

BRITISH STANDARD

Lighting for buildings –

Part 2: Code of practice for daylighting

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Foreword

Publishing information

This part of BS 8206 is published by BSI and came into effect on 30 September 2008. It was prepared by Subcommittee CPL/34/10, *Light and lighting*, under the authority of Technical Committee CPL/34, *Lamps and related equipment*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This part of BS 8206 supersedes BS 8206-2:1992, which is withdrawn.

Information about this document

This part of BS 8206 represents a full revision of the standard. This revision has been prepared to take account of the publication of BS EN 12464-1 and BS EN 15193. In particular, some of the manual calculations that appeared in the 1992 edition have been omitted and a new annex on climate-based daylight modelling has been added. There is also a new clause on daylighting and health.

Annex B in the 1992 edition gave what was termed “service illuminances” for tasks. Task lighting is now specified in BS EN 12464-1 and this annex, therefore, has been deleted.

The standard describes good practice in daylighting design and presents criteria intended to enhance the well-being and satisfaction of people in buildings, recognizing that the aims of good lighting go beyond achieving minimum illumination for task performance. Simple graphical and numerical methods are given for testing whether the criteria are satisfied, but these are not exclusive and computer methods may be used in practice. Sunlight and skylight data are given.

The aim of the standard is to give guidance to architects, engineers, builders and others who carry out lighting design. It is recognized that lighting is only one of many matters that influence fenestration. These include other aspects of environmental performance (such as noise, thermal equilibrium and the control of energy use) fire hazards, constructional requirements, the external appearance and the surroundings of the site. The best design for a building does not necessarily incorporate the ideal solution for any individual function. For this reason, careful judgement needs to be exercised when using the criteria given in the standard for other purposes, particularly town planning control.

NOTE Figure 2 in this standard is reproduced from the CIBSE Lighting Guide LG10 Daylighting and window design [1] by permission of the Chartered Institution of Building Services Engineers.

Use of this document

As a code of practice, this part of BS 8206 takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this part of BS 8206 is expected to be able to justify any course of action that deviates from its recommendations.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Section 1: General

1 Scope

This part of BS 8206 gives recommendations regarding design for daylight in buildings. It includes recommendations on the design of electric lighting when used in conjunction with daylight.

NOTE Data for daylight and sunlight calculations are given in Annex A.

2 Terms and definitions

For the purposes of this part of BS 8206, the following terms and definitions apply.

2.1 daylight

visible part of global solar radiation [BS EN 12665:2002]

NOTE Daylight consists of a combination of sunlight (see 2.10.1) and skylight (see 2.11.1).

2.2 window

construction for closing a vertical or near-vertical opening in a wall or pitched roof, which will admit light and may provide ventilation [BS 6100-1:2004, 5.3.5]

2.3 rooflight

construction for closing an opening in a flat roof or low pitched roof, intended primarily for lighting and consisting of a frame and glazing [BS 6100-1:2004, 5.3.13]

2.4 transom

horizontal member dividing an opening or frame of a window or door [BS 6100-1:2004, 5.3.24]

2.5 obstruction

anything outside a building which prevents a direct view of the sky from a given reference point

2.6 no-sky line

outline on a given surface of the area from which no sky can be seen

2.7 working plane

horizontal, vertical or inclined plane in which a visual task lies [BS 6100-7:2008, 52002]

NOTE If no information is available, considered to be horizontal and 0.7 m above the floor for offices; horizontal and 0.85 m above the floor for industry and in dwellings.

2.8 window reference point

point in the centre of a window or rooflight opening on the plane of the inside surface of the window wall or roof

NOTE This is used in determining sunlight penetration and average daylight factor.

2.9 supplementary electric lighting

electric lighting used continuously in combination with daylighting

2.10 sunlight**2.10.1 sunlight**

that part of the light from the sun that reaches the earth's surface as parallel rays after selective attenuation by the atmosphere

2.10.2 probable sunlight hours

long-term average of the total number of hours during the year in which direct sunlight reaches the unobstructed ground

NOTE A period of "probable sunlight hours" is the mean total time of sunlight when cloud is taken into account.

2.10.3 solar altitude

angle between a line passing through the centre of the solar disc and a horizontal plane on the earth's surface [BS 6100-7:2008, **59006**]

NOTE This is illustrated in Figure 1.

