BRITISH STANDARD

BS 5489
Part 9 : 1996

Road lighting

Part 9. Code of practice for lighting for urban centres and public amenity areas

ICS 91.160.20; 93.080.30

Committees responsible for this British Standard

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Chartered Institution of Building Services Engineers
Civil Aviation Authority
Council for the Protection of Rural England
County Surveyors' Society
Department of Transport (Highways Agency)
Electricity Association
Institution of Civil Engineering Surveyors
Institution of Electrical Engineers
Institution of Lighting Engineers
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Contents

Foreword

This Part of BS 5489 has been prepared by Subcommittee CPL/34/8. It supersedes BS 5489 : Part 9 : 1992 which is withdrawn.

The 1990 edition of this Part of BS 5489 extended the code of practice on road lighting to those areas within villages, towns and cities which have an importance for social or other reasons, and for which lighting conditions different from those described in other Parts of BS 5489 were considered desirable or appropriate.

The 1992 edition introduced a revised definition of maintenance factor and incorporated editorial improvements. However it was not a full review or revision.

This revision introduces new recommendations for car park lighting and makes some editorial corrections to the previous edition.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Code of practice

Introduction

The general principles of road lighting are given in Part 1 of this British Standard. In urban and amenity areas, people should be attracted by a pleasant visual scene. During the hours of darkness, the surrounding environment and people need to be easily recognized. During the hours that business and commercial concerns are open, a relatively high level of lighting is needed which can usually be achieved by a combination of public and private lighting.

In view of the diverse nature of each particular site being considered no uniform method of lighting provision is suggested and it is most important to recognize that an individualized approach has to be taken. For this reason this Part of this British Standard makes basic recommendations only with regard to the overall lighting provisions, related to each area.

In most of these areas, lighting is needed on surfaces other than the horizontal. Light in many instances is particularly needed on the faces of pedestrians to ease identification.

During the day it is important to ensure that all lighting equipment complements rather than detracts from the appearance of the area. All the physical and psychological criteria such as height of columns and size, design and light distribution of luminaires should be in accord. The general lighting should define the area rather than the traffic route. During the early evening when all shop window lights and signs are illuminated this should all be considered as a part of the lit environment. However it is important to remember that during the late evening and during the night when shops are closed and the commercial light is reduced or extinguished, the public lighting should aid the security of shops and pedestrians' safety as well as the safe passage of any vehicular traffic.

The addition of an attractive and dynamic side to the general lighting installation can in many cases be left to the supplementary commercial lighting referred to above which, if carefully controlled, can introduce useful variations in overall lighting effects.

1 Scope

This Part of BS 5489 gives recommendations for the lighting of urban centres and public amenity areas for all road users. Vehicular and pedestrian traffic is involved and, therefore, all exterior public areas alongside, under or over roads are included. As visual orientation and location are important to both drivers and pedestrians within urban centres, recommendations for the highlighting of landmarks at night are also given.

2 References

2.1 Normative references

This Part of BS 5489 incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the inside back cover. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this Part of BS 5489 only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

2.2 Informative references

This Part of BS 5489 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Definitions

For the purposes of this Part of BS 5489 the definitions given in BS 5225 : Part 1 : 1975, BS 5489 : Part 1 : 1992, BS 5489 : Part 7 : 1992 and BS 6100 : Subsection 2.4.1 : 1992 apply, together with the following.

3.1 background luminance

The average luminance of the immediate surround of the object being viewed.

3.2 conservation area

A statutory, designated area of architectural merit needing special attention to preserve its character.

3.3 cycle path

A means of passage designed for cyclists.

3.4 footpath

A means of passage for pedestrians.

NOTE. Footpaths may be across open spaces or between buildings.

3.5 horizontal illuminance

The illuminance on a horizontal surface of the area being considered (measured in lux).

NOTE. In the text horizontal illuminance is denoted by the symbol E_H.

3.6 luminaire

Apparatus which controls the distribution of light given by a lamp or lamps and which includes all the components necessary for fixing and protecting the lamps and for connecting them to the supply circuit.

