

Australian/New Zealand Standard™

Interior and workplace lighting

Part 2.2: Specific applications—Office and screen-based tasks



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AS/NZS 1680.2.2:2008

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Engineers Australia
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Australian/New Zealand Standard™

Interior and workplace lighting

Part 2.2: Specific applications—Office and screen-based tasks

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PREFACE

This Standard was prepared by the Standards Australia/Standards New Zealand Committee LG-001, Interior and Workplace Lighting to supersede AS 1680.2.2—1994, *Interior lighting—Office and screen-based tasks*.

This Standard forms Part 2.2 of the AS/NZS 1680 series, which covers lighting of interiors and workplaces. It is intended to be read in conjunction with the general recommendations and requirements of AS/NZS 1680.1, and the structures of the two Standards are closely aligned to facilitate this. It is also noted that, in many cases, parts of various other Standards in the AS/NZS 1680 series will also be applicable, depending on the nature of the building and the visual tasks involved.

The AS/NZS 1680 series currently consists of the following:

AS/NZS

1680	Interior and workplace lighting
1680.0	Part 0: Safe movement
1680.1	Part 1: General principles and recommendations
1680.2.1	Part 2.1: Specific applications—Circulation spaces and other general areas
1680.2.2	Part 2.2: Specific applications—Office and screen-based tasks (this Standard)
1680.2.3	Part 2.3: Specific applications—Educational and training facilities
1680.2.4	Part 2.4: Industrial tasks and processes
1680.2.5	Part 2.5: Hospital and medical tasks
1680.3	Part 3: Measurement, calculation and presentation of photometric data
1680.4	Part 4: Maintenance of electric lighting systems

NOTE: Until the revision of this series is complete, some of the above Standards might have, as a main title, 'Interior lighting'.

The significant changes that have been made in this Standard in relation to the previous publication include the following:

- (a) Updating in line with the replacement of white-on-black CRT screens with coloured screens capable of producing a light-coloured background and flat, matt-finish screens.
- (b) Additional information in relation to glare.
- (c) Alteration of the recommended maximum glare index from 16 to 19 in all applicable areas (Appendix E).

The term 'informative' has been used in this Standard to define the application of the appendix to which it applies. An 'informative' appendix is only for information and guidance.

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Australian/New Zealand Standard Interior and workplace lighting

Part 2.2: Specific applications—Office and screen-based tasks

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out recommendations for the lighting of offices and similar tasks, including screen-based tasks. While the tasks may be commonly performed in interiors called ‘offices’, they may also be performed in other interiors; for example, reading, writing and screen-based tasks frequently occur in most types of interior workplaces.

This Standard contains material that adds to or amends the recommendations in AS/NZS 1680.1:2006 and is intended to be read in conjunction with that Standard and with any applicable specific recommendations in other Standards in the AS/NZS 1680 series.

NOTE: See Appendix E for advice on ergonomic and other factors relating to the lighting and use of screen-based equipment (SBE).

The use of this Standard without reference to AS/NZS 1680.1:2006 is a misapplication of the Standard.

1.2 APPLICATION

If any recommendation in this Standard differs from the general recommendations of AS/NZS 1680.1, the recommendation in this Standard should prevail apart from departures from the illuminance recommendations in this Standard where it should be in accordance with the clauses specifically addressing this matter in Section 3 of AS/NZS 1680.1:2006.

1.3 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS	
3590	Screen-based workstations
3590.2	Part 2: Workstation furniture
AS/NZS	
1680	Interior and workplace lighting
1680.1	Part 1: General principles and recommendations
1680.2.1	Part 2.1: Specific applications—Circulation spaces and other general areas
1680.2.3	Part 2.3: Specific applications—Educational and training facilities
2946	Suspended ceilings, recessed luminaires and air diffusers—Interface requirements for physical compatibility

1.4 DEFINITIONS

For the purpose of this Standard, the definitions given in AS/NZS 1680.1:2006 and those below apply.

1.4.1 Screen-based equipment (SBE)

Equipment which displays information on a screen. The term includes visual display units (VDUs), microform readers and optical comparators.

1.4.2 Visual display unit (VDU)

A device comprising a screen on which information is displayed. It may also include a keyboard or other device from which the display is controlled.

1.4.3 SBE workstation

A facility at which people may operate screen-based equipment (SBE). It includes desks and the facilities which accommodate the SBE, input device, documents and other associated equipment.

SECTION 2 GENERAL REQUIREMENTS OF GOOD INTERIOR LIGHTING

The following applies in addition to Section 2 of AS/NZS 1680.1:2006. Where any conflict arises between the two documents, the recommendations in this Section are to be applied.

Difficulties previously experienced with unwanted reflections, contrast dilution and poor visibility associated with screen-based tasks have now been largely overcome by developments in screen display technology.

While most of the visibility problems associated with conventional cathode ray tube (CRT) displays have been overcome, these problems are reappearing with the emergence of flat-screen displays (e.g. liquid crystal and gas plasma). In addition, older forms of monochrome CRT displays and microform readers may continue to be used for some time into the future.

It is therefore important that, where operators are involved in the prolonged use of this equipment, full attention be given to the control of distracting and contrast-reducing reflections.

Difficulties in reading screen-based text are not always due to poor lighting. Reading glasses, especially those with bifocal or multifocal lenses, typically assume that the reading material will be held at 300-450 mm from the eyes and in such a position that the reader will look through a lower portion of the lens while reading. As screen-based equipment (SBE) is often read at longer distances than this and with a line of sight closer to the horizontal, the solution to a problem with reading SBE screens might require a different design of reading spectacles either instead of, or in addition to, alterations to the lighting provided.

SECTION 3 TASK VISIBILITY

3.1 GENERAL

The following applies in addition to Section 3 of AS/NZS 1680.1:2006. Where any conflict arises between the two documents, the recommendations in this Section are to be applied.

3.2 RECOMMENDED ILLUMINANCES

Recommended values of maintained illuminance for various office and screen-based tasks are given in Appendix E. Although Appendix E assumes an office environment, SBE can be found in many other locations.

Because the information displayed on some SBE is self-luminous, the maintained illuminance provided by the general lighting for that type of equipment can be less than recommended for paper-based office tasks if the operator has only to attend to the information displayed on the screen. However, it should be noted that a working environment with a maintained illuminance of less than 160 lx may appear gloomy unless particular attention is given to the lighting and decor of the walls, ceilings and furnishings.