2.10.4 solar azimuth

horizontal angle between a vertical plane passing through the centre of the solar disc and a vertical north-south plane

NOTE 1 Solar azimuth is measured clockwise from due north.

NOTE 2 This is illustrated in Figure 1.

2.11 skylight**2.11.1 skylight**

that part of the light from the sun that reaches the earth's surface as a result of scattering in the atmosphere

2.11.2 standard overcast sky

completely overcast sky for which the luminance L_γ at an angle of elevation γ above the horizon is expressed as a function of the luminance L_z at the zenith by the formula:

$$L_\gamma = \frac{L_z(1 + 2 \sin \gamma)}{3}$$

NOTE This formula for overcast sky luminance distribution is presented as an alternative formula in BS ISO 15469:2004, Clause 6.

BS ISO 15469:2004 also contains fifteen other formulae for different types of sky.

2.11.3 daylight factor

ratio of illuminance at a point on a given plane due to light received from a sky of known or assumed luminance distribution, to illuminance on a horizontal plane due to an unobstructed hemisphere of this sky [BS 6100-7:2008, **59011**]

NOTE 1 For the purposes of the calculation of daylight factor in this standard, it is assumed that the sky has the luminance distribution of the standard overcast sky.

NOTE 2 Direct and reflected sunlight are excluded from all values of illuminance.

NOTE 3 The point in an interior for which the daylight factor is calculated is known as the "room reference point".

2.11.4 average daylight factor

ratio of total daylight flux incident on a reference area to total area of reference area, expressed as a percentage of outdoor illuminance on a horizontal plane due to an unobstructed hemisphere of sky of assumed or known luminance distribution [BS 6100-7:2008, **59012**]

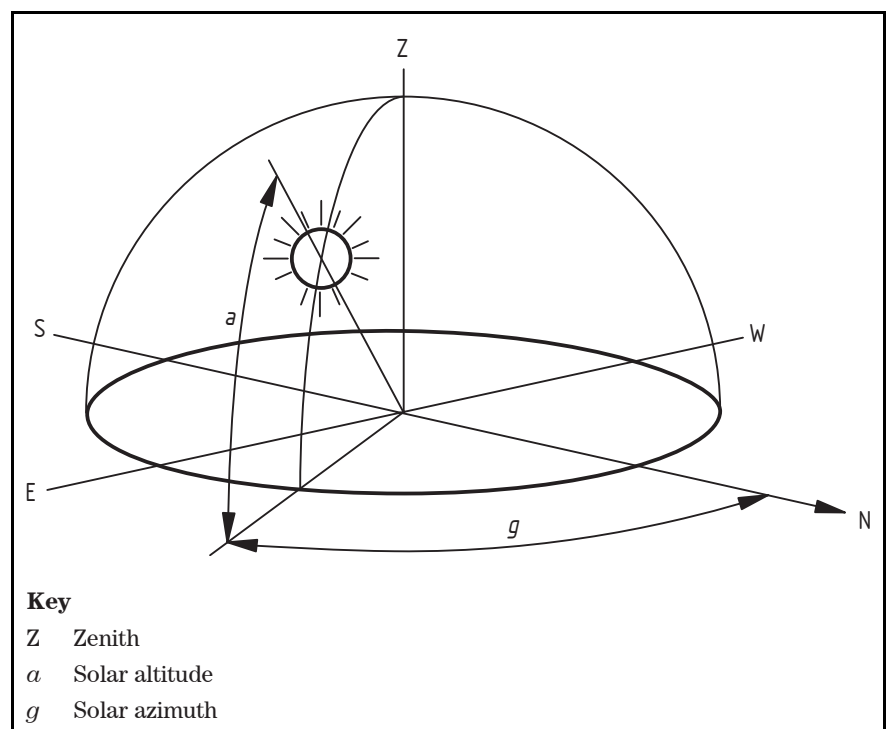
NOTE 1 For the purposes of this standard, it is assumed that the average daylight factor is the mean daylight factor over a horizontal working plane, unless stated otherwise.

NOTE 2 Direct and reflected sunlight are excluded from all values of illuminance.

2.11.5 vertical sky component

ratio, expressed as a percentage, of that part of illuminance, at a point on a given vertical plane, that is received directly from a standard overcast sky (see **2.11.2**), to illuminance on a horizontal plane due to an unobstructed hemisphere of this sky

Figure 1 **Solar altitude and solar azimuth**



Section 2: Aims and criteria for design

3 The contribution of daylight

3.1 General

Daylighting gives to a building a unique variety and interest. An interior which looks gloomy, or which does not have a view to the outside when this could reasonably be expected, will be considered unsatisfactory by its users. The recommendations of this part of BS 8206 recognize that a principal aim of the designer is to produce interiors which are comfortable and give pleasure to their occupants.

