

Australian/New Zealand Standard™

Interior and workplace lighting

**Part 2.3: Specific applications—
Educational and training facilities**



AS/NZS 1680.2.3:2008

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Australian Electrical and Electronic Manufacturers Association
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Engineers Australia
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Australian/New Zealand Standard™

Interior and workplace lighting

Part 2.3: Specific applications— Educational and training facilities

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee LG-001, Interior and Workplace Lighting to supersede AS 1680.2.3—1994, *Interior lighting—Educational and training facilities*.

The objective of this Standard is to provide those involved with the lighting of educational and training facilities, whether knowledgeable in lighting design or not, with understanding of the various aspects involved in creating strong visual conditions by the choice of lighting appropriate to the task and relevant surface colours and finishes. However precise lighting arrangements are not specific and it is envisaged that creating a design to provide such conditions will typically require the knowledge and expertise of a qualified lighting designer.

This Standard forms Part 2.3 of the AS/NZS 1680 series, which covers lighting of interiors and work places. 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
1680.2.3	Part 2.3: Specific applications—Educational and training facilities (this Standard)
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 of recommendations in relation to lighting for the vision impaired.
- (b) Upgrading of advice on various types of projection tasks.
- (c) Significant revision of the information provided in relation to theatre and stage lighting.
- (d) Alteration of the recommended maximum glare index from 16 to 19 in all applicable areas (Appendix D).

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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FOREWORD

The aim of this Standard is to create a visual environment in which essential task details are made easy to see and adverse features which may cause visual fatigue are either excluded or appropriately controlled. The Committee is of the view that the greatest scope for achieving this lies with improvements in lighting quality rather than in the provision of higher illuminances.

While the provision of sufficient illuminance on the task is necessary in many instances task visibility depends more on the way in which the light is applied. Furthermore, the creation of the comfortable visual conditions required in order to maintain efficiency throughout the whole work period depends less on the quantity of light than on factors such as the distribution of light throughout the workplace; the use of suitable finishes on the walls, ceiling and equipment; the choice of luminaries with adequate glare control; and the elimination of unwanted reflections.

This is not a code to be followed rigidly, allowing no room for individual choice. It is a Standard that indicates paths to be followed and gives reasons for the advisability of following them. In some cases, it mentions limits within which lighting systems should be kept. Within these limits designers and engineers have great latitude in creating energy efficient and pleasing lighting designs.

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Interior and workplace lighting

Part 2.3: Specific applications—Educational and training facilities

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out recommendations for the creation of good seeing conditions in educational and training facilities by means of appropriate lighting and interior colour treatment. 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 1680.2 series.

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/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
1680.2.2	Part 2.2: Specific applications—Office and screen-based tasks

AS

2293	Emergency escape lighting and exit signs for buildings
2293.1	Part 1: System design, installation and operation
2560	Guide to sports lighting
2560.2.2	Part 2.2: Lighting of multipurpose indoor sports centres

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 Educational and training facilities

An interior space or building complex comprising many such spaces, which provides facilities for structured learning or training programs for applications that may range from pre-school to tertiary levels.

NOTE: Throughout this Standard, educational and training facilities are referred to as 'educational facilities'.

SECTION 2 GENERAL REQUIREMENTS OF GOOD LIGHTING

2.1 INTRODUCTION

Section 2 of AS/NZS 1680.1:2006 applies with the exception of the recommendations in Clauses 2.2 and 2.3.

2.2 GENERAL

While any visual task requires the provision of a certain, minimum level of illumination, the creation of the visual conditions required to maintain comfort and efficiency throughout the whole work period also depends greatly on how the light generated is applied, including factors such as the distribution of light throughout the workplace; the use of suitable finishes on the walls, ceiling and equipment; the choice of luminaires with adequate glare control; and the elimination of unwanted reflections.

While this is true of all illuminated environments, in educational and training facilities it is especially important to address all of the relevant factors, including those stated above, and not to adopt or accept an approach that concentrates purely on simple parameters such as average illuminance.

2.3 SPECIAL CONSIDERATIONS

Although good lighting is essential in educational and training facilities, difficulties with visual tasks in such environments cannot always be solved by adjustments to the lighting. Tasks in educational and training facilities can be located at various distances from the eyes, ranging from normal reading distances to, for example, reading chalkboards from the back of a classroom. Other tasks, such as screen-based tasks, may be located at middle distances. Students might have visual correction (e.g. spectacles) for an assumed near viewing distance, e.g. reading, but unless refractive errors are corrected for all viewing distances, people may complain of maladjusted equipment or poor lighting.

Further, as the eyes are not dimensionally stable until about age 20, in schools there may be a range of uncorrected refractive errors present in the population.

