

Chapter 9: Office lighting

9.1 Functions of lighting in offices

As the UK has moved from a manufacturing economy to a service economy, the number of people working in offices has increased. The purpose of office work is the collection, recording and distribution of information, together with the making of decisions based on that information and the direction of effort to carry out the decisions made. What has changed in offices over the last twenty years has been immense growth in the ability to collect, record and distribute information rapidly, over vast distances, electronically. This process began with the introduction of the personal computer, gained strength with the development of local networks and reached its full flowering with the arrival of e-mail and the World Wide Web.

The function of lighting in offices is primarily to make the information handled visible, without discomfort. Consequently, the change from paper-based work to screen-based work has important implications for lighting. In the paper-based office, the primary surface to be viewed is horizontal and increasing the amount of light makes any information on that surface more visible. In the computer-based office, the primary surface to be viewed is vertical and increasing the amount of light in the office makes the information displayed on the self-luminous screen less visible. But this distinction is more theoretical than actual, a survey of offices today would reveal very few that were completely screen-based or completely paper-based. The vast majority of offices use a combination of paper and screen. This means that any lighting installation designed for an office today has to be satisfactory for materials that are self-luminous, i.e. computer screens, and seen by reflected light, i.e. paper, and for lines of sight that can be both across the office and down at the desk.

9.2 Factors to be considered

Offices come in many different forms. They can be private or multi-occupied. If multi-occupied they can be open-plan or furnished with cubicles. They can have varying amounts of daylight available. They can fill complete buildings or be part of other buildings. Despite the variability faced by the designer of office lighting, the objectives are the same everywhere. They are:

- to facilitate quick and accurate work
- to contribute to the safety of those doing the work
- to create a comfortable visual environment.

To meet these objectives it is necessary to consider many aspects of the situation.

9.2.1 Legislation and guidance

There are several different pieces of legislation relevant to office lighting, ranging from statements of general principle to specific requirements.

Under the Health and Safety at Work Act 1974 the employer must, as far as reasonably practicable, provide and maintain a safe working environment with adequate lighting.

In Section 8 of the Offices, Shops and Railway Premises Act 1963, reference is made to suitable and sufficient lighting, either natural or artificial.

Most associated Regulations and Acts call for adequate lighting and installation maintenance, some of these are listed below:

- Health and Safety (Signs and Signals) Regulations 1996, (plus BS 5266, EN 1838)
- Building Regulations, Part L: Conservation of fuel and power
- Building Regulations, Part B: Fire safety
- Fire Precautions (Workplace) Regulations 1997
- Visual Display Screens Act 1992
- Electricity at Work Regulations 1989.

Extensive guidance on office lighting is given in the SLL Lighting Guide 7: *Office lighting*.

9.2.2 Type of work done

The stereotypical office consists of a room filled with workstations or desks where individuals handle information presented either on paper or on a screen. While this is undoubtedly part of the work done in an office, frequently office work requires verbal communication between individuals. This can be done by telephone, via a video link or face to face. That this is so is evident from the existence of meeting rooms, conference rooms, boardrooms and training rooms in many offices. The lighting of such spaces should be designed to facilitate non-verbal communication as well as the visibility of paper and screen-based materials. Offices also contain circulation and reception areas, such areas frequently representing the public face of the business. The lighting of such areas should be designed to send the required message to the visitor.

9.2.3 Screen type

An important consideration for office lighting is the optical and geometric properties of the computer screens in the office. The relevant optical properties are diffuse reflectance, specular reflectance, display polarity and display background luminance. The relevant geometric properties are screen tilt and curvature.

The optical properties of the screen matter because they determine the visibility of reflections from the screen relative to the visibility of the display itself. The higher the diffuse reflectance, the greater will be the reduction in contrast of the display. The higher the specular reflectance; the sharper will be the reflected image in the screen and the greater the probability that it will be distracting. A positive polarity screen (bright characters on a dark background) will make reflected images more visible than a negative polarity (dark characters on a bright background) screen. The higher the background luminance of the display, the less visible will be the reflected image in the screen. What all this means is that a computer screen with anti-reflection treatment and a negative contrast display with a high background luminance, has a low probability of disturbing screen reflections. Conversely, a screen without anti-reflection treatment, using a positive contrast display with a low background luminance will be very sensitive to the lighting conditions.

