



## Design and Assessment of Exterior Lighting Schemes

When considering the night-time lighting of any building, monument, park or feature designers and planners need to assess the advantages of the proposed lighting scheme against any possible adverse effects. The lighting of our buildings, roads, sports fields, exterior signs and car parks have clear advantages but affects those who use them or view them at night. Light may enhance our world, but may also cause glare, cause annoyance by unwanted light intruding into our homes or waste unnecessary amounts of energy and therefore money. The poles, columns, brackets and luminaires all remain visible during the day and, without careful design, may be unsightly. A balanced approach is needed to achieve a high quality lit environment for all of us to enjoy and benefit from.

### 1 Environmental factors

There are a number of environmental factors that need to be considered when contemplating exterior lighting. These are the direct energy usage, the visual impact of the lighting equipment during the day, the effect of light spillage on surrounding properties (obtrusive light), the spill light into the night sky (light pollution), the effect of the light on animal and plant species, interference with adjacent transport routes, and in some circumstances the embodied energy of the installation itself.

These factors vary in importance depending on the type of lighting and the location. The lighting of a small office car park in a town is less likely to be a problem than a similarly lit car park on the edge of a National Park. The need to provide light for safety should not be compromised for the sake of energy saving or fear of light pollution, but rather the scheme should be designed well to satisfy all requirements.

### 2 Initial considerations

Before starting to look at the individual environmental factors that may be affected by a lighting scheme, it is important to run through a series of strategic decisions to see what needs lighting. Only once you have established an exact need can you try to design out or mitigate any adverse effects.

#### 2.1 Should it be lit?

This is perhaps the most obvious starting point. Just because a building owner in a conservation area would like to floodlight his or her building this is not reason enough on its own to proceed. Similarly, not all advertising signs need be lit; neither do all sports training grounds have to be allowed to operate at night.

*If it is established that there is a real need to install lighting, then we must look to limit the amount of lighting to that strictly necessary to achieve the aims of the scheme.*

#### 2.2 Should all of it be lit?

If the Town Hall is to be lit should all of it be lit or just the significant features? A road through a mainly rural area may only need the junctions and crossings lit to minimize accidents in potentially dangerous locations.

*Blanket lighting is rarely necessary. By concentrating on those parts or areas that most need lighting and by providing each with just the right amount of light, a significant reduction in energy use, overall brightness and obtrusiveness can be made. This can increase the effectiveness of a scheme whilst reducing any undesirable effects from the lighting.*

#### 2.3 How long does it need to be on?

It may be that the lighting only needs to be on for part of the night, or for some days of the week, or for just part of the year.

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- Advertising and shop signs are most effective whilst there are passing viewers. The lighting of such signs can easily be arranged to go off once the street becomes quiet.
- The lighting of a building or monument may only need to be on at the weekends or for special events. The time when its lights are on can be restricted to those hours when there will be passersby to see it.

*Lighting only when necessary reduces energy use, reduces maintenance costs and reduces the overall impact on plant and animal species.*

## 3 Detail considerations

Once you have concluded that something needs to be lit and you have established what parts need to be lit and for how long, you can move onto the actual selection or assessment of lamp source, luminaire types and luminaire locations

### 3.1 What form should the lighting take?

Choosing the right lighting for the purpose not only determines the energy use and the spill of light past the intended target, but also affects the daytime appearance of the installation.

- Some types of luminaire are very precise in their beam control while others are less so and have spill light which travels to areas and in directions that are not required.
- The use of shutters and baffles may reduce night time light spill, but is likely to mean that the light fitting itself is less acceptable in appearance during the day unless it can be concealed from sight. In addition, these devices can reduce the efficiency of the luminaire.
- The visual impact of the lighting equipment during the day, including poles, brackets and cabling, should be considered.

*The correct choice of lighting equipment can minimize environmental impact and improve efficiency.*

### 3.2 Where should the light come from?

The position of the lighting equipment not only determines the lit appearance of the building, area or object being lit, but affects the visibility of the lighting from the surrounding area, and the spill of light into the night sky and onto adjoining properties.

- Where high mounting heights result in lighting being mounted on high poles or towers these may be visually intrusive during the day. Lighting at high level can normally be seen from a great distance, especially in rural areas.
- There may be conservation restrictions on mounting lights on or by listed buildings or in conservation areas.
- Lighting from sunken pits will reduce the visual impact of the installation during the day, but may result in more overshoot of light into the night sky unless accurate aiming and baffling are used. Lights in sunken pits also need more maintenance to remove leaves, dirt and gravel from grills or glass covering the luminaire. Often lighting equipment mounted above ground can be screened from normal directions of view with planting or other devices.