So, notwithstanding the fact that good lighting and good task design can assist with any vision difficulty, in such cases the most helpful action will be to provide the appropriate vision correction.

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 SPECIAL CONSIDERATIONS FOR VERY YOUNG OBSERVERS

While not strictly a lighting matter, it must be noted that the visual system of very young observers (i.e. up to about 6 to 8 years of age) cannot achieve the acuity (the ability to detect fine detail) that older observers can: this is the reason for large print in children's books. Consequently, it is important that the designers of visual tasks for the very young are aware of the limits of the visual system and that lighting designers are aware of which characteristics of tasks can be significantly affected by lighting decisions and which are user dependent.

3.3 DIVERSITY OF TASKS

Educational facilities contain a wide range of tasks with visual components varying from very demanding, such as dissection and sewing, to easy and casual, such as movement and orientation. The tasks can be located on planes from the horizontal (writing) to the vertical (chalkboard, etc.) and can be at various distances from the observer (see Clause 2.3).

A feature of most spaces is that they are multi-function and multi-task. This makes the design of most spaces very difficult if ideal seeing conditions are to be provided for all tasks.

It should be noted that educational facilities can contain the full range of visual tasks found in industrial, office and medical facilities. The relevant Standards in the AS/NZS 1680.2 series should be consulted for advice on the lighting of such tasks.

3.4 NEED FOR FLEXIBILITY

Clause 3.3 suggests that there needs to be flexibility in the lighting solutions proposed so that the various tasks can be best performed. Ideally, the capacity should be available to vary the illuminance and vary the direction of lighting by switching, and to control daylight entry. Some tasks, principally slide and cine projection, require almost total blackout conditions. Further advice is given in Section 10.

3.5 SPECIAL CONSIDERATIONS FOR THE VISION IMPAIRED

The vision impaired are those who, even with the best correction, continue to have visual defects. These may be acuity, contrast or visual field defects. Descriptions of the degree of visual impairment include terms such as 'partially sighted' and the classification 'legally blind'. The designer of lighting for an educational or training facility should seek advice regarding the specific nature and degree of any impairment among students to be catered for.

It is beyond the scope of this Standard to provide detailed advice on lighting for the vision impaired but, with the assistance of appropriate medical advice, suitable local lighting solutions can be achieved for many visual defects, in spaces designed for general use. Attention is particularly drawn to recommendations covering lighting needs for the partially sighted issued by the International Commission on Illumination (CIE) [Ref. 1]. Refer also to Clause 10.7.

3.6 SPECIAL CONSIDERATIONS FOR SCREEN-BASED TASKS

Screen-based tasks in educational and training facilities include microfiche readers and personal computers but not images from overhead projectors, data projectors, video monitors or slide or cinema projectors (see Clauses 3.7 to 3.10). Screen-based tasks are increasingly common in educational facilities. Advice on the task characteristics of and the lighting requirements for screen-based tasks is given in AS/NZS 1680.2.2.

3.7 SPECIAL CONSIDERATIONS FOR OVERHEAD PROJECTION TASKS

Overhead projection refers to the projection of an image, normally from a large transparency, to a suitable screen. The quality of the projected image depends upon the quality of the projector, the correct location and adjustment (including focus) of the projector and the provision of suitable transparencies that provide an image that is sufficiently large and sharp for legibility from the most distant viewing position. The foregoing are all equipment and task design matters, beyond the scope of this Standard.

Because they project a high luminance image, overhead projectors can be used with normal room lighting, allowing writing tasks to be undertaken and the speaker to be seen. Further, the surround illuminances can be designed to produce comfortable and pleasant viewing conditions.

However, care is needed to ensure that good contrast is maintained in the projected image by minimizing the direct light from luminaires that could arrive on the projection screen. This is especially important if low-contrast images are to be presented.

3.8 SPECIAL CONSIDERATIONS FOR VIDEO PROJECTION TASKS

Video projectors usually project images onto a screen from high-luminance cathode ray tube (CRT) displays using suitable optics. (Other technologies are used but rarely in educational facilities.) While relatively bright images are possible, most video projectors require dimmed lighting conditions to maintain good luminance contrasts and saturation of colour. The dimmed conditions are usually not suitable for sustained reading or writing tasks.

3.9 SPECIAL CONSIDERATIONS FOR VIDEO MONITOR TASKS

Video monitors are similar to a traditional television receiver, using a CRT, and are often used in educational buildings either on stands (in small rooms) or suspended from the ceiling (normally in larger rooms). In larger rooms more than one monitor may be installed. The luminance of the monitors is sufficient for their use under normal room lighting conditions but veiling reflections in the screen may be a major problem.

