



## 6.5 Light and lighting

### 6.5.1 General

The comfort and safety of users and staff, the protection of the collections and the quality of specific facilities are all factors that have a very direct influence on the way a library is subsequently used.

Lighting deserves special attention, bearing in mind the positive or negative effects the chosen solution may have.

The aim of this chapter is to lay down a series of technical aspects and recommended levels that may serve as a guide when planning lighting for a library.

There are two factors that determine the appropriate lighting comfort during the course of the day:

- a) the configuration of the building's facade and roof, which determines entry of daylight;
- b) artificial lighting.

An important aspect to bear in mind is the coefficient of reflection, which is the relationship between the amount of incident light and the amount reflected from a surface as a consequence of its colour. White has a coefficient of reflection of 80 %, but very dark colours such as dark brown and black can have a value between 3 % and 5 %.

Another important factor is the brightness of the finishing material of surfaces and furniture. Matte surfaces are recommended for greater comfort.

In addition to the influence of colours and finishes, the various surfaces in a room reflect light according to their location. The following reflection factors are recommended: more than 70 % for the ceiling, from 30 to 70 % for the walls, from 20 to 40 % for the floor and from 30 to 40 % for the furniture.

## 6.5.2 Recommended lighting levels<sup>1</sup> according to the activities in an area

Functional areas	Lighting level (lx)
User places, reception/loan desks and information points	500
IT-workplaces	150 to 300
Open and closed stacks	200 to 400 Minimum 200 on the lower shelf
Stacks and exhibition areas for rare books, unprotected graphic material in colour and other special documents	20 to 50 A specific study is required depending on the material stored.
Entrance area	250 to 400
Multipurpose hall (events, lectures and other activities)	300 ambient light Adjustable from 0 to 400 according to the activity taking place.
Exhibition area (except for rare materials)	300 to 700
Area/rooms for meetings and events	100 to 300
Learning centre and training rooms	500
Circulation spaces	150 to 300
Offices for administration	500 On the plane of the work surface
Open-plan offices for administration	750 to 1000 On the plane of the work surface.
Recreation/communication area for users	200
Storerooms and utility management space	150 to 200
Toilets	100 to 200

During the day, a combination of natural and artificial light could be used to achieve these levels.

<sup>1</sup> Lighting level: (Symbol: E (lx) - Unit: Lux, defined as unit per m<sup>2</sup> (lx=lm/m<sup>2</sup>)). This parameter is a characteristic of the object that is illuminated. It indicates the quantity of light falling per unit area of the surface of the object when it is illuminated by a light source.

Illumination is inversely proportional to the square of the height above the surface. In libraries, the quantity of light is usually calculated for the plane of a horizontal work surface, which is usually installed at a height of 70 to 80 cm.

### **6.5.3 Natural light**

Natural light is understood as the light provided by the sun, which varies in position, colour and intensity in the course of the day, and varies according to the season, the weather conditions and the geographical location.

The control of natural light has three main aims:

- a) Energy conservation
- b) Visual comfort

The following points must be borne in mind in library buildings:

- Avoid letting direct sun fall on tables or shelving.
  - Avoid glare, reflections and shadows.
- c) Preservation of the collections

Factors that condition the level of natural light:

- a) climate;
- b) orientation of the facades;
- c) shape of the building;
- d) light openings (windows, skylights, etc.);
- e) nearby buildings and other features that surround the library.

In most cases, fixed or movable mechanisms to modify the light of the sun must be installed (ledges, visors, blinds, curtains, screening films, etc.).

The chosen system must be robust and easy to clean and maintain. In the case of moveable protective elements, it is recommended they be electrically operated and controlled exclusively by the library staff.

### **6.5.4 Artificial light**

#### **6.5.4.1 General**

Artificial lighting can provide illumination anywhere and at any time, but its energy cost is very different to the zero expenditure needed for natural light. Artificial lighting is, together with air conditioning, the greatest consumer of energy in a library.

According to the proportion of light that strikes objects directly, artificial light can be direct, diffused or indirect.

Direct light is recommended for lighting work areas, area/rooms for meetings and events, etc.

Indirect lighting, where light is projected onto a reflecting surface and is reflected from there, is characterised by a sensation of lightness and lack of glare. It is recommended for rooms where computers are used, to provide ambient light in study areas and wherever uniform lighting without shadows or bright spots is required.

One solution for obtaining visual comfort is to combine the two methods, using indirect light for general illumination and direct light in particular areas where it is most called for.

