

BS 5489-1:2013



BSI Standards Publication

Code of practice for the design of road lighting

**Part 1: Lighting of roads and public
amenity areas**

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Published by BSI Standards Limited 2012

ISBN 978 0 580 70690 5

ICS 93.080.40

The following BSI references relate to the work on this document:

Committee reference EL/1/2

Draft for comment 12/30217236 DC

Publication history

First published as CP 1004, January 1952

Second edition, October 1963

Third edition, September 1973 (later amended to become BS 5489-1)

Fourth edition as BS 5489-1, February 1987

Fifth edition, August 1992

Sixth edition, December 2003

Seventh (present) edition, December 2012

Amendments issued since publication

Date	Text affected
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Foreword

Publishing information

This part of BS 5489 is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 December 2012. It was prepared by Subcommittee EL/1/2, *Road lighting*, under the authority of Technical Committee EL/1, *Light and lighting*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This part of BS 5489 supersedes BS 5489-1:2003+A2:2008, which is withdrawn.

Relationship with other publications

BS 5489 consists of two parts:

- Part 1: *Lighting of roads and public amenity areas*;
- Part 2: *Lighting of tunnels*.

This part of BS 5489 contains guidance and recommendations that are intended to support BS EN 13201¹⁾ and to assist designers of lighting systems in using that standard.

Where references are made to specific lighting classes in BS EN 13201-2:2003, the equivalent classes in CIE 115:2010 [N1] are also included. It is expected that the CIE 115 classes will be adopted in the new edition of BS EN 13201-2, currently in preparation.

The preferred approach is to use the BS EN 13201-2:2003 lighting classes. Whichever approach is adopted, it is essential that that approach is used consistently throughout a specific lighting project or area for all criteria, and that it is clearly specified to avoid confusion.

Information about this document

This is a full revision of the standard. The principal changes are to align the standard with current best practice and with the BS EN 13201 series¹⁾.

The aim of this standard is to promote wider understanding of the lighting of roads and public amenity areas and to give guidance on the design decisions that need to be made. Rather than being prescriptive, it makes recommendations that are essential to the design process and that will enable production of designs that are appropriate and justifiable.

Use of this document

As a code of practice, this part of BS 5489 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 5489 is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

¹⁾ At the time of publication of this part of BS 5489, the BS EN 13201 series is undergoing revision. A new part, prEN 13201-5, is in preparation.

The design of lighting for roads and public amenity areas can be a complex process with many different aspects and therefore it is important that this standard is read thoroughly to ensure that all relevant issues are taken into account.

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.

1 Scope

This part of BS 5489 gives recommendations on the general principles of road lighting, and its aesthetic and technical aspects, and advises on operation and maintenance.

It gives recommendations for the design of lighting for all types of highway and public thoroughfare, including those specifically for pedestrians and cyclists, and for pedestrian subways and bridges, but it excludes the lighting of vehicular tunnels which is covered in BS 5489-2.

It gives recommendations for the design of lighting for urban centres and public amenity areas.

It gives additional recommendations for lighting around aerodromes, railways, coastal waters, harbours and navigable waterways, in order to minimize the possibility of the lighting interfering with these modes of transport.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS 5266-1, *Emergency lighting – Part 1: Code of practice for the emergency escape lighting of premises*

BS 6100-2, *Glossary of building and civil engineering terms – Part 2: Vocabulary – Spaces, building types, environment and physical planning*

BS 8300, *Design of buildings and their approaches to meet the needs of disabled people – Code of practice*

BS EN 40 (all parts), *Lighting columns*

BS EN 12464-1:2011, *Light and lighting – Lighting of workplaces – Part 1: Indoor work places*

BS EN 12464-2:2007, *Lighting of work places – Part 2: Outdoor work places*

BS EN 12665, *Light and lighting – Basic terms and criteria for specifying lighting requirements*

BS EN 12767, *Passive safety of support structures for road equipment – Requirements, classification and test methods*

BS EN 13201-2:2003, *Road lighting – Part 2: Performance requirements*²⁾

BS EN 13201-3, *Road lighting – Part 3: Calculation of performance*²⁾

BS EN 13201-4, *Road lighting – Part 4: Methods of measuring lighting performance*²⁾

BS EN 60598-1, *Luminaires – General requirements and tests*

BS EN 60598-2-3, *Luminaires – Part 2-3: Particular requirements – Luminaires for road and street lighting*

BS EN 62305 (all parts), *Protection against lightning*

PD 6547, *Guidance on the use of BS EN 40-3-1 and BS EN 40-3-3*

²⁾ At the time of publication of this part of BS 5489, the BS EN 13201 series is undergoing revision.

Other publications

- [N1] COMMISSION INTERNATIONALE DE L'ÉCLAIRAGE. *Lighting of roads for motor and pedestrian traffic*. CIE 115. Vienna: Commission Internationale de l'Éclairage, 2010.
- [N2] INSTITUTION OF LIGHTING PROFESSIONALS. *Code of practice for electrical safety in highway electrical operations*. GP03. Rugby: Institution of Lighting Professionals, 2011.³⁾
- [N3] INSTITUTION OF LIGHTING ENGINEERS. *Safety during the installation and removal of lighting columns and similar street furniture in proximity to high voltage overhead lines*. GP10. Rugby, Institution of Lighting Professionals, 2004.³⁾
- [N4] ELECTRICITY ASSOCIATION. *Model code of practice covering electrical safety in the planning, installation, commissioning and maintenance of public lighting and other street furniture*. Engineering Recommendation G39/1. Electricity Association, 1992.
- [N5] INSTITUTION OF LIGHTING PROFESSIONALS. *Guidance notes for the reduction of obtrusive light*. GN01. Rugby: Institution of Lighting Professionals, 2011.³⁾

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this part of BS 5489, the terms and definitions given in BS EN 12665, BS EN 13201-2:2003, BS EN 13201-3, BS 6100-2 and the following apply.