The problems are similar to those with screen-based equipment (SBE) but there is usually a much wider range of viewing angles and the avoidance of unwanted reflections can be very difficult to achieve. Flat screens with diffusing surfaces on monitors can reduce the problems. Care is needed in the location of monitors and the selection of suitable lighting equipment for rooms containing monitors.

3.10 SPECIAL CONSIDERATIONS FOR SLIDE AND CINE PROJECTION

Due to the small size of the transparency being projected it is not usual to be able to achieve sufficiently high screen luminances to maintain contrast and colour saturation under normal lighting conditions, except where the projected image is quite small. In general, slide and cine projection require full blackout conditions or a degree of dimming that makes other tasks difficult or impossible to perform. If slides are being used by a speaker, it is important the speaker is visible to the audience and able to read any notes. Special lighting is needed for both.

Special care is needed with rear projection systems since veiling reflections can occur in the protective transparent screen that typically exists.

3.11 SPECIAL CONSIDERATIONS FOR VERY SMALL TASKS

High levels of local lighting can assist with very small tasks, such as jewellery making, some electronics assembly, some anatomical procedures and some small mechanical systems. However consideration should be given to the use of magnification when very small tasks are involved.

3.12 RECOMMENDED ILLUMINANCES

For educational and training facilities, the maintenance illuminance should be not less than the applicable value given in Appendix D.

SECTION 4 DIRECTIONAL EFFECTS OF LIGHTING

The recommendations of Section 4 of AS/NZS 1680.1:2006 apply.

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 SPECIAL ADVICE ON TASKS

Additional advice on the avoidance of unwanted reflections in screen-based tasks is given in Section 3 of this Standard and in AS/NZS 1680.2.2.

S E C T I O N 6 S U R F A C E S

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 SCREEN-BASED TASKS

The recommendations of Section 6 of AS/NZS 1680.2.2:2008 apply.

6.3 SPECIAL CONSIDERATIONS FOR SINGLE-SIDE LIT CLASSROOMS

Most school classrooms utilize daylight by means of windows in one wall (single-side lighting). This has been traditional and, while it can minimize the use of electric lighting near the windows, can create severe disability glare problems from some locations within classrooms. High veiling luminances may also result on various types of projection screens.

See Clause 10.4 for advice on the integration of daylight and electric light in single-side lit classrooms.

6.4 SPECIAL CONSIDERATIONS FOR LECTURE ROOMS

Lecture rooms have multiple functions, often with conflicting lighting and surround (reflectance) requirements for different tasks which may be happening simultaneously. Multiple or flexible lighting solutions may be required. It is not uncommon for a speaker to be using slides and an overhead projector while expecting the audience to read and take notes. Ideally the speaker should be the focus of attention, the object of regard. The lighting should reveal the speaker, especially the face, in a pleasant way. It is almost impossible to achieve the appropriate surround conditions to centre attention on the speaker since white projection screens will always act as distractions. Spill and reflected light from inadequate lectern lighting can wash out visual aids and uplift the speaker, producing an unpleasant appearance.

Attention is drawn to recommendations for the visual environment in lecture rooms given in the CIBSE *Lighting Guide 5* [Ref 2], *Lecture teaching and conference rooms*.

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

The lamps used should be a type having colour appearance and colour rendering properties complying with the applicable recommendations of Appendix D.

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 MAXIMUM GLARE INDEX VALUES

Where the glare evaluation system is used for the assessment of discomfort glare from electric lighting, the calculated glare index should be not greater than the applicable value recommended in Appendix D.

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 SELECTION OF LIGHTING EQUIPMENT

There are many locations within educational facilities where lighting equipment is exposed to the possibility of physical abuse or to risk of accidental damage. In the selection of luminaires and lighting control systems, particular consideration should be given to their capability of withstanding such conditions.

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 SCREEN-BASED TASKS

The recommendations of Section 10 of AS/NZS 1680.2.2:2008 apply.

10.3 DIVERSITY OF TASKS

The diversity of tasks in educational facilities was discussed in Section 3. Educational institutions often emphasize minimizing capital cost as the main criterion in lighting design. It will be seen that economical and effective lighting can be achieved if attention is paid to the needs of various tasks and appropriate lighting systems are selected.

10.4 INTEGRATION OF DAYLIGHT AND ELECTRIC LIGHT

Educational buildings have traditionally attempted to achieve a high utilization of daylight and to minimize electric lighting, especially in general purpose classrooms. Roof lighting has not been used, except in some workshops, but roof lighting provides good opportunities for the effective utilization of daylight and, especially, integration with electric lighting. Note that the visual aids requirements of the teaching spaces listed below can be in conflict with simple daylighting techniques.