Given that the optical properties of the screen are such that reflections are likely to be seen, then the geometry of the screen becomes important because it determines the probability that high luminances, such as those produced by luminaires, will be in a position to cause disturbing reflections in the screen. Office lighting installations are almost always installed in or on the ceiling, so the further the screen is tilted from the vertical the more likely it is that disturbing reflections will occur. As for screen curvature, the more curved the screen, the larger the area of the office that is reflected in the screen.

Wherever possible, it is desirable to know the optical and geometric properties of the screens that will be used in the office because different properties place different constraints on the design of the office lighting (see Section 9.3.3 Maximum luminances).

9.2.4 Daylight availability

Most offices have access to daylight through windows. Depending on the time of day and season of the year, the weather conditions, the size and shape of the windows, the orientation of the windows and the presence of external obstructions, the amount of daylight available in the office can vary over a wide range. It will always be necessary to install electric lighting for use after dark but whether or not to invest in a control system that automatically adjusts the electric lighting to supplement the available daylight will depend on the amount of daylight available. As a crude guide, in offices where the minimum daylight factor is less than 2 percent there is little to be gained from modifying the electric lighting. Where the minimum daylight factor is more than 5 percent, controlling the electric lighting to blend with daylight should always be considered.

Of course, daylight will only be available if the window is unobstructed and a short walk around any business district will show how frequently windows are obstructed. Windows may be obstructed for a number of reasons. Among them are visual discomfort caused by a direct view of the sun or bright sky; visual discomfort caused by the presence of high luminance patches of sunlight on the workstation; visual discomfort caused by reflected images of the windows in computer screens; and thermal discomfort caused by excessive radiant heating or cooling. Visual discomfort can be minimised by careful attention to external shading of the windows or the use of different types of glazing or internal screening (see SLL Lighting Guide 7: *Office lighting*). The problem of reflections from computer screens can be solved by orienting the screens so that they are perpendicular to the plane of the windows. As for thermal problems, these have to be dealt with through the heating and ventilating system.

9.2.5 Ceiling height

Ceiling height is important for office lighting design because it determines whether indirect lighting is an option. Floor, furniture and wall mounted indirect lighting luminaires rely on height to shield the occupants of the office from a direct view of the lamp. This is the reason why the vast majority of floor mounted luminaires are at least 1.8 m high and why wall and furniture mounted indirect luminaires should have their top surface at least 1.8 m above the floor.

This minimum height above the floor for luminaires sets a minimum ceiling height that can be used for indirect lighting. As a rule of thumb, floor furniture and wall mounted indirect lighting luminaires are best used with ceiling heights in the range 2.5 m to 3.5 m. Below 2.5 m there is a risk of high luminance ‘hot spots’ being produced on the ceiling. Above 3.5 m the additional energy consumption required for floor mounted indirect lighting becomes difficult to justify.

Where indirect luminaires are suspended from the ceiling, the luminaires need to be well above normal head height. A minimum height of 2.3 m to the underside of the luminaire is recommended. As for the separation from the ceiling, this is a matter of luminaire design. Manufacturers usually specify a minimum separation from the ceiling. This minimum should not be ignored.

9.2.6 Obstruction

Obstructions in offices are created by the use of partitions between individual workstations and/or the use of full height partitions to subdivide the office.

The degree of obstruction created by the use of partitions between individual workstations will depend on the height of the partitions; the higher the partition, the greater the obstruction. 1.2 m high partitions provide visual privacy for anyone sitting at the workstation but not when standing. 2 m high partitions provide visual privacy for both sitting and standing occupants. An office equipped with 2 m high partitions is effectively a collection of very small offices. This has both advantages and disadvantages for lighting. The advantage is that luminaires and windows are very unlikely to be seen reflected in the computer screen. The disadvantage is that the amount of light on the workstation will be reduced unless allowance is made for the additional light absorption in the design of the electric lighting. As for daylight, the presence of partitions between workstations limits the role of windows in providing a view out, the amount of daylight reaching the workstation being negligible.



