



Chapter Ten

PART J6 – ARTIFICIAL LIGHTING AND POWER

Including:

- Explanations of the provisions, equipment and systems
- Specification J6 – Lighting and Power Control Devices

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1. Introduction to Part J6

The BCA measures for artificial lighting and power are designed to curb unreasonable energy use in the lighting systems in all building classifications including the sole-occupancy unit of a Class 2 building and a Class 4 part of a building.

Research prepared by the Australian Greenhouse Office indicated that lighting is expected to be responsible for 16% of the electrical energy used in a building. Lighting inefficiencies also have a compounding effect in

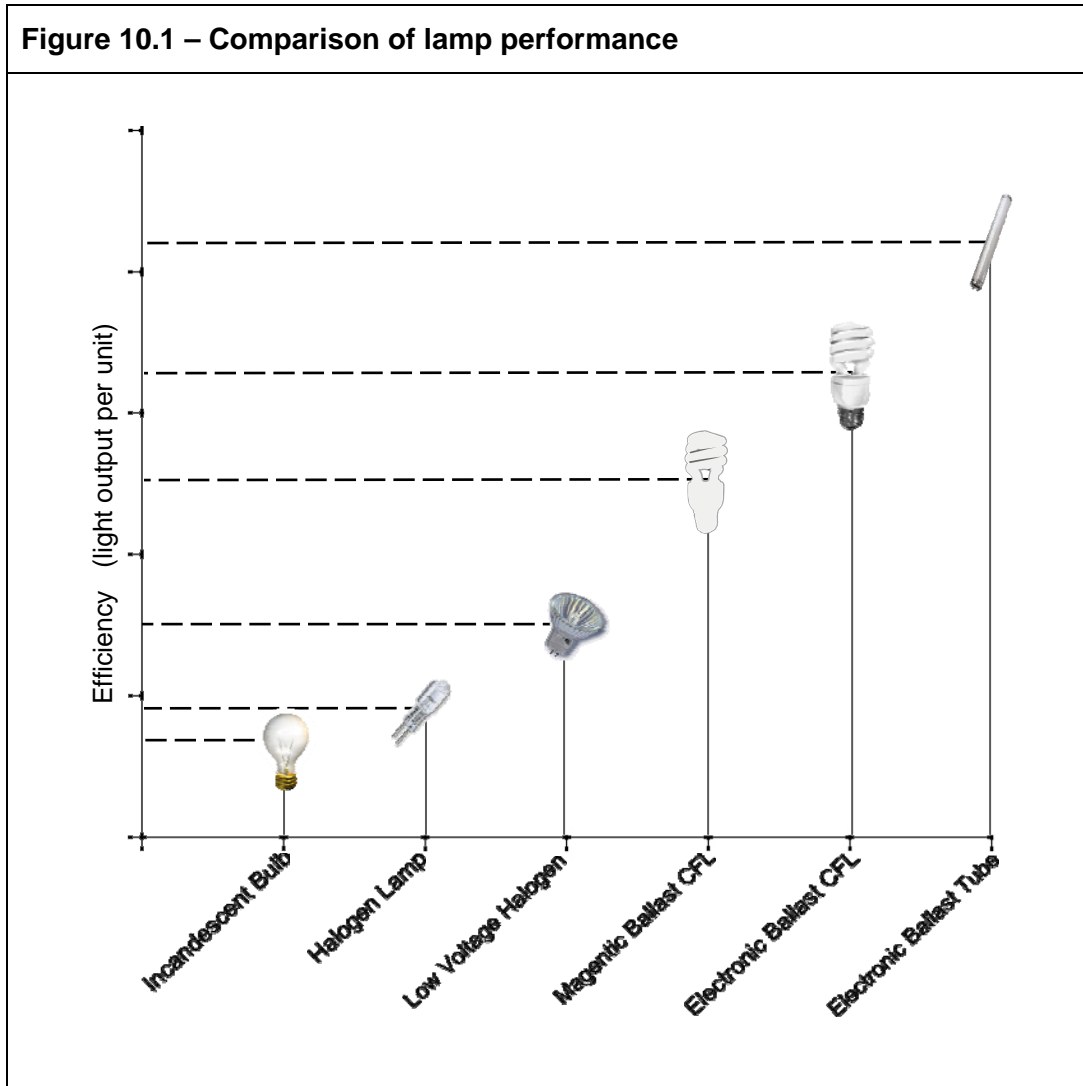
warmer climates because the extra electrical load for lighting translates to waste heat that increases the load on the air-conditioning system.