#### 6.5.4.2 Requirements and recommendations

- Artificial lighting must facilitate the practice of all activities carried out in spaces of different dimensions and with varying ceiling heights.
- Care must be taken to provide light with the appropriate quality, intensity and direction, with balanced contrast. Lighting must provide visual comfort for users and staff, and ensure the conservation of the collections.
- A certain degree of uniformity is required (minimum illumination/medium illumination) with values close to 0.5 (Emin/Emed). Otherwise, flexibility in the use of spaces is reduced.
- It must provide light of an appropriate colour, which depends on the choice of lamp<sup>2</sup>. It is recommended that lighting should have an Ra (colour rendering index)<sup>3</sup> of more than 80.
- Glare must be avoided, which depends on the specific design of the luminaire<sup>4</sup>. These should light the work surfaces, but not shine in the eyes of those who are working at them. Luminaires should have a UGR (Unified Glare Rating)<sup>5</sup> of less than 19.
- Lamps and luminaires should be chosen depending on the initial and replacement cost, as well as on resistance and durability. Moreover, the design of the luminaires should facilitate replacing the lamps.
- To facilitate energy saving independent circuits must be established depending on the activities planned and also on the location of the areas relative to the natural light sources. In this case, it can also be useful to incorporate a sensor system to regulate the ignition. It is also recommended that presence detectors are installed in the toilets.
- According to the type of library and its characteristics, it may be convenient to locate light switches so that they are accessible only to library staff.
- External areas pertaining to the library (car parks, paths, ramps, etc.) must also be illuminated, as must residual spaces which might otherwise pose a security threat.

#### 6.5.4.3 Placement of the luminaires

There are two options:

- a) Locating the luminaire independently of the furniture:

This makes it possible to alter the distribution of the furniture, flexibility of use being the main advantage.

A uniform illumination system may be chosen, or the installation of different types of light that offer a varied ambiance.

Systems that are independent of the false ceiling are preferable, since they will make it easier to change the distribution of the lighting.

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<sup>2</sup> Lamp: Manufactured source of optical radiation, generally visible.

<sup>3</sup> Ra (colour rendering index): A measure of the ability of a light source to reproduce the colours of objects faithfully.

<sup>4</sup> Luminaire: Device which distributes, filters or transforms the light emitted by one or more lamps, along with the accessories needed to support them, protect them and connect them to the electrical circuit, and which also contain, where necessary, the auxiliary components needed for operation.

<sup>5</sup> UGR (Unified Glare Rating): An index of the unpleasant glare coming directly from luminaires in an interior lighting installation.

In some areas it may be recommendable to install a lighting track system. This makes it easy to change both the model and the location of the luminaires, with the consequent increase in flexibility and in the variety of lighting conditions.

b) Incorporating lighting into the furniture:

This reduces flexibility, but creates sharply differentiated ambiances, which in the case of study tables assists concentration.

It makes it possible to provide the level of lighting required on the work surface without also providing it in other spaces where it is not necessary, with consequent energy saving.

On the other hand, as the furniture has to be connected to the electricity supply, it is more difficult to move it; also, maintenance costs will be higher because of malfunctions and vandalism.

Finally, a combination of the two options may be decided upon, the choice depending on the type of library.

#### **6.5.4.4 Lighting conditions in the main areas of a library**

##### **6.5.4.4.1 Reading rooms**

In reading rooms the possibility should be considered of enabling users to adjust the lighting themselves, in terms both of direction and intensity. This can be achieved either with a lighting system incorporated into the furniture or by means of more sophisticated mechanisms that make it possible to control lighting remotely. The first of these options has the disadvantages, as already noted, that flexibility is reduced and maintenance costs will be higher. The second option is preferable but is very costly at present. Hence, it would be viable for libraries where flexibility is not an issue, with firmly defined reading areas where change is not expected.

###### *6.5.4.4.1.1 User places*

In the user places lighting should be concentrated on the work surfaces with the possibility of varying the intensity of the light according to need.

The position of the light source must be such that it does not cause shadows for left-handed people.

Continuous tables, in many cases installed with their back to perimetral architectural elements such as walls or partitions, require that the light source be located so as to avoid shadows being thrown by the users themselves. (For working with a laptop, see 6.5.4.4.1.2).

###### *6.5.4.4.1.2 IT-workplaces*

In IT-workplaces no natural light should fall directly on the computer screens.

Neither must artificial light be reflected in them. Therefore the light source should be behind the equipment and raised above it. Indirect light is the most effective solution.

##### **6.5.4.4.2 Stacks**

###### *6.5.4.4.2.1 Open stacks*

The most effective solution is a linear luminaire parallel with the shelving, so that the light falls on the vertical plane and clearly illuminates the spines of the books. This effect can be achieved with luminaires incorporated into the shelving or independent of it. The first option, which requires the shelf units to be connected to an electricity supply, makes it difficult to move the shelves and makes them more expensive. With the second option there is a danger that shelving could be badly sited in relation to the light source.

A more flexible solution might be an arrangement perpendicular to the shelving, with a distance between luminaires that will ensure an adequate level of lighting.

The reflected light generated by the material and colour of the flooring can help achieving the level of lighting required for the bottom shelves (minimum 200 lx).

#### 6.5.4.4.2.2 Compact shelving areas

For the compact shelving, where the aisles between the shelving units are of variable width, an installation perpendicular to the shelving is recommended.