3.1.1 arrangement

pattern according to which road lighting luminaires are sited in plan, e.g. staggered, opposite, single-sided or twin central

3.1.2 competent person

person who has training and experience relevant to the matter being addressed and an understanding of the requirements of the particular task being approached

NOTE A competent person is expected to be able to advise on the best means by which the recommendations of this British Standard may be implemented.

3.1.3 conservation area

statutory, designated geographical area of architectural interest, the character or appearance of which it is desirable to preserve or enhance

3.1.4 cost

intended and unintended, financial or non-financial negative effect caused by a scheme

3.1.5 design spacing

required distance between the geometric centres of adjacent road lighting luminaires, calculated as specified in BS EN 13201-3, for a straight and level section of the particular type of road

3.1.6 edge illuminance ratio (EIR)

see 3.1.20

³⁾ Obtainable from the Institution of Lighting Professionals, Regent House, Regent Place, Rugby, CV21 2PN.

3.1.7 emergency lane

lane not normally or regularly used by road users except in emergency or during breakdown

NOTE The emergency lane is often referred to as a hard shoulder. Where a hard shoulder is regularly or has become permanently open to traffic, it is not considered, for the purposes of road lighting design, to be an emergency lane.

3.1.8 footbridge

bridge over an obstacle to pedestrians, provided for the passage of non-motorized traffic only

3.1.9 geometry

interrelated linear dimensions and characteristics of the road lighting system, i.e. spacing, mounting height, transverse position and arrangement

3.1.10 high-mast lighting

system of lighting for large areas using masts carrying clusters of luminaires

NOTE High-mast lighting columns are typically greater than 18 m in height.

3.1.11 lamp lumen maintenance factor (LLMF)

ratio of the luminous flux of a lamp at a given time in its life to the initial luminous flux

NOTE 1 Lamp manufacturers can provide this data either in tabular or in graphical form.

NOTE 2 For LEDs, refer to A guide to the specification of LED lighting products 2012 [1].

[SOURCE: BS EN 12665, modified – Notes 1 and 2 have been omitted and new notes added]

3.1.12 lamp survival factor (LSF)

fraction of the total number of lamps which continue to operate at a given time under defined conditions and switching frequency

[SOURCE: BS EN 12665, modified – Notes 1 and 2 have been omitted]

3.1.13 lifecycle

complete cycle of scheme, from decision to light and the provision of funds up to the decommissioning, removal and recycling or disposal of the scheme apparatus

3.1.14 lifetime

time from construction up to removal of a scheme

3.1.15 mounting height

nominal vertical distance between the photometric centre of a road lighting luminaire and the surface of the road

3.1.16 residential road

road that carries little vehicular traffic, other than that generated by residents

3.1.17 road bridge

structure carrying the road under consideration over another road, railway, river, etc.

3.1.18 set-back

shortest distance from the forward face of a lighting column to the edge of a carriageway

3.1.19 S/P ratio

ratio of the luminous output of a light source evaluated according to the CIE scotopic spectral luminous efficiency function, $V'(\lambda)$, to the luminous output evaluated according to the CIE photopic spectral luminous efficiency function, $V(\lambda)$

3.1.20 surround ratio (SR)

average illuminance on strips just outside the edges of the carriageway in proportion to the average illuminance on strips just inside the edges

NOTE This is expected to be replaced by "edge illuminance ratio (EIR)" upon publication of the revised edition of BS EN 13201-2. A definition of EIR will be given in that standard.

3.1.21 traffic flow

number of vehicles passing a specific point, at a specific time, in a stated time

3.2 Symbols

For the purposes of this part of BS 5489, the following symbols apply.

$\bar{E}$	maintained average horizontal illuminance, in lux (lx)
$E_{\min}$	maintained minimum horizontal illuminance at any point, in lux (lx)
F_y	LED failure fraction: percentage of LED modules at their rated life that have failed
H	mounting height, in metres (m)
$\bar{L}$	maintained average road surface luminance, in candelas per square metre (cd/m^2)
L_x	LED rated life: length of time, in hours (h), during which LEDs will provide more than a claimed percentage (x) of initial light output
MF	maintenance factor
R_a	general colour rendering index as defined in CIE 13.3 [2]
r	reduced luminance coefficient
s	design spacing, in metres (m)
TI	threshold increment, as a percentage (%)
U_l	ratio of the minimum to the maximum road surface luminance found in a line along the centre of a driving lane
U_o	ratio of minimum illuminance (luminance) to average illuminance (luminance) of/on a surface
W_L	width of driving lane, in metres (m)
W_r	width of relevant area of carriageway, in metres (m)
v	speed limit, in miles per hour (mph) ⁴⁾
x	percentage of initial luminous flux of an LED
y	percentage of LEDs that will have failed at end of rated life
Φ	luminous flux of light source or lamp(s) in luminaire, in lumens (lm)
θ_f	luminaire tilt in application, in degrees (°)

⁴⁾ 1 mph = 1.61 km/h.

4 General considerations

NOTE Attention is drawn to the statutory requirements listed in references [3] to [18]. There is no statutory requirement to provide road lighting. Neither are there any statutory requirements to install a particular class of lighting if a decision is made to light a particular road. However, there are statutes that empower highway authorities to light roads. The provision of road lighting on a previously unlit road might involve statutory requirements and might cause the imposition of speed limits.

4.1 Reasons for road lighting

Road lighting encompasses the lighting of all types of highway and public thoroughfare, assisting traffic safety and ease of passage for all users. In this respect, good lighting can be one of the measures used to reduce night-time traffic collisions. It can allow pedestrians to see hazards, orientate themselves, recognize other pedestrians and feel more secure. It also has a wider social role, with the potential of helping to reduce crime and the fear of crime, and can contribute to commercial and social use at night of town centres and tourist locations by improving the daytime and night-time appearance.

Road lighting should provide visual clues and reveal obstacles so that safe vehicular progress is possible. It should reveal all the features of the road and traffic that are important to all road users, including pedestrians.