If the operator has to refer frequently to input text or reference manuals, or is required to take notes, the lighting system should provide a maintained illuminance over the task area of not less than the value recommended in Appendix E for such tasks. The required illuminance can be provided by local lighting; however, the illuminance on the task resulting from the use of local lighting should not be significantly greater than the applicable value recommended in Appendix E, so as to minimize adaptation problems for the SBE user. The local lighting should be arranged in accordance with Section 10 and should be capable of being switched off by the operator when not required.

NOTE: For further information on the use of local task lighting, see Clause 10.5.

3.3 CONSIDERATIONS FOR OFFICE TASKS

3.3.1 Diversity of tasks performed

Many different tasks are performed in offices, ranging from relatively simple filing tasks to intense study of a variety of documents, the production of drawings with fine detail and screen-based tasks. The visual requirements for these tasks vary although there are common factors.

It should be noted that some tasks may be located in vertical or near vertical planes, e.g. filing, noticeboards, copy stands. The recommended maintained illuminance should be provided on these surfaces in the plane in which they are normally used.

A feature which is common to most offices is that from time to time the tasks, and generally the associated lighting requirements, vary from one area to another within the space.

3.3.2 Need for flexibility

The considerations described in Clause 3.3.1 suggest that flexibility is a prime requirement of most office lighting systems. This means that it should be possible with the minimum of time and cost to vary an office lighting system. Where possible, provision should be made for changing the characteristics of the lighting by raising or lowering the illuminance, or varying the lighting arrangement by means of switching.

3.4 WORKSTATIONS

3.4.1 General considerations

A workstation is often thought of as involving one type of task. However, a number of different tasks may be performed, for example, reading, writing, filing, drafting, screen-based tasks, copying and communications systems. The foregoing tasks can be located on horizontal and (near) vertical planes. Some may be lower than the desk height of the workstation (e.g. some filing, tower-type computers and their controls and disk drives).

The lighting that is provided should be appropriate to the characteristics and likely duration of each task. For example, reading, writing and screen-based tasks might be sustained while filing might be intermittent.

A careful task analysis should be completed before designing the lighting for offices containing workstations. However, if task information is not available the advice given in Clause 3.4.2 should be considered if it is known that workstations are to be installed in an office space.

3.4.2 Influence of workstations on lighting design

This Clause treats the workstation as a task unit. The workstation is similar to some industrial tasks (e.g. a large machine). It not only has lighting requirements but, due to its large size, can have a major impact on the performance of the selected lighting system.

Recommendations for the preferred location of SBE and associated equipment, and consequent visual fields at desk-top screen-based workstations are given in AS 3590.2. However workstation layouts generally allow for a number of different seat and desk orientations. Therefore, predominant task viewing directions and the orientation of SBE screens within the workstation cannot be predicted with certainty (see Clause 5.2).

The use of workstations that are partially surrounded by medium-height partition screens (typically 1.5 m to 1.8 m above floor) requires special attention by the lighting designer, as the partition screens around the workstations create shadows and reduce the illuminance on the desk or bench area where the task is generally located. However, such partition screens can have a beneficial effect of reducing discomfort glare and, possibly, veiling reflections.

Because workstation partitions can obstruct direct light and reduce the amount of reflected light reaching the task area, it follows that solutions which involve provision of the required maintained illuminance by means of a general lighting system alone may have a high energy demand.

Workstation areas are therefore most suited to local lighting systems in conjunction with a relatively low level of general lighting (as environmental lighting) for the circulation spaces and non-critical task areas. This environmental lighting system should be designed to achieve the objectives stated in Section 10 of AS/NZS 1680.1:2006 and, where SBE is installed, to minimize unwanted reflections in screens.

3.5 SCREEN-BASED TASKS

3.5.1 General considerations

Screen-based equipment is now used in most types of workplace, and particularly in offices. Workspaces containing SBE can generally be lit in accordance with AS/NZS 1680.1:2006 provided that attention is also given to the specific recommendations of this Standard.

NOTE: Viewing distances for screen-based tasks may be greater than for paper-based tasks (see Section 2).

3.5.2 Influence of display characteristics

Screen-based tasks can be self-luminous (as with cathode-ray tube, LED and plasma screen displays), be back-lit (as with some liquid crystal devices), be transilluminated (as with some microform readers and optical comparators), be a luminous projected image (as with data projectors and some microform readers) or rely upon reflected light (as with some liquid crystal displays and 'falling letter' displays).

Each form of display has implications for the design of the lighting system in the interior in which the equipment is used. No recommendations are given for the characteristics of these display technologies, except to note those that are determinants of task visibility (see Clause 3.5.4). It is important that the nature of the display be determined as part of the task analysis.

3.5.3 Main objectives

The main objectives in lighting for screen-based tasks are to provide—

- (a) adequate task visibility (see Clause 3.5.4); and
- (b) a comfortable visual environment so that the task can be performed with minimum fatigue (see Clause 3.5.5).

The elements necessary to achieve these objectives will depend on the duration and complexity of the task.

NOTE: Careful attention should be paid to the recommendations in Clauses 3.5.4 and 3.5.5 where the operator has to work with the SBE for sustained periods. However, compliance with the recommendations in Clause 3.5.5 is less important where the SBE is used only intermittently or for brief periods.

3.5.4 Task visibility

For SBE, the legibility of the task depends on the following factors:

- (a) Properties of the image on the screen such as contrast, sharpness, letter height and spacing, line spacing; steadiness and freedom from perceptible flicker; luminance and uniformity of luminance and, especially in the case of some flat-panel technologies, the direction of view with regard to the screen and the illuminant (on the screen).
- (b) Properties of the screen surface with respect to the suppression of specular reflections.
- (c) Prevention of a noticeable dilution of image contrast resulting from unwanted reflections (see Section 5).

It will be necessary to provide appropriate lighting for any associated tasks (see Clause 3.4.1). Some flat-panel displays are not self-luminous but require lighting to reveal the task (as a shadow on a lighted backplane), e.g. some liquid crystal displays. Visibility can be dependent upon the direction of the lighting as well as the direction of view.

3.5.5 Visual comfort

Given adequate task visibility, visual comfort mainly depends on the following:

- (a) Freedom from distracting reflections in the screen (see Section 5).
- (b) Correct relationship between the average luminance of the task surroundings and that of the task itself (see Section 6).
- (c) Control of glare from luminaires and windows within the task surroundings (refer to Section 8 of AS/NZS 1680.1:2006).

