lamp control gear Particular requirements for d.c. or a.c. supplied electronic control gear for LED modules”
- AS/NZS 62560:2017 titled “Self-ballasted LED-lamps for general lighting services by voltage > 50 V - Safety specifications”.
- IEC 62386 titled “Digital addressable lighting interface”

- IEC 62262 titled “Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)” and IEC/TR 62696 ED.1.0 titled “Luminaires - Application of the IK code IEC 62262”
- AS/NZS 60529 titled “Degrees of protection provided by enclosures (IP Code)”
- AS/NZS 1680.0 titled “Interior lighting Safe movement” and all other applicable parts of AS/NZS 1680 “Interior and workplace lighting”
- AS/NZS 1158 all applicable sections
- AS 4282:1997 titled “Control of the obtrusive effects of outdoor lighting”
- AS2560 titled “Guide to sports lighting” and all applicable sections
- Section J part 6 of the National Construction Code unless otherwise stated.

The general requirements for various parameters are set out by location in the Luminaires specification guide. Where an activity or location is not specifically referred to in this guide, then lighting performance must be provided that meets the needs of the area and meets or applies the principles and methodologies explained and implied in the standards.

0.03 Lighting Design

Design Considerations

In developing the lighting layout consult with the design team and select luminaires and place them to achieve optimal efficacy, and maximum efficiency balanced with good lighting design outcomes:

- Obtain dimensioned floor plans, furniture layouts, sections and elevations in the early stage of design. These must show the height and type of ceiling, beams and columns, skylights etc.
- Design luminaire layouts in a regular and symmetrical pattern (i.e. spaced evenly between trusses and skylights etc.) and fully coordinated with ceiling fans, skylights, etc.
- Attention should be given to the colours and finishes of interior surfaces.
- Light level calculations are to be carried out with industry standard lighting design software. Ignore contributions made by daylight in determining total installed lumens. However, designs should consider the effects of gloom as outlined in AS/NZS 1680.1
- Consider the furniture layouts to determine the orientation of luminaires. Especially when positioning luminaires in Materials Technology spaces to ensure adequate illumination on machines and work surfaces; avoid potential stroboscopic effects and avoid shadows from ductwork

- Mount luminaires as high as possible, but generally no higher than 4000mm AFFL (excluding Gymnasiums and Halls), to improve luminance uniformity and reduce direct glare in the direction of normal view.
- Allow easy access for maintenance in the arrangement of luminaires
- Select fittings carefully and choose fittings appropriate to the area usage, e.g. in the Gymnasium, luminaires are often used as targets for balls. Impact resistant diffusers strongly fastened to the luminaire body are to be used
- The standard lamp colour temperature is 4,000°K, except in certain toilet areas where the Design Guide requires the use of blue colours.
- The colour Rendering Index (CRI) for light sources must be minimum 80 or higher.
- Methods of fixings and cable runs should be discussed with the Project Architect, and detailed in both the architectural and electrical specifications
- Consider clearances from ceiling fans when using chain or wire suspension. Generally, use lighting support channels in situations where luminaires could be swung into a ceiling fan
- Consider the use of electrified trunking systems for integration of lighting and emergency as well as the provision of flexibility in the lighting system to suit application changes in the space.

Lighting associated with Heritage assets subject to areas of fabric significance must be considered in conjunction with the specific Conservation Management Plan and the principles of the Burra Charter.

In some areas, the nature of the architectural or interior design will require a lighting system that compliments certain elements. In these areas, robust, affordable solutions that are practical for long term ownership should be considered. In other locations, there will be low requirements for aesthetic consideration. The use of simple and basic luminaire designs is in these areas is acceptable.

For existing schools, lighting retrofits should consider the current use of spaces. For example, libraries in schools are now more likely to include substantial areas where screen-based tasks are carried than there would have been as little as 10 years ago. There have also been a significant number of Interactive White Boards and projectors installed in classrooms and shadowing can occur. These changes in application and furniture layout places an expectation of any proposed lighting system to meet the new needs of the space. Where the lighting in an existing space is being replaced, lighting design that provides what is needed rather than mimics what is currently in place should be demonstrated wherever possible.

Lighting Design Software

Lighting designs should be carried out utilising industry standard lighting design software such as AGI32, Dialux or Relux.

Modelling with software must provide output that clearly demonstrates that the proposed design is compliant with the standards including but not limited to the following parameters:

- Maintained illuminance values (average, maximum and minimum) on horizontal surfaces such as floors or working planes as required, broken down to identify the parameters defined in AS/NZS1680.4 or AS/NZS1158 as applicable
- Maintained illuminance values (average, maximum and minimum) on vertical surfaces such as walls, shelves or racks as required, broken down to identify the parameters defined in AS/NZS1680.4 or AS/NZS1158 as applicable
- Unified Glare Rating (UGR) as defined by AS/NZS1680,
- Uniformity as defined by the applicable standard for indoor or outdoor illumination,
- Lighting power density in System Watts/m2

The following is a guide to the reflectance of different surfaces for use in design and calculation:

- White painted plaster board and render 85%
- White painted brick 75%
- Light face brick (cream) 35%
- Dark face brick (dark brown) 20%
- Light timber (radiata pine) 35%
- Dark timber (dark stained) 20%
- Light carpet (beige) 30%
- Dark carpet (dark blue) 5%
- Medium carpet (green) 10%

Illuminance

Where illuminance levels are specified for indoor applications they are maintained illuminance levels.

The maintained illuminance levels must meet the recommended levels as specified in the AS/NZS 1680 standard., and the maintained illuminance values achieve a uniformity of no less than the values given in Table 3.2 of AS 1680.1:2006, with an assumed standard maintenance factor of 0.8.

The methodology and resources provided in AS/NZS 1680.4:2017 to determine the maintenance factor for a particular luminaire in application.

Maintenance factors are to be calculated using the following formula from the AS/NZS1680.4:

MF = LLMF × LSF × LMF × RSMF

Where LLMF = lamp lumen maintenance factor, LSF = lamp survival factor (used to include driver life in maintenance factor), LMF = luminaire maintenance factor and RSMF = room surface maintenance factor.

Example: LLMF = 0.7, LSF = 0.9, LMF = 0.87 (from table B1 of AS/NZS 1680.4 where the environment is clean and the luminaires are cleaned every 1.5 years) and RSMF = 0.97 (from table B3 of AS/NZS 1680.4 where the environment is clean and the surfaces are cleaned every 1.5 years)

Therefore, maintenance factor = .7 x .9 x .87 x .97 = .531657 or .53

For the use of LED's in application in NSW Public Schools, the lamp lumen maintenance factor must be 0.8. This is necessary because there is no defined time-based replacement strategy for luminaires. End of life will be defined by total failure or when light levels are no longer meeting required standards. The industry accepted operational period where luminaires are considered at end of life is when the produced light is 70% of initial output. This is usually expressed as xx,000 hours L70.