Figure 9.1
A view of partitioned office

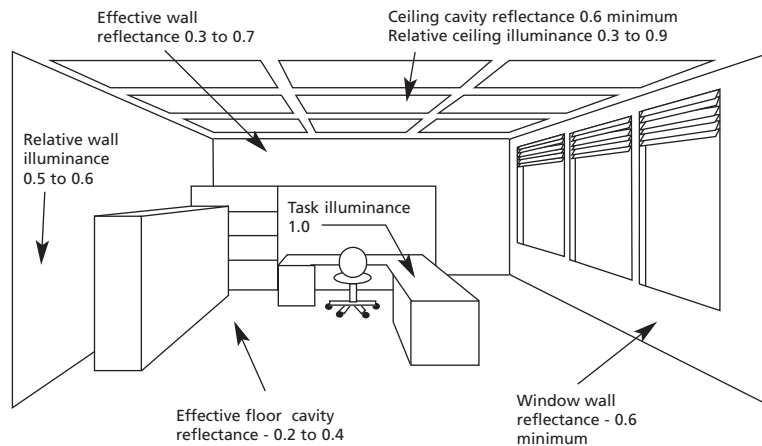
Most office buildings constructed for lease show the office floor as one large open space but require the lighting to be designed so as to allow full height partitions to be installed to subdivide the space into offices of different sizes. The effect of these partitions will depend on the size of the offices created and the reflectance of the partitions. The smaller the office and the lower the reflectance of the partitions, the greater is the reduction in illuminance. Ideally the designer needs to know the size of the smallest office in order to determine the most suitable type and layout of lighting. Thought will also have to be given to the control system for the lighting.

9.2.7 Surface finishes

The colour and reflectance of all the surfaces in an office influence the distribution of light. Figure 9.2 gives recommended ranges of average cavity reflectances for floor and ceiling and the average wall reflectance.

Figure 9.2

Recommended ranges of floor and ceiling cavity reflectance, wall reflectance and relative surface illuminance in offices



When estimating the average surface or cavity reflectance it is necessary to take into account all the reflectances forming the surface or cavity. For example, if a painted wall is lined with filing cabinets, the average wall reflectance is made up of the reflectances of the painted surface and the filing cabinets weighted by the area of each. Table 9.1 gives the reflectances of some common materials found in buildings and some paint colours. Details of the reflectance of other materials can often be obtained from the manufacturers or by the methods described in SLL Lighting Guide 11: *Surface reflectance and colour*.

For direct lighting, where the luminaires are recessed into the ceiling, light reaching the ceiling and upper part of the walls is first reflected from the floor and work stations. To avoid a gloomy appearance caused by dark walls and ceiling it is necessary to have a floor cavity reflectance towards the top end of the range given in Figure 9.2. Unfortunately, it is difficult to achieve this without using a light floor finish, something that is not practical in heavily trafficked offices. The solution to this problem is a supplementary lighting installation designed to light the ceiling directly.

There are also limitations on the colour of the floor finish. Where direct lighting with luminaires recessed into the ceiling is used, the ceiling is illuminated primarily by light reflected from the floor. Consequently, a strongly coloured floor will result in a strongly coloured ceiling.

Table 9.1 Reflectances of common materials found in buildings and some paint colours

Materials	Reflectance	Paint colours and BS 4800 code	Reflectance
White paper	0.8	White 00E55	0.85
Stainless steel	0.4	Pale cream 10C31	0.81
Cement screed	0.4	Light grey 00A01	0.68
Light carpet	0.3	Strong yellow 10E53	0.64
Light oak veneer	0.4	Mid grey 00A05	0.45
Teak veneer	0.2	Strong green 14E53	0.22
Dark oak veneer	0.1	Strong red 04E53	0.18
Quarry tiles	0.1	Strong blue 18E53	0.15
Window glass	0.1	Dark grey 10A11	0.14
Dark carpet	0.1	Dark brown 08C39	0.10
		Dark red-purple 02C39	0.10
		Black 00E53	0.05

There is much to be said for the use of high reflectance surface finishes of neutral or low chroma colour, particularly in small offices. Surface finishes of this type increase the inter-reflected component of the illumination thereby diminishing shadows and reducing the probability that the occupants will experience discomfort glare or be annoyed by veiling reflections.

For indirect lighting (see Section 9.4), it is important to provide a high ceiling cavity reflectance free from colour. Failure to do this will result in an inefficient installation producing coloured light. It is also desirable to use large areas of high reflectance on the walls to enhance the inter-reflected component of the illumination, with small areas of colour to offset the blandness of indirect lighting.

For direct/indirect lighting (see Section 9.4), a high ceiling cavity reflectance free from colour is again desirable to ensure the efficiency of the indirect lighting. However, there is no need to have a high floor cavity reflectance as the ceiling is illuminated by the indirect lighting.