Recommendations are made in this section about three separate uses of windows, which are:

- a) for view;
- b) to enhance the overall appearance of interiors, using sunlight (the direct beam) and skylight (diffuse daylight);
- c) for lighting of visual tasks.

It is important to consider the primary function to be served by each window or rooflight in a building, because the criteria differ. Two of the functions, the overall illumination of the interior and the task lighting, may be fulfilled also by electric lighting, which has different qualities. For many buildings, the best design uses daylighting and electric lighting together, with appropriate lighting control, during daytime hours.

3.2 Daylight and health

3.2.1 Regulation of the circadian system

The role of the circadian system (which controls daily and seasonal body rhythms) is to link the functions of the body (e.g. the sleep/wake cycle, and changes in core body temperature and in hormone secretion) with the external day/night cycle. Disruption to this system from lack of light can cause problems such as depression and poor sleep quality which could lead to more serious problems. Therefore, it is important that occupants of buildings, particularly those of limited mobility in, for example, hospitals and nursing homes, and people who might be unable to go outside much, are given access to high levels of daylight, particularly in the mornings, to assist the entrainment of circadian rhythms. Therefore, buildings used by such people should have spaces with high levels of daylight, such as conservatories, which are readily accessible to them.

3.2.2 Mood

Mood can be modified by lighting. Daylighting is dynamic and variable and is strongly favoured by building occupants. Adequate access to daylight can have a positive impact on mood especially in situations where people are static for long periods of time, for example, in a hospital ward.

3.2.3 Seasonal affective disorder (SAD)

A small percentage of people suffer a seasonal mood disorder known as seasonal affective disorder (SAD) with a further number suffering a mild form known as sub-syndromal SAD (S-SAD). Symptoms include depression, lack of energy, increased need for sleep and increased appetite and weight gain, occurring in the winter when there is little daylight. Such symptoms can be reduced by exposure to daylight.

3.2.4 Ultraviolet (UV) radiation

The ultraviolet (UV) radiation in sunlight can be damaging to the skin. However, with people spending many daylight hours behind glass in buildings, there is the danger of insufficient exposure to UV radiation to maintain healthy levels of vitamin D. A vitamin D deficiency leads to rickets in children and softening of the bones in adults.

Exposure to sunlight, even through glass, can kill many types of viruses and bacteria and so can be of great value in winter when there is a high incidence of respiratory infections.

4 Windows and view

4.1 Principle

Unless an activity requires the exclusion of daylight, a view out-of-doors should be provided irrespective of its quality.

All occupants of a building should have the opportunity for the refreshment and relaxation afforded by a change of scene and focus. Even a limited view to the outside can be valuable. If an external view cannot be provided, occupants should have an internal view possessing some of the qualities of a view out-of-doors, for example, into an atrium.

4.2 Analysis of view

In planning the position of windows, the following factors are important.

- a) Most people prefer a view of a natural scene: trees, grass, plants and open space.
- b) In densely built-up areas, a view of the natural scene may not be available. When only buildings, sky and street can be seen, it is especially desirable that the view be dynamic, i.e. including the activities of people outside and the changing weather, but even a static view is usually better than none.
- c) A specific close view may be essential, particularly for security and supervision of the space around dwellings.
- d) There is often a need for privacy. This varies with the building type and with the expectations of the users. The view into a building should be considered when the view outwards is determined.

Most unrestricted views have three “layers”, as follows:

- 1) upper (distant), being the sky and its boundary with the natural or man-made scene;
- 2) middle, being the natural or man-made objects themselves;
- 3) lower (close), being the nearby ground.

Views which incorporate all three “layers” are the most completely satisfying.

4.3 Size and proportion of windows

The size and proportion of windows should depend on the type of view, the size of the internal space, and the position and mobility of occupants. A variety of window shapes and sizes is illustrated in Figure 2. Some circumstances may suggest a tall window which allows occupants anywhere to enjoy the full vertical span of the view. A narrow horizontal window will only offer a similar prospect to those close to it; a narrow vertical window is also restrictive yet will admit a deeper penetration of daylight. For a given area of window, the more exaggerated the horizontal or vertical proportions, the more restricted will be the position of occupants who can experience the views. A view of the immediate foreground will be experienced normally only by those close to the window.