LED duration in hours to L80 or L90 (where they are at 80% and 90% of initial output respectively) can be important for establishing cost of ownership (as long life with good output has commercial value), it does not assist in establishing maintained illuminance. "B values" such as B_{10} or B_{50}, which represent the average percentage of luminaires in an installation that will not meet the life value referred to above, usually do not include complete failure.

Control gear or driver life is usually reported through a different methodology which is Life in hours to % failure. Most electronic ballasts and LED drivers are rated to 50,000hrs with less than 10% failure. To ensure that the maintenance factor properly reflects the position of the system at end of life, this requires that the Lamp Survival Factor (LSF) in the calculation be set at .9.

There are commercial benefits in the use of light fittings that have component or engineered solutions that will deliver longer operating lives. These would typically utilise the LED's in such a way that they would have tested lives higher than 50,000-hours L70

B_{10}. Also control gear or drivers can be rated to higher than 50,000hrs operating life at <10% failure.

The fact that the initial operating light levels will be significantly higher than the maintained illuminance levels creates the opportunity to improve energy efficiency in application with the use of a lighting control system to deliver constant light output (CLO)

Exterior lighting applications governed by AS/NZS1158 utilise a slightly different formula for calculating the maintenance factor. Methods explained in applicable standards should be applied but should utilise the principles explained above.

Uniformity

Uniformity refers to the integration of lighting within a space to provide an even level of light without creating significant contrast issues. Uniformity looks at the difference between task area lighting and ambient lighting as well as the interaction of lighting between various areas of a space.

The design of lighting systems that delivers the correct uniformity are required to minimise the “distraction and dissatisfaction” of people working and moving within a space. A properly designed lighting system with Uniformity gradients in line with the standards will deliver a better overall lighting outcome and seek to minimise risks associated with health, safety and security.

Uniformity can be calculated automatically in most lighting design software. Therefore, compliance with the uniformity requirements of the applicable standard should be demonstrated by the presentation of the output from lighting design software.

The uniformity values achieved must be no less than the values stipulated in Table 3.2 of the AS/NZS 1680 standard.

Glare

Artificial lighting can be major glare sources if not selected and used correctly.

Unified Glare Rating (UGR) is a function of the luminaires performance within a given space and as a result the UGR is unique to the luminaire in that space. Therefore, UGR must be calculated using design software which calculates the performance of the luminaire in the space.

The UGR rating must be calculated in accordance with the procedure outlined in Clause 8.3.3 of AS/NZS 1680.1:2006 standard, and the calculated value must not exceed the maximum values specified in Table 8.2 of the standard.

According to the above standard, the UGR system must be applied to interior areas where any of the following applies:

- Screen-based tasks are performed such as offices, classrooms and reception areas.
- Rooms are large and multiple luminaires are regularly in line of sight of occupants, such as gymnasiums and multi-purpose halls.
- The view of occupants is above or level with the typical horizontal plane for long periods such as control rooms, or lecture theatres.
- The room surfaces (walls/carpets) are darker than is typical

AS/NZS 1680.1:2006 states:

“For the purpose of determining compliance with the recommended maximum UGR, the calculated value should be rounded (up or down) to the nearest whole number corresponding to the above scale; differences of less than 1.5 being rounded down and differences of 1.5 and greater being rounded up. For example, a calculated UGR of 20.4 would be rounded down to 19.”

Therefore, lighting designs should calculate to at least 1 decimal place and a maximum calculated UGR of 20.4 is not considered a failure to comply.

Linear luminaires (those which are typically longer than they are wide) cause less direct glare when viewed end-on rather than side-on, therefore linear luminaire layouts should:

- Run parallel to the main window wall.
- Run parallel to the normal direction of view.
- Run parallel to the long dimension of rectangular rooms, particularly long and narrow ones.

Where any of the above are in conflict, user comfort must take precedence. The orientation of the luminaires should follow the principles outlined above with consideration given to the specific distribution characteristics of the luminaire proposed.

0.04 Luminaire Considerations

The selection of luminaires that are fit for purpose is an essential element of the required design. Luminaires must be selected and installed in such a way that they will meet the specific needs of the project. Guidance should be sought from individual sites to ensure that their specific conditions are met.

Select luminaire types to suit the nature of the task to be performed and/or the atmosphere to be created; provide appropriate lighting distribution and glare control characteristics. Recessed troffer or surface mounted square sided luminaires (clean room type) must be specified in rooms where food is prepared to comply with Health Regulations. Troffers may also be needed in Special Program Spaces to maintain overhead clearance.

The following elements of the design and construction of luminaires must be considered on a site by site basis and appropriate selections made.

- Impact resistance – the ability of the luminaire to resist impacts without significant damage
- Ingress protection – the ability of luminaire to resist the ingress of moisture or solid objects
- Tamper proofing – the ability of the luminaire to resist tampering, so that access to the components of the luminaire or its installation can only be managed with specific tools
- Life expectancy – the ability of the luminaires to deliver operation for an acceptable of time based on operating hours
- Ease of maintenance – the ease with which replacement of components can be carried out.
- The use of automatic presence detectors is encouraged as this type of control can lead to significant reductions in operating costs and in particular energy savings. Consider utilising DALI dimming to reduce output in periods of non-activity with off states being triggered to occur at selected real times.

To ensure flicker-free lighting, the following luminaire requirements should be considered:

- LED lighting – electronic drivers with 12-bit or greater resolution

Impact Resistance

For safety and security reasons there are some areas which require luminaires with a significant level of impact resistance. Luminaires intended for use in certain locations and applications will be susceptible to impacts due to activity (e.g. gymnasiums, multi-purpose halls and external areas) as well as acts of vandalism.

Luminaires are to be tested via the same procedure as set out in in IEC 62262.

Ingress Protection

Ingress protection identifies the requirements of a luminaire to be protected against the penetration of solid foreign objects such as dust and bugs or the ingress of moisture.

Areas where the resistance to ingress of dust and bugs may be highly important include kitchens for hygiene purposes and areas where luminaires are hard to maintain (such as limited accessibility) and therefore cannot be easily cleaned.

Areas where resistance to ingress of water may be more important are: external areas subjected to weather and internal areas such as bathrooms. In these areas ingress protection feature is required in the luminaire.

Tamper Proofing

It is essential that luminaires used in some areas are tamper proof, such as in the low ceiling areas and outdoor circulation areas. It is required that these luminaires are

designed and constructed to be intrinsically difficult to damage or open. Further, all external screw fixings shall require a special tool. Star head stainless steel screws and screwdrivers must be used.