For general guidance, Table 9.2 recommends the range of reflectances for the most common surfaces in an office.

Surface	Reflectance
Ceiling	> 0.7
Walls	0.5–0.7
Partitions	0.4–0.7
Floor	0.1–0.3
Furniture	0.2–0.5
Window blinds	0.4–0.6

Table 9.2
Recommended reflectance ranges for common office surfaces

9.3 Lighting recommendations

9.3.1 Illuminances

Offices contain rooms with different functions. Tables 9.3 to 9.5 give the recommended maintained illuminances for the most common spaces in an office building. The recommended maintained illuminance is the minimum average illuminance that should be provided in the given space throughout the life of the installation. Unless specified otherwise, the recommended maintained illuminance is measured on a horizontal working plane at desk height. Table 9.3 gives the recommended maintained illuminances for the primary office spaces. A primary office space is a space where most of the work is done and where most of the staff spend most of their time.

Table 9.3 Recommended maintained illuminances on a horizontal working plane in primary office spaces.

Space	Recommended maintained illuminance
Open plan office – mainly screen based work	300 lx
Open plan office – mainly paper based work	500 lx
Deep plan core area (more than 6m from window)	500 lx
Cellular office – mainly screen based work	300 lx
Cellular office – mainly paper based work	500 lx
Graphics work stations	300 lx
Dealing rooms	300–500 lx
Executive offices	300–500 lx

These maintained illuminances are adequate for task performance but are insufficient to ensure comfortable visual conditions, particularly for deep offices with windows and large open plan offices. For deep offices with windows, there is a risk that the parts of the office away from the windows will look dull compared with the parts adjacent to the windows. This perception can be overcome by taking care to light the walls of the office as well as the horizontal plane. For large open plan offices, lighting the walls is still useful but will not be effective in the centre of the office where there are no walls. In such areas, an additional illuminance criterion should be applied. This is the ratio of cylindrical illuminance to horizontal illuminance at a height of 1.2 m above the floor. Table 9.4 gives the minimum values of this ratio recommended for different floor reflectances.

Table 9.4 The minimum cylindrical/horizontal illuminance ratios recommended for different floor reflectances

Floor reflectance	Minimum cylindrical/horizontal illuminance ratio
0.1	0.48
0.2	0.37
0.3	0.26

For a regular array of luminaires, the cylindrical/horizontal illuminance ratio should be calculated or measured at two positions, one directly beneath a luminaire and the other at the midpoint between luminaires. The minimum cylindrical/horizontal illuminance ratio should be exceeded at both positions.

Offices frequently contain a number of secondary spaces that are used intermittently for a wide variety of purposes. Table 9.5 gives the recommended maintained horizontal illuminances for these secondary spaces. Where face to face interaction is important it will also be necessary to provide adequate vertical illuminance. These spaces can contain specialised equipment or furnishings that require lighting to different illuminances than the general lighting (see SLL Lighting Guide 7 for advice).

Table 9.5 Recommended maintained illuminances for secondary office spaces

Space	Recommended maintained illuminance	Recommended maintained illuminance for special situations
Meeting or break-out rooms	300 lx (for normal meetings)	500 lx (if more intense reading and writing is done)
Training rooms	300 lx (for normal meetings)	500 lx (if more intense reading and writing is done)
Conference rooms	300 lx (for normal meetings)	500 lx (if more intense reading and writing is done)
Board rooms	300 lx (for normal meetings)	500 lx (if more intense reading and writing is done)
Reprographics rooms	300 lx (vertical on reprographic equipment)	300 lx (on collating, binding and dispatch tables)
Libraries/information centres	300 lx (general)	200 lx (vertically on bookcases); 500 lx (on reading desks and counters)
Archives/document stores	300 lx (general)	200 lx (vertically on fronts of shelving)
Break rooms	200 lx (general)	300 lx (on serving and preparation areas)
Medical rooms	300 lx (general)	500 lx (on medical examination area)
Canteens/restaurants	200 lx (general)	300 lx (serveries); 500 lx (kitchens)

All offices have circulation areas and service areas. Table 9.6 gives the recommended maintained illuminances for these areas, some of which will contain special equipment that requires lighting to different illuminances than the general lighting in the space.