Unless a view of the sky is to be deliberately excluded (and the penetration of daylight severely limited) window heads should be above standing eye height. Sills, normally, should be below the eye level of people seated. Transoms should not obstruct significant parts of the view from normal standing or sitting positions. Special consideration should be given to window heights in buildings such as nurseries, schools, hospitals and care homes. Guidance on sill heights in hospitals is given in NHS Health Technical Memorandum 55 [2].

The most limited views occur in a deep room when windows are confined to one wall only. Table 1 gives guidance on minimum window area for a satisfactory view when fenestration is restricted to one wall; higher proportions are recommended. The table gives total glazed area of the room as a percentage of the internal window wall area. When there are windows in two or more walls, the total area of glazing should not be less than the area that would be recommended if the windows were restricted to any one wall. The openings should be distributed to give views from all occupied areas of the room.

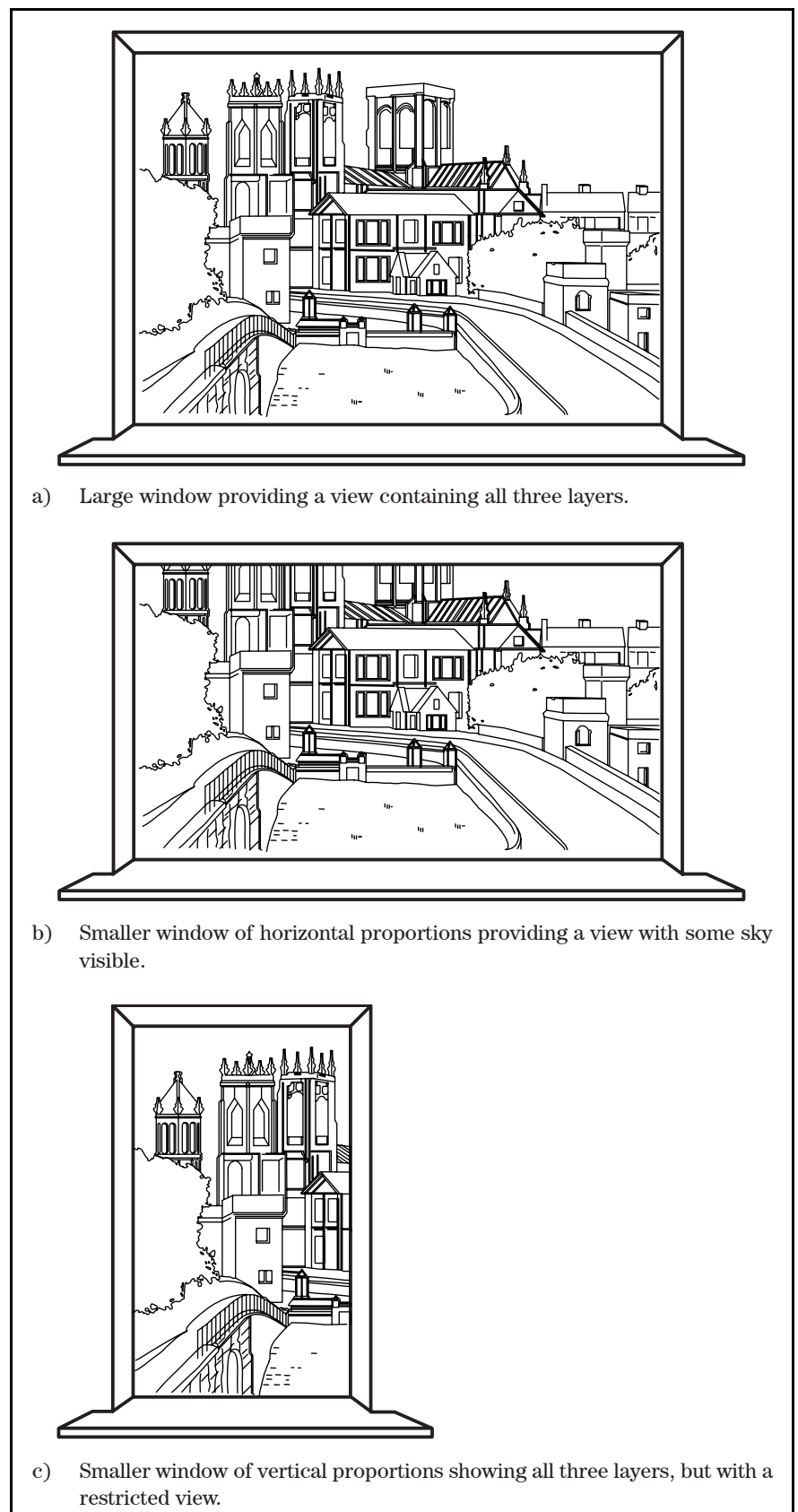
Table 1 **Minimum glazed areas for view when windows are restricted to one wall**