Refer to **Figure 10.1** for a comparison of lamp performances. It should be noted that in this diagram the output of a tube lamp with an electronic ballast is about 80 Lumens/Watt and that of the halogen lamp about 20 Lumens/Watt. Accordingly, the establishment of minimum standards for the use of lighting energy is an important step in controlling building energy use.



Source: www.yourhome.gov.au

Design alert: *These provisions within the BCA may require additional information to be provided when seeking building approval. Plans will require statements of lamp rating, associated room areas and possibly control gear ratings which could be in the form of schedules similar to those used for windows.*



2. Scope of Part J6

The lighting provisions apply to all buildings, including within the sole-occupancy unit of a Class 2 building and a Class 4 part. This is consistent with the philosophy adopted for the Housing Provisions.

The requirements in Part J6 address the following elements-

- a. limits on the efficiency or power consumption rate of artificial lighting installations, including some outside the building;

- b. control of switching arrangements for lighting and power, including automated cutoff in some cases, depending on the building Class and the size of the lighting installation.
- c. control of interior decorative and display lighting;
- d. control and efficiency of artificial lighting around the perimeter of a building; and
- e. time switches for boiling water and chilled water storage units.

The Specification to Part J6 contains further information on appropriate design requirements for lighting and power control devices, including-

- a. corridor lighting timers;
- b. time switches;
- c. motion detectors; and
- d. daylight sensors and dynamic lighting control devices.

3. Intent of Part J6

3.1 Lighting and power provisions

The intent of Part J6 is to enable artificial lighting and electric power energy to be used in a responsible manner and avoid excessive use.

Lighting used in buildings, particularly commercial buildings, is a high consumer of electric power, which is usually a high source of greenhouse gas emissions. Accordingly, there are significant gains to be achieved by introducing requirements which encourage more efficient use of this power.

In line with the requirements of the Housing Provisions, lighting in Class 2 sole-occupancy units and a Class 4 part of a building is also addressed, as well as the common areas of a Class 2 building.

The main concerns addressed by this





Part are that lighting is often installed far in excess of the lighting needed for the task or that inefficient fittings are used. For instance, ambient lighting installed for aesthetic or mood purposes is not generally required for safety or operational purposes and there are opportunities to save power by restricting excessive usage. Shops, in particular, tend to have very high lighting levels to attract customers.

3.2 Specification J6 – Lighting and power control devices

Specification J6 provides more explicit technical details for the operation and location of control devices. This information is not readily available in documents such as Australian Standards and, accordingly, has been developed for use with the BCA requirements.

4. Clause by Clause Analysis

The following section of this document provides a detailed analysis of each of the clauses in J6 – Artificial Lighting and power and in Specification J6 – Lighting and Power Control devices.

The analysis discusses important points that should be considered when designing or assessing a building for compliance with the BCA DTS Provisions.

4.1 Further reference material

The following reference documents are recommended if further information is required in regard to this Part. Each document, or information about the document, is available from the ABCB website, www.abcb.gov.au:

- a. Determination of Average Lighting Power Densities for Commercial Buildings - May 2002.
- b. LIGHTING, ART + SCIENCE PTY LTD, Review of Section J6 of the BCA, November 2008.
- c. LIGHTING, ART + SCIENCE PTY LTD, Building Code of Australia – Residential Lighting Control Options, October 2008.

4.2 Important terminology

a. BCA definitions

Illumination power density

This definition has been developed to identify the total amount of power that will be consumed by the lighting systems in a space, including the effect of lamps, ballasts, current regulators and control devices within the fittings. The total is arrived at by calculating the power used and then dividing it by the floor area of the space.