Fixings should be countersunk in such a way that they present no edges that can be gripped by makeshift tools. The fixings must be designed in such a way that they are robust enough to be unaffected by impacts as tested to achieve the required IK rating. The fixings shall also remain tight once they have been installed to the recommended torque setting.

All components of the luminaire must be of appropriate quality to be fit for purpose and remain unaffected by attempts to tamper with or damage the luminaire.

Life Expectancy

As has been already clarified in the above section covering maintained illuminance, the life expectancy of luminaires is the operating period in hours that has elapsed where the luminaires are producing ≤70% of their initial output and are at ≤ to B_{10}

Further, light sources must be from binning with variation no greater than 3 MacAdam steps. LM 80 testing should demonstrate that colour shift through the reasonable working life will not be significant.

In application, the life of individual LED's or arrays of LED's (usually integrated within the luminaire and therefore not cheaply replaced) will be affected by the total hours of use per week. The following table provides guidance on general hours of use by location, taking into consideration reduced operation during school holidays and on weekends, but specific sites and rooms may have different operating hours.

Table 01: Life of Luminaires in NSW Public School

NSW Public Schools	Operating hours / year	Minimum rated life in hours to L70 (70% of initial output)	Minimum operating life in years
Security lighting	4380	50,000	11
Internal Rooms and external circulation areas	2000	50,000	25
Store Rooms	200	30,000	150

Luminaires must:

- Be constructed with high quality components from reputable manufacturers.
- Be designed to operate effectively in the ambient temperatures ranges that each application may experience.

- Be designed for efficiency and ease of serviceability including cleaning
- Be subjected to appropriate quality control at manufacture to ensure that they operate as specified “straight out of the box” for the prescribed period of operation.

In applications where 30 years of operation will not reasonably be expected to be delivered without intervention, then luminaires should be capable of simple replacement of components such as control gear or LED arrays.

In low use applications, where a luminaire can be reasonably expected to operate for 30 years without intervention, e.g. in general store rooms, a lower cost / lower quality option can be considered.

Ease of Maintenance

Ease of maintenance and sustainability are important considerations. This creates the need to utilise engineering practices and components that will deliver an operating life of 25 years with the fewest interventions for maintenance and replacement as possible.

Luminaires with replaceable components such as control gear or LED arrays are more sustainable and are therefore required in most applications. Luminaires that are constructed using Zhaga components should be considered wherever possible as they provide the ability for interchangeable light source modules to be sourced from multiple suppliers.

Integration of DALI options

Where indicated, luminaires must be available with an option that allows for dimming control via the industry standard control protocol Digital Addressable Lighting Interface (DALI). A project may utilise a control system that will require dimming. Luminaires must be available with DALI compliant control gear as an option where required.

DALI is the preferred protocol as it allows a variety of head end control without the need for single supplier proprietary solutions.

See Section 0.07 Local Switching below for more details.

Integration of Emergency and Exit Lighting

Where indicated in the tables within, a project may require luminaires with an integrated emergency lighting function. LED light sources are to be used for these applications. All areas that require emergency lighting systems must be provided with system solutions that comply with all relevant standards including but not limited to AS2293 and the NCC.

The NCC requires emergency lighting and exit signs in many areas of schools.

Use emergency luminaires that utilise LED technology wherever possible.

- Position and mount emergency lighting in locations complying with AS /NZS 2293.1 and the NCC.
- Provide central testing of these lights by means of a single test switch with timer located on the local distribution board, operable without interruption to the primary lighting supply.
- Place a notice indicating the method of testing adjacent to the switch.
- Select emergency lights that are sufficiently robust for the application and with no direct access to the lamp.
- Include an emergency luminaire in the main switchroom.

Exit Signs:

- Provide to all exit doors and internal paths leading to an exit door, by self-contained, single point, battery back-up LED exit signs complying with NCC and relevant AS requirements.
- Provide mains charging and mains sensing for these units.
- Install low illuminance area internally illuminated exit signs in halls or other spaces that may be provided with low levels of illumination during normal use.
- Install a suitably labelled test switch with timer in the EDB cupboard.
- Do not combine exit signs and emergency luminaires in the same fitting where the emergency luminaire could be a distraction, (e.g. in a darkened hall).
- Select signs that are sufficiently robust for the application and with lamps having a long operating life.

New Build sites:

For new build sites, it is preferred that the utilisation of a central system for the management of emergency lighting be designed. Therefore, emergency luminaires or proposed standard luminaires with integrated emergency, must be fitted with emergency modules that can operate on a fully compatible central system.

Existing Sites:

When designing emergency lighting systems as a component of an upgrade within existing sites, the option of central systems should be considered. If a central system is designed, luminaires or proposed standard luminaires with integrated emergency, must be fitted with emergency modules that can operate on a fully compatible central system.

In existing sites where the application of a central system is deemed to complex or costly then standalone emergency lighting will be considered acceptable.

0.05 Energy Conservation

This NSW Department of Education reasonably expects lighting systems to be as efficient as possible. Notwithstanding the need to provide good quality of light and long life-cycles, there is also a need to deliver lighting with low energy consumption

Maximum illumination power density

Section J part 6 of the National Construction Code provides tables that define the maximum illumination power density that is acceptable in various locations. This, and all other elements of Section J part 6 should be applied appropriately

Energy Saving Certificates

The NSW Department of Education intends to obtain Energy Savings Certificates (ESCs) wherever possible. These certificates are generated under the Energy Savings Scheme administered by the Independent Pricing and Regulatory Tribunal (IPART). Certificates must be generated by an Accredited Certificate Provider and this requires the use of luminaires that are approved product list.

The inclusion of product on the ESS list relates only to the ability of the product to meet applicable requirements of the scheme itself and does not endorse that a listed product will meet any product quality, performance or safety claim that the product's manufacturer or supplier makes. Only products of a quality that are fit for purpose in the applications for which they are proposed should be used

0.06 Lighting Control

Smart Control Concepts

The specifications identify lighting control opportunities that may be applicable by location. The following provides guidance on the control techniques available and their application.

The use of lighting controls will assist in substantially improving energy efficiency on sites, and should be considered for all new lighting systems, in new build or site refurbishments.

In existing schools where smart lighting control is not financially viable, it will be deemed acceptable to utilise traditional existing control infrastructure.

The required communication protocol for the luminaires is DALI. The following systems for the control of luminaires fitted with DALI control gear are considered acceptable:

- Diginet Rapix suite of products.
- Clipsal C-bus suite of products
- Philips Dynalite suite of products
- KNX based systems

Systems must be designed to be as simple as possible. This simplicity must extend from the topography to ease of use.

It is a specific requirement that programming of any control system must be relatively simple and not limited to costly specialist consultants. Allowances should be made in system design specifications for user group training of control systems and for the programming of the system as part of the commissioning and hand over process. All equipment and manuals necessary to operate and maintain the system must be provided to the school and Asset Management.