It is not a primary function of lighting to provide visual guidance for traffic; however, where possible, lighting should be arranged to assist such routing, and the components of the lighting installation should be arranged so as not to visually mislead motorists as to the route ahead (see 4.2.3 and 4.3.4.3).

Transport and environment policy is increasingly emphasizing the need to improve conditions for walking and cycling. One factor that has been identified as possibly influencing decisions to travel by these modes is the quality of walking and cycling routes. After dark, lighting has an important role to play in helping to create acceptable conditions. Traditionally, footway lighting has often been considered little beyond functional lighting for the space alongside the carriageway. However, lighting can offer more, and can contribute to creating an environment that is pleasant and interesting as well as satisfying the basic functional objectives.

When lighting is provided on a previously unlit road, it is important to obtain guidance on whether certain traffic signs will have to be illuminated. The provision of traffic calming measures might require particular lighting arrangements.

NOTE Further guidance relating to lighting for traffic calming features is given in ILP TR25 [19].

4.2 Lighting design

COMMENTARY ON 4.2

Lighting design is a complex task, and there are many parameters which need to be considered in the development of a lighting design. Foremost of the parameters is the health and safety of users and others affected by the design (including road workers). Other considerations include maintenance, electrical energy and other lifecycle costs. It is recommended that anyone undertaking lighting design is adequately trained in the profession and competent to do so. Attention is drawn to the Construction (Design and Management) Regulations 2007 [18].

Information on the selection of lighting classes is given in Annex A and PD CEN/TR 13201-1:2004 (undergoing revision).

4.2.1 Visual tasks for motorists

COMMENTARY ON 4.2.1

The motorist has to seek and absorb sufficient visual information in order to position themselves correctly on the road and match their speed to the driving environment. The gathering of information is key to early anticipation and negotiation of hazards, obstacles, changes in road geometry and events. That early anticipation allows road users to plan and execute actions that leave a safe margin of error in terms of distance, vehicle stability and motorist workload.

As only a small part of the central field of vision of a motorist is in sharp focus, most information is received peripherally and, therefore, not in detail. A motorist is likely to focus directly on a significant object that appears in the field of vision, but for a motorist to detect the presence of an object it has to present sufficient contrast against its background. This is true both by day and night, but at night the motorist's ability to perceive contrast is considerably poorer at low lighting levels.

The ability to manoeuvre safely requires that objects and visual guidance information be perceived in time for the motorist to act comfortably and safely. Visual performance and the visibility of objects are related to the level and distribution of the road surface luminance. The higher the road surface luminance, the better is the visual performance. The uniformity of the road surface luminance also has a significant influence on object visibility.

Road lighting should achieve the class of lighting, in accordance with BS EN 13201-2:2003, appropriate to the conditions normally found at a particular time, so as to provide adequate brightness of the general scene and to maximize the contrast between objects and their background.

Whereas in most lighting situations the aim is to light objects rather than their backgrounds (positive contrast), in most road lighting situations for vehicular traffic the converse is true (negative contrast). The relatively small amount of light available should be used to maximum effect by lighting the road surface and the immediate surrounds to reveal objects in silhouette. Exceptions to this approach include subsidiary roads (see 7.2), pedestrian areas and car parks in urban centres (see 7.4), and some conflict areas (see 7.5).

Good visual conditions should prevail over the entire road scene to enable the various levels of the driving task to be executed safely.

NOTE 1 The success of this method of lighting depends on designing the distribution of light from the luminaires to take advantage of the reflection properties of the road surface.

NOTE 2 The effectiveness of lighting with negative contrast is reduced when vehicle headlights are on.

4.2.2 Visual tasks for pedestrians – Recognition and personal safety

COMMENTARY ON 4.2.2

Lighting is needed to provide a street which is not only safe for people to use but is also perceived to be safe. The factors contributing to an environment perceived to be safe are a general feeling of safety which can result from an appropriately lit street; visual comfort, which can be defined as a pleasant environment in which glare is not considered to be a problem; and perceived ability to judge the intent and/or identity of other road users. The factors contributing to safe movement are the ability to detect obstacles on the pavement surface which could otherwise be a trip hazard, and to judge the intent and/or identity of other people at a distance sufficient to take avoiding action if necessary.

Pedestrians also need to be able to recognize signs, and see potential hazards.

In situations where it is considered that the recognition of other people or their intent is particularly important, it is recommended that a lighting class from the ES series of lighting classes given in BS EN 13201-2:2003, Table 5⁵⁾, or from the E_{sc} lighting classes given in CIE 115:2010 [N1], Table 7, should be applied.

4.2.3 Visual guidance

The lighting installation should give visual guidance by revealing the run of the road, particularly at T-junctions and bends. This function of the lighting should be achieved by careful positioning of lighting equipment, complementing the lane and edge of carriageway markings.

To avoid misleading patterns of luminaires, any change in lighting system along the carriageway should be visually linked with the road layout. For example, unexpected breaks should be avoided by continuing lighting for one or two lighting columns past any overbridges, gantries and large traffic signs until motorists have an unambiguous view of the road at the end of the lighting.

4.2.4 Lighting of the surrounds and footways

Objects on the footway, or to one side of the carriageway, or in the centre of the carriageway but on a bend, will be seen at least partially against the surrounds of the road. These should therefore receive sufficient light to provide a light background against which objects can be seen in silhouette, or, if such a background is absent, to reveal objects by positive contrast.

NOTE 1 Adequate lighting on the surrounds helps the motorist to perceive more of the environment and make speed adjustments in time. The function of the surround ratio (SR) or edge illuminance ratio (EIR) is to ensure that light directed on the surrounds is sufficient for objects to be revealed.

NOTE 2 Adequate lighting on the surrounds is beneficial to reveal people who might be about to step into the carriageway and vehicles emerging from side roads.

NOTE 3 This light is also of assistance to pedestrians, as it reveals the footway surface, obstructions and other pedestrians.