Depth of room from outside wall (max.) m	Percentage of window wall as seen from inside (min.) %
<8	20
$\geq 8 \leq 11$	25
$> 11 \leq 14$	30
> 14	35
<i>NOTE Windows which are primarily designed for view may not provide adequate task illumination.</i>	

When windows are confined to one wall only, it is recommended that the total width of the windows should be at least 35% of the length of the wall.

Figure 2 Views from windows of different shapes and sizes

Reproduced from CIBSE Lighting Guide LG10: *Daylighting and window design* [1], by permission of the Chartered Institution of Building Services Engineers.



5 Daylight and room brightness

5.1 General

The value of daylight goes beyond the illumination of tasks. A daylit room varies in brightness with time, colours are rendered well and architectural form and surface texture can be enhanced by the direction of illumination. Above all, windows give information to the people in a building about their surroundings. Weather and the time of day can be inferred from the changing light.

The user's perception of the character of a daylit interior (often described in terms like "bright and well-lit", or "gloomy") is related to the brightness of all the visible surfaces. This overall luminance depends on the quantity of light admitted and the reflectance of interior surfaces. The reflected light within the room can be as important as the direct illumination.

Sunlight and skylight are both important in general room lighting, but they differ greatly in their qualities. The criteria for each should be satisfied. Sunlight gives patches of high illuminance and strong contrasts; adequate skylight ensures that there is not excessive contrast between one area of the room and another, or between the interior and the view outside. The methods for evaluation of daylight discussed in 5.2 to 5.8 are significant simplifications. In practice, daylight provided by a real sky varies continuously both in amount and distribution. To correctly represent this situation, new climate-based methods are being developed. Climate-based daylight modelling is discussed in Annex B.

If the total glazed area cannot be made large enough for adequate general daylight, supplementary electric lighting is needed to enhance the general room brightness in addition to any need there may be for task illumination (see 7.2).

5.2 Sunlight: principle

Sunlight should be admitted unless it is likely to cause thermal or visual discomfort to the users, or deterioration of materials.

Provided that the entry of sunlight is properly controlled, it is generally welcome in most buildings in the UK. Dissatisfaction can arise as much from the permanent exclusion of sunlight as from its excess. However, uncontrolled sunlight is unacceptable in most types of building. Good control is particularly important in working interiors and other rooms where the occupants are unable to move around freely. Generally, sunlight should not fall on visual tasks or directly on people at work. It should, on the other hand, be used to enhance the overall brightness of interiors with patches of high illuminance.

Considerations of sunlight should influence the form of the building from the early stages of design, because incorrect decisions about the orientation of rooms or the geometrical shape of the building may preclude the admission of sunlight or cause excessive overshadowing of surroundings. The orientation of windows should take into account the periods of occupancy and any preferences for sunlight at particular times of day. The provision of sunlight is important in dwellings, particularly during winter months. Sunlight is especially valued in habitable rooms used for long periods during the day and in buildings, such as those for the elderly, where the occupants have little direct contact with the outside. In some cases, it is important that there should be direct sunlight on external surfaces seen from a window.

NOTE 1 Sunlight entering a room can have a significant effect on thermal comfort and on the energy consumption of the building. In winter it can be an important contribution to the heating; but excessive solar gain causes serious discomfort and, in air-conditioned buildings, unnecessary use of energy in cooling. Sunlight as a source of thermal energy is considered in BS 8207 and in BS 8211-1.

NOTE 2 Control of admission of sunlight is covered in 8.1.

5.3 Sunlight duration

Interiors in which the occupants have a reasonable expectation of direct sunlight should receive at least 25% of probable sunlight hours (see 2.10.2). At least 5% of probable sunlight hours should be received during the winter months, between 21 September and 21 March. Sunlight is taken to enter an interior when it reaches one or more window reference points. A calculation procedure is given in 12.2.