*Lighting from above, where aesthetically acceptable, will minimize light spill into the sky, but will be more visually intrusive on the surroundings.*

### 3.3 What lamps should be used?

The choice of lamps will affect the colour of the lighting, the appearance of the object or area being lit and the energy usage.

- Lamps with a high colour rendering index, such as fluorescent, metal halide, white LEDs and SON (high pressure sodium), are far more acceptable to the general public than low pressure sodium. They enhance the recognition of faces and car colours in the street leading to a greater sense of pleasantness and security.
- The monochromatic light from low pressure sodium lamps, whilst being more energy efficient, is not really acceptable in residential, shopping or work areas. It can, however, be filtered out more easily by astronomers for observation of the sky thus minimising the effect of sky glow. Most animals and plants seem less affected by this type of lamp.
- The colour temperature of the light effects the mood of the lighting (warm/cold) and can enhance or diminish the natural appearance of certain materials. For example most warm

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light sources enhance the appearance of red brick.

- The effects of side spill from all lights should be considered especially where they can be seen from the surrounding countryside or domestic properties. Monochromatic low pressure sodium lamps are more obvious and these should not in general be used in, or where visible from, sensitive areas.

*The choice of lamp type will depend on the balance of environmental factors in a particular area.*

## 4 Choice of lighting levels

With some external lighting tasks the lighting level needs to be chosen to provide a minimum level of light so that a task can be performed correctly and safely. Such tasks could be the unloading of vehicles in a goods yard, manoeuvring aircraft at an airport or playing sport at a competitive level. For such tasks the correct lighting level should be selected from the SLL Code for Lighting and the design carried out according to any relevant CIBSE/SLL Lighting Guides such as 'The Industrial Environment', 'Sports Lighting' and 'The Outdoor Environment'.

For other external lighting applications the lighting levels are selected to show up an object against the prevailing luminance of their surroundings. Such objects could be advertising, building façades or signs. An advert within a well-lit city centre street will need more lighting than the same advert in a less well-lit street to achieve the same visual impact. A rural church needs less light to stand out in its environment than an abbey in a city centre.

To avoid over-lighting objects and to reduce unnecessary energy expenditure and waste light production the International Commission on Illumination (CIE) has published a document 'Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installation'. This sets out a series of environmental zones that range from

E1, which are dark landscapes such as large areas of our national parks, to E4 for bright inner city areas. The intensity of light from individual lights and the resultant lighting levels recommended are more restricted towards the E1 category.

The definitions of the four zones are:

**E1: Intrinsically dark areas** National Parks, Areas of Outstanding Natural Beauty, etc.

**E2: Low district brightness areas** Rural or small village locations, quiet suburbs.

**E3: Medium district brightness areas** Small town centres or urban locations.

**E4: High district brightness areas** Town/city centres with high levels of night-time activity.

Where an area or building to be lit lies on the boundary of two zones or is visible from another zone, the values used should be those applicable to the darker zone.

Certain sub areas of zones may warrant lower levels. A park or incursion of greenbelt into a city would warrant a lower zone classification than E3 or E4. Certain historic urban settings may well require a lower zone than given in the table. Even within a single city the brightness of a district will vary according to use and character.

The following table has been taken from the CIE guide. However, the wording of notes 1 to 3 has been altered to make them clearer and notes 4 and 5 have been added.

**Where: ULR = Upward Light Ratio of the Installation** and is the maximum permitted percentage of luminaire flux for the total installation that goes directly into the sky. (Formerly Upward Waste Light Ratio)

**Ev = Vertical Illuminance in Lux normal to window glazing**

**I = Light Intensity in Kilo-Candelas**

**L = Luminance in Candelas per Square Metre**

**Curfew = Planning restriction on use of lighting after certain time; often 23:00**

TABLE 1 – OBTRUSIVE LIGHT LIMITATIONS FOR EXTERIOR LIGHTING INSTALLATIONS

Environmental Zone	Sky Glow ULR [Max %]	Light into Windows Ev [Lux] (1)		Source Intensity I [kcd] (2)		Building Luminance Before curfew (3)	
		Before curfew	After curfew	Before curfew	After curfew	Average L (cd/m <sup>2</sup> )	Maximum L (cd/m <sup>2</sup> )
E1 (4)	0	2	1*	0	0	0	0
E2	2.5	5	1	20	0.5	5	10
E3	5.0	10	2	30	1.0	10	60
E4	15.0	25	5	30	2.5	25	150

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## Notes to table:

**(1) Light into Windows** – These values are suggested maximums for any window. So any new lighting will have to produce less than this value if there is any existing light trespass at a specific window

\* Acceptable from public road lighting and other safety lighting installations only.

**(2) Source Intensity** – This is the intensity going beyond or over shooting the area being lit from any single source in the potentially obtrusive direction. The figures given are for general guidance only and for some large sports lighting applications with limited mounting heights, may be difficult to achieve.