It is worthwhile noting that lamps plugged into a general power outlet are not covered by this definition as they are difficult to regulate and accordingly will not need to comply with the BCA requirements. However, any hardwired lamp must comply, as must a fitting plugged into an outlet specifically designed for a lighting appliance.

Lamp power density

This definition has been developed to identify the amount of energy used in a space by the lamps alone (excluding lighting ballasts, etc). The total energy of the lighting is arrived at by adding the nominal Wattage of all the lamps in the space and then dividing this by the floor area of the space.

Again, lamps plugged into a general power outlet are not covered by this definition. However, a hardwired lamp must comply.

Refer to the explanation on BCA Clause J6.2 for a practical application of the requirement.

Figure 10.2 provides an example.

Light source efficacy

In simple terms, this definition relates to the energy efficiency of the lighting device. The effectiveness of the lighting device is measured by the amount of lighting (illumination measured in lux or as lumens per unit area) divided by the electric power (in Watts) that will be used by the lamp. In regards to the interpretation of light source efficacy values, the higher the rating, the more efficient is the lamp.



b. Other terms of interest

Lumens (lm)

The term Lumens is first mentioned in Note 2 to Table J6.2a and is the determined unit of luminous flux (the light emitted from the light source or luminare). In regards to numerical values, the higher the Lumen value the more light is emitted.

The Lumen value is obtainable from the manufacturer and is described as the “lm” value in lighting product literature.

Watt (W)

This is the determined SI value (international system of measuring units) for electric power and is used to rate electrical appliances and lights. It describes the amount of energy used by an appliance, the lighting system or the lamp.

J6.0 DTS Provisions

This Clause establishes that the DTS Provisions in J6 are part of an overall energy efficiency solution and each DTS Provision within Section J must be applied in order to meet the Performance Requirements.

In simple terms, the building must comply with all the appropriate DTS Provisions in Section J in order to be considered as complying with the BCA.

Accordingly, if there is any variation from the prescribed DTS requirements in one part, then the entire energy efficiency measures for the building will need to be checked to ensure that there is no unintended effect on the other parts as a consequence of an Alternative Solution being adopted for one part. See A 0.10 (c).

J6.2 Artificial lighting

J6.2(a) Artificial lighting requirements for residential buildings

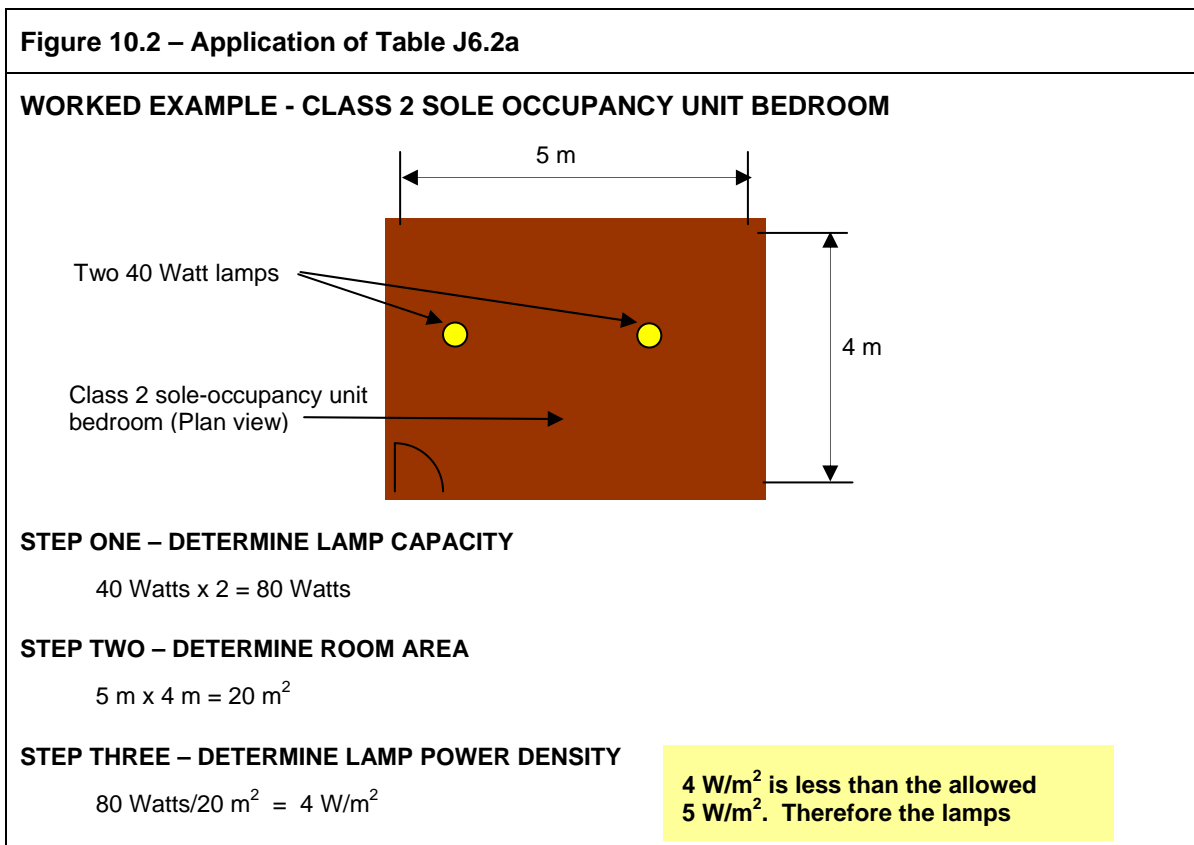
Subclause J6.2(a) is about lighting in dwellings, i.e. the sole-occupancy unit of a Class 2 or a Class 4 part of a building. Subclause (i) establishes the separate maximum power input values permitted for lamps within the building and on its verandahs and balconies.