Table 9.6 Recommended maintained illuminance for circulation and service areas

Space	Recommended maintained illuminance	Recommended maintained illuminance for special situations
Entrance halls/reception	200 lx (general)	300 lx over reception desks and seating areas
Stairs/escalators	150 lx (on treads)	
Lift lobbies	200 lx (on floor)	
Corridors	100 lx (on floor)	
Security/control rooms	200 lx (general around CCTV monitors)	300 lx where there is use of written materials
Cleaner's cupboards	200 lx (general)	
Plant room	200 lx (general)	200 lx vertically on control panels, valve sets and instruments etc
Workshops	300 lx (general)	300 lx vertically on machines, 500 lx on workbenches
Lift motor rooms	200 lx (general)	200 lx vertically on sides of winding machine and front of control panel
Generator/UPS rooms	200 lx (general)	200 lx vertically on sides of generator, front of control panel and instruments etc
Storeroom for bulk items	200 lx (general)	
Storeroom for small items	300 lx (general)	200 lx vertically on front of shelving

9.3.2 Light distribution

The illuminances given above are averages. To avoid complaints about non-uniform lighting, it is necessary to have limits on how much the illuminance on any single work surface is allowed to drop below the average. For any individual work surface, e.g. a desk, the illuminance uniformity (the ratio of the minimum illuminance/average illuminance) should not be less than 0.7.

Most offices are furnished with many desks or workstations. To ensure different desks or workstations are perceived to be treated equally, the illuminance uniformity (minimum average illuminance on the desks/overall average illuminance) should not be less than 0.7. This illuminance diversity criterion applies to electric lighting designed to produce a uniform illuminance across the whole working plane. Where there is daylighting from side windows, or where individual control of the light output from luminaires is used, the illuminance uniformity criterion should be ignored.

The appearance of the office will also be affected by the illuminance of the walls and ceiling as well as the working plane. Figure 9.2 shows desirable ranges of illuminance on the walls and ceiling as a percentage of the average working plane illuminance. What illuminances are actually achieved on the walls and ceilings will depend on the type of office lighting used. For direct lighting, the ceiling illuminance will be at the bottom end of the specified range. If this cannot be achieved, some form of supplementary lighting to brighten up the ceiling is required. For indirect lighting, it will not be possible to achieve a ceiling illuminance within the range specified, unless the illuminance on the working plane is increased through supplementary lighting. For direct/indirect lighting it should always be possible to achieve wall and ceiling illuminance percentages within the ranges specified.

9.3.3 Maximum luminances

One of the concerns of people working in offices is the reflection of high luminance objects in computer screens. Such reflections can be disturbing because they mask the display or distract attention from it. This used to be a major problem when screens used bright characters on a dark background and were highly reflective but the development of better quality, higher luminance screens that allow dark characters on a bright background, and the wider use of screen treatments to reduce both diffuse and specular reflections made it less of a problem. Nonetheless, there are still many of the older type of screens in use and some of the new screens designed to provide a crisp image are very specular so it is necessary to recognise that lighting needs to be designed with care if problems are to be avoided.

The obvious solution to reflections from screens is to obtain a better quality screen. However, if it is necessary to solve a screen reflection problem by doing something about the lighting then the answer is not to exceed the maximum luminance limits set for luminaires. Table 9.7 gives the maximum luminances of any part of a luminaire that can be seen in a screen, for different screen types. The luminance limit is normally applied at and above a 65° angle of elevation where the screens are not tilted back more than 15° . Where screens are unusually sensitive to reflections, it may be necessary to use a 55° luminaire luminance limit angle.

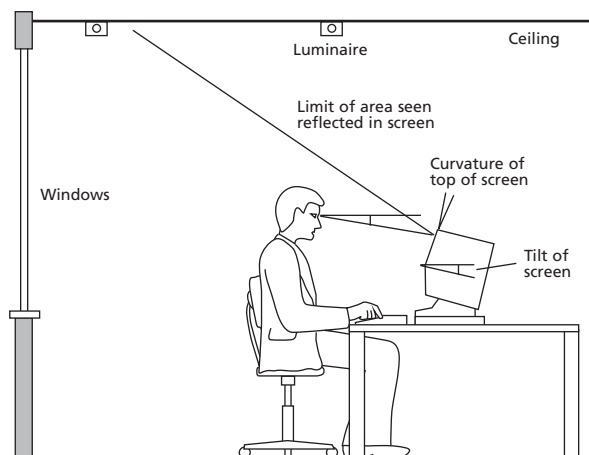


Figure 9.3
Defining what can
be seen reflected in
a display screen

Table 9.7 Maximum luminaire luminance limit for different types of computer screen