- (d) Freedom from distractions in the task surroundings. The task surroundings should be as free as possible from unnecessary distractions, particularly the movement of people or objects. The risk of this type of distraction occurring increases as the operator's normal line of sight approaches the horizontal.

NOTE: The above assumes that the display device is capable of providing good visibility, is free from flicker, etc., and will not provide an excessive luminance contrast with the surrounds (i.e. that the screen is not 'too bright').

SECTION 4 DIRECTIONAL EFFECTS OF LIGHTING

4.1 GENERAL

The following applies in addition to Section 4 of AS/NZS 1680.1:2006. Where any conflict arises between the two documents, the recommendations in this Section are to be applied.

4.2 SPECIAL CONSIDERATIONS

Care should be taken to avoid contrast diluting reflections in self-luminous tasks, such as SBE. This may limit the freedom of the designer in creating the desired modelling in some locations. Note, too, that some flat-panel technologies require directional control of lighting to produce maximum task visibility (see Clause 3.5.4).

SECTION 5 UNWANTED REFLECTIONS

5.1 GENERAL

The following applies in addition to Section 5 of AS/NZS 1680.1:2006. Where any conflict arises between the two documents, the recommendations in this Section are to be applied.

5.2 REFLECTIONS IN SBE SCREENS

Reflections in the task or its surroundings interfere with visual efficiency and comfort in one or both of the following ways:

(a) *By reducing task contrast*

With SBE, a reduction in task contrast can occur as a result of—

- (i) an overall diffuse reflection from the screen phosphor or backplane, resulting from extraneous light incident on the screen, thereby reducing the (brightness) contrast of the information displayed; or
- (ii) localized specular reflections of bright objects, e.g. windows or luminaires, appearing in the front surface of the screen, veiling the information displayed.

Similar reflections can also reduce the contrast in hard copy tasks. For example, pencil marks become harder to see when they catch the light, because the added sheen causes the black pencil marks to appear pale grey or to disappear altogether. Printed matter can be similarly affected, depending upon the gloss of the printing or the paper, or both.

- 1 Reflections which result in a reduction in task contrast are commonly referred to as 'veiling reflections'.
- 2 The use of colour displays may enhance task visibility because the information displayed can be presented as a chrominance (colour) contrast in addition to a luminance (brightness) contrast.
- 3 The continuing development of screen technology has resulted in a significant increase in screen luminance, contrast, colour and a more diffuse surface. As a result the veiling reflections in SBE, while still a problem in some applications, are less prevalent and severe in the majority of SBE applications. Often people would prefer to tolerate some reflection in screens rather than lose outside views and vertical illuminance in the space.

(b) *By causing distraction and annoyance*

Reflections of the kind described in Item (a)(ii) can give rise to distraction and annoyance even though the reflected images are not sufficiently bright to cause a noticeable reduction in contrast. Distraction and annoyance can also be caused by conspicuous reflections in dark, high-gloss desk tops or other shiny surfaces within the immediate task surroundings.

The SBE screen should therefore be located and orientated to minimize dilution of image contrast caused by extraneous light falling on the screen. In addition, the location and orientation should be such that troublesome reflections from windows, luminaires and other objects do not appear on the SBE screen when viewed from the operator's normal working position.

Where it is not possible to satisfactorily orientate the SBE screen with respect to windows in order to control reflections of the windows in the screen, it will usually be necessary to provide blinds (see Clause 10.3.4). Partition screens may also be used as a means of controlling troublesome reflections from windows or other sources.

SECTION 6 SURFACES

6.1 GENERAL

The following applies in addition to Section 6 of AS/NZS 1680.1:2006. Where any conflict arises between the two documents, the recommendations in this Section are to be applied.

6.2 SPECIAL CONSIDERATIONS FOR SBE

Efforts made to minimize unwanted reflections in SBE screens and to control discomfort glare by using direct-type luminaires can result in gloomy or soporific interiors. This is because walls may receive little direct light.

Since SBE is viewed in a near vertical plane, the direct lighting of the walls, e.g. by wall washing, may result in distractions if high wall reflectances are used. Satisfactory interiors will result, with wall lighting, if the lower end of the recommended range of wall reflectances in AS/NZS 1680.1:2006 is used. The recommendations on ceiling reflectances in AS/NZS 1680.1:2006 should be followed.

6.3 SPECIAL CONSIDERATIONS FOR WORKSTATIONS

Some workstations can be thought of as small offices. The finish of workstation surfaces should be selected having regard to the recommendations in Section 6 of AS/NZS 1680.1:2006.

6.4 SPECIAL CONSIDERATIONS FOR PARTITION SCREENS

Open-plan offices are often subdivided using either freestanding or fixed partition screens. These should comply with the recommendations of Section 6 of AS/NZS 1680.1:2006. In addition the reflectances should be in the range 0.5 to 0.7.

6.5 SELECTION OF COLOURS

Highly saturated colours should not be used for the main surfaces of the interior (walls, floors, ceilings, furniture) which may form part of the task surroundings. This does not preclude small areas of saturated colour for decorative effect.

SECTION 7 LIGHT SOURCE COLOUR

7.1 GENERAL

The following applies in addition to Section 7 of AS/NZS 1680.1:2006. Where any conflict arises between the two documents, the recommendations in this Section are to be applied.

7.2 LAMP COLOUR APPEARANCE AND COLOUR RENDERING PROPERTIES

Lamps used should be of a type having colour appearance and colour rendering properties complying with the applicable recommendations of Appendix E.

Within a given space, the light sources used for task lighting should be —

- (a) of a uniform colour appearance, i.e. within the same colour appearance group; and
- (b) have a colour appearance which is compatible with the light sources used for the general lighting.

SECTION 8 GLARE AND RELATED EFFECTS

8.1 GENERAL

The following applies in addition to Section 8 of AS/NZS 1680.1:2006. Where any conflict arises between the two documents, the recommendations in this Section are to be applied.

8.2 DISCOMFORT GLARE FROM ELECTRIC LIGHTING

The use of SBE usually requires a direction of view closer to the horizontal than for conventional desk work. Consequently, a higher degree of glare control is necessary.

Where the interior contains screen-based tasks that require sustained attention, the glare evaluation system described in Section 8 of AS/NZS 1680.1:2006 can give a quantitative assessment of the discomfort glare.

Values of glare index calculated in accordance with the glare evaluation system should be not greater than the applicable value recommended in Appendix E.