Based on the definition of lamp power density, the provisions apply only to artificial lighting permanently wired to the dwelling’s lighting circuits. Therefore, lights connected by plugs to general power outlets are exempt.

In order to determine the values, it is necessary to identify the total power or Wattage of the lamps installed and then divide this value by the total floor area of the space they serve. Refer to **Figure 10.2** for an example.

Subclause J6(a)(ii) provides an alternative approach for dwellings with sophisticated control systems. Suitable control devices are listed in Table J6.2b. Because these controls are likely to further reduce the energy used, a concession on the lighting power limit is given. This approach, which sets an Illumination Power Density (rather than Lighting Power Density), is similar to the approach used for commercial buildings.

This concession recognises that the requirements need to be, or can be, tempered in certain situations where sensing, switching devices, or room sizes have an impact on the performance of the lighting.



J6.2(a)(iii) requires the actual lamp or illumination power to be used rather than an assumed nominal allowance. This may pose an administrative issue for the building official who might need to require actual fittings to be installed or provide only conditional approval.

J6.2(a)(iv) does not specifically require a lighting transformer or ballast but, if one is installed, it is to be of the more efficient electronic type.

J6.2(a)(v) requires halogen and fluorescent lamps to be separately switched. This enables the more efficient fluorescent lamps to be used routinely and the less efficient halogen lamps turned on only when needed.

Subclause J6.2(b) Artificial lighting requirements for commercial buildings

Subclause J6.2(b) is about lighting in buildings other than dwellings, i.e. Classes 3 and 5 to 9 buildings. Like J6.2(a), this subclause sets a lighting power allowance in terms of the defined Illumination Power Density. This includes for power losses in ballasts, control devices and the like.



Subclause (i) explains that the allowance is the sum of the individual allowances for all spaces and the individual load allowances are calculated by taking the maximum illumination power density value from Table J6.2a and multiplying it by the area of the space.

The maximum illumination power density values in Table J6.2a have been based on a lighting design complying with the recommendations of AS 1680 for the nature of the task, including an allowance for a safety margin in design and the physical limitations in placing a discrete number of fittings in a uniform array. **Figure 10.3** shows how some of the values correspond to the lighting levels of AS 1680.

The figures have been set at a level that can be achieved with reasonable surface reflectances, high efficacy light sources, low loss control gear and high efficiency luminaires.