Constant Light Output

Constant Light Output (CLO) systems consisting of dimming luminaires and light level sensors are highly recommended as they are effective in maintaining the required illuminance values. CLO systems ensure that the lit environment remains compliant at the lowest possible Watts per square metre for the reasonable operating life of the luminaires. As stated previously in this guide, maintained illuminance values required for design compliance will result in areas being over-lit for a large proportion of their operating life without a CLO system.

Sensors can be fitted to each luminaire or by utilising sensors that control groups of luminaires.

Once in operation a CLO system delivers compliant light levels over the life of a system by reducing the light through dimming and ramping the levels up over the lifespan of the luminaire. These systems should be seamless and invisible in operation to users of the locations.

It is reasonably anticipated that a CLO system may reduce energy usage by up to 25% over the life of the luminaires to which it is installed.

Daylight harvesting and dusk to dawn management

Daylight Harvesting utilises light level sensors to reduce and increase light levels in response to the effects of daylight. It can be delivered as a component of a CLO system and requires no additional hardware above and beyond that required for a CLO to operate.

Daylight harvesting is recommended in areas where there is a rapid transition from natural day light to a dark environment, such as when entering a multi deck or underground car park from a street in full daylight, or in a classroom where daylight from windows is within the field of view.

Occupancy Sensing

The use of Occupancy sensing is beneficial in reducing energy consumption in areas which are not in constant use and are not required to be constantly lit for safety or security reasons.

Occupancy sensing requires the use of presence detectors (passive infrared, microwave or hybrid), selected as appropriate for application, to establish the occupancy of the space and deliver lighting outcomes as required.

For safety reasons, where dimming is utilised, the system should dim to a pre-arranged light level for a period of time before dimming completely. In areas where there are no dimming luminaires in play, the occupancy sensor should only be connected to some of the luminaires. The remaining luminaires should remain on for safety purposes.

Real Time Clock

The use of a real-time clock (or astronomical clock) in the system will make it possible for the system to deliver control events at preset times to ensure that the system minimises use of lighting when not needed.

The use of this type of timer control will require a system that delivers a warning system in the form of slow dimming or light flashing at a pre-set time before the ‘off event’. An override switch system must also be installed and clearly marked. The over-ride period will re-trigger the off-event warning at the appropriate time.

Local Scene Control

Local scene controls can be used to change light levels in zones or groups to suit the activity in the area as it develops and changes. Scene control is typically carried out by the use of a multi switch combination or a touch screen mounted in an appropriate location.

Local scene control is of value in areas where various functions are carried out that require different light levels at different times. For example, are to be considered in teaching space where projectors are utilised, or where video conferencing is carried out.

Remote Management

Remote management utilises technology to make it possible to operate lighting from a remote location.

Remote management should be considered where practical to suit the requirements of the intended use.

Period Bell Linked Control

Existing schools may have a system linked to the period-bell-alarm timer to control luminaires in the appropriate rooms. In existing schools with period-bell-alarm timers and no smart control, this system may be considered if occupancy sensors are deemed cost prohibitive.

The system is to operate as follows:

- Controlled luminaires are to automatically turn-off nominally 3 minutes after the bell sounds. Turn-off is to be in two steps other than in small rooms, one step after 3 minutes and the second group 2 minutes later (5 min).

- If the lighting is required for the next period, occupants of that room can prevent the lights turning off by pressing the ON switch/es after the bell sounds.
- The luminaires in each room can be turned off at any time by pressing the OFF switch/es.
- The off signal is to be capable of transmission at the end of normal school hours or at other selected times without the bells sounding, with the lighting turning off in two steps (other than in small rooms).

By separating the lighting circuits from power circuits on the EDB, and using contactors to control the lighting circuits, a signal transmitted from the period bell control to the appropriate distribution boards will be able to control the lighting. This transmission can either be electronic or via hard wiring, with possible sharing of the period bell control cabling.

Lighting in the following spaces should not be linked to a period bell system:

- Staff Studies
- Gymnasium
- Movement Studio
- Administration Offices
- Materials Technology spaces
- Plant rooms and Switch rooms
- Store rooms