For an existing lighting system that does not comply with the recommended maximum glare index, it is sometimes possible to rearrange the workstations so that the luminaires are not within the task surroundings. Another solution may be the use of partition screens to prevent a direct view of the luminaires from directions of concern.

Where tubular fluorescent lamps are used in louvred, low-brightness luminaires, the maximum glare index will normally occur in orientations near to the diagonals of the louvre cells.

8.3 DISCOMFORT GLARE FROM WINDOWS

The luminaires may not be the only cause of discomfort glare. The effect of sky glare and glare resulting from external surfaces that are lit by sunlight can have a greater effect on visual comfort than electric lighting. The control of glare should not be limited to luminaire selection. The use of light coloured vertical surfaces will reduce the contrast between the sky and the surfaces in the room and reduce the resulting sky glare. The sky glare can be further reduced by control mechanisms such as window shading and glazing with reduced transmission in the visible spectrum.

This may have a greater effect on visual comfort and performance than a highly controlled luminaire.

8.4 AVOIDANCE OF GLOOM

Care should be taken to ensure that the measures that are taken to control discomfort glare from electric lighting do not result in an unpleasant, gloomy interior (see also Clause 6.2) and Section 8 of AS/NZS 1680.1:2006.

8.5 HIGH ANGLE GLARE

Some users of SBE or people carrying out tasks at a near horizontal viewing direction experience glare from luminaires immediately overhead. These luminaires are outside the part of the visual field that is subject to glare and are often outside the peripheral view. This glare is believed to be a result of light either entering the top edge of spectacle lenses or being refracted by the cornea. The effect is usually associated with the use of open bottom reflector fittings. The use of smaller diameter lamps, with higher surface luminance, in open bottom fittings may increase the prevalence of the effect.

SECTION 9 LIGHT SOURCES, LUMINAIRES AND CONTROL SYSTEMS

9.1 GENERAL

The following applies in addition to Section 9 of AS/NZS 1680.1:2006. Where any conflict arises between the two documents, the recommendations in this Section are to be applied.

9.2 LUMINAIRES FOR LOCAL LIGHTING

Luminaires used for local lighting require careful attention to light distribution, glare control and thermal characteristics. If they are required to be adjustable then the extent of travel and any rotation requirements should be considered. Freestanding luminaires should be stable and have a low centre of mass to maintain stability. See Clause 10.5.3 for advice on luminaires for local lighting with SBE.

When selecting task lighting luminaires, it should be noted that high-gloss finishes on the exterior of the luminaires may give rise to distracting reflections, e.g. images of bright windows or overhead luminaires.

SECTION 10 LIGHTING SYSTEMS

10.1 GENERAL

The following applies in addition to Section 10 of AS/NZS 1680.1:2006. Where any conflict arises between the two documents, the recommendations in this Section are to be applied.

10.2 SPECIAL CONSIDERATIONS FOR SBE

10.2.1 General

Clauses 10.2.2 to 10.2.5 set out recommendations for the characteristics of various types of lighting systems for the lighting of interiors where SBE is used.

10.2.2 Suspended and surface-mounted luminaires

If suspended or surface-mounted luminaires utilize some form of wrap-around light controller, their bright sides may make them unsuitable for interiors with SBE, except in offices where no luminaires can be seen reflected in the SBE screen.

Suspended and surface-mounted luminaires with opaque sides and flat, low-brightness light controllers are generally suitable for the lighting of SBE areas. If low-brightness controllers are used, see also Clause 10.2.3. Where suspended, an upward light-output ratio of at least 0.3 can produce a satisfactory visual environment provided the ceiling is not so bright as to be distracting or to become a source of unwanted reflections in screens.

10.2.3 Recessed luminaires

Recessed luminaires that utilize low-brightness light controllers are suitable for minimizing screen reflections in SBE areas. However, to avoid a gloomy environment, supplementary indirect lighting might be required to raise the brightness of the ceiling.

The use of luminaires with a narrow distribution (e.g. downlights) located above the SBE operator should be avoided as they over-illuminate the operator's clothing, relative to the illumination of the general background, resulting in the operator becoming a source of reflections in the screen.

10.2.4 Indirect lighting

Totally indirect general lighting can produce a minimum of screen reflections in SBE working areas. However, indirect lighting can result in an unstimulating environment for work.

Care should be taken to position the luminaires at a sufficient distance below the ceiling to ensure a satisfactory luminance pattern. A non-uniform luminance pattern is preferred but, in order to minimize the possibility of distracting bright patches, the variation in the luminance of the ceiling should not exceed the applicable limits in Sections 8 and 10 of AS/NZS 1680.1:2006.

10.2.5 Luminous ceilings

In addition to the advice given in Section 10 of AS/NZS 1680.1:2006, luminous ceilings should not be installed in interiors where SBE is used unless the space has a room index of 2 or less.

10.3 SPECIAL ARCHITECTURAL/INTERIOR DESIGN CONSIDERATIONS

10.3.1 General

Efficient and effective office lighting requires careful and close integration of the lighting equipment with the architectural/interior design elements to create optimal lighting systems. Section 6 addresses the importance of the reflectance and colour of surfaces as part of the lighting systems. The following Clauses give guidance on design elements that need careful consideration.

10.3.2 Ceiling grid

Most offices have ceilings installed in a regular grid pattern. For suspended ceilings the grid is determined by the suspended rails which support the ceiling panels. For convenience and to achieve good appearance, the layout of luminaires should conform to the ceiling grid. This recommendation, together with the normal practice of installing ceiling-mounted recessed luminaires in a regular pattern, imposes severe restrictions in the location and spacing of the luminaires for a general lighting system. This in turn, with the choice of luminaire, controls the steps of illuminance that can realistically be achieved and, consequently, the energy demands of the lighting system.

10.3.3 Partition/wall grid

Office spaces are often constructed as large open areas in which walls and partitions are installed later to suit the occupants of the space. The walls and partitions are generally installed to a predetermined spacing which bears a close relationship to and is a multiple of the ceiling grid dimension. The pattern of columns and wall and window mullions in the space may also affect the partition/wall grid spacing dimensions.

The selected partition/wall grid should be considered when determining the spacing and location of ceiling-mounted luminaires as it is undesirable for luminaires to extend over walls. It is desirable to have equal numbers of luminaires in rooms of equal size. Problems may be overcome by removing, relocating or adding ceiling-mounted luminaires when the partitions/walls are installed but it is desirable to minimize the number of such changes.