3.7 maintained illuminance

The average or minimum illuminance on the reference surfaces ensured by appropriate lamp renewals and maintenance.

3.8 reflectance

The ratio of the light flux reflected from a surface to the light flux incident on it.

3.9 sparkle

A subjective contribution to the enhancement of the visual scene made without causing visual discomfort or disabling glare.

3.10 floodlighting

Lighting, by projection, of a scene or object in order to increase considerably the illuminance relative to the surroundings.

3.11 isolux curve

Locus of points on a surface where the illuminance has the same value.

3.12 candela

The luminous intensity in a given direction of a source which emits monochromatic radiation of frequency 540×10^{12} Hz and of which the radiant intensity in that direction is 1/683 W/sr.

NOTE. This definition is repeated from BS 5775 : Part 6 : 1993.

4 Objectives of lighting

This Part of BS 5489 differs from most other Parts of the standard in that the efficient lighting of the road surface for traffic movement is not the only or main consideration. A balance with many other aspects has to be achieved.

Urban centres serve many users, each with differing and sometimes conflicting lighting needs. A master plan should be drawn up which contains the various elements in order of their importance and emphasis. These may include many of the following which should, therefore, all be considered:

a) lighting design and choice of equipment in relation to the architectural scene and urban landscape;

b) lighting to provide safety for pedestrians from moving vehicles and to deter antisocial behaviour;

c) lighting commensurate with the character and volume of vehicular traffic (including cyclists);

d) control of illuminated advertisements in the interests of amenity;

e) control and integration of permanent floodlighting installations into the visual master plan;

f) control of temporary special lighting effects, such as floodlighting and festive decorations;

g) control of road and direction signs and their relationship with other illuminated material;

h) control and blending of lighting from both public and private sources e.g. bus shelters and telephone kiosks;

i) protection of residential developments from light pollution;

j) protection of installations from accidental or deliberate damage;

k) maintenance of installations.

5 Traffic

5.1 Categories of traffic

The relative balance of the needs listed in clause **4** depends on the type of traffic, which can be divided into the following categories:

a) primarily vehicular;

b) mixed vehicular and pedestrian;

c) wholly pedestrian.

The lighting levels for the general traffic situations within urban centres are given in table 1.

5.2 Primarily vehicular traffic

The minimum lighting level should be that given in the appropriate category in BS 5489 : Part 2. However, there is a need for the lighting to accentuate the change in area use from that where the motorist is the prime road user to where a growing number of pedestrian activities are occurring. One way to mark this change of use is to alter the appearance of the lighting equipment to a more decorative type and/or change the colour of the light source. Whilst there is still a need to define a traffic route, normally achieved by direction signs, the lighting should define the area and general street scene. This last point is of special relevance when considering the daytime appearance of the installation.

Table 1. Lighting levels for general traffic situations

Category and type		$\bar{L}$ cd/m^2	U_O	U_L	E_H (average) lx	E_H (minimum) lx
9/1 ***City or town centre***						
9/1/1	Primarily vehicular	1.5	0.4	0.7	n/a	n/a
9/1/2	Mixed vehicular and pedestrian areas, including service areas	n/a	n/a	n/a	30	15
9/1/3	Wholly pedestrian	n/a	n/a	n/a	25	10
9/2 ***Suburban shopping street***						
9/2/1	Primary vehicular	1.5	0.4	0.7	n/a	n/a
9/2/2	Mixed vehicular and pedestrian areas, including service areas	n/a	n/a	n/a	25	10
9/2/3	Wholly pedestrian	n/a	n/a	n/a	15	5
9/3 ***Village centre***						
9/3/1	Primary vehicular	1.0	0.4	0.5	n/a	n/a
9/3/2	Mixed vehicular and pedestrian areas, including service areas	n/a	n/a	n/a	15	5
9/3/3	Wholly pedestrian	n/a	n/a	n/a	10	5

Key

$\bar{L}$		is the maintained average road surface luminance (in cd/m^2);
U_O		is the overall uniformity ratio;
U_L		is the longitudinal uniformity ratio;
E_H	(average)	is the maintained average horizontal illuminance (in lx);
E_H	(minimum)	is the maintained minimum horizontal illuminance at any point (in lx);
n/a		not applicable.