**(3) Building Luminance** – This should be limited to avoid over lighting, and relates to the general district brightness. In this reference building luminance is applicable to buildings directly illuminated as a night-time feature as against the illumination of a building caused by spill light from adjacent floodlights or floodlights fixed to the building but used to light an adjacent area. This should be kept to a minimum.

**(4) Zero illuminance** - The '0' value shown for various criteria in zone E1 does not preclude the installation of lighting for necessary task lighting or to meet health and safety requirements. Obviously, if a farm in a National Park needs to have exterior lighting for the moving of dairy herds, connecting machinery to tractors or similar tasks then it needs to be provided. But this should be in a well-designed manner so that it is not intrusive into the dark landscape that surrounds the farm and is not too visible from a distance.

**(5) Local variations** – Some Local Planning Authorities may issue additional or supplementary planning guidance for exterior lighting installations. You should therefore check with the Local Planning Authority before starting the design or installation of any exterior lighting.

## 5 Specific lighting applications

This section gives specific recommendations for a number of lighting installation types.

### 5.1 Exteriors of buildings

When considering whether a building should be lit, its importance as an individual entity, its position in the immediate surroundings and the view of it from the wider surrounds should be considered. If the building is within a district or urban space covered by an overall master plan for lighting, then the brightness of the building should be matched to that of surrounding properties.

If it is worthy of lighting then it must be considered whether the whole building should be lit or whether just, say, the central portico or certain key features only should be picked out. The colour of light should be chosen in relation to the materials of the building itself and of the surrounding street lighting or area lighting.

Next the times of lighting need to be established. A solar cell can bring the lighting on after dusk but when should it be switched off by the time clock? Does the building need to be lit every day of the week or for all of the year? A building at a seaside resort may only need to be lit during the summer season; civic buildings in a town centre may only need to be lit on a Friday and Saturday night.

### 5.2 Road Lighting

There are British Standards (BS5489) for the lighting of various categories of roads and their junctions, but there are still many cases where the decision can be made to light or not light – especially in rural and sparsely populated areas. If there is a wish to light a section of road in order to reduce accidents then the lighting can be placed only at the strategic places where there is the highest likelihood of accidents. More guidance can be found in the SLL Lighting Handbook and Code for Lighting.

The type of lighting column and luminaire can be chosen depending on the location. In a town centre the use of high widely spaced columns gives an economical installation. In a conservation area lower column heights may be chosen. Sometimes the use of luminaires with too tight a distribution (full cut-off) can lead to needing more columns to meet uniformity along the road, which leads to higher energy use and road brightness, resulting in more light reflected into the sky.

In a rural location columns and luminaires may be chosen to put light just onto the road way and immediate verge with minimal spill onto the surrounding countryside and being hardly visible themselves. The same type of road passing through a village would need luminaires that spill more light back onto the pavements and front gardens to increase the sense of security of the occupants and to make the whole street scene more appealing to pedestrians and road users alike.

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Lamp colour must be selected with care as it affects not only the visual appearance of the road and its surroundings, but also energy usage and the ability of astronomers to filter out stray light that reaches the sky. In some limited circumstances it may be possible to switch off certain lights late at night when there is a lower vehicle and pedestrian traffic flow. Some new types of lamp ballast also allow the reduction of the quantity of light being produced at these slack times.

### 5.3 Signs and Advertisements

Not all advertising sites or signs have to have electric lighting. If for instance an advertising site within a town shopping area can be seen between buildings from a nearby site of historic interest or residential area then it may appear intrusive at night.

The luminance of an advertisement should be chosen in relation to its surroundings. In a city centre an advertisement may need greater levels of lighting to stand out than in a less well lit suburb.

Advertising and signage need only be lit while there are people around to view them. It is quite reasonable to restrict the times that such signs or adverts are lit.

By their nature large advertising poster panels are so positioned or have facilities incorporated that allow safe access to the top of the panel for pasting-up new posters. This generally allows access for re-lamping top mounted lights, which provide less spill light into the sky than bottom mounted lights.

It should be remembered that the glow from large self luminous signs and external TV screens can not only be intrusive itself but can cast unfortunate amounts and colours of light on nearby buildings. The flickering light from large urban TV screens can be an annoyance to nearby residents.

### 5.4 Car parks

Public car parks that are used in the evening almost always need lighting for safety and security, but some private car parks may not be used in the evenings and could have minimal or no lighting installed. Lighting should be designed to be easily turned off by a supervisor or security staff once the car park has been closed for the night.

High mast lighting of open car parks and internal lighting of open sided multi-storey car parks can often be seen from afar. Care must be taken in the selection and positioning of equipment to minimize this visual intrusion into areas around the car park.