On all traffic routes except those with heavily trafficked adjacent footways and/or cycle tracks, and emergency lanes of motorways, lighting of the surrounds should be achieved by applying surround ratio (SR) or edge illuminance ratio (EIR) to the values given in BS EN 13201-2:2003, calculated in accordance with BS EN 13201-3.

For traffic routes with heavily trafficked adjacent footways and/or cycle tracks, an appropriate lighting class from BS EN 13201-2:2003 should be applied to a footway or other relevant area adjacent to the carriageway.

In the case of motorways with an adjacent emergency lane, the appropriate lighting class should be provided for the emergency lane to ensure a sufficiently bright background for revealing objects viewed towards the outer edge of the carriageway. This lane should be assumed to be a separate area for the purpose of calculation.

On motorways without an adjacent emergency lane, surround ratio (SR) or edge illuminance ratio (EIR) should be applied to the adjacent verge.

⁵⁾ These are expected to become SC classes in the new edition of BS EN 13201-2, currently in preparation.

4.2.5 Glare

NOTE Disability glare reduces the contrast between objects and their background so that their visibility is decreased.

In traffic route lighting, the parameter threshold increment (T_I) is used as a measure of disability glare, and maximum values of this parameter are set for each ME lighting class in BS EN 13201-2:2003 and M lighting class in CIE 115:2010 [N1]. At conflict areas on traffic routes, T_I cannot always be calculated and in these situations luminaire intensity limits should be used as recommended in BS EN 13201-2:2003.

For residential and subsidiary roads, intensity limits should be used to control direct glare from luminaires as recommended in 7.2.1.

4.2.6 Maintenance

4.2.6.1 General

The maintained levels of the relevant lighting classes should be in accordance with BS EN 13201-2:2003. In order to achieve this, and to ensure the provision of the selected class, it is essential that appropriate luminaire cleaning and light source replacement routines are accounted for by the designer with reference to local policies. Maintenance programmes should include light source replacement, luminaire cleaning, renewal of failed parts, checking of gaskets, optical components, and screens or baffles, checking of alignment and monitoring of operation. It is desirable to minimize the frequency of maintenance visits.

NOTE 1 Monitoring for non-operable lighting is usually by means of night-time inspection. However, electronic monitoring systems can provide viable alternatives.

NOTE 2 The actual levels of lighting provided by a lighting system at a specific time can only be determined by on-site measurement, which can be costly and disruptive to traffic flows. Experience gained over many years indicates that cyclical maintenance, lamp changing and other maintenance requirements (see 4.2.6.2) carried out to criteria used in the design can generally maintain the lighting within acceptable levels.

NOTE 3 Apart from the deterioration of those luminaire parts that can be corrected by cleaning, there is also a long-term deterioration that is permanent and cumulative. The rate of this deterioration depends on the quality of the original materials and the IP rating of the luminaire, but eventually the restoration of photometric performance might necessitate replacement of the optical system or even of the whole luminaire.

The frequency of replacement of light sources is a matter of local policy, cost and light source type used. Decisions should not be made purely on economic grounds, but should take all the relevant factors into account, including:

- a) the lamp survival factor for its environment (from manufacturers' data);
- b) the lamp lumen maintenance factor for the specific light source and control gear combination (from manufacturers' data);
- c) the system power consumption variation through the anticipated lifecycle;
- d) possibility of interference with traffic;
- e) ease of access and extent of traffic management required;
- f) the required frequency of night inspection monitoring;
- g) the frequency of need for cleaning of luminaires, related to the local environment and the IP rating of the light source enclosure;
- h) the overall proportion of outages that can be tolerated at any time without undue detriment to the level and quality of lighting;

- i) the grouping of outages that can be tolerated at any time without undue detriment to the level and quality of lighting;
- j) the frequency of inspection for electrical safety;
- k) the frequency of inspection for structural safety of lighting columns and other supporting systems;
- l) the impact of light source outages on safety and security;
- m) the impact of light source outages on the electrical system, including controllers.

4.2.6.2 Maintenance factor

The luminance or illuminance levels in service should not fall below the maintained levels specified for the lighting class selected from BS EN 13201-2:2003. The calculation methods in BS EN 13201-3 should be used to determine luminance and illuminance levels and quality criteria.

These methods incorporate a maintenance factor (*MF*), which is the product of the lamp lumen maintenance factor and the luminaire maintenance factor.

NOTE 1 In some instances, such as pedestrian subways, an additional factor is taken into account, the lamp survival factor.

The lamp lumen maintenance factor should be obtained from the luminaire manufacturer's data, taking account of light source type, controller type, switching regime, operating environment and light source change policy.

NOTE 2 Typical values of luminaire maintenance factors are given in Annex B. Alternatively, luminaire maintenance factors established by local testing may be used.

NOTE 3 Maintenance factors for LEDs are discussed in Annex C.

4.2.6.3 Maintenance of high-mast lighting

High-mast lighting systems, and other specialized installations using more complex mechanical, hydraulic, or electrical equipment, generally require additional maintenance. They should be inspected and maintained regularly in accordance with manufacturers' recommendations, and depending on local conditions. There should be a specific maintenance schedule and manual associated with such assets, and the maintenance should be carried out by competent persons with suitable specialist equipment.

NOTE Detailed inspection regimes are given in ILP TR07 [20].

4.2.6.4 Roads with limited maintenance access

Motorways, dual carriageways, grade-separated junctions, bridges and other traffic-sensitive streets pose additional maintenance problems which are associated with particular means of access for maintenance and with particular routine and emergency operations. The safety issues and cost constraints imposed by these problems can affect the choice of lighting arrangements, and should be taken into account at the design stage. Factors that should be taken into account include:

- a) the effect of narrow or repeatedly discontinuous emergency lanes;
- b) the needs of contra-flow lane working, including the use of crossovers, for all types of highway maintenance work;
- c) the need to minimize the risk to lighting maintenance personnel, other road workers and road users;
- d) the need to minimize delays to traffic;

- e) work on lighting mounted in the central reserve of a dual carriageway, which requires the diversion of traffic away from the right-hand lane in either one or both carriageways;
- f) work on lighting mounted on the outside of a dual carriageway, which requires the diversion of traffic away from the left-hand lane in each carriageway;
- g) work on lighting mounted on the outside of a dual carriageway with emergency lanes, which requires the occupation of the emergency lane (rather than a traffic lane) by maintenance vehicles;
- h) the use of maintenance operations with less restricting effects on other traffic, such as mobile lane closures with vehicle-mounted signs;
- i) the implications and cost of traffic management.