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For spaces not listed in Table J6.2a, a maximum illumination power density can be calculated for a range of illuminance levels using the notes section of the table. The notes also contain a requirement that, if the illumination level is greater than 620 Lux, very efficient lighting units must be used, i.e. 80 Lumens per Watt or better.

Figure 10.3 - Relationship of maximum illumination power density to AS 1680 illuminance levels

Location	AS 1680 recommended illuminance, Lux	Maximum illumination power density W/m ²	Lumens/Watt
Auditorium, church and public hall	160	10	16
Board room and conference room	240	10	24
Carpark - general	40	3	13
Carpark – entry zone (first 20 m of travel)	800	25	32
Corridors	160	6	27
Control room, switch room, and the like	160	10	16
Courtroom	320	12	27
Entry lobby from outside the building	160	15	11
Health-care - children's ward	240	10	24
Health-care - examination room	400	10	40
Health-care- patient ward	240	7	34
Kitchen and food preparation areas	240	8	30
Laboratory	400	15	27
Library – general	240	12	20
Library – reading room	320	10	32
Museum and gallery - circulation, cleaning and service lighting	240	8	30
Office – artificially lit to an ambient level of 200 lux or more	320	9	33
Office – artificially lit to an ambient level of <200 lux	160	7	23
Plant room	80	5	16
Public toilet	80	5	16
Restaurant, cafe, bar, hotel lounge and a space for the serving and consumption of food or drinks	80	18	4
Retail space including a museum and gallery that sell art objects	160	20	8
School - General purpose learning areas and tutorial rooms	320	8	40
Storage, shelving no higher than 75% of the height of aisle lighting	160	8	20
Storage, shelving higher than 75% of the height of aisle lighting	160	10	16



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Service area, cleaner's room and the like	80	5	17
Wholesale storage and display area	320	10	32

Also, in note 3 under Table J6.2a there is a concession for small enclosed spaces. This is because walls absorb light energy and so less illumination would be available at the working surface level unless some compensation is permitted. A formula is given for calculating the adjustment based on a Room Aspect Ratio.

Table J6.2a contains two levels of maximum illumination power density for offices. General open areas that are lit to 200 Lux or more may use 9 W/m^2 while offices lit to less than 200 Lux, where task lighting is intended to supplement the general lighting, have a maximum for general lighting of only 7 W/m^2 .

Subclause (iii) provides some rules for when there are multiple lighting systems serving the same space and where there is track lighting.

The energy saving features in Part J6 may not always be appropriate to the use of a space and there are situations when life safety must take precedence. Subclause J6.5(c) lists exemptions which take account of such situations.

Table J6.2b - Illumination power density adjustment factors

It is recognised that there are many variables in lighting that make it harder to stay within the maximum illumination power density limits. Rather than setting higher limits that allowed for the worst case, a series of adjustment factors have been included in table J6.2b that provide credit for using additional energy control devices, similar to the concession offered for the effect of small spaces.

The adjustment factors are applied to the illumination power density allowance for the space prior to comparison with the actual load. This means that, if a designer chooses to use a less efficient light source or luminaire, compliance can still be achieved by including a supplementary control device such as an occupancy sensor or photoelectric device.

Occupancy sensors represent an efficient way of tailoring the lighting to the functional needs of the space. The fewer lights that are controlled by an individual sensor, the greater the potential energy savings but these may not be enough to offset the cost of the sensor. Therefore, there is a graduated scale of adjustment factors which vary with the area of lights controlled.



The designer can look at the relative cost/benefit ratio of each option for the project. The cost/benefit may not be a simple balance of the cost of the detector versus the potential energy saving. The criterion may be to provide surplus illumination power density allowances to offset another area.

Figure 10.4 is a worked example of Sub-clause J6.2(b)(i).

Figure 10.4 – Worked example of J6.2(b)(i)

WORKED EXAMPLE - SMALL LABORATORY

The laboratory is 5 m by 7 m. Its floor area is 35 m² and the perimeter is 24 m. The ceiling is 2.6 m high. The lighting design has a proposed aggregate design illumination power load (load for all lighting fittings) of 500 W which includes all ballasts and it incorporates a manual dimming system which operates all of the lights as a single block.