10.3.4 Windows and roof lights

The location, size and degree of shading of windows and roof lights are important and require consideration to avoid glare and to achieve the most appropriate layout when planning the switching and circuiting of the luminaires.

It is important for SBE areas that any blinds or curtains that are provided for the control of sunlight penetration be of such a type that, when drawn and sunlit, they do not become so bright as to become a source of reflections in the SBE screens. This applies particularly to curtains or blinds of materials that are partially light transmitting, e.g. scrim curtains or micromesh blinds.

The daylight provided by the windows will affect the way in which office workers and their equipment are arranged. Workers located adjacent to windows should preferably be side-on to the windows.

It is desirable that similar lighting conditions should be available when work is carried out at night as well as during the day; accordingly a row of luminaires should be installed near outside window walls. Separate switching of the perimeter luminaires will allow them to be used at night to simulate the 'flow of light' from the windows and, when an adequate daylight contribution is available, the luminaires can be switched off to conserve energy.

The interior environment can be further improved at night if windows are provided with curtains or blinds that can be drawn and illuminated by the electric lighting, thus effectively replacing the dark specular windows with surfaces that increase the utilization factor for the space.

10.4 ADDITIONAL ADVICE ON ENERGY EFFICIENT LIGHTING

10.4.1 General considerations

The lighting of office spaces represents the greatest single use of electric lighting in industrialized societies. In a typical air-conditioned office building, lighting accounts for a very significant proportion of the energy consumed in the building.

In view of the need to minimize electrical energy consumption, lighting designers need to seek solutions to the lighting of offices which will maximize energy savings. Relatively low-cost measures may be adopted to achieve energy goals. However, whilst reducing electrical energy consumption, energy savings should not be at the expense of a reduction in lighting quality.

10.4.2 Achieving energy savings

It is beyond the scope of this Standard to examine in detail all of the possible means of saving energy in office lighting. The comments which follow are intended to assist lighting designers to achieve energy efficient solutions.

The following list of suggestions is provided in addition to the advice given in AS/NZS 1680.1:2006:

- (a) *Predominant task requirements* Design general lighting systems for the predominant and not the most demanding task in the space. Provide means to facilitate the increase of illuminances by the addition of localized general lighting or local task lighting in areas where the tasks require higher illuminances.
- (b) *Switching and control groups* Attention to the arrangement of switched groups of lamps or luminaires and to circuit arrangements which permit override control of functional area groups at switchboards will enable users to exercise energy control by switching off lights or reducing levels where possible in local areas. A simple strategy is the provision of dual switching of multi-lamp luminaires allowing a simple 50% reduction in the case of two-lamp luminaires or 33% or 67% reduction in the case of three-lamp luminaires. This strategy requires careful luminaire design to ensure that the appearance of a partially lit luminaire is not irritating.
- (c) *Cleaners' lighting* Cleaning of most offices is a daily task, usually occupying between one and three hours each night. It is not unusual for full office lighting to be switched on during this period, representing a significant cost and waste of energy. As the tasks involved in cleaning are less visually demanding than many office tasks, lower illuminances can be adopted appropriate to the tasks performed.

It is recommended that the switching of general lighting systems be arranged so that approximately one third of the normal lighting level can be provided by the operation of 'cleaners' light switches. These switches may be used to operate multi-pole contactor switching devices to minimize the number of separate switches required. The system may be integrated with the dual level switching systems described above.

- (d) *Automatic switching and dimming* A number of lighting control systems and design strategies are available which affect energy savings in office lighting by switching off lights that are not required, without adverse effects on use of the space by occupants. Where lighting control systems are installed the designer can adapt these to switch off luminaires when not needed or to otherwise reduce lighting levels, using various inputs including time, daylight illuminances and movement.

- (e) *Local lighting systems* Local task lighting systems in conjunction with a relatively low level environmental lighting system will be more energy efficient than a general lighting system. The environmental lighting should be designed to provide pleasant viewing conditions in the space and to allow for general movement and brief, simple reading tasks outside workstations as required. The gradation in brightness between the task area, task surroundings and general background that results from the combination of local and environmental lighting systems will provide a better and more comfortable visual environment than the relatively uniform conditions which apply with general lighting systems.
- (f) *Daylight* In perimeter zones, daylight can make a useful contribution to the illuminance which, depending on daylight availability, will permit electric lighting to be dimmed or switched off, thus reducing electric energy consumption. To use dimming controls, controlled groups of luminaires need to run parallel to the window walls since daylight illuminances on the workplane reduce rapidly with distance from the window.

Control of solar gain is vital if daylighting strategies are to provide net energy benefits. Direct sun and sky glare should also be avoided by the use of overhangs or other shading devices (which can be designed to reflect daylight into the interior), adjustable screening or the use of appropriate glazing materials. Glare can also be reduced by the use of light-coloured surfaces around the windows or the provision of a moderate illuminance on the immediate surround and the selection of light reflectances for surface finishes and floor coverings to reflect light onto the window surrounds.

See Section 10 of AS/NZS 1680.1:2006 for advice on the integration of daylight and electric lighting.

10.5 ADDITIONAL ADVICE ON LOCAL (TASK) LIGHTING WITH SBE

10.5.1 General considerations

Local lighting can be used with SBE, usually for illuminating associated tasks, in a space where the general lighting system may be for environmental lighting.

The local lighting may be an integral part of a workstation. Luminaires could be supported by the desk or table, mounted on floor stands, or take the form of ceiling or wall-mounted spotlights.

Local task lighting should not be used as the sole means of illuminating an interior but should be used in combination with appropriate general (environmental) lighting.

Where used, local task lighting should comply with the recommendations of AS/NZS 1680.1:2006 in respect of task illuminance and the control of glare and unwanted reflections.

10.5.2 Method of use

Luminaires should be positioned to illuminate only the necessary task areas but the area of high illuminance should preferably not have hard edges. Usually the most critical task is that of reading associated documents.

If the documents are on a manuscript holder the luminaire should be located above it, adjusted so that any potential reflection of the light source will be directed below the operator's eye level.

If the documents are read on a horizontal desk top, illumination should be directed from one or both sides by luminaire(s) above the front edge of the task area. Care must be taken to avoid spill light on the screen.

Local task lighting for keyboards is rarely necessary but, if required, it should be directed from the side. It is desirable that the light source be well diffused to reduce reflections in concave keytops.