The degree of satisfaction is related to the expectation of sunlight. If a room is necessarily north facing or if the building is in a densely-built urban area, the absence of sunlight is more acceptable than when its exclusion seems arbitrary. It is the duration of sunlight in an interior, rather than its intensity or the size of the sunny patch, which correlates best with the occupants' satisfaction.

5.4 Skylight: principle

The general illumination from skylight should be such that there is not excessive contrast between the interior and the view outside.

The interior of a room will appear gloomy not only if the total quantity of light entering is too small but also if its distribution is poor. In addition, high contrast between the surfaces surrounding windows (or rooflights) and the sky can cause glare.

5.5 Average daylight factor

The average daylight factor (see 2.11.4) is used as the measure of general illumination from skylight. It is considered good practice to ensure that rooms in dwellings and in most other buildings have a predominantly daylit appearance. In order to achieve this the average daylight factor should be at least 2%.

If the average daylight factor in a space is at least 5% then electric lighting is not normally needed during the daytime, provided the uniformity is satisfactory (see 5.7). If the average daylight factor in a space is between 2% and 5% supplementary electric lighting is usually required.

NOTE Excessive daylight can cause visual discomfort and be associated with overheating (see 5.2).

5.6 Minimum values of average daylight factor in dwellings

Even if a predominantly daylit appearance is not achievable in a dwelling, it is recommended that the average daylight factor should be at least the relevant value as given in Table 2.

Table 2 Minimum average daylight factor

Room type	Minimum average daylight factor %
Bedrooms	1
Living rooms	1.5
Kitchens	2

Where one room serves more than one purpose, the minimum average daylight factor should be that for the room type with the highest value. For example, in a space which combines a living room and a kitchen the minimum average daylight factor should be 2%.

5.7 Uniformity of daylight

Surface reflectances and the disposition of glazing should be such that inter-reflected light in the space is strong and widespread.

The uniformity of daylight is considered to be unsatisfactory if:

- a significant part of the working plane (normally more than 20%) lies behind the no-sky line; or
- in a room lit by windows in one wall only, the depth of the room is too large in comparison with the height and the width of the windows. (A procedure for calculating this is given in 13.3.)

In the case of rooflights, unsatisfactory variation in general lighting occurs when the distance between adjacent openings is large in comparison with the ceiling height. The maximum acceptable ratio between rooflight spacing and ceiling height depends on the type of rooflight. Detailed information is given in CIBSE Lighting guide LG10 [1]. In interiors lit primarily by rooflights, the reflectances of the floor and ceiling should be as high as possible.

5.8 Contrast between the interior and the view outside

Glare from windows can arise from excessive contrast between the luminance of the visible sky and the luminance of the interior surfaces within the field of view. The window walls, the window reveals, and the interior surfaces adjacent to rooflights should be of high reflectance (white or light-coloured). Walls generally should not be glossy.

In addition, glare from the sky and bright external surfaces can be reduced by:

- a) providing additional illumination on the window wall from other windows;
- b) reducing the luminance of the sky as seen from the interior with translucent blinds, curtains or tinted/solar-control glazing, if adequate illumination can be provided by other sources;

NOTE 1 Translucent blinds can give a perception of glare if sunlight falls on them (see 8.1).

- c) splaying window reveals, to give a larger area of intermediate brightness between the exterior view and the window wall.

The aim should be to achieve a subtle gradation of luminance from the darker parts of the room to the visible sky.

Glare from direct sunlight, or from sunlight reflected in glossy external surfaces, should be controlled with shading devices (see Clause 8).

The use of tinted glazing will reduce the amount of daylight entering and can affect colour perception. External colours might appear distorted, especially when the view outside is seen simultaneously through different types of glass. The perception of internal colours can be altered, unknown to the viewer, when the main source of light is a window of tinted glazing. Care should be taken in the use of tinted glazing materials when safety or task performance requires good colour recognition.

NOTE 2 Some heavily tinted glazings can affect the view out of a building. It has been found that if the transmittance of the glass falls below 25% a significant proportion of the people using the building find the view out unacceptable.

6 Daylight for task lighting

6.1 General

When there are visual tasks to be carried out, the principles of lighting design using daylight are the same as those for electric lighting: it is necessary both to achieve a given level of illumination and to take account of the circumstances that determine its quality.