NOTE. For primarily vehicular circumstances the lighting and criteria set out in BS 5489 : Part 2 apply.

5.3 Mixed vehicular and pedestrian traffic

The lighting levels given in BS 5489 : Part 2 and BS 5489 : Part 3 should be regarded as minimum levels. It is important that pedestrians should be able to recognize any potential danger as well as appreciate their surrounding environment.

Where pavements are narrow or subject to very considerable pedestrian traffic then consideration should be given to the removal of the lighting columns and the use of wall brackets as referred to in BS 5489 : Part 1. To the motorist, road surface luminance is still important, but of equal importance is the need to see and clearly define pedestrian movements on the adjacent pavements. For this, illuminance on other planes is of importance. For pedestrians there are more needs: to see the vehicles and to see each other. Luminaire brightness needs to be carefully controlled in order to avoid glare. It should be noted that this does not only apply just to the public lighting installation but to the whole urban landscape of commercial signs, shop windows and the like.

At night, modest scale decorative floodlighting can assist traffic movement. A local landmark, known and used during the day as a means of orientation by both motorists and pedestrians, can be totally lost during the hours of darkness. This may be overcome by a purpose-designed floodlighting scheme, a single spotlight attached to an adjacent road lighting column or even by 'spill light' from strategically positioned road lighting luminaires (see clause **15**).

5.4 Wholly pedestrian traffic

The objective is that the lighting should promote easy movement of pedestrians and create a feeling of general security and well being. To achieve the latter, recognition of the behaviour and intentions of other pedestrians is important, and for this good colour rendering and good illuminance are very desirable. In commercial and leisure areas the provision of good lighting can add to the general amenity and so encourage people to visit and make use of the facilities.

6 Security and safety

The general lighting needs of traffic referred to in clause **5** in most cases serve the needs of security and safety. Additionally it is beneficial to utilize any public lighting installation throughout the hours of darkness rather than simply during times of major traffic movements. If normal lighting levels are very high, such as in some town and city centres, some form of 'multiple lighting' (see clause **21**) could be considered to reduce overall running costs. Special care should be taken to ensure that there are no dark corners. In such areas, where necessary, more than one lighting unit should be employed so that a single lamp failure does not leave an area in total darkness. To aid in crime detection, differentiation of colours is useful and this should be taken into account.

To provide a sense of security it should be possible to recognize whether another person is likely to be friendly, indifferent or aggressive, in time to make an appropriate response. The lighting level should give sufficient illuminance on a person's face to enable such recognition. In those situations within the scope of this standard, this can generally be achieved by using the lighting levels for horizontal illuminance given in tables 1 to 5, with luminaire mounting heights of between 4 m and 12 m.

NOTE. The quantification of light on vertical planes presents a difficulty because of the multiplicity of planes at each measurement point which has to be taken into account. To some extent, this can be overcome by using the value for the average illuminance on an infinitesimally small vertical half cylinder situated at average head height (1.5 m). However with this measure, the semi-cylindrical illuminance, it is necessary to take into account at least three orientations of the half cylinder (the curved surface facing up, down and across the street). In addition, no simple method has yet been evolved for calculating semi-cylindrical illumination from a complete installation other than by using a computer (see annex A).

7 Trade and commerce

A function of public lighting in urban centres, in addition to that of general safety and security, is to enhance the night-time environment. The provision of good and attractive lighting is likely to assist in stimulating trade and commerce. Many instances can be cited where the specific attraction of this public lighting is known to attract large numbers of people, to the direct advantage of the local trade and commerce.

8 Visual appreciation

Added interest can be given to areas which people may wish to see by the use of imaginative lighting. These will include conservation areas and other areas of local importance containing buildings and monuments of historical interest.