4.2.6.5 Safe working clearances near overhead electricity supply lines

Safe working clearances should be adhered to during design, erection, installation, commissioning and maintenance operations on all road lighting near overhead electricity supply conductors.

When undertaking a lighting design where overhead electricity supply lines are present; the design should be in accordance with recommendations contained within the following documents:

- ILP GP03 [N2];
- ILP GP10 [N3] (supplement to GP03);
- Electricity Association Engineering Recommendation G39/1 [N4].

If there is any doubt regarding the safety relating to any such installation, the operator of the line should be consulted to obtain the clearances that have been agreed with the distributor and the supply authority, and to establish the accurate position and height of the line.

When undertaking a lighting design where overhead electricity supply lines are present, a risk assessment should form part of the design process. This should assess the risks associated with design, installation, operation, maintenance and decommissioning. The results of the risk assessment should be made known to all relevant parties and included in the design pack.

NOTE Attention is drawn to the Electricity Safety Quality and Continuity Regulations 2002 [21].

4.3 Environment

4.3.1 General

Environmental issues associated with road lighting are prime considerations when designing a new or replacement lighting scheme. The issues that designers should address include:

- minimizing obtrusive light;

NOTE 1 Guidance is given in ILP GN01 [N5].

- undertaking a visual impact assessment;

NOTE 2 Guidance will be given in ILP PLG04 [22], currently in preparation.

- daytime and night-time appearance;
- effect on flora and fauna as well as human health;

NOTE 3 Some species of flora and fauna are protected by legislation.

- specific environmental issues within local planning policies.

Subclause 4.3 indicates some matters that should receive attention and gives recommendations, but it is recognized that in aesthetics, subjective judgements can apply. Furthermore, the safety of users should take precedence over aesthetics in the event of any conflict of interest between these two factors. Planning authorities or other appropriate organizations should be consulted on matters of appearance.

NOTE 4 The environmental impact of lighting can be reduced by varying the lighting level to allow the appropriate lighting class to be applied at the relevant time, even switching off at certain times if deemed appropriate. Further guidance is given in 4.4.4.

4.3.2 Appearance

4.3.2.1 Daytime appearance

The design and siting of road lighting and other road equipment can make a great difference to the street scene, even though this might not be consciously appreciated. In situations such as a processional way or monumental bridge, the design and placing of lighting columns can make a positive formal contribution to the scene. In such cases, the siting should be carefully related to the architectural or landscape setting.

More usually, however, buildings, trees, paved surfaces, grass and people provide all the interest required, and road lighting equipment should be made as unobtrusive as possible.

The designer should consult the client to determine whether there are opportunities to reduce street clutter.

4.3.2.2 Night-time appearance

An aspect of planning any lighting scheme is the positive contribution it can make to the improvement of the night environment. The basic design should ensure as far as possible that the lighting directly helps to create a pleasant and attractive night-time atmosphere, especially for areas of civic importance (see 7.4).

While efficient lighting for traffic and pedestrian safety is essential, consideration of the whole visual scene at night is highly desirable for many reasons. In designing lighting for urban and residential roads, efficient lighting for traffic and pedestrian safety is an essential factor. Other factors such as amenity and environmental requirements and the assistance in perception of a safe environment that lighting provides should also be taken into account.

The colour rendering index of the light source (R_a) should be suitable for the application or task and should be ≥ 20 . In civic centres, shopping streets, boulevards, promenades and other places that are the hub of social activity and have a high night-time pedestrian use, light sources with an $R_a \geq 60$ should be used.

Where street crime is a major problem and the police use CCTV for prosecution, they should be consulted regarding the lighting requirements, including colour rendering and level.

The colour appearance of light sources should be suitable for the application or task and is quantified by the correlated colour temperature (T_{cp}). Values of T_{cp} are usually categorized into one of three groups (warm, intermediate or cool colour appearance) as shown in Table 1.

Table 1 Light source colour appearance groups

Colour appearance	Correlated colour temperature, T_{cp} K
Warm	<3 300
Intermediate	3 300 to 5 300
Cool	>5 300

4.3.3 Siting of lighting columns

4.3.3.1 General

COMMENTARY ON 4.3.3.1

One of the most difficult aspects of a lighting design is in the siting of lighting columns. Each street is different and presents differing challenges. Particularly on an established street, there are many topographical and physical features which can determine both suitable and unsuitable locations.

Intersections, pedestrian crossings, bends, gradients and crests of hills occur frequently and their particular lighting might require compromise. In addition, there are constraints on the siting of lighting columns caused by overground and underground obstructions, as well as the need to consider the effect of road lighting equipment on the access to properties for occupation and maintenance.

Prior to finalizing lighting column locations, distributors' and statutory undertakers' service/plant drawings should be examined, and a site survey should be carried out by competent persons, to ensure that the designed location is suitable. Factors that should be taken into account include, but are not limited to, the following:

- overhead power lines or other obstruction (see 4.2.6.5);
- underground power lines or other utility services or obstruction;
- trees, including potential growth and accounting for summer foliage (see 4.3.3.2);
- dropped kerbs;
- preference for alignment with property boundaries;
- need to minimize obtrusive light (see 4.3.5), especially where it could affect residential property windows;
- views from residential properties;
- potential for vehicle impacts (see 4.3.3.3);
- provision of road restraint systems or use of passively safe lighting columns (see 4.3.3.4);
- accessibility for maintenance.