Screen type	Maximum luminaire luminance (cd/m^2) where some negative polarity displays are used	Maximum luminaire luminance (cd/m^2) where only positive polarity displays are used
Type 1: Good or moderate screen treatment	1000	1500
Type 2: No screen treatment	200	500

Limiting luminaire luminance is important to solving a problem of screen reflections because luminaires are often the highest luminance object in the office, but not always. Sometimes, the view out of the window will have a higher luminance and, with indirect and direct/indirect lighting, the ceiling may have the highest luminance. For indirect lighting, it is recommended that the average luminance of the major surface reflecting light, which is usually the ceiling, should be less than 500 cd/m^2 and the maximum luminance at any point should be less than $1,500 \text{ cd/m}^2$. Further, the luminance variation across the surface should change gradually and not suddenly. The same criteria can be applied to windows, which will usually mean fitting some form of blind.

9.3.4 Discomfort glare control

Discomfort glare is controlled by ensuring that the unified glare rating (UGR) of the lighting installation does not exceed the maximum recommended value. Table 9.8 gives the maximum UGR values for different parts of an office. It is important to appreciate that differences in UGR of less than one unit are not meaningful.

Discomfort can also be caused by a view of the sun or bright sky through a window. This source of discomfort can be limited either by the use of light shelves and similar elements of the building structure or by blinds. The best blinds are those that shield the occupants from the excessive brightness while preserving some of the view out.

Table 9.8 Maximum UGR values for different parts of an office

Category of space	Type of office	Maximum UGR
Primary office space	Open plan offices	19
	Deep plan areas	19
	Cellular offices	19
	Graphics work stations	19
	Dealing rooms	19
	Executive offices	19
Secondary office space	Meeting rooms	19
	Training rooms	19
	Conference rooms	19
	Board rooms	19
	Reprographics rooms	22
	Libraries/information centres	19
	Archives/document stores	25
	Tea points/rest rooms	22
	Sick bays/medical rooms	19 (16 toward practitioner for medical examination)
	Canteens/restaurants	22
	Entrance halls/reception	22
Circulation areas	Atria	-
	Stairs escalators	25
	Lift lobbies	22
	Corridors	25
Service areas	Security/building control rooms	22
	Cleaner's cupboards	25
	Plant rooms	25
	Workshops	22 or 19 depending on task
	Lift motor rooms	25
	Generator/UPS rooms	25
	Storerooms	25

9.3.5 Light source colour properties

Light sources with a CIE general colour rendering index (CRI) of at least 80 should be used in all parts of the office, except the service areas. For service areas, light sources with a CRI of at least 60 are acceptable.

As for colour appearance, the correlated colour temperatures (CCT) of light sources commonly used in offices varies from 3,000 K to 5,000 K and sometimes as high as 6,500 K. The choice between these different CCTs is a matter of individual preference. CCTs at the lower end of this range will give a warm appearance to the interior but do not blend well with daylight. Higher CCTs will blend better with daylight but give a cool colour appearance to the space.

Very high CCTs will also produce a perception of greater brightness for the same luminance and enhance visual acuity. Whatever light source CCT is chosen should be used throughout the office.

9.4 Approaches to office lighting

9.4.1 Direct lighting

Direct lighting uses luminaires that are designed to emit the vast majority of their light output directly down onto the nominal horizontal working plane. Any upward light emitted plays an insignificant part in lighting the task. Direct lighting luminaires can be surface mounted, recessed into the ceiling or suspended (Figure 9.4).



Figure 9.4
Direct lighting
in an office

The main potential problem with direct lighting is the fact that the ceiling and the upper parts of the walls tend to be underlit resulting in a gloomy, cave-like appearance. This problem can be alleviated in a number of ways. One is by using high reflectance finishes to the floor, furnishing, walls and ceilings. If this is not practical, then supplementary wall mounted uplighting can be used or a direct lighting luminaire can be chosen that diverts a small amount of light onto the ceiling (Figure 9.5). This will have the effect of making the office appear brighter and more interesting although care has to be taken to avoid high luminance patches appearing on the walls or ceiling as these may be seen as high luminance reflections in computer screens.