10.5.3 Luminaire characteristics

The luminaire should be constructed or positioned so that the light source and bright portions of reflectors are screened from the operator's view. If the luminaire is located close to the operator's head then it is important to keep radiated heat and surface temperatures to a minimum.

Small, high-luminance light sources are generally not suitable for use in desk-mounted luminaires unless these have a means of reducing luminance to avoid high contrast shadows in the task area. Where the luminaire is located some distance from the task, precise control of the light distribution is particularly important, although hard-edged beams must be avoided.

Adjustable and portable luminaires have advantages for flexible layout of workplaces, allowing for changes of equipment or task and meeting the needs of different operators, e.g. right- or left-hand preference. If adjustable portable luminaires are selected, either the adjustment range should be limited or the SBE operators should be instructed in the correct use of the luminaire to ensure optimum results and to avoid discomfort to others.

Where large variations of ambient lighting are possible, dimming controls on the task light can be useful.

10.6 SPECIAL CONSIDERATIONS FOR WORKSTATION LOCAL LIGHTING

Where local lighting is used in conjunction with workstations, the luminaires should preferably be adjustable in position and orientation. Where non-adjustable luminaires are used they should be installed in a manner that will not produce contrast-reducing reflections in the task area (see Figure 10.1).

In particular, the local lighting should not be installed in front of the operator since gloss/semigloss materials can image light sources (see Figure 10.1(a)). Ideally, fixed or adjustable task lighting should be installed to the side of the operator so that reflections are not directed towards the eyes. Further, the design/location should accommodate the 'handedness' of the operator. Figure 10.1(b) shows how the recommended location, for a right-handed person, minimizes both unwanted reflections and shadowing of the task area.

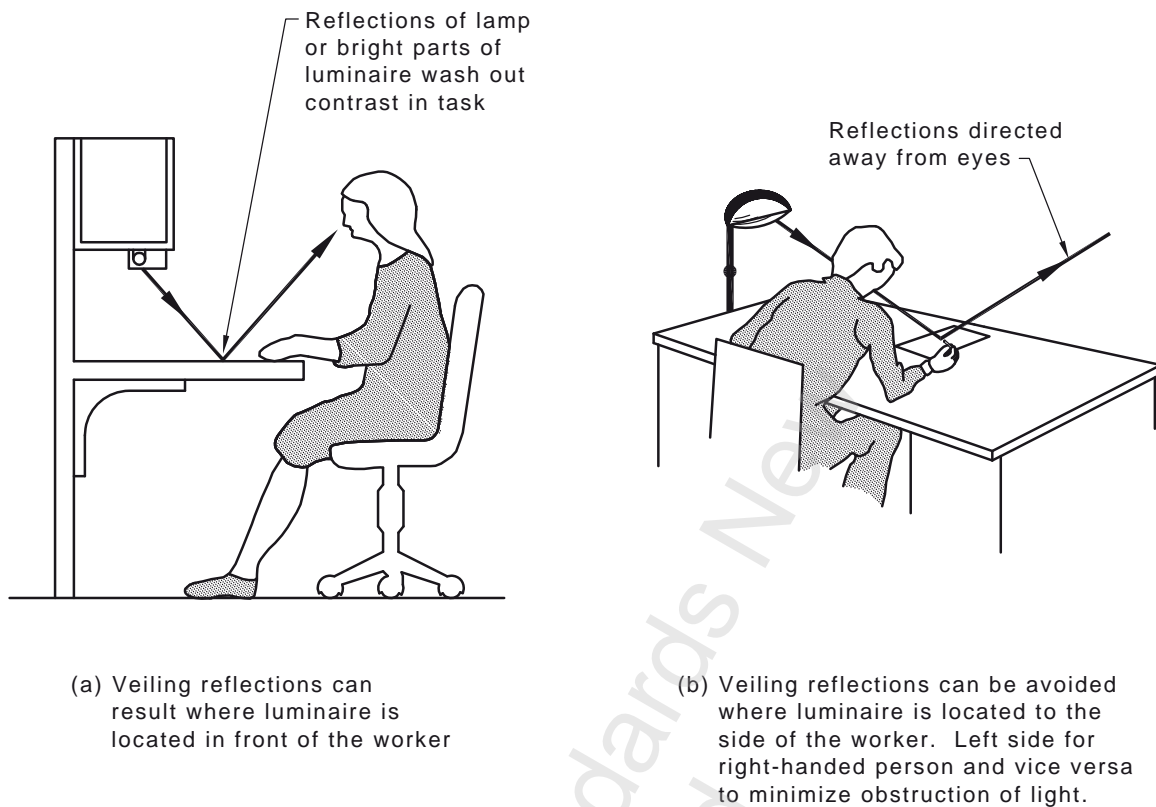


FIGURE 10.1 LOCATION OF TASK LIGHTING LUMINAIRES FOR WORKSTATIONS

10.7 SPECIAL CONSIDERATIONS FOR MICROFORM READERS

Microform readers that are intended to be used for reading low contrast images are particularly susceptible to reduction of contrast due to even moderate levels of extraneous illumination from the interior lighting. Workstations or spaces set aside for one or more microform readers should be lit to the recommendations of Item 2.4, Table E1. The associated tasks should be independently lit to the recommendations of Item 2.2(a), Table E1.

Microform readers and optical comparators of the back projection type require more care in their location relative to the luminaires than those of the front projection type, to avoid unwanted reflections.

SECTION 11 LIGHTING DESIGN PROCEDURE

The recommendations in Section 11 of AS/NZS 1680.1:2006 apply.

SECTION 12 MAINTENANCE OF LIGHTING SYSTEMS AND EQUIPMENT

The recommendations in Section 12 of AS/NZS 1680.1:2006 apply.

APPENDIX A MEASUREMENT OF ILLUMINANCE

(Informative)

The recommendations in Appendix B of AS/NZS 1680.1:2006 apply.

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APPENDIX B

NOTES ON THE USE OF UTILIZATION FACTOR TABLES BY THE LIGHTING
DESIGNER

(Informative)

The recommendations in Appendix C of AS/NZS 1680.1:2006 apply.

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APPENDIX C
NOTES ON CHANGES TO ILLUMINANCE RECOMMENDATIONS

(Informative)

The recommendations in Appendix D of AS/NZS 1680.1:2006 apply.