It should also be noted that the traditional, single-sided lighting of general purpose classrooms and laboratories can result in poor seeing conditions from some parts of the room due to one or more of the following factors: adaptation problems due to view of the bright sky or sunlit external surfaces; disability glare, reducing the visibility of chalkboards, etc., for the same reasons; disability (adaptation problems) due to the entry of sunlight onto desks or chalkboards, etc.; veiling reflections of bright external surfaces in gloss and semigloss interior finishes, especially whiteboards and worn chalkboards; a gloomy appearance on overcast days due to high sky luminances. Various techniques can be used to minimize these problems—most are architectural, involving orientation; the arrangement of window and flanking walls; the use of light shelves; sufficiently high ceilings to achieve useful daylight penetration; and light (high reflectance) internal finishes.

10.5 GENERAL PURPOSE CLASSROOMS

The general purpose classroom is the most common type of teaching space. It is typically a flat-floored, square room with sides of about 10 m, and is used for general teaching. The room is sometimes arranged with an obvious focus of attention but at other times the room may be used with flexible furniture arrangements and varied teaching positions. This basic room may also be modified for special purposes, such as art classes, sophisticated visual aids, and computer instruction. However, the most common application of the room is paper-based reading and writing with teaching using chalkboards, whiteboards, overhead projectors, etc., from the front of the room.

The lighting systems used should provide the required maintained illuminance over the whole of the potential desk area (or floor area in some schools); adequate wall and ceiling luminances for comfortable seeing conditions, including accommodating potentially high sky luminances; and the recommended illuminances on chalkboards, notice boards, etc.

To facilitate the use of visual aids it is necessary to be able to control the lighting, including the entry of daylight, by suitable switching and the use of curtains and blinds. Dimming provides better results and working conditions than simple switching arrangements. Note the advice in Section 3 regarding various visual aids.

10.6 ART ROOMS

Art studios usually involve the creation of three-dimensional objects or work from three-dimensional objects (such as models). Special attention should be given to any directional lighting needs (see Section 4 of AS/NZS 1680.1:2006). Lamps with good colour rendering characteristics may be necessary. The required colour appearance of the lamps will depend upon any integration with daylight or the requirements of the media being used (for example, colour photography). Directional lighting is also useful for the inspection of glazes and the texture of materials. Any special lighting requirements should be established in the design brief. Sometimes art facilities have exhibition spaces or galleries. Generally, these require some form of adjustable lighting, such as track-mounted luminaires.

10.7 CLASSROOMS FOR THE VISION IMPAIRED

Where classrooms are provided for the vision impaired, higher illuminances than normal will be required, although there are some impairments that require lower than normal illuminances. Very good glare control is also needed and supplementary lighting of vertical tasks, such as chalkboards, is usually also necessary.

10.8 CLASSROOMS FOR THE HEARING IMPAIRED

The hearing impaired often depend upon speech (lip) reading for much of their understanding. The lighting should provide sufficient modelling for the movements of the lips and other facial features to be easily perceived.

10.9 DRAFTING ROOMS

Although modern drafting is typically performed on a computer, the following remains relevant to any space used for drawing or for the checking of plans, etc.

Drafting often involves the discrimination of fine detail for extended periods, hence the high illuminances that are recommended. The media used for drafting are sometimes specular or semi-specular suggesting the importance of avoiding unwanted reflections. Body shadow can reduce the effectiveness of the lighting if the luminaires are poorly located. Drafting rooms are usually lit using uniform arrays of luminaires. However, where drafting machines are used (tiltable, freestanding tables and squares) consideration should be given to the use of board-mounted local lighting (e.g., using suitable angle-poise luminaires) to achieve the desired task illuminance.

10.10 LABORATORIES

These involve special tables or benches at which very detailed work may be carried out, particularly in dissection, inspection of reactions, instrumentation and measurement. If the benches are in fixed locations the lighting system may be designed for the task areas, with the circulation spaces receiving the spill light. This gives localized general lighting over the task areas. Colour rendering may be important in some laboratories. Various forms of local lighting might be used with some activities, requiring the provision of an adequate number of power socket outlets.

10.11 SEWING ROOMS

Sewing and other needlework tasks are among the most difficult, since the thread is usually the same colour as the cloth being sewn. The stitching is seen, in part, by the glint of the thread. Directional lighting, from small sources, assists since the glint will be more obvious. Local lighting is needed in addition to the general lighting. The local lighting may be machine-mounted and may be integral with the sewing-machine.