#### 6.5.4.4.2.3 Stacks and exhibition areas for rare books, unprotected graphic material in colour and other special documents

See Chapter 6.1.2.2

### 6.5.4.4.3 Other spaces

#### 6.5.4.4.3.1 Reception/loan desks and information points

Illumination should be concentrated on the work surface. The design and location of the luminaires can also make it easier for users to identify the service desks.

#### 6.5.4.4.3.2 Multipurpose halls (events, lectures and other activities), exhibition areas and certain other spaces (young adults library, music library, informal areas, etc.)

These areas need flexible, directional lighting adapted to current use, with a system for regulating lighting intensity that will enable the illumination levels mentioned above to be obtained. In exhibition rooms it is desirable that the lighting should flood the walls.

### 6.5.4.5 Artificial light generation systems using electrical energy

The advantages and disadvantages of the light sources (lamps) most used in libraries are indicated below.

Light source	Advantages	Disadvantages
<b>Incandescent</b>	<ul style="list-style-type: none"> <li>- Warm light.</li> <li>- Visual comfort.</li> <li>- Very good colour rendering.</li> <li>- Low purchase cost.</li> <li>- Immediate start-up and restart.</li> <li>- Able to operate in any position.</li> <li>- Easy installation and handling.</li> <li>- No auxiliary units required.</li> </ul>	<ul style="list-style-type: none"> <li>- High energy consumption.</li> <li>- Low luminous efficiency<sup>6</sup> (8 to 25 lm/W).</li> <li>- High heat generation.</li> <li>Only a small proportion (less than 10%) of electrical energy is converted into light. The rest produces heat.</li> <li>- Short service life (1,000 hours).</li> </ul>
	Due to the low luminous efficiency, incandescent lights have been prohibited in some countries and are about to be prohibited in others.	
<b>Halogen incandescent</b>	<ul style="list-style-type: none"> <li>- Visual comfort.</li> <li>- Small size, enabling more precise control of the cone of light.</li> <li>- Perfect colour rendering.</li> <li>- Immediate start-up and restart.</li> </ul>	<ul style="list-style-type: none"> <li>- High energy consumption.</li> <li>- Low luminous efficiency (25 lm/W).</li> <li>- High heat generation.</li> <li>- Somewhat short service life (2,000 hours).</li> </ul>

<sup>6</sup> Luminous efficiency: (Symbol: lm/W - Unit: Lumen/Watt). The luminous flux emitted by a light source for each unit of energy consumed.

	<ul style="list-style-type: none"> <li>- Easy installation and handling.</li> <li>- No auxiliary units required, except in the case of low - voltage bulbs, which require a transformer.</li> </ul>	<ul style="list-style-type: none"> <li>- Need for auxiliary transformers for the low-voltage version.</li> </ul>
<b>Fluorescent</b>	<ul style="list-style-type: none"> <li>- Provides uniform light (free of shadows).</li> <li>- Low consumption.</li> <li>- High luminous efficiency (65 to 100 lm/W).</li> <li>- Minimal heat generation.</li> <li>- Moderately long service life: greater than 6,000 hours.</li> <li>- Available in a wide range of shapes and sizes.</li> <li>- Variety of light colours.</li> <li>- Easy replacement.</li> </ul>	<ul style="list-style-type: none"> <li>- Cold light, in spite of the range of available light colours.</li> <li>- Auxiliary units required (except for compact lamps, which have the auxiliary circuits incorporated).</li> <li>- Unless an electronic reactance is used, a stroboscopic effect is produced and diffusers become necessary with consequent reduction of luminous efficiency.</li> </ul>
<b>Metal halides</b>	<ul style="list-style-type: none"> <li>- High luminous efficiency (70 to 95 lm/W).</li> <li>- Medium-long service life: 2,500 to 14,000 hours.</li> </ul>	<ul style="list-style-type: none"> <li>- Start-up and restart are not immediate (about 10 minutes for the discharge to be established)</li> <li>- Auxiliary units required</li> <li>- Moderately high purchase and replacement costs.</li> </ul>
<b>LED (Light Emitting Diode)</b>	<ul style="list-style-type: none"> <li>- Can produce a specific colour without the need for filters.</li> <li>- Low consumption (depending on manufacturer).</li> <li>- No heat emitted with the light (although the diode can overheat).</li> <li>- Very resistant to impacts.</li> <li>- Long service life: between 50,000 and 60,000 hours.</li> </ul>	<ul style="list-style-type: none"> <li>- Variable luminous efficiency (up till now, 5 to 70 lm/W, depending on manufacturer).</li> <li>- Difficult to create warm white light.</li> <li>- High initial cost.</li> </ul>
<p>At present, LEDs are already an alternative for general library illumination. It is a constantly-evolving technology, and it is possible that developments will resolve many of the disadvantages mentioned above, particularly with regard to luminous efficiency (up to 100 lm/W) and the quality of white light. Consequently, the data provided here may vary as research proceeds, and will need to be updated as it does so.</p>		