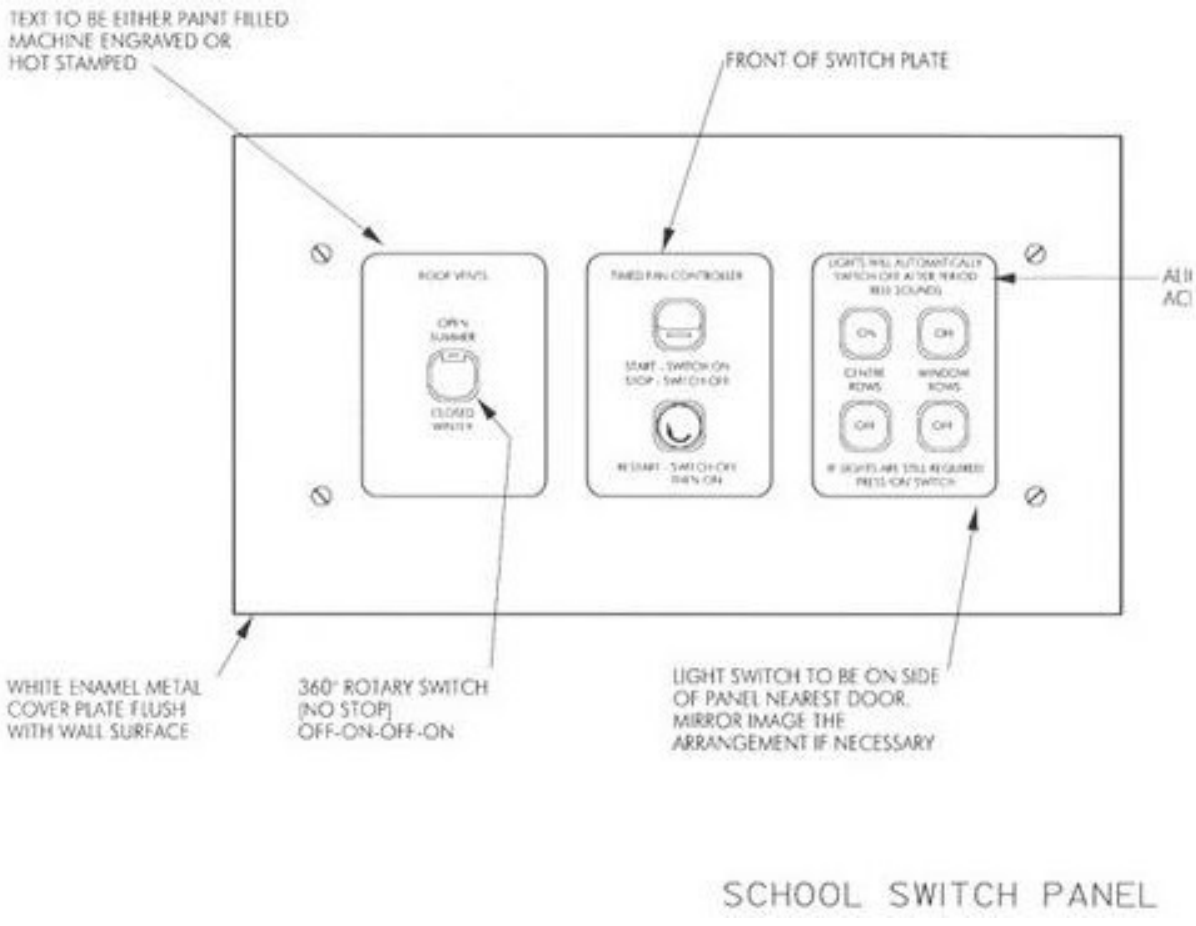
0.07 Local Switching

Local switching should be provided where it is identified that the users can benefit from manual operation of the lighting and other lighting automation technology is considered cost prohibitive. The switching should be clearly marked and robust.

- Provide switching to fittings in areas as required by NCC.
- Provide automatic control where required by the Design Guide.
- Where local switching is installed:
- Use push button timers where possible with appropriate time periods, e.g. 2 hours for classrooms, 15 minutes for store rooms. Dual contacts rated at 12.5 amps minimum each
- Arrange switching to take advantage of daylight, i.e. switch luminaires in rows parallel to windows.

- Provide separate switched group for luminaires near/close to Interactive White Boards, or in large rooms to switch lighting off when not in use.
- Provide multi-way switching for rooms with more than one main access.
- Provide push button timers in infrequently used rooms
- Group switches together along with the fan controller and ceiling ventilator damper control in a common switch grouping. Place grouping inside the entry door on the lock side. Locate the light switches nearest to the door and align with the height of the door handle. Label all controls. Develop switch panels similar to the sketch below.
- Use only switchplates that require the use of a tool to remove the cover.
- Use switch mechanisms that cannot be forced from the switchplates. Use either front-loading mechanisms or rear loading mechanisms that are secured by screws.

Figure 01: School Switch Panel



Note: where DALI is used, switch mechanisms that perform the functions drawn above should be utilised but may use electronics to achieve the result.

Use a stainless-steel fascia plate where five or more switches are grouped, e.g. in the Hall, the Gymnasium, Movement Studio or Clerical Office.

Within areas such as corridors, student toilets and shower rooms mount switches at 1800mm above floor to avoid damage and use types with a minimum of IPX4 rating.

0.08 Specific Area Considerations

External Access

External Access Lighting shall be provided to illuminate building entrances, footpaths, sheltered walkways, roadways and car park. Locate luminaires in consultation with the Project and/or Landscape Architect.

External Access Lighting must:

- Be minimal and designed to prevent glare to pedestrians, nearby residents and to motorists. Evidence of compliance with AS4282, AS/NZS 1158 and other applicable Australian Standards must be provided by the designer.
- Be located so as to link various sources of illumination such as street lighting (for carpark and roadways) and internal security lighting (for footpaths, walkways and entrances).
- Illuminate building entry doors.
- Highlight ‘accident-prone’ areas such as changes in level, stairs and ramps.
- Provide vertical illumination.

Use weather proof, vandal-resistant type fittings in all external Access Lighting. Select and install fittings to provide an effective seal around the diffuser and seal at the cable entries to prevent insect entry.

Bollard fittings are to be avoided due to their susceptibility to vandalism, difficulty in providing appropriate vertical illumination and the ease with which produced light can be obscured by bushes and other vegetation.

Ensure illumination at building entry points allows adequate illumination for persons to safely access the interior lighting switches. In instances where the internal lighting switch panel is not near the entry door it may be necessary to extend the external lighting circuit to control an additional luminaire inside the building.

Poles for mounting luminaires shall be specifically designed to include access hatches, entry hatch for underground cables, equipment panel and rag-bolt base mounting. Normal water pipe and direct buried poles are not to be used.

Local switching

Where local switching is provided for external access areas, group access lighting into logical use type groups, such as:

- Lighting associated with a hall or similar facilities that could be used by community groups that will not need access to other areas of the school. This lighting can be grouped with car park lighting and may include toilet facilities in another building. It may require control of external lighting in switchboards located in other buildings

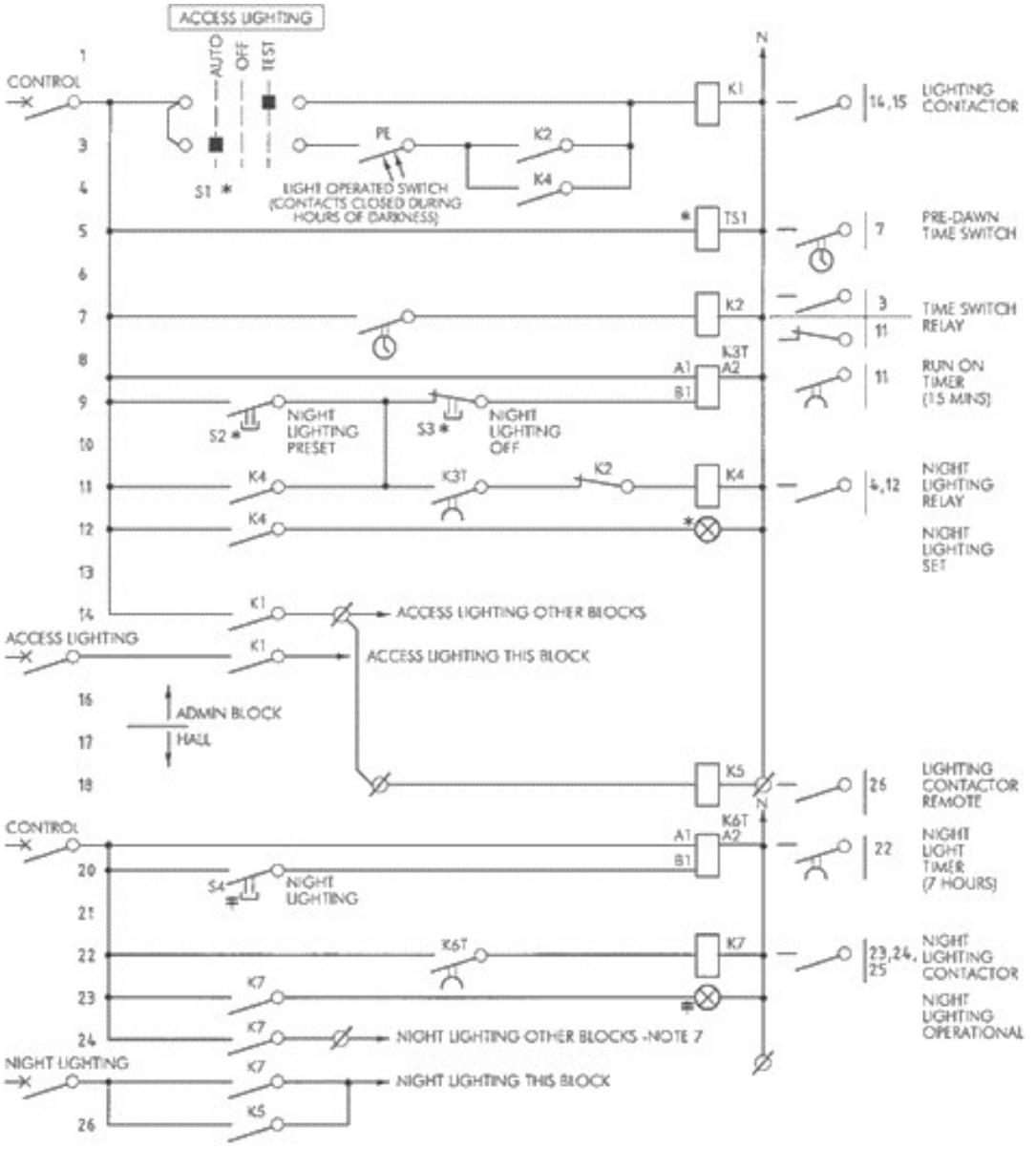
Locations of external lighting controls:

- Administration block foyer. This switch panel is to contain a three-position selector switch, night lighting “on” and “off” push buttons, a neon night lighting “set” indicator light and a seven-day digital time switch. This panel is to be a DIN enclosure with cover recess mounted near the security panel.
- Lighting switch panel in the hall and/or other buildings that are designed for community use. This switch panel is to contain a pushbutton to turn night lighting “on” (as required for Entertainment Venues) and a neon night lighting “on” indicator light and also to contain a push-button to turn night lighting “off” with 15 minutes run-on timer to allow safe departure from the site before the lighting goes off.

Control functions: The following lighting control functions are to be included:

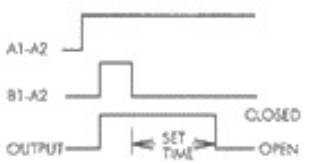
- Predawn Function: With the selector switch in the “auto” position, all access lighting is turned on by the time switch between 5:00 am and 9:30 am (Monday to Friday) and turned off at sunrise via a photocell, to allow safe entry to the school for cleaners.
- Night Function: With the selector switch in the “auto” position, access lighting can operate after hours via a pushbutton in the administration block. This function is only to operate at night and be controlled via a Photocell. At the end of the night function the lighting is turned off at this panel or will run for a total of 2 hours. A 15-minute run-on timer allows safe departure from site before the lighting goes off. The pre-dawn function will continue to operate and will reset the system, if the night function is not turned off.
- The access lighting push button switches on external lighting associated with the hall. It will operate for a nominal seven-hour period by timer control and then turn off. Also provide “off” push button to override the access lighting with 15 minutes run-on timer to allow safe departure from the site before the lighting goes off.
- The position “test” allows manual operation in the daytime for maintenance of external lighting.
- Provide interface between access lighting control panel in Administration block and Hall switch panel.

Figure 02: Access Lighting Control



NOTES :

1. TIMER K3T & K6T FUNCTION DIAGRAM:



2. LABEL S2:
PRESS TO SET ACCESS LIGHTING TO OPERATE THE FOLLOWING NIGHT

3. LABEL S3:
PRESS TO TURN NIGHT LIGHTING OFF - IT STAYS ON FOR 15 MINUNTES

4. LABEL S4:
PRESS TO TURN NIGHT LIGHTING ON - IT WILL RUN FOR 7 HOURS THEN GO OFF

5. ITEMS MARKED WITH '*' ARE ON THE ACCESS LIGHTING SWITCHPANEL IN THE ADMIN BLOCK FOYER

6. ITEMS MARKED WITH '#' ARE ON THE HALL SWITCHPANEL

7. EXTEND IF NECESSARY FOR ANY ACCESS LIGHTING CONTROLLED FROM OTHER BLOCKS THAT MUST BE ON WHEN THE HALL IS IN USE FOR EXAMPLE, CARPARK OR TOILETS

8. TS1 INITIAL SETTING: ON -5a.m., OFF -9.30a.m. MONDAY TO FRIDAY

9. K2 NOT REQUIRED IF TS1 HAS DUAL SET OF CHANGE-OVER CONTACTS

Internal Access

Internal Access Lighting is used to illuminate circulation areas such as foyers, entry vestibules, corridors and stairs. In most instances:

- Circulation areas should be well lit to ensure traffic safety
- A gradual change of luminance from one area to another is preferred and should be designed in where practical
- Where a more relaxed atmosphere is desirable, decorative luminaires may be considered. However, since these luminaires are on for long periods, use only long-life luminaires.

Where local switching is provided for external access areas:

- Placement of luminaires switches should ensure users' safety and convenience
- Two-way switching shall be avoided when possible
- Co-ordinate switch locations with external access lighting to ensure safe after-hours access to internal lighting switches

Security Lighting and CCTV

The lighting and control systems must be designed to integrate with and support any Closed-Circuit Television (CCTV) systems present or proposed in the specific site.

Both the CCTV and lighting must operate in a complimentary fashion. To reduce glare, recessed lighting should be fully flush and aimed in a manner that will ensure that the light source itself or any diffuser illuminated surfaces are not in direct view of the camera.

Lighting designers must consult with the designers of the CCTV system in new builds to ensure that co-ordinated performance outcomes are achieved.

For upgrades of existing sites, the lighting system must be designed in consultation with the CCTV suppliers / operators.

Refer to 00 PLANNING AND DESIGN/0001C DESIGN CHECKLIST - SAFETY for additional requirements.

Gymnasiums, Movement Studios and Halls

Select luminaires that are suitable for the application with consideration given to robustness, luminaire noise, optical qualities, maintenance of illumination and reduced luminaire maintenance.

Lighting in Gymnasium, Movement Studios and Communal Halls must be well planned and properly equipped to:

- Suit the activities proposed for the space, which may include a range of activities from ball sports to the sitting of exams.
- Provide adequate illumination for the different tasks to be performed.
- Comply with Australian Standards regarding safety and emergency lighting.
- Utilise motion sensing dim to lower levels when activity is reduced and off when not required.
- Do not provide portable scaffold for luminaire maintenance. However, locate luminaires and provide for access to enable a portable system to be positioned for this purpose.
- The diffuser must be made of high impact acrylic or similar vandal-resistant/impact resistant material that is not be prone to discolouring by UV radiation.
- Bolt or screw fixed clips should be used, normal spring clips often release under impact, and are not acceptable.
- As these spaces are also used for quiet activities, luminaires must be quiet in operation and without any discernible ballast hum.