10.12 INDUSTRIAL ARTS AND CRAFTS WORKSHOPS

Rotating machinery is often used in industrial arts and crafts workshops and can be a potential source of hazards. Special task lighting is usually needed in workshops; the task lighting can be integral with a machine or can be bench mounted. Sometimes integral magnifier/lamps are used where fine inspection is needed.

Special attention to the potential hazards created by rotating machinery can include colour rendering consideration to reveal conspicuous paint colours marking hazards or safety control switches and avoiding dangerous stroboscopic effects by reducing luminaire flicker. Where fluorescent or discharge lamps are used this might include specifying high frequency electronic ballasts or the installation of the general lighting in the room over three phases of the electricity supply.

10.13 COMPUTER TRAINING ROOMS

Refer to AS/NZS 1680.2.2 for advice on the lighting of spaces containing screen-based tasks.

10.14 LECTURE THEATRES

Typically, lecture theatres are characterized by a stepped floor which in some cases is steeply raked. The stepped floor is to improve sight lines. It is often not realized that what takes place in a lecture theatre is similar to a stage performance.

It is important, therefore, in lighting a lecture theatre, not to forget the central role of the speaker. The speaker should, whenever speaking, be visible and lit in a pleasant manner (that is, with the illumination vector* at about 45 degrees). The other functions of the lecture theatre should be subordinate, as appropriate, to the need to see the lecturer. For example, the lecturer should not be in darkness when slides are shown.

Lecture theatres are complex, multi-functional, multi-task spaces that require very careful design of an effective lighting system. The following indicates some of the lighting issues:

- (a) The lecturer should be visible and, preferably, slightly brighter than the background in order to create a visual centre of attention. This can be partly achieved using the appropriate mix of surround and directional lighting but partly by decisions made about the surround reflectances.
- (b) The lecturer should be able to read notes, select transparencies, etc., using local task lighting. This lighting may be incorporated into a lectern but the direction of the light should not be from the top of the notes, should not uplight the lecturer's face or be visible from the audience and it should not spill onto any projection screens.
- (c) Any visual aids should be appropriately sized to suit the theatre and should not be washed out by the house (audience) lighting, the lectern lighting or any other spot lighting.

* See Section 4 of AS/NZS 1680.1.

- (d) The audience may need to take notes during audiovisual presentations. General lighting provided for this purpose should be capable of being dimmed and should not spill onto the screen.
- (e) For verbal presentations the house lighting should be able to operate for normal reading/writing tasks. If the conditions described in (d) apply, it is usually necessary to have wall washing luminaires to provide adequate wall luminances for comfortable seeing conditions.
- (f) A bench may be provided for demonstrations. This should be lit so that good modelling of displayed objects is achieved.
- (g) If dimming is used, it should be stable over the whole of the dimming range for the lamp type selected.
- (h) If a projection box is included in the theatre, care is needed to limit spill light from the projection box. Direct-type lighting with some task lighting may be indicated.
- (i) Good lighting control systems are essential from all lecturing points (and any projection box). It is better to label lighting controls by function rather than the luminaires controlled; for example, in a major theatre the controls might include 'off', 'full', 'slides', 'video', 'OHP', 'lectern' and 'bench'.
- (j) A manual describing the operation of the lighting in a complex theatre should be provided.

10.15 AUDITORIUMS AND GENERAL PURPOSE HALLS

10.15.1 General

Auditoriums generally comprise a seating area and a stage. At different times the whole or a part of the facility may serve as an assembly room, lecture theatre, concert hall, theatre, cinema, sports arena, exhibition or examination venue. Often the same facilities can also be used, after hours, for community or social purposes.

The lighting system should be carefully planned to suit each of these diverse applications and appropriate equipment installed. Reference should be made to other Clauses of this Standard or other Standards in the AS/NZS 1680.2 series for advice on applicable lighting requirements.

When planning any except the smallest auditorium or stage, the lighting should be designed in conjunction with other technical services, with advice from appropriate specialists.

10.15.2 Seating area

The basic lighting for the seating area should be planned for audience assembly purposes and for visual tasks such as reading programs. The seating area may at times be used for examination purposes and the lighting system should also be capable of satisfying this function. The system should allow smooth, non-distracting dimming between settings. If windows are used for illumination or ventilation, means should be provided to darken them while maintaining the ventilation function.

NOTE: Attention is drawn to the Building Code of Australia and local ordinances that may specify minimum requirements for emergency evacuation lighting, and exit signs and locations for seating area lighting controls.

10.15.3 Aisle lighting

Aisle lighting should be installed if floors are sloped at greater than 1 in 12, or are stepped. Each step should be defined by this lighting system by producing a contrast between the step and its riser. Aisle lights should be well screened from the stage and audience and should illuminate steps and aisles without producing high luminances which would be distracting in a darkened room.