In some factories and superstores it may be possible to designate a smaller area of the car park close to the building for the night shift and leave the rest of the car park unlit. Some lights may need to be left on after hours for security reasons.

BS 5489 Part 9 gives appropriate illuminance values for urban and rural environmental zones and should be consulted.

### 5.5 Loading bays and external storage areas

For loading docks and external packing or storage areas, safety is most important as there is likely to be a combination of reversing lorries, moving fork lift trucks and people on foot. Good quality lighting is needed to ensure that open areas are lit to the appropriate levels and from the best directions to provide good vertical illumination without glare.

At the loading dock thresholds well designed and located luminaires are needed to provide the necessary task and safety levels onto the loading platforms and into the backs of lorries whilst minimising glare towards reversing drivers.

Careful consideration of the heights and locations of lighting poles can give good even light coverage of the working areas, minimise daytime appearance and reduce spill beyond the site or working area.

Further guidance is available in the SLL Lighting Guide 1, 'Industrial Lighting'.

### 5.6 Sports lighting

Do pitches need to be used at night; if so for how long? Can matches or training finish at a set time? Do training pitches need to be used at weekends? Do all pitches at a training ground need to be lit?

For sports areas where both training and matches take place, variable level lighting can be installed so that less light is used during training sessions. It is important that the lighting controls are under management supervision to avoid players or coaches turning all the lighting to

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'international match standard' when just having a small training session! It is simple to provide accessible switches that bring on the 'training' level lighting but to have the 'match' level lighting controlled by a key-switch. See SLL Lighting Guide 4, 'Sports' for more information.

The daytime appearance of the poles or towers must be considered. If it is unacceptable during the daytime, poles can be obtained which can be lowered or recessed into the ground by hand or hydraulically when not in use.

## 5.7 Parks and gardens

Routes through parks and other open areas that are used at night may need lighting for safety or amenity reasons. It is also possible to increase the use and appreciation of decorative gardens and urban landscapes by appropriate lighting at night. By carefully studying the layout of planting along routes and the usage patterns of the routes, lighting can be concentrated on the places and at the time most needed.

Monuments and fountains can be key features at night providing key points of interest and orientation. These features within otherwise dark or minimally lit parks, gardens or streets need surprisingly little light to make them stand out. See SLL Lighting Guide 6, 'The Outdoor Environment' for more information.

## 6 Conclusions

- Only light what is necessary.
- Only light the parts you need to.
- Only light when it is necessary.
  
- Consider the lighting needs and the health and safety of those having to perform tasks at night outdoors.
- Consider the daytime appearance of lighting equipment.
- Select colour rendering and colour temperature of lamps to suit the quality of the environment and materials being lit
- Position lights and choose their distribution so as to avoid spill into the sky and onto neighbouring properties.

## 7 Further reading

*The Outdoor Environment* CIBSE Lighting Guide **LG6** (London: The Chartered Institution of Building Services Engineers) (1992)

*The Industrial Environment* CIBSE Lighting Guide **LG1** (London: Chartered Institution of Building Services Engineers) (2001)

*Sports Lighting* CIBSE Lighting Guide **LG4** (London: Chartered Institution of Building Services Engineers) (2006)

*Code for Lighting* (London: Chartered Institution of Building Services Engineers) (2009). Sections on outdoor environment and obtrusive light.

*Code for Lighting CD, Obtrusive lighting guide.* (London: Chartered Institution of Building Services Engineers) (2009).

*SLL Lighting Handbook* (London: Chartered Institution of Building Services Engineers) (2009) Chapters 16, Road Lighting; chapter 17, Exterior workplace lighting; chapter 18, Security lighting.

*Lighting the environment. A guide to good urban lighting* (London/Rugby: Chartered Institution of Building Services Engineers/Institution of Lighting Engineers) (1996)

*Road lighting and the environment* Department of Transport (London: The Stationery Office) (1993)

*Lighting in the Countryside. Towards good practice* DETR/Countryside Commission (London: The Stationery Office) (1997)

*Guidance notes for the reduction of light pollution – revised* (Rugby: Institution of Lighting Engineers) (2003)

*Guidance for minimizing sky glow* CIE Publication **126** (Vienna: International Commission on Illumination) (1997)

*Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installation* CIE Publication 150 (Vienna: International Commission on Illumination) (2003)

*Guidelines for minimizing urban sky glow near astronomical observatories* IUA/CIE Publication **01** (Vienna: International Union of Astronomers/International Commission on Illumination) (1980)

*BS 5489 Road lighting. Part 9 Code of practice for lighting urban centres and public amenity areas* (London: British Standards Institution) (1996)

*Brightness of Illuminated Advertisements* Technical Report TR 5 (Rugby: Institution of Lighting Engineers) (1991)

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