Due to the differences in illumination requirements between movement activities and intensive work at a desk, both of which may be undertaken in a multi-purpose space, consider installing two separate lighting systems. Include appropriate controls and signage to switch between these two systems or modes.

Local switching

Where local switching is installed, provide the following luminaire groups and label switches:

- Stage (or raised platform)
- Wings (or side stage)
- Hall front
- Hall middle
- Hall back (2-way)

To allow safe passage to the lighting panel, provide 2-way switches at both main entry doors, for hall back lighting.

Control lighting associated with the hall and stage areas from the Stage Control Equipment Cupboard. The cupboard should contain the following:

- Stage lighting patch panel
- Provision for dimmer unit and its remote control from the rear of the hall

- 4 double socket outlets on separate circuits adjacent to the patch panel for initial non-dimmed supply to lighting outlets
- Sound reinforcing equipment

Consider lines of sight between the cupboard and the stage area and hall. Co-ordinate with the Project Architect to ensure that doors do not obstruct these lines; if necessary, provide a viewing port between the cupboard and the hall.

Switching is to be accessible to authorised persons only. All switch panels are to be recessed into the wall and are to be fitted with a hinged lockable door, operated by NSW Public Works ‘E’ key.

Install override switches in the main area to switch on the general lighting in the event of an emergency situation. Most halls will require a minimum of four override switches: at the exit doors at either side of the stage and near both exit doors at the end away from the stage. Lighting override switches to be latching mushroom-head push button switches of the twist to reset type, labelled: LIGHTING OVERRIDE.

Toilets available for use in Gymnasium, Movement Studio or Hall, even if physically separated, are to be guarded against unauthorised switching by means of a lockable switch on the Hall M.S.P. This switch is to override all other switches controlling the toilet lighting.

Stage Lighting

The purpose of stage lighting in a live theatre production is to illuminate the acting area, including the performers and background scenery. The acting area should be illuminated to give emphasis and visibility to the actor's face, wherever the actor stands on the stage.

For effective illumination, it is necessary to light the actor's face from the front, and from at least two directions. This can be done with 2 spotlights approximately 90° apart, 45° above actors’ line of sight and to the side. The plane of illumination is generally at the level 1600mm above F.F.L., i.e. above the stage.

General Concept

Generally, divide the acting area into smaller areas that can be fully illuminated by a spotlight beam. This will permit flexibility of emphasis and visibility over the various parts of the stage. Assume beam spread of about 3 to 4 metres across the minor elliptical axis.

An average acting area of 8m by 5m will normally be divided into six sections. The location of the acting area spotlights can be determined by projecting 45° from the centre of each section towards the walls and auditorium ceiling.

The ceiling mounted lighting of the auditorium will normally illuminate the front areas of the stage while the rear areas will be illuminated from the stage side of the proscenium.

Note that this Design Guide requires a minimum of 6 outlets on the ceiling of the auditorium and 6 outlets on the stage side of the proscenium.

Special Effect Lighting

Special effects may require top, side and back lighting on the performer. Although seldom used, provisions should be made.

- Back lighting can be provided by installing two outlets adjacent to the cyclorama.
- Side and top lighting can be provided using the rear area spotlight outlets.
- Background scenery is normally lit separately using rows of border lights (battens).

Border lights

Border lights are space filling lighting instruments and provide general down lighting across the stage and overhead illumination of curtains and scenery.

The number of rows of border lights depends on the number of curtains. Most secondary schools have a front curtain and a cyclorama, requiring two rows of border lights. One to be mounted on the stage side of the proscenium and one in front of the cyclorama. Wire each row of border lights to 4 separate circuits for colour mixing i.e. 4 outlets are required for each row of border lights.

The standard lighting support bar used in the industry is a 48mm OD GWP, 3.2 mm thick. The lighting bar on the stage side of the proscenium should be placed such that it will not clash with the proscenium teaser and luminaires mounted on the bar will not be seen by audience sitting 3m from the stage.

Stage Lighting Installation – Secondary schools halls and movement studios

- Equipment to be provided includes, but not limited to:
- Minimum 3 stage lighting bars
- Stage lighting outlets on bars
- Minimum 24-way patch panel
- 5-pin 3-phase and neutral 50Amp plug socket for a future dimmer
- 2.5 kW dimmers (with space for a second rack) wall mounted with sockets and integral RCD Protection
- 12 channel dimmer control panel
- Stage lighting luminaires.

Wire stage lighting outlets back to a patch panel equipped with flexible cords, which can be plugged either into the future dimmer, or to the 4 double socket outlets adjacent to the patch panel. Provide a positional plan of all outlets near the patch panel. Label all outlets.

Use separate neutral conductors for each outlet.

The front lighting bar location should be approximately 45° above the line of sight of a person near the front of the stage.

Provide control of general lighting at the stage and near the main entry. In addition, the dimmer requires control from the stage and near the rear of the Hall. Install a 32 mm HD-uPVC conduit and cable between the stage control equipment cupboard and the remote control outlet for this purpose.

The cabling and sockets to be used are as follows:

- Cabling - 2 x twisted pair overall shielded data cable
- Sockets - 5 Pin XLR connector; wall box mounted
- Male type connection at control desk linked to female type at dimmer position in equipment cupboard.
- Male type connection adjacent to dimmer linked to female type at lighting bar
- Male type connection at remote control position linked to female type adjacent to dimmers

Minimum of three lighting support bars are required:

- One suspended from the ceiling of the auditorium for front area spotlights. Careful co-ordination is required to avoid other equipment e.g. Basketball ring and backboard assemblies.
- One on the stage side of the proscenium for rear area spotlights and first border lights.
- One adjacent to cyclorama (approx. 1m in front) for cyclorama border lights.

Provide control of general lighting at the stage control cupboard. Control the dimmer from various parts in the room. Install a 32mm HD-uPVC conduit and cable between the stage control equipment cupboard and the remote control outlets.

Stage Lighting Installation – Primary school halls

Only basic stage lighting equipment is normally provided for the Communal Space raised platform in Primary Schools. This is indicated in the individual Rooms and Spaces Technical data.

Provide single socket outlet for future stage special lights in hall ceiling.

Provide two individually switched double socket outlets on each side of the hall, adjacent to and 600 mm above the bottom of each vertical lighting bar.