10.15.4 Stage and performance lighting

The design of stage and performance lighting is a specialist field outside the scope of this Standard. An overview of requirements is provided to assist the designer of the seating area lighting to coordinate with the stage and performance lighting.

Stage and performance lighting is often temporary with luminaires generally fixed to steel pipes (lighting bars) by clamps to facilitate relocation. Electrical connection to the luminaires is by plug and flexible cable via socket outlets near the lighting bars. The luminaires may be located above and to the sides of the stage, and above and to the sides of the auditorium seating space.

The stage and performance luminaires are generally of specialized design different to general lighting luminaires and unsuitable for that purpose. Sources are often filament lamps with short operating life. Different optical designs are used to achieve a wide range of beam spreads and beam shapes, and luminaires generally accommodate attachments for colour filters, stencil masks, etc.

The stage and performance lighting is commonly dimmed using permanent and/or temporary dimming equipment. The dimmers may be centralized or distributed around and above the stage and auditorium space. The dimming equipment is normally centrally controlled from one or more positions in the auditorium using manual or automated programmable systems. Power circuits from the dimmers may run directly to the lighting outlets, or via patching panels to allow flexibility in allocating luminaires to dimmers.

10.15.5 Working lighting

The stage and performance lighting is unsuitable for use as general lighting to stage areas, fly towers above the stage and lighting bridges, catwalks and ceiling spaces containing equipment above the seating area. These areas are commonly accessed by riggers and stage hands when setting up stage lighting, equipment and sets before a performance or function. Working lighting to these areas is required and may be provided by wire guarded linear fluorescent battens above the working or catwalk areas and stairs. The working lighting is not used during a performance or production so does not require shielding from audience and seating positions. The switching or control of the working lighting is preferably arranged so that it cannot be inadvertently switched on during a performance.

10.15.6 Blue lighting

During a performance it is often necessary for stage hands and riggers to move about the back stage, fly tower and catwalk areas without being seen by the audience. A system of minimal lighting suitable for scotopic vision should be provided to reveal trip and fall hazards in these areas. This lighting is usually monochromatic blue or red (generically referred to as 'blue lighting') to minimize the likelihood of being seen by the audience. Examples of luminaire types are bulkheads on catwalk kick rails, and directional surface downlights over stairs. The switching or control of the blue lighting is preferably coordinated with the working lighting so that common control positions are provided for each.

10.15.7 Power supplies

Power supplies to auditoriums and stages should be adequate for the very large peak loads involved. Where any major dramatic or musical performances are contemplated it is recommended that stages be equipped with at least one, but preferably two or more, three-phase, five-pin sockets having a minimum rating of 40 A.

10.15.8 Projection boxes

Clause 10.14(h) applies to projection boxes in auditoriums.

10.15.9 Other uses

If the auditorium is used for a range of purposes, requiring significantly different illuminances from, say, theatre use, the provision of multiple lighting systems may be necessary. For example, the lighting needs for some sports may be different from those for normal audience lighting (see also Clause 10.22).

10.16 VIDEOCONFERENCING ROOMS

Videoconferencing rooms generally have a unidirectional seating orientation because of the limited mobility of the video camera and monitor. The lighting system should be arranged so as to—

- (a) generally illuminate the space, including conference tables where the participants need to read documentation;
- (b) adequately illuminate the face and upper body of each of the participants; and
- (c) illuminate the wall behind the participants to limit the luminance contrast between the participants and their background to within the capabilities of the video camera.

The front wall, behind the camera/monitor, may be used to indirectly illuminate the participants but some direct illumination of the participants is essential to give modelling.

The type of luminaires used and their position or orientation should be such as will—

- (i) minimize direct light spill onto the camera lens and monitor screen; and
- (ii) provide appropriate modelling of the faces of the participants, avoiding harsh or unnatural shadow effects. See further information in Section 4 of AS/NZS 1680.1:2006.

Daylight should be excluded from the interior. The lamps used should be all of approximately the same correlated colour temperature and compatible with the camera requirements. Where dimming facilities are provided, the change of colour temperature produced by the dimming should be within the tolerance of the camera.

Lamp control gear associated with the luminaires may need to be of special design or installed remotely to minimize noise.

10.17 CORRIDORS AND STAIRS

For the lighting of circulation spaces such as corridors and stairs, see the recommendations of AS/NZS 1680.2.1.

10.18 FOOD SERVICE FACILITIES

For the lighting of food service areas such as kitchens, cafeteria and dining rooms, see the recommendations of AS/NZS 1680.2.1.