Figure 9.5
Reflectors suspended below
a direct luminaire to reflect
some light onto the ceiling

Undesirable high luminance reflections of the luminaires can be eliminated by choosing luminaires within the luminance limits specified in Table 9.7. The same luminance limits will minimise discomfort glare to occupants looking across the office. To eliminate overhead glare it is necessary to shield any direct view of high luminance light sources such as T5 fluorescents, or clear envelope metal halides. In addition, it is better not to use highly specular reflectors with such high luminance light sources as these reflectors can provide an image of the light source with almost the same luminance as the light source itself.

For comparable illuminance distributions on a horizontal working plane, direct lighting will almost always be more energy efficient than either indirect or direct/indirect lighting. However, the effectiveness of direct lighting may be compromised where there is a lot of obstruction from partitions in the space. It is also important to appreciate that surface mounted or suspended luminaires may interfere with air distribution in the office, thereby causing thermal discomfort. Coordination of luminaire layout and air distribution pattern is very desirable.

9.4.2 Indirect lighting

Indirect lighting uses luminaires where all, or almost all, of the light produced by the luminaire is reflected off some surface, usually the ceiling, before reaching the working plane. In the interests of energy efficiency it is important to ensure that the surface from which the light is reflected has a high diffuse reflectance, at least 0.7 and preferably 0.8 and higher. In the interests of colour rendering, it is important that the reflecting surface is spectrally neutral in colour. The lighting effect produced by indirect lighting is typically diffuse, without strong modelling or shadows. Therefore, it is important to use the office décor to provide some visual interest and variety. This can take the form of small areas of strong colour associated with architectural features or gentle spotlighting of interesting features such as artwork or notice boards.

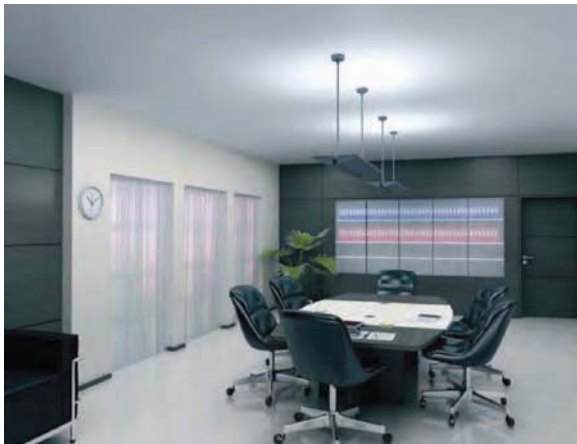


Figure 9.6
Indirect lighting in an office

Indirect lighting can be highly effective in a heavily obstructed office. Further, provided the maximum surface luminances given in Section 9.3.3 are not exceeded, there should be no problem with either discomfort glare to the occupants or high luminance reflection from screens.

Indirect lighting is most suitable for ceiling heights within the range 2.5 to 3.5 m. Indirect luminaires can only be used at ceiling heights in the range 2.3 to 2.5 m if careful attention is paid to light distribution to avoid high luminance spots occurring immediately above the luminaire. Ceiling heights greater than 3.5 m can be used but at extra cost in terms of installed power. Indirect lighting luminaires will usually be seen against the ceiling. To avoid excessive contrast, the outer surfaces of indirect luminaires should be light in colour.

Occasionally, ceiling recessed luminaires in which the vast majority of the light from the light source is reflected from the interior of the luminaire before exiting the luminaire are described as indirect luminaires. This is misleading. Such luminaires should be treated as direct lighting luminaires.

9.4.3 Direct/indirect lighting

Direct/indirect lighting uses a luminaire or a combination of luminaires that provides some lighting on the working plane directly and some after reflection from a surface, usually the ceiling. Direct/indirect lighting can be very effective because the two components are complementary. By using direct/indirect lighting the office will have not only well-lit walls and ceiling but also some modelling (Figure 9.7).

The exact proportion of direct and indirect lighting is not critical in most circumstances although the appearance of the office will change with a change in proportions. As a rule of thumb, if the lighting is to be considered direct/indirect lighting, the minimum percentage for either component is 20 percent. The recommendations and limitations given above for direct lighting and indirect lighting should be applied to each component separately.