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APPENDIX D

LIGHTING AND ERGONOMIC FACTORS RELATING TO THE USE OF SBE

(Informative)

D1 SCOPE

This Appendix sets out information on lighting and related ergonomic factors involved in the design of a visual environment suited to the use of SBE.

Recommendations for the ergonomic design of all elements of screen-based workstations, including visual display units, furniture and input devices, are set out in the AS 3590 series.

D2 ARRANGEMENT OF SBE

The use of SBE results in the arrangement of this equipment in work areas in one of the following ways:

- (a) *Where a number of SBE are situated in an area devoted exclusively to their use* This arrangement has the advantage that the workspace can be tailor-made to suit the various task requirements and personal needs of the operators.
- (b) *Where SBE are distributed throughout the workspace amongst other office tasks* This arrangement is often employed as a means of overcoming one of the disadvantages of (a), namely, the longer lines of communication. With this arrangement the SBE tasks and the normal office tasks are located in the one space.

However, whilst the visual environment may be acceptable, in terms of the quality of lighting, for normal office tasks, it may not be acceptable for prolonged screen-based tasks.

- (c) *Where a small number of SBE are located in an open area adjacent to the main office area* With this arrangement the operators are not entirely isolated (i.e. they have visual contact and easy direct contact with their associates) yet the visual environment can be specifically designed to suit the SBE tasks.

D3 THE OPERATOR'S FIELD OF VIEW**D3.1 Provision for visual relief**

Many screen-based tasks require very limited eye movement or changes of focus. Prolonged use of the eyes in such a fixed manner can be very fatiguing. It is therefore important that consideration be given to the provision of some feature within the operator's general field of view which will allow the eyes to relax. Features which provide visual relief include the following:

- (a) A view out through a window or into a larger office area. While windows should not be within the task surroundings, it is sufficient if the operators can avail themselves of the view by either turning their heads or rotating their chairs.
- (b) In windowless areas features such as photomurals, travel posters or wall hangings can serve as satisfactory visual rest centres when located at a distance significantly greater than the screen reading distance. Where such features are not within the task surroundings they can have quite high luminance values provided they are so placed that they do not become sources of distracting reflections for other SBE operators.

D3.2 Luminance differences

For SBE operators the following two conditions involving luminance differences within the field of view should be considered:

- (a) *The luminance ratios between the message on the screen, the screen background and the immediate task surroundings* Most SBE incorporate means of adjusting the contrast between the message and the screen background; thus the operator can fix the luminance balance between these two, based on personal preference. However, if there is a large luminance difference between the screen and any substantial area, e.g. luminaires and windows, within the immediate task surroundings, disability and discomfort glare may occur.
- (b) *The luminance ratios between the various surfaces within the field of view* This situation differs from that described in (a) because it is a dynamic condition. The operator is continually changing eye fixation between the display, the keyboard and any source documents and other objects within the field of view which attract attention—consciously or subconsciously. In this circumstance large differences in the luminance of component parts of the field of view can cause visual discomfort and reduce visual performance. This applies not only to small, very bright components such as luminaires or sky seen through a distant window but also to large, dark surfaces filling a substantial part of the operator's field of view, e.g. the whole of the task surroundings. Task surroundings which have an average luminance less than about one quarter that of the task itself (including any hard copy items) can cause considerable dissatisfaction if work is continuous.

The conventional means of controlling the luminance balance between the major components within the field of view is by manipulating the range of reflectance of the various surfaces. However, the sky luminance, as seen through a window, may also need to be controlled by means of blinds or curtains (see Clauses 5.2 and 10.3.4).

D4 WINDOWS

Section 10 of AS/NZS 1680.1:2006 covers the provision for the admission of daylight in the workspace. The Section also includes recommendations for the control of sky glare and direct sunlight penetration. These recommendations will also apply to SBE areas, in addition to the recommendations within Clause 5.2 of this Standard.

APPENDIX E

SPECIFIC RECOMMENDATIONS FOR OFFICE AND SCREEN-BASED VISUAL TASKS

(Informative)

E1 INTRODUCTION

Specific recommendations for the lighting of various types of working areas of offices are set out in Table E1.

E2 RECOMMENDATIONS

The recommendations of Table E1 should be read in conjunction with AS/NZS 1680.1:2006 and with the following, as applicable:

(a) *Column 1: Type of interior or activity*

If the particular interior/activity is not specifically listed in Table E1, the recommendations for a comparable interior/activity should be adopted, as appropriate.

(b) *Column 2: Maintained illuminance*

See AS/NZS 1680.1:2006 for the definition of maintained illuminance and information on its application in lighting design.

The value of maintained illuminance recommended in Column 2 should be provided on the appropriate plane in accordance with Section 3 of AS/NZS 1680.1:2006.

For some interiors, separate illuminance recommendations are given for the task and the background/environment which apply as follows:

- (i) Where general lighting alone is used to provide both task and background/environment lighting, the illuminance throughout the room should be not less than the maintained illuminance recommended for the task.
- (ii) Where a system of local lighting is provided for tasks in combination with general lighting, the local lighting should be capable of providing the illuminance recommended for the task and the general lighting may be at the reduced illuminance recommended for the background/environment. However, where a reduced level of general lighting is provided, particular attention should be given to the illumination of walls. This might require the outermost rows of luminaires to be located closer to the walls than the conventional half-spacing or the provision of a separate environmental lighting system to ensure that the walls are adequately lit.
- (iii) Where a combined system of local lighting and general lighting is employed and task illuminances of 600 lx or greater are provided, the maintained illuminance for the general lighting should be not less than 240 lx in order to avoid excessive contrasts between the task and its surroundings.

(c) *Column 3: Lamp colour appearance group*

The lamp colour appearance groups recommended in Column 3 are those defined in Section 7 of AS/NZS 1680.1:2006 by reference to the correlated colour temperature. Information on the correlated colour temperature of particular lamps is normally given in manufacturers' catalogues.

(d) *Column 4: Lamp colour rendering group*

The lamp colour rendering groups recommended in Column 4 are those defined in Section 7 of AS/NZS 1680.1:2006 by reference to the CIE general colour rendering index, R_a . Information on the CIE colour rendering index of particular lamps is normally given in manufacturers' catalogues.

(e) *Column 5: Maximum glare index*

Section 8 of AS/NZS 1680.1:2006 provides two alternative systems for the control of discomfort glare from electric lighting, namely—

- (i) a luminaire selection system; or
- (ii) a glare evaluation system.