10.19 LIBRARIES AND LEARNING RESOURCE CENTRES

Libraries range from very simple rooms (with a reading area surrounded by book stacks) to complex learning resource centres and the general, specialist and technical libraries in colleges and universities. Many libraries include a reading area requiring uniform illumination, adequate for reading printed materials, plus stack areas with special lighting to make possible the reading of information on the spines of shelved books. Libraries may include circulation desks, card and SBE catalogues, conference and seminar rooms, display and exhibition areas, microfilm viewing areas, audiovisual rooms, technical processing areas and offices. Some may have word processing rooms for student use.

General lighting systems can be used over open reading and writing areas. Study carrels may produce obstruction to general lighting and local lighting may be indicated. Ideally the local lighting should be provided from the sides and should allow for both right-handed and left-handed users. The internal finishes of the carrel should have reflectances in the range 0.4 to 0.6. The lighting over stack areas should provide illuminances to the bottom row of books and be free from body shadows. The lighting should be designed so that the relocation of the stacks does not need the lighting to be redesigned. Areas where SBE are used should comply with the relevant clauses of AS/NZS 1680.2.2.

10.20 FIRST AID FACILITIES

For the lighting of first aid facilities, see the recommendations of AS/NZS 1680.2.1.

10.21 OFFICES

For the lighting of offices, see the recommendations of AS/NZS 1680.2.2.

10.22 PHYSICAL EDUCATION SPACES

Physical education spaces may be purpose designed or part of a multi-function space.

Recommendations for the lighting of multipurpose sports halls are given in AS 2560.2.2. These spaces may also be used for examination purposes and should comply with the applicable recommendations where intended for such purposes. General purpose halls may also be used for physical education activities. (See also Clause 10.15.)

In those areas where the luminaires may be subject to damage (e.g. due to ball sports or vigorous athletic activity), consideration should be given to the use of protective grids. However, where such grids are used, allowance should be made for any reduction in light output due to obstruction from the grids.

10.23 SAFETY LIGHTING

In some teaching areas such as woodworking, metalworking, foundry workshops or chemical laboratories, dangerous situations may arise for both students and teachers if failure of the normal lighting occurs. In such locations, consideration should be given to the provision of high-risk task area lighting.

It should be noted that emergency evacuation lighting (see AS 2293.1) serves a different purpose from high-risk task area lighting and the illuminances required by AS 2293.1 might not be sufficient to reveal dangerous situations such as those described above.

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.

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.

APPENDIX C
NOTES ON CHANGES TO ILLUMINANCE RECOMMENDATIONS
(Informative)

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

APPENDIX D

SPECIFIC RECOMMENDATIONS FOR EDUCATIONAL AND TRAINING FACILITIES

(Informative)

D1 INTRODUCTION

Specific recommendations for the lighting of educational and training facilities are set out in Table D1. Quantitative recommendations are expressed as minimum values with the exception of the glare index recommendations in Column 5 which are maximum values.

D2 RECOMMENDATIONS

The recommendations of Table D1 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 a particular interior/activity is not specifically listed in Column 1, 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 values of maintained illuminance recommended in Column 2 represent the lowest value of the average illuminance over the task area or throughout the interior which should apply at any time during the life of the lighting system. For design purposes, it will be necessary to select an initial illuminance which is significantly greater than the recommended maintained illuminance to allow for the progressive loss of light which will occur over time (see Section 12 and Appendix D of AS/NZS 1680.1:2006).

Maintained illuminances are specifically intended to apply in the plane of the task. This means that for flat, horizontal desk-tops, tasks lying on the desk require the maintained illuminance on a horizontal plane. For vertical tasks, e.g. library bookshelves or chalkboards, the maintained illuminance should be provided on the relevant vertical plane. For tasks that are tilted, like draughting desks, the relevant maintained illuminance should be provided on that tilted plane.

For tasks not included in Column 2 choose a listed task that closely resembles the task in question. Select a task that has a similar contrast and is about as difficult to read. Tasks that are subject to veiling reflections are so indicated in Column 6.

If there is more than one task and each requires different illuminances, the designer must choose between them. There are several alternative methods for combining many criteria.

The illumination requirements of many tasks may be satisfied by the use of a flexible lighting system. For example, by designing for the highest level and provided dimming or switching capabilities, the user may adjust the lighting from task to task. Multi-level control systems may be suitable.

(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 only relate 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 glare evaluation system is only appropriate 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 that are specific to particular tasks or interiors are given in Column 6. These recommendations should be taken in conjunction with the quantitative recommendations given in Columns 2 to 5 of the Table.