Design load As stated, the design illumination power load is 500 W.

Allowed load From Table J6.2b, the maximum illumination power density allowed for a laboratory is 15 W/m².

Adjustment factors

From Table J6.2b, the illumination power density adjustment factor for a manual dimming system that controls at least 75% of the floor area, in a building Class other than 2 or 4, is 0.95.

From Table J6.2a, Note 3, the adjustment factor for room size, depends upon the Room Index which is:

$$A/(H \times C)$$

$$\text{i.e. } 35 / (2.6 \times 24)$$

i.e. 0.56. Since this Room Aspect Ratio is less than 1.5, Note 3 allows an adjustment factor for room aspect. The factor is calculated as:

$$0.5 + (\text{Room Aspect Ratio}/3)$$

$$\text{i.e. } 0.5 + (0.56/3)$$

$$\text{i.e. } 0.69$$

Dividing the maximum illumination power density of 15 W/m² by this adjustment factor gives the higher value of 21.7 W/m².

Note 4 of Table J6.2a allows the adjustment factor from Table J6.2b for the manual dimming system to be applied in addition to the adjustment for room aspect. The permissible illumination



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power density then becomes:

21.74 / 0.95

i.e. 23 W/m²

The illumination power load allowance is space area x maximum illumination power density, which is 35 x 23 = 805 W

OUTCOME: As the aggregate design illumination power load of 500 W is less than the illumination power load allowance of 805 W, the design complies.

Lighting calculator

The ABCB has produced a calculator to assist in assessing compliance with J6.2.

Subclause J6.2(c)

When applying the provisions of J6.2(a) and (b), it is important to remember that the following lighting systems are exempt from the provisions:

J6.2(c)(i) emergency lighting, as required by BCA Part E4.

J6.2(c)(ii) lighting associated with signage and lighting within display cabinets and cases that are fixed in place. This concession will apply to

both external and internal signage, including lighting that highlights signs. In regards to display cases, the lighting must be within the fixed cabinet or case to be exempted;

J6.2(c)(iii) lighting installed in the accommodation areas within a detention centre such as jails, remand centres etc. Accommodation should be interpreted as the area specifically set aside for the detainees. Ancillary areas, such as staff common rooms and administrative sections, will not receive this concession.

J6.2(c)(iv) lighting used for heating, such as in a bathroom. These systems use heat radiated from the special purpose lamps to warm room occupants – from a simplistic perspective, the higher the Wattage, the hotter the system. The use of such a system should be nominated on the building approval documents.

The screenshot shows the 'LIGHTING CALCULATOR FOR USE WITH J6.2(b), BCA VOLUME ONE' interface. It includes a table with columns for Description, Floor area, Height, Design Illumination, Location, Adjustment Factor, Fixed Lighting Percentage, Design Lamp Power Factor, Adjustment Factor, Fixed Lighting Allowance, Design Lamp Power Load Allowance, and Lighting System. A summary table at the bottom shows a total power load of 500 W, which is less than the allowance of 805 W, resulting in a 'Pass' status.

Description	Floor area of the space	Height of the space	Design Illumination Power Load	Location	Adjustment Factor	Fixed Lighting Percentage	Design Lamp Power Factor	Adjustment Factor	Fixed Lighting Allowance	Design Lamp Power Load Allowance	Lighting System	Share of % of Allowance Load
Laboratory - Ward 1	35.0 m ²	24 m	2.6 m	500 lux	Laboratory - within 0.6 to an ambient level of 400 lx or more	(i) Manual lighting system				144 W	29% of 805	
Ward 1	400.0 m ²			300 lux	Health-care - patients' ward	(ii) Fixed lighting	85%	75%	600 W	75% of 805	29% of 805	
Examination room - Ward 2	50.0 m ²	20 m	3.3 m	500 lux	Health-care - examination room				144 W	18% of 805	21% of 805	
Lobby	20.0 m ²	18 m	3.3 m	300 lux	Entry lobby from outside the building				60 W	8% of 805	7% of 805	
Office	20.0 m ²	18 m	2.7 m	400 lux	Office - within 0.6 to an ambient level of 200 lx or more				80 W	10% of 805	11% of 805	
Total									500 W	624 W	77% of 805	