Direct/indirect lighting luminaires come in several different forms. One form uses the same light source or sources to provide the two components. Another uses different light sources for the two components. In this case, an option is often available to switch or dim the two components independently. This option may be used to allow occupants to adjust the direct lighting in their local area to match their own preferences but the extent of interaction between adjacent areas needs to be considered. Some direct/indirect lighting luminaires come with a canopy attached to provide a close-up reflector for the indirect component. This is useful in spaces with very high ceilings. Yet another form of direct/indirect lighting uses two entirely different luminaires for the two components, usually direct lighting luminaires and free standing or wall mounted uplighters.



Figure 9.7
Direct/indirect
lighting in an office

9.4.4 Localised lighting

Unlike direct lighting, indirect lighting and direct/indirect lighting, which are most frequently used to provide a uniform illuminance across the whole working plane, localised lighting deliberately sets out to provide non-uniform lighting, with a higher illuminance around the workstations and a lower illuminance elsewhere. Workstations typically occupy about 25 to 30 percent of office floor area so this approach offers the potential for energy savings but with reduced flexibility unless care is taken to ensure easy movement and reconnection when workstations are relocated.

Localised lighting can take various forms such as luminaires in or suspended from the ceiling above each work station, or free standing direct/indirect lighting adjacent to a work station, or indirect lighting located in the centre of a cluster of workstations (Figure 9.8).

Luminaires recessed into or surface mounted on the ceiling are usually part of a re-locatable ceiling tile system. Suspended luminaires can be connected to a ceiling mounted track system. The direct component of free standing direct/indirect lighting adjacent to the work station should ideally be positioned to throw light from either left or right side of the work surface and should cover the task area with a uniformity ratio of 0.8 or better. Lighting placed in front of the task area is likely to produce veiling reflections.



Figure 9.8
Localised lighting

9.4.5 Supplementary task lighting

Supplementary task lighting consists of a task light attached to each desk or workstation. Supplementary task lighting is usually designed so that the ratio of task area illuminance to the ambient illuminance is 2:1 as this gives a reasonable balance between visual comfort and energy savings.

Supplementary task lighting luminaires should allow the occupant some degree of control, both of light output and position. Control of light output can be provided either by switching or dimming. The position of the luminaire should be limited so as to ensure that it cannot become a source of discomfort to others. To avoid discomfort to those sitting at the desk, the supplementary task lighting should not be above sitting eye height. Further, the luminaire should not be positioned so low that deep shadows are cast across the work area. As a rule of thumb, the minimum height for the luminaire above the task area should not be less than 0.5 of the width of the task area. Task lighting luminaires need to be mechanically and electrically safe and not too hot to touch or work close to.

9.4.6 Cove lighting

Cove lighting aims to produce indirect lighting by throwing light across the ceiling from a ledge or recess high up on a wall. This approach has three limitations. First, great care has to be taken to avoid the wall immediately above the cove and the adjacent ceiling having a luminance higher than the maximum luminance limits given in Table 9.7. Second, depending on the cove's distance below the ceiling it may be difficult to light the ceiling more than 2 to 3 m from the wall. Third, the energy efficiency is low. Apart from in corridors, this method is rarely used in offices today.

9.4.7 Luminous ceilings

Luminous ceilings usually consist of an array of light sources contained above a translucent diffusing ceiling. The surfaces of the cavity above the ceiling are finished in a high diffuse reflectance. The cavity itself has to be high enough for the individual light sources not to be detectable through the diffusing material. Although luminous ceilings are not a form of indirect lighting, they produce a very similar light distribution. Luminous ceilings vary widely in energy efficiency depending on the transmittance of the diffusing material and the light source used. However, they almost always pose problems for access and maintenance so are rarely used in offices today.

9.4.8 Daylight

Regulation 8(2) of the Workplace Regulations states that ‘The lighting in (every workplace) shall, as far as is reasonable practicable, be by natural light.’ This means that the provision and control of daylight should be considered for every office. Of course, most building footprints and the fact that daylight predictably fails every night means that reliance can rarely be placed on daylight alone. What is required is a useful combination of daylight and electric light. For a comprehensive guide see SLL Lighting Guide 10: *Daylighting and window design*. For details of various approaches to combining electric lighting and daylighting in offices see SLL Lighting Guide 7: *Office lighting*. For guidance on some of the factors to consider about daylighting, see Chapter 7 of this *Handbook*.