NOTE 1 Further guidance is given in HSE publication HSG 47 [23].

NOTE 2 Minor adjustments might be necessary for practical or aesthetic reasons, with care taken to ensure that these do not significantly affect the photometric performance of the installation.

NOTE 3 In some circumstances, public lights and associated equipment can be fixed to private buildings or sited on private land.

Lighting columns adjacent to bridges should be sited so that light from the luminaires is not obstructed and does not cause nuisance or glare to road users approaching or crossing the bridge. Lighting columns should if possible be sited so as not to interfere with the view of buildings or monuments of architectural interest, or with scenic views.

4.3.3.2 Effect of trees

Lighting columns when first installed should be sited so as not to require substantial cutting back of trees, taking into account the fully mature spread of the tree.

NOTE 1 In tree-lined roads, lower mounting heights than usual may be used to bring luminaires below the tree canopy.

In new streets where trees are to be planted, the lighting should be designed in consultation with the landscape architects and/or by taking into account the landscaping plan or the tree schedule.

NOTE 2 Careful siting of trees and luminaires can help to minimize interference with the performance and operation of the lighting by the foliage.

Lighting columns in the vicinity of trees should be sited so as to minimize issues such as:

- incorrect photocell operation;
- impaired maintenance access;
- damage to luminaire, column, foundation and electrical cables.

NOTE 3 Recommendations for trees in relation to design, construction and demolition, including some guidance relating to lighting schemes, are given in BS 5837.

4.3.3.3 Lighting columns as hazards

Many accidents involve a motorized vehicle leaving the carriageway, and if the vehicle collides with a lighting column, the severity of the injuries to the occupants might be increased. The number of such collisions is likely to decrease with increased clearance of the lighting columns from the edge of the carriageway; the recommended minimum clearances according to the design speed of the road given in Table 2 should therefore be achieved wherever practicable. The set-back of lighting columns should be sufficient to allow the free passage of all people on any footway.

NOTE 1 Blind and partially sighted people, people with limited mobility, wheelchair users and people pushing prams will need additional space.

Table 2 Recommended minimum clearances from edge of carriageway to face of lighting column

Design speed km/h	Horizontal clearance m
≤50	0.8
80	1.0
100	1.5
120	1.5

In situations such as motorways, where lighting columns are often protected by safety barriers, the set-back should be determined by the design requirements of the safety barrier.

The lowest point of overhang of luminaires or bracket arms that overhang the carriageway, or are within the respective horizontal clearances given in Table 2, should have a vertical clearance of at least 5.7 m from the level of the carriageway surface. Therefore, no part of a lighting column or luminaire should protrude over the carriageway of a public highway open to vehicular traffic (or

be within the respective horizontal clearances given in Table 2) if less than 5.7 m in height, unless a height restriction applies. Similarly, the height clearance over a pedestrian-only area of a public highway not accessible to vehicular traffic should be not less than 2.1 m.

NOTE 2 Where there are cyclists or horse-riders, or in areas with high levels of vandalism, a greater height is likely to be necessary.

In residential roads having footways of width 3 m or less, and situated directly adjacent to the carriageway, lighting columns should if possible be sited at the rear of the footway, i.e. away from the carriageway.

NOTE 3 In that position they are less likely to suffer impact from passing vehicles; they also cause less restriction to the effective width of the footway, and less obstruction to vehicles using private driveways. Where there is a verge between the carriageway and the footway, this can be utilized to site lighting columns if adequate clearance from the carriageway can be maintained in accordance with Table 2.

In cycle paths and shared paths, the lighting columns should be sited with sufficient clearance to avoid presenting a hazard to cyclists, particularly at night if the lighting is not functioning or is operating part-night.

NOTE 4 In the unlit state after dark, lighting columns can be made more visible to cyclists by having a reflective band at a suitable height above ground level.

4.3.3.4 Passively safe lighting columns

COMMENTARY ON 4.3.3.4

On roads where traffic speeds are high and there are few pedestrians or cyclists, the installation of passively safe (also known as breakaway or energy-absorbing) lighting columns is an alternative to rigid lighting columns to reduce the severity of injury.

As indicated in 4.3.3.3, when vehicles collide with lighting columns the occupants can suffer severe injuries. The design of lighting installations should aim to minimize the probability of collisions with lighting columns.

NOTE 1 BS EN 12767 gives guidance on a suitable risk assessment approach to design.

In situations where collisions with lighting columns are deemed likely, the problem should be designed out by relocating the lighting columns to a safer location, if necessary in consultation with an appropriately qualified highway design engineer. The appropriate class from BS EN 12767, which provides a system of classification in passive safety terms for support structures for road equipment including lighting columns, should be specified when passively safe lighting columns are to be used.

NOTE 2 ILP TR30 [24] provides additional guidance.

4.3.4 Arrangements

4.3.4.1 Mounting heights

When choosing the mounting height, technical and economic constraints and daytime appearance should all be taken into account.

For aesthetic reasons, the height of the lighting column and luminaire should not exceed that of nearby buildings.

NOTE 1 The typical height to the eaves of a two-storey house is approximately 6 m.

NOTE 2 Typical mounting heights are 5 m and 6 m for residential and subsidiary roads, 8 m, 10 m and 12 m for traffic routes, and 12 m and 15 m for high-speed dual carriageways and motorways; but in special situations where particular aesthetic or environmental factors apply, the use of other mounting heights might be more appropriate.

NOTE 3 If mounting heights are reduced, adjustments to other parameters might be necessary, e.g. an increase in the number of luminaires.

NOTE 4 Where a solid background is absent, the lighting columns and luminaires tend to be silhouetted against the sky in daytime. The conspicuousness of the installation as a whole can, in these circumstances, be reduced by increasing the mounting height and spacing (in order to decrease the number of lighting columns).