TABLE D1
SPECIFIC RECOMMENDATIONS FOR EDUCATIONAL AND TRAINING FACILITIES

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	AUDITORIUMS				See recommendations of Clause 10.15.
1.1	160	1, 2	1B, 2	19	Include provision for higher illuminance for exhibitions. Switching and dimming facilities are desirable.
1.2	80	1, 2	1B, 2	19	
1.3	240	1, 2	1B, 2	19	
1.4	(Special application, see Clause 10.15.4)				Aisle lighting may be required.
2	CLASSROOMS				Higher illuminances may be required depending on the nature of the laboratory tasks.
2.1	(See recommendations under Item 5)				
2.2	(See recommendations of AS/NZS 1680.2.2)				
2.3	(See recommendations of AS/NZS 1680.2.2 and Clause 10.9 herein)				
2.4	240	1, 2	1B, 2	19	
2.5	320	1, 2	1A, 1B	19	
2.6	240	1, 2	IB, 2	19	
2.7	320	1, 2	IB, 2	19	
2.8	320	1, 2	IB, 2	19	
2.9	240	1, 2	IB, 2	19	
2.10	Sewing rooms				
	(a) General	320	1, 2	IB, 2	19
	(b) Task area	800	1, 2	IB, 2	–
					The use of local lighting is recommended.

* Refer to Table 8.2 of AS/NZS 1680.1:2006.

(continued)

TABLE D1 (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	CONFERENCE ROOMS					
3.1	Conferring	240	1, 2	1B, 2	19	See additional recommendations for meeting rooms in AS/NZS 1680.2.2.
3.2	Video conferencing					See recommendations of Clause 10.16. The illuminances provided should be compatible with the type of camera.
	(a) Conference table	600	–	–	–	
	(b) Rear wall	160	–	–	–	
	(c) Auxiliary graphics	800	–	–	–	The illuminance should be provided on the plane of the display. Portable lighting may be used for this purpose where the facility is required only occasionally.
4	FOOD SERVICE FACILITIES— DINING AREAS	(See recommendations of AS/NZS 1680.2.1)				
5	GRAPHIC DESIGN AND MATERIAL					
5.1	Colour selection	800	1, 2, 3	1A	19*	For colour matching, the spectral quality of the light source is important. The use of specially lit colour matching booths may be appropriate for some tasks.
5.2	Charting and mapping	800	1, 2, 3	1A	19*	
5.3	Graphs	800	1, 2, 3	1A	19*	
5.4	Keylining	800	1, 2, 3	1A	19*	
5.5	Layout and artwork	600	1, 2	1B	19*	
5.6	Photographs, moderate detail	400	1, 2	1B	19*	Veiling reflections may occur on glass surfaces.

* Refer to Table 8.2 of AS/NZS 1680.1:2006.

(continued)

TABLE D1 (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
6 LIBRARIES					
6.1 Audio listening areas	160	1, 2	2	19	
6.2 Audiovisual areas	240	1, 2	1B	19	
6.3 Book repair and binding	320	1, 2	1B, 2	19	
6.4 Book stacks	240	1, 2	2	19	Locate luminaries so that there will be adequate vertical illuminance on the face of stacks.
6.5 Card files	320	1, 2	2	19	
6.6 Carrels, individual study areas	320	–	–	–	The use of local lighting may be appropriate.
6.7 Cataloguing	320	1, 2	2	19	Task subject to veiling reflections.
6.8 Circulation desk	320	1, 2	2	19	
7 OFFICES	(See recommendations of AS/NZS 1680.2.2)				
8 INDOOR SPORTS FACILITIES	(See recommendations of AS 2560.2.2)				
9 WORKSHOPS					
9.1 Rough bench or machine work	240	1, 2	2, 3	22	Eye protection will be required for some activities.
9.2 Medium bench work or machine work	400	1, 2	2	19	Supplementary local lighting may be desirable. Eye protection will be required for some activities.
9.3 Fine bench or machine work	800	1, 2, 3	2	19	Supplementary local lighting may be desirable. Eye protection will be required for some activities.
9.4 Extra-fine bench or machine work	1 200	1, 2, 3	2	19*	Supplementary local lighting may be desirable. Eye protection will be required for some activities.

* Refer to Table 8.2 of AS/NZS 1680.1:2006.

APPENDIX E
BIBLIOGRAPHICAL REFERENCES

(Informative)

- 1 CIE Publication No. 123, *Low Vision—Lighting needs for the partially sighted*. Vienna, International Commission on Illumination, 1997.
- 2 CIBSE *Lighting Guide 5, Lecture teaching and conference rooms*. London, Chartered Institution of Building Services Engineers, 1991.

NOTES

NOTES

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