IMPORTANT NOTICE AND DISCLAIMER IN RESPECT OF THE LIGHTING CALCULATOR
The Lighting Calculator has been developed by the ABCB to assist in developing a better understanding of lighting energy efficiency parameters. While the ABCB believes that the Lighting Calculator, if used correctly, will produce accurate results, the calculator is provided "as is" and without any representation or warranty of any kind, including that it fits for any purpose or of merchantable quality, or functions as intended or at all. Your use of the Lighting Calculator is entirely at your own risk and the ABCB accepts no liability of any kind.

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J6.2(c)(v) lighting used for a specialist process nature such as in an operating theatre, fume cupboard or clean workstation. These lights are usually separate from the general overhead lighting and are often built into specialised equipment.

J6.2(c)(vi) lighting used for performances such as theatrical or sporting events, which is also often separate from any general overhead lighting.

J6.2(c)(vii) lighting used for the permanent display and preservation of works of art or objects in a museum or gallery other than those for retail sale, purchase or auction. These lights are to facilitate and enhance viewing the works of art and so are also excluded.

J6.3 Interior artificial lighting and power control

The provisions of this Clause cover the switching and control of lighting in buildings of various Classes and for automatic control of lighting and power in Class 3 buildings. The intention is to ensure that rooms are not unnecessarily lit or using power when vacant.

Subclause J6.3(a) – Individual lighting controls for each space

This subclause requires lighting in each room or space within a building to be operated separately from other rooms or spaces. In simple terms, the lighting in each space must be switched by its own light switch or group of switches. The Clause prevents the use of a master light switch to operate all lights in a number of rooms or areas.

Design alert: *The term “space” may apply to a separate activity area within a larger room and is not necessarily defined by walls. An example would be a TV area within a larger recreational room. These spaces should be defined on the architectural plans.*

Subclause J6.3(b) Occupant activated light and power switch

Subclause (b) requires each sole-occupancy unit within a Class 3 building, except one accommodating the aged or people with a disability, to have a device to cut off power for artificial lighting, air-conditioning, local exhaust fans and bathroom heating when there are no occupants.



The device must be activated by the presence of occupants. It can, for example, be operated by a motion detector or a security card reader which turns power off when the card is removed.

Subclause J6.3(c) Lighting switch location and area of operation

Subclause (c) requires that a lighting switch be in a visible position in the room where the lighting is being switched or in an adjacent room that offers a view of the lighting being switched. It also limits the area of lighting that a single switch can control. The area permitted varies according to the Class of the building and the size of the space being lit.

Subclause J6.3(d) Lighting controls

Subclause (d) requires that 95% of the lighting in a building or storey of Class 5 to 9 which is larger than 250 m² be controlled by devices which can turn it off out-of-hours. The devices can include a time switch or motion detector complying with in Specification J6.

Subclause J6.3(e) Separation of switching

Subclause (e) requires that, a storey larger than 250 m² in a Class 5, 6 or 8 building must have separate controls for artificial lighting in the natural lighting zone adjacent to windows and for general lighting not in that zone. There are exemptions for small rooms, natural lighting zones with few light fittings or where most of the lighting in the room is in the natural lighting zone.

Subclauses J6.3(f) and (g) Exceptions

Subclause (f) exempts emergency lighting that is required by Part E4 and functionally essential lighting from the preceding parts of Clause J6.3. Subclause (g) exempts from Sub-clause (d) any lighting whose sudden loss would create safety risks. Lighting installations in the patient care areas of a Class 9a building or in a Class 9c aged care building are given as examples.

J6.4 Interior decorative and display lighting

The provisions of this Clause cover decorative and display lighting inside a building and window display lighting. The interior lighting, such as used for a foyer mural or art display,

must be (i) be separately controlled from other artificial lighting, (ii) have separate manual switching for each area that operates during different periods, except where operating times coincide such as in a museum or art gallery, and (iii) have a separate time switch, in accordance with Specification J6, for display lighting uses more than 1 kW.