4.3.4.2 Lighting unit assemblies

4.3.4.2.1 General

Lighting columns should conform to BS EN 40 and PD 6547. When specifying lighting columns, it should be ensured that the weight and windage area of the luminaire(s), the wind speeds to be expected at the location, and any loads imposed by additional items fixed to the lighting column (such as signs and banners), are taken into consideration.

The lighting unit should be designed as a whole even though it consists of the separate parts of lighting column, bracket and luminaire; a luminaire that is aesthetically suitable with one lighting column might be incongruous with another. Luminaires and lighting columns are often made by different manufacturers, and therefore great care should be exercised in the choice of equipment to ensure a good aesthetic match.

For high-mast lighting, the mast, head frame and luminaire assembly should be of good integrated design.

Low mount lighting systems, incorporating luminaires which are designed for mounting heights of 1.0 m or less, may be used in areas with design restrictions such as maintenance, access or visual impact. For such systems, the supporting structures are not bound by the requirements of BS EN 40 as they are outside its scope; they should however be fit for purpose, and should be set back so that the clearance of the luminaire from the edge of the carriageway is at least 450 mm.

4.3.4.2.2 Size and type of luminaires

The dimensions and profile of the luminaire should be appropriate to its background.

4.3.4.2.3 Form of bracket

COMMENTARY ON 4.3.4.2.3

For low mounting heights in particular, post-mounted luminaires without brackets can be aesthetically advantageous. However, when brackets are to be used, large arc or quadrant brackets used to support the luminaire are usually more conspicuous than straight lines, because they contrast more with the surrounding lines of roofs. A straight horizontal bracket gives the illusion of sagging; a straight rising bracket is preferable.

A smooth line should be preserved, if possible, where there is a row of luminaires.

A very long bracket, such as might result from siting the lighting column well back from the kerb and using the maximum permissible overhang, can present a poor appearance. This should therefore be avoided unless essential for reasons of safety, or when surrounding objects effectively obscure its full length.

Bracket projection should be as short as possible and it is recommended that it does not exceed one quarter of the mounting height.

4.3.4.2.4 Colour of lighting equipment

Colour and finish should be appropriate in the context of the environmental surroundings. Care should be taken to avoid the use of highly reflective finishes where these could cause a traffic hazard, whilst taking account of the fact that dark matt finishes can create a hazard in the event of light source failure or part-night switch off.

4.3.4.2.5 Overall appearance

COMMENTARY ON 4.3.4.2.5

A combination of luminaire, bracket and lighting column that is satisfactory as a single unit might not look good when a number are seen together, especially in long straight or slightly sinuous roads and at complex junctions. In a long, straight road an array of curved brackets can make a tunnel; in a slightly sinuous road such brackets appear to interlace and form a confusing and ugly pattern.

At complex junctions, the lighting equipment and arrangement should be as simple as possible in order to avoid an unsightly or confusing view for road users.

The lighting scheme as a whole should be compatible with its setting.

NOTE Possible solutions include using fewer lighting columns of increased height, each with multiple luminaires on short brackets, or using post-mounted luminaires.

4.3.4.3 Luminaire arrangements

4.3.4.3.1 General

There are many variables to take into account when designing a lighting installation. With the choice of arrangement, designers should appraise ease of maintenance, traffic management costs and road worker safety.

NOTE 1 The following are typical lighting arrangements:

- a) opposite: used on wide roads or dual carriageways;*
- b) staggered: generally used on traffic routes, residential and subsidiary roads;*
- c) single-sided: used on narrow roads, widely separated carriageways, curved link roads and slip roads;*
- d) twin central: used on dual carriageways; provides clear visual guidance for the through route at junctions;*
- e) combined twin central and opposite: used for wide carriageway layouts and merge and divide areas where one type of lighting alone is inadequate;*
- f) axial median lighting: used for very wide carriageways, and is an alternative to twin central or opposite. The luminaires have a light distribution with a strong transverse component and are either:*
 - 1) suspended from catenary wires (catenary lighting); or*
 - 2) supported above the central reserve on double arm lighting columns having brackets in line with the axis of the motorway;*
- g) high-mast lighting: used where carriageway layouts, sight lines and lighting column mounting limitations on structures preclude conventional lighting, e.g. large junctions, grade-separated junctions and toll plazas.*

NOTE 2 For lighting on bridges, see 7.6.

The pattern of luminaires for sections of road with special requirements, such as conflict areas, bends or where physical features cross the road, should be laid out first. The pattern necessary for uninterrupted sections of road can then be added to the layout.

The layout should be examined in perspective to ensure that the array of lighting columns does not form a visual pattern to motorists which gives a misleading impression of the route ahead, and if possible should assist by giving route guidance.

NOTE 3 This guidance can be especially significant on winding roads, at complex junctions and in fog.

Unless separate lighting is to be provided, the selected lighting arrangement should also conform to the recommendations given in 4.2.4 for the lighting of adjacent areas such as footways and cycle tracks, using either surround ratio (SR)/edge illuminance ratio (EIR) or a specific lighting class applied to the adjacent areas.

4.3.4.3.2 Luminaire arrangements for single carriageways

For single carriageways, one or more of the following three arrangements should be used for the arrangement of luminaires:

- a) staggered;
- b) opposite;
- c) single-sided.

NOTE 1 For many road widths, depending on mounting height, luminaire, and light source type and output, two or all three of the arrangements can provide a system of lighting that meets the requirements of the selected lighting class.

NOTE 2 Choice of lighting arrangement may be made on the grounds of economy, also taking into account the appearance and environmental aspects.

4.3.4.3.3 Luminaire arrangements for dual carriageways

Where dual carriageways are separated by a wide central reserve, the carriageways should be treated separately.

NOTE 1 Normally, when the distance between the outer carriageway edges is not excessive, dual carriageways can be lit as a single road.

NOTE 2 With the use of appropriate mounting height and luminaire and light source type, dual carriageways can be satisfactorily lit by means of staggered or opposite arrangements mounted on the outside edges of the road, or by twin luminaires on the central reserve only.