Imaginative lighting design can also do much to subdue the less visually attractive features within an urban environment by highlighting the more attractive and worthwhile features.

9 Arcades and canopied areas

The lighting of arcades and canopied areas should be to a relatively high level to match that of the adjacent shop windows etc. Good colour rendering light sources should be used.

The lighting levels for arcades and canopied areas are given in table 2.

10 Subways, footbridges, stairways and ramps

10.1 General

Subways, footbridges, stairways and ramps should all be lit to a higher level than their surroundings (see table 3). In subways it is important that vertical surfaces are well illuminated and the lighting engineer should request that all surfaces are as light coloured as is practicable.

The lighting engineer should be consulted at the design stage to determine the location of the chosen luminaires relative to their performance so that the electrical intake cabinets and wiring conduits can be moulded into the construction.

In the event of an already constructed subway the design of the lighting and the type of luminaires and cable conduits should be such as to minimize the scope for abuse. Recessed ceiling fittings do not light the ceiling adequately, giving the impression of a reduction in height.

Surface-mounted luminaires are vulnerable to vandalism. Unless used in sufficient numbers, bulkhead fittings produce poor lighting due to the inadequate space to height ratio. Good lighting can be produced using cornice-mounted luminaires in continuous runs with panel infills, behind which all circuit wiring conduits can be fixed. This system gives a high degree of protection to the lighting installation except against abuse to the diffuser.

Lamp colour and colour rendering are both important factors to be considered. In general, tubular fluorescent lamps give suitable lamp colour and good colour rendering.

On long and complex subways the lighting should be operational over a 24 h period. It is recommended that the installation be designed to give higher levels during daylight hours which can be switched to lower levels of illuminance during the hours of darkness. Switching can be carried out by either time switch or photocell.

During the daytime the brighter surroundings of a subway entrance area, relative to a low level of subway interior lighting, can create a 'black hole' effect. At night a reversal of this effect can be experienced when emerging from the subway into lower levels of exterior lighting. In order to overcome this undesirable situation during the daytime the entry area of the subway should be provided with extra threshold zone lighting (see note 3 to table 3). At night the threshold zone values should be reduced, with exterior approaches to the subway provided with good levels of light.

For footbridges and stairways it is important that the risers are illuminated differently to the treads so as to accentuate the steps even if the difference is already highlighted by the use of different materials.

On footbridges care should be taken to install the lighting units in such a manner as to complement the structure but with due consideration given to future maintenance.

10.2 Emergency lighting

On longer complex subways, emergency lighting, in accordance with BS 5266 should be considered, lasting for a minimum duration of 1 h.
Self-maintained units are recommended.

If the area forms part of an escape route from a shopping centre, car park or transport interchange it is essential that emergency lighting is installed.

Table 2. Lighting levels for arcades and canopied areas

Type	Day		Night	
	E_H (average) lx	E_H (minimum) lx	E_H (average) lx	E_H (minimum) lx
Open arcade	n/a	n/a	75	50
Totally enclosed arcade or canopied areas	250	150	150	75

Key

E_H (average) is the maintained average horizontal illuminance (in lx);

E_H (minimum) is the maintained minimum horizontal illuminance at any point (in lx);

n/a not applicable.

NOTE. Illuminance uniformity ratio (E_H (minimum) to E_H (average)) should be as high as possible but no lower than 0.4.

Table 3. Lighting levels for subways, footbridges, stairways and ramps

Type		Day		Night	
		E_H (average) lx	E_H (minimum) lx	E_H (average) lx	E_H (minimum) lx
Subways:	open	n/a	n/a	50	25
	enclosed	350	150	100	50
Footbridges:	open	n/a	n/a	30	15
	enclosed	350	150	100	50
Stairway/ramp:	open	n/a	n/a	30	15
	enclosed	350	150	100	50

NOTE 1. 'Open' equates to major daylight penetration.

NOTE 2. For 'enclosed' areas emergency lighting needs to be considered. It is essential that it is installed if the area forms part of an escape route from a shopping centre, car park or transport interchange.