Install two 100W LED floodlights (or similar instantaneous lamp of equivalent or better light output) on each of the two vertical lighting bars. If there is an identified need for the characteristics of halogen lamps in this application then 500W floods can be used.

Care should be taken to ensure that heaters or other ceiling mounted items are not installed between the spotlights and the stage or too close to the spotlights.

Provide ON/OFF switches located in a labelled panel in the SRS cupboard for the socket outlets.

No provision for dimming is required. However, where a new Communal Hall is being built on an existing school site, the school may choose to install a dimming system at their own cost. Liaise with the client to allow for dimming system where selected.

Provide control switches in SRS Sound cupboard for lighting bar socket outlets in Hall.

Specification

01 General

It is DoE's policy to utilise the most energy efficient and cost-efficient technology available. For new schools, new buildings and refurbishments within existing schools' designers must select fittings that meet the LED performance specifications in 02 Products. For existing buildings where like for like replacement is required, refer to the pre-qualified items listed in 03 Execution

Table 02: Summary of General LED Luminaire requirements

Category	Requirement
Safety and regulation	The luminaire, LED and power supplies shall be suitable for connection to the public electricity supply in NSW and in particular comply with the following:
Safety and regulation	AS/NZS 3000:2007 and its amendments titled "Electrical installations (known as the Australian/New Zealand Wiring Rules)" (installation only)
Safety and regulation	AS 2946:1991 (R2013) titled "Suspended ceilings, recessed luminaires and air diffusers - Interface requirements for physical compatibility" (installation only)
Safety and regulation	Equipment must carry the Regulatory Compliance Mark (RCM) mark and must be classified in accordance with the requirements set out in AS/NZS 4417: 2012 and amendments titled "Regulatory compliance mark for electrical and electronic equipment".

Category	Requirement
Safety and regulation	Luminaires must be constructed in accordance with the applicable sections of AS/NZS 60598 and all current revisions
Safety and regulation	Luminaires must be tested and proven to be compliant with AS/NZS CISPR 15:2011 titled “Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment”
Safety and regulation	LED power supplies when integrated within luminaires must be compliant with the applicable elements of AS/NZS 61347 which covers lamp control gear
Safety and regulation	LED power supplies when not integrated within the luminaire must be compliant with AS/NZS 61347.2.13
Safety and regulation	Luminaires for use in Emergency Lighting systems within sites must also comply with the requirements of AS 2293 titled “Emergency escape lighting and exit signs for buildings” titled “Lamp control gear Particular requirements for d.c. or a.c. supplied electronic control gear for LED modules”
Safety and regulation	Control equipment including Digital Addressable Lighting Interface (DALI) drivers within luminaires shall conform with the applicable elements of IEC 62386 titled “Digital addressable lighting interface”
Luminaire life LED’s	At least 50,000 hours to 70% of initial output (B10). Evidenced by LM80 and TM21 reports. Higher than 50,000 hours is of value to us please show L70 B10 rating in column 5 if higher.
Luminaire life: Power Supply / Driver	Power supplies / Drivers to also be at least 50,000 to less than 10% failure. Better life is of value to us please show your life to less than 10% failure in column 5 if longer
Light Source	Colour temperature: 4000 K (cool white) unless otherwise required
Light Source	CRI: ≥80.
Warranty	5 years minimum unconditional on hours of operation. Warranty statements must be provided.
Photometric Performance	IES file prepared by NATA-registered laboratory (or testing by mutual recognition arrangement network member) preferably to IESNA LM79.
Photometric Performance	Designs must show maintenance illuminance on working plane in accordance with AS/NZS 1680 recommendations unless task lighting is to be provided where applicable. Methods of calculation of maintenance factor to be in line with principles outlined in AS/NZS 1680.4
Photometric Performance	Glare management and uniformity also to comply with AS/NZS 1680 and can only be shown as a design within the site or similar (where applicable).

Category	Requirement
Efficiency of luminaire must be delivered lumens per system Watt	Surface mounted lighting must be 100 lumens per Watt or better.
Efficiency of luminaire must be delivered lumens per system Watt	Recessed downlights/spotlights must be 65 lumens/Watt or better.
Efficiency of luminaire must be delivered lumens per system Watt	Street and flood lighting must be 120 lumens per Watt or better
Control gear, power supply and drivers	Power supply losses to be included at all times, so that the rated power of the luminaire is the connected load not just LED load.
Control gear, power supply and drivers	Must be rated to support mains voltages in Australia as outlined in AS60038
Control gear, power supply and drivers	Earth leakage must be ≤ 0.5 mA
Control gear, power supply and drivers	Circuit loads mustbe designed and calculated to ensure no false tripping of protection devices such as RCD's can occur. (Design and Installation)
Control gear, power supply and drivers	Compliance with AS/NZS 61347 where applicable.
Environmental Conditions	Maximum operating temperature: 50°C.
Environmental Conditions	Minimum operating temperature: -10°C.
IP rating for dust and moisture ingress	Generally, at least IP 44 unless inground or submerged in which case IP 68. Utilise appropriate IP rating to suit application
IK rating for impact resistance	Generally, at least IK08 where luminaires can be reasonably expected to receive impacts. Utilise appropriate IK rating to suit application

Category	Requirement
Power factor	Greater than 0.90.

New Builds and Refurbishments- New LED Lighting

Please download this Excel spreadsheet for LED luminaire requirements for each location within a school LED Luminaire requirements

02 Product

As per current NATSPEC.

03 Execution

As per current NATSPEC.

04 Selections

As per NATSPEC except as follows:

Existing Schools Like for Like Replacement

Table 03: Existing School Like for Like Replacement LED Luminaire requirements

Location	Lamp	Colour Temperature	Other Specifications	Prequalified Items
General internal spaces	28W T5 Fluorescent	4000K	Totally enclosed prismatic diffuser High performance reflector	Pierlite 'Unilux EP' Thorn 'NEWLANDS'
Movement Studio **Communal Hall**	28W T5 Fluorescent	4000K	High protection rating	Pierlite 'SCRN' Trilux 'PSN' Moonlighting 'CELLITE'
Library	28W T5 Fluorescent	4000K	Direct/indirect upward/downward lighting	Klik lighting Austube tubular lighting Pierlite 'TCO' series with opal diffuser

Location	Lamp	Colour Temperature	Other Specifications	Prequalified Items
External areas **Areas exposed to moisture** **Areas exposed to mechanical damage**	28W T5 Fluorescent	4000K	Impact resistant Vandal proof	Pierlite 'VO'
Gymnasium	250W/400W Metal Halide	-	High performance reflector Auxiliary lamps	Pierlite 'Powerlux' Versalux 'Multilux' Wadco 'Ultralux'
Dark room	15W Safelight	-	-	Kodak 'Pyramid' 402 5300 Vanbar 'Patterson Dome' 25-0760