The recommended values of maximum glare index in Column 5 apply to the glare evaluation system. Recommendations for the luminaire selection system are fully described in AS/NZS 1680.1:2006 and this system may be used as an alternative to the glare evaluation system for all applications for which a maximum glare index of 19 or more is recommended.

The luminaire selection system is appropriate only for interiors which utilize a regular array of the same type of luminaire.

(f) *Column 6: Other recommendations and advice*

Additional descriptive recommendations and advice are given in Column 6 that are specific to particular tasks or interiors. These recommendations should be taken in conjunction with the quantitative recommendations given in Columns 2 to 5 of the Table.

TABLE E1
RECOMMENDATIONS FOR OFFICE AND SCREEN-BASED VISUAL TASKS

1	2	3	4	5	6
Type of interior or activity	Maintained illuminance lx	Lamp colour appearance group	Lamp colour rendering group (minimum)	Maximum glare index	Other recommendations and advice
1 GENERAL TASKS INVOLVING TYPING, READING, WRITING					See Paragraph E2(b) for the application of the task and background/environment illuminance recommendations.
1.1 Task	320	1, 2	1B, 2	19	
1.2 Background/environment	160	1, 2	1B, 2	19	
2 SCREEN-BASED TASK AREAS					Recommendations for screen-based task areas apply to word processing, computer-aided drafting and similar areas.
2.1 Keyboards	160 (240)	1, 2	1B, 2	19*	Where poor quality reference material requires a high illuminance, the terminal areas illuminance should be raised to the higher level stated to avoid excessive contrast between the adjacent area.
2.2 Reference material:					High levels of illuminance on self-illuminating screens tend to reduce screen contrast.
(a) Good, simple	240	1, 2	1B, 2	19*	
(b) Average detail	320	1, 2	1B, 2	19*	
(c) Poor, fine detail	600	1, 2	1B, 2	19*	See Paragraph E2(b) for the application of the illuminance recommendations
2.3 Background/environment	160	1, 2	1B, 2	19*	
2.4 Microform reading areas	20-40	1, 2	1B, 2	19*	

* In an environment designed in accordance with the recommendations of AS/NZS 1680.1:2006, a maximum glare index of 19 will be satisfactory. However, if the environment departs from the recommendations or, as a result of task analysis, discomfort glare is likely to be a problem, a maximum glare index of 16 is recommended.

(continued)

TABLE E1 *(continued)*

1	2	3	4	5	6
Type of interior or activity	Maintained illuminance lx	Lamp colour appearance group	Lamp colour rendering group (minimum)	Maximum glare index	Other recommendations and advice
3 DRAFTING OFFICES					For computer-aided drafting, see the recommendations under Item 2.
3.1 Drawing board	600	1, 2	IB, 2	19*	Required illuminance should be provided by local lighting.
3.2 Reference material:					
(a) Good, simple	320	1, 2	IB, 2	19*	
(b) Poor, fine detail	600	1, 2	IB, 2	19*	Required illuminance should be provided by local lighting.
3.3 Background/environment	240	1, 2	IB, 2	19*	See Paragraph E2(b) for the application of the illuminance recommendations.
4 COMPUTER ROOMS					
4.1 Equipment rooms	320	1, 2	IB, 2	22	Computer equipment rooms may be operated 'lights out' or with low level security lighting when the space is unattended. Provision for supplementary task lighting should be available to assist with maintenance as the general lighting may not be effective for maintenance tasks.
4.2 Terminals	(See recommendations for screen-based task areas under Item 2)				
4.3 Reference materials					

* In an environment designed in accordance with the recommendations of AS/NZS 1680.1:2006, a maximum glare index of 19 will be satisfactory. However, if the environment departs from the recommendations or, as a result of task analysis, discomfort glare is likely to be a problem, a maximum glare index of 16 is recommended.

(continued)

TABLE E1 (continued)

1 Type of interior or activity	2 Maintained illuminance lx	3 Lamp colour appearance group	4 Lamp colour rendering group (minimum)	5 Maximum glare index	6 Other recommendations and advice
5 MEETING ROOMS					The lighting requirements of a meeting room are dependent on the nature and duration of the activity and the degree of formality required. The subcategories listed are not intended to be exhaustive but to give an indication of the variety of functions. The designer should look at the specific functions of the room rather than the area or room name.
5.1 Meeting rooms	320	1, 2	IB, 2	19	Small, informal meeting rooms can be used for extended periods of office work. One wall should be uniformly illuminated to allow for material to be displayed.
5.2 Training rooms, seminar rooms	240	1, 2	IB, 2	19	<p>These are rooms which cater for larger groups of people where there is minimal note taking or reading. The front of the room should have good vertical illuminance on the presentation wall and the presenter.</p> <p>Glare should be controlled in the general viewing direction of the occupants but the presenter may need to be subjected to some glare to achieve the necessary vertical illuminance.</p> <p>Lighting control should allow the lighting to be dimmed or selectively switched for the use of audiovisual equipment.</p> <p>See advice on the lighting of classrooms and lecture theatres in AS/NZS 1680.2.3.</p>

(continued)

TABLE E1 (continued)

1 Type of interior or activity	2 Maintained illuminance lx	3 Lamp colour appearance group	4 Lamp colour rendering group (minimum)	5 Maximum glare index	6 Other recommendations and advice
5.3 Conference rooms, boardrooms	240 (160)	1, 2	IB, 2	19	<p>These rooms serve a variety of functions involving meetings, presentations and formal and informal functions. The lighting system or systems should be flexible to suit the variety of needs.</p> <p>The lighting system should be able to perform the functions of Items 5.1 and 5.2 when required. Provision should be made for a reduced level of lighting, corresponding to the lesser of the two recommended illuminances, to suit informal activities.</p> <p>See advice on lighting requirements for video conferencing in AS/NZS 1680.2.3.</p>
6 RECEPTION AREAS	(See recommendations of AS/NZS 1680.2.1)				
7 PHOTOCOPYING AND PRINTING ROOMS					
7.1 Intermittent	160	1, 2	2	25	
7.2 Sustained, collating	240	1, 2	2	19	
7.3 Colour copying	240	3	1A, 1B	19	
8 FILING AREAS					
Sorting:					
(a) Simple, clear detail	240	1, 2	2, 3	19	
(b) Difficult, fine detail	320	1, 2	2, 3	19	
9 STOREROOMS, STRONGROOMS, FILE STORAGE AREAS	(See recommendations of AS/NZS 1680.2.1)				

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