Sub-Clause (b) requires window display lighting, usually on the perimeter of the building, to be controlled separately from other display lighting.

J6.5 Artificial lighting around the perimeter of a building

The provisions of this Clause cover external lighting around the perimeter of a building, which must (i) be controlled by a daylight sensor or programmable time switch control, (ii) use high efficacy lamps or a motion detector if the total load exceeds 100W and (iii) have a separate time switch, in accordance with Specification J6, when used for decorative purposes.

Subclause J6.2(b) exempts emergency lighting required by Part E4 and lighting around a detention centre from the requirements of (a)(ii) but not from (a)(i)

J6.6 Boiling water and chilled water storage units

The power supply to a boiling water or chilled water storage unit must be controlled by a time switch in accordance with Specification J6. The requirement does not apply to instantaneous heating units without storage that do not operate or lose heat when not in use.

Specification J6 – Lighting and Power Control Devices

The Specification contains the technical details for any lighting and power control devices that are required by Part J6. .

Compliance with the provisions of this Specification should be verified and substantiated by manufacturer's data sheets during the building approval process. Verification would be



similar to current approval processes for emergency lighting where details of the intended systems should form an integral part of the approval process and approved documentation.

Specification J6 provides specific details on the operational arrangements for the following electrical equipment-

- a. corridor lighting timers;
- b. a time switches;
- c. motion detectors; and
- d. a daylight sensor and dynamic lighting control device.

Clause 2 - Lighting timers

A corridor lighting timer is installed so that artificial lighting needed only for transiting between occupied parts of a building will operate on demand before turning off automatically in a reasonable time. The provisions within Clause 2 are intended to provide a safe, reliable switching and lighting arrangement without running unnecessarily.

The provisions recognise that a timer switch needs to be available near every entry door and visible when the corridor is not lit. The area controlled by a single push button timer is limited to 100 m² to avoid wasteful use, Even so, at least 5 percent of lights in areas larger than 25m² must operate separately from the timer to allow a constant low level of lighting for people to enter the space safely. The 5 percent of lighting that is allowed to remain active can usually be achieved by an exit sign or similar fitting. The percentage applies to numbers of lights and not to the energy usage of the lighting.

Design alert: *Where the corridor or space is part of an exit or other space defined under Part F4.4, the artificial lighting levels should comply with F4.4.*

Clause 3 - Time switch

The time switch provisions apply to electric power for air-conditioning plant, ventilation plant and boiling water or chilled water storage units, as well as to general lighting switches not covered by Clause 2. The switches are intended to turn off the power automatically. The time switch can be programmed to accommodate the needs of the



specific occupancy. However, the program must be capable of turning off the system after normal occupation has finished.

Design alert: *The term “normal occupation” would, for example, also include suitable allowance for after hours cleaning and other building functions outside the traditional 9am to 5pm operation of business premises.*

Clause 4 - Motion detectors

The motion detector requirements for lighting include details of detection thresholds, the area or the number of lights controlled, how long they operate after activation and override facilities. The Clause separates these requirements into three applications, i.e. in a residential building (a Class 2, 3 or 9c building) other than within a sole-occupancy unit, in a non-residential building (a Class 5, 6, 7, 8, 9a and 9b building), and outside a building.

Clause 5 - Daylight sensor and dynamic lighting control devices

The daylight and dynamic lighting sensors are designed to respond to changes in the illumination levels (lux) within a designated area. The provisions define essential operational parameters for the sensors. These details can be verified from manufacturer's literature.

It is important to appreciate that the provisions require the sensor or control device to be designed to operate only the artificial lighting.

Either dimmed or stepped switching is acceptable, provided the process complies with the arrangements in Sub-clause (a)(ii). Once again, the technical requirements of this Clause can be verified by manufacturer's data.

Subclause (b) places limits on any manual override switch for sensors or dynamic control devices. It cannot bypass the controls to switch lights on, independently of the dimming arrangements.