4.3.4.3.4 Luminaire arrangements for dips and crests of hills

At a dip, there is no special lighting problem. At a crest, however, it is necessary to limit glare from luminaires beyond the crest; these can be viewed at angles where the intensity is high, and the more distant luminaires can appear low in the scene. At such situations, luminaires should be used that conform to installed intensity classes G4, G5 or G6 as specified in BS EN 13201-2:2003.

NOTE Similar considerations apply to the lighting of some bridges (see Commentary on 7.6.2).

4.3.5 Obtrusive light

COMMENTARY ON 4.3.5

Control of the light distribution of installations is necessary in order to limit obtrusive light and sky glow. In some cases lighting can be intrusive at night, e.g. in rural and open areas where lighting can be seen as an intrusion in an otherwise darkened environment.

Upward light should be minimized in all road lighting installations by controlling the intensity of light from luminaires as installed, at angles above the horizontal.

NOTE 1 The installed intensity classes from BS EN 13201-2:2003 can be used for this purpose.

Precautions should be taken to avoid unnecessary light intrusion into adjacent properties. However, a limited level of illumination onto front gardens and the face of properties might in some cases, and at the discretion of the client, be allowed in order to enhance the appearance of the area and the protection of property.

NOTE 2 Further information is given in ILP GN01 [N5].

Lighting schemes in, or adjacent to, environmentally sensitive areas should be given particular attention. Such areas include green belts, national parks, dark sky parks and areas of outstanding natural beauty. Similarly, schemes close to the edge of residential areas should also receive special attention. In these cases the light distribution should be controlled to minimize light spill onto adjoining areas by selection of an appropriate installed intensity class from BS EN 13201-2:2003.

NOTE 3 There are other advantages in controlling obtrusive light. Light spill affects ecological diversity as night hunters are often placed at a disadvantage. The ILPIBCT publication Bats and lighting in the UK [25] provides specific guidance on lighting in areas where bats are prevalent.

In the following situations, luminaires should be used which, when installed, conform to classes G4, G5, or G6 as specified in BS EN 13201-2:2003:

- traffic routes and motorways in environmentally sensitive and open areas;
- roundabouts and mini-roundabouts, particularly in environmentally sensitive areas and/or with unlit approach roads;
- elevated roads and bridges;
- remote isolated junctions.

NOTE 4 Information on lighting in the vicinity of astronomical observatories is given in the joint IAU/CIE publication Guidelines for minimising urban sky glow near astronomical observatories [26] and the CIE publication Guideline for minimising sky glow [27].

4.3.6 Sustainability

COMMENTARY ON 4.3.6

There are measures which can be taken to improve the sustainability of a road lighting solution.

To achieve a sustainable solution does not require significant financial investment, but it does require appreciation of the impact of the scheme from different points of view. Through innovative and considered decision-making, sustainability can be achieved with little additional investment at the design and construction stage relative to the cost of operating the scheme over its lifetime. It might be the case that a sustainable solution will cost less over its entire lifecycle than a less sustainable solution.

Along with technological solutions such as energy-efficient light sources and controls, and using renewable energies for their electricity source, simple practices such as selection of the appropriate lighting class and use of variable lighting can help to make lighting more sustainable.

Sustainability also requires issues of waste, pollution and energy in the products' lifecycle to be addressed. Guidance on energy-efficient design is given in 4.4.

When designing lighting schemes, the design should be as sustainable as possible whilst meeting the required design parameters.

NOTE Guidance is given in Annex D.

4.4 Electrical energy

COMMENTARY ON 4.4

Lighting accounts for a significant proportion of electrical energy usage within the built environment and electrical energy costs are forecast to trend upwards in the foreseeable future. The need for sustainable design (see 4.3.6) is also relevant.

4.4.1 General

Designers should develop appropriate energy-efficient designs in accordance with the recommendations in 4.4.2 to 4.4.5.

NOTE 1 Energy efficiency measures will be covered in BS EN 13201-5⁶⁾.

NOTE 2 Attention is drawn to Directive 2009/125/EC (the Ecodesign Directive) [28].

NOTE 3 Useful information can be found in the EU Green public procurement publication on street lighting [29].

4.4.2 Measures to minimize electrical energy use

NOTE 1 Energy efficiency measures will be covered in BS EN 13201-5⁶⁾, which will define the calculation and measurement of energy efficiency coefficients of road lighting installations. This is based on the system power necessary to light the relevant area based upon the selected lighting class. The coefficients apply for all traffic areas covered by the lighting classes as defined in BS EN 13201-2:2003.

Good lighting can contribute to electrical energy and carbon reduction strategies, and should be at the forefront of any electrical energy and carbon reduction strategy developments. There are various strategies available, each of which should be carefully assessed. These strategies include the following.

- **Variable lighting.** The road lighting standards classify the required lighting class based on usage; therefore when the use of a road or area reduces, for example, between midnight and 0600hrs, and providing the equipment is suitable, the lighting levels can be reduced through dimming. See 4.4.4 for further guidance.
- **Trimming.** Trimming can be applied to switch on and switch off ambient light levels. Modern light sources operated on the optimum electronic control gear do not require as much time to warm up to full output, therefore the lighting can be switched on closer to the time required, thus reducing the operating hours.
- **Part-night.** Lighting is turned off between certain hours such as midnight to 0600hrs. Longitudinal uniformity should be maintained during the switch off and switch on that occur during the hours of darkness, that is, switching not occurring at dusk and dawn. The control system should switch lights on and off in a contiguous order, as a random approach will temporarily compromise longitudinal uniformity.
- **Switch off.** Lighting is switched off and removed.

If either of the last two options are considered, the highway authority should ensure that road safety is not discernibly compromised. If moving to part-night or switch off then the authority should ensure that the highway signage, white lining and other features are assessed by a qualified highway engineer to ensure that they are compliant for an unlit road. These two options should only be implemented once a full risk analysis and user consultation have been undertaken.

⁶⁾ In preparation as prEN 13201-5 at the time of publication of this part of BS 5489.