NOTE 3. Where longer subways have poor daylight penetration, or where subway user confidence needs to be ensured, it may be necessary for the threshold illuminance value to be up to twice the value of the general daytime service level.

Key

E_H (average) is the maintained average horizontal illuminance (in lx);

E_H (minimum) is the maintained minimum horizontal illuminance at any point (in lx);

n/a not applicable.

11 Car parks

11.1 General

The purpose of lighting car parks is to enable users to proceed safely, and to allay the fear of crime.

Lighting is needed for both pedestrians and vehicle drivers. For pedestrians lighting for good viewing conditions and avoidance of dark areas is necessary. For drivers the emphasis is on good lighting for vehicle movements and parking.

The variation in character of car parks in terms of size, structure, location and access means that different lighting techniques are necessary.

At vehicle entry/exit points there is likely to be contrast between the car park and surrounding lighting conditions. At night there may be a need to arrange for a zone with a value between the two.

At pay stations additional task lighting, of good colour rendering, to identify coinage and to deter crime may be required. Pedestrian access points to car parks should have appropriate lighting provisions.

The use of monochromatic (e.g. low pressure sodium) lamps is not recommended as the light from these does not allow the identification of colours.

Where car park lighting is in the vicinity of navigational signalling systems of airports, railways or other transport systems, reference should be made to BS 5489 : Part 8.

Containing lighting within the general curtilage of each car park is important for energy saving reasons and for the avoidance of light pollution.

NOTE. Further information is given in the *Guidance notes for the reduction of light pollution*, 1994 [1].

11.2 Enclosed car parks

A welcoming atmosphere is required to allay the fear of crime and measures should be taken to provide such an atmosphere by the use of light coloured finishes on all surfaces in the field of view (e.g. reflection factors on walls and ceilings should be not less than 0.5) and the use of lamps of warmer colour appearance. The protrusion of the luminaires below the ceiling surface may make the ceiling appear dark. To reflect light onto the ceiling, floor surfaces should be given as light a finish as possible. Dark niches should be eliminated.

The illuminance level in enclosed car parks is not as important as the illuminance uniformity ratio (minimum illuminance to average illuminance). Good uniformity produces easy viewing conditions and gives the impression of a space with a much higher illuminance. To achieve good uniformity, consideration should be given to the spacing of luminaires and reflectance factors. The lighting levels given in table 4 and the uniformities which these would give represent the ideal lighting conditions that should be maintained throughout all hours of use. If it is not possible to achieve these uniformities because of factors such as beams or poor surfaces, the average illuminance should be increased to compensate for this drop. The lowest acceptable uniformity is 0.4.

Table 4. Recommended levels of lighting for multi-storey and underground car parks[1)]

Area	E_H (average) lx	E_H (minimum) lx
Parking bays and access lanes	75	50
Ramps, corners and intersections	150	75
Entrance/Exit zones (vehicular)	Night 75 Day 300	n/a
Pedestrian areas, stairways, lifts lobbies	100	50
Open roof level	See table 5	

Key

E_H (average) is the maintained average horizontal illuminance on the floor;

E_H (minimum) is the maintained minimum horizontal illuminance at any point within the calculation grid (see figure 1);

n/a not applicable.

[1)] Illuminance uniformity ratio (E_H (minimum) to E_H (average)) should be as high as possible but no lower than 0.4.

At entry/exit points there is likely to be a contrast between the internal and external lighting conditions which can cause viewing difficulties. Reduced interior lighting or higher values of exterior lighting may be necessary at night. By day, the contrasts in lighting at entry/exit areas can be reduced by increasing the interior lighting levels in these areas.

The lighting installation should clearly illuminate the correct circulation route along and between each level. Luminaires should be sited at each route intersection so that these areas are illuminated to a higher level than the average illuminance of the whole area.

The design, orientation and location of luminaires in the driver's line of sight should be arranged to ensure that glare is minimized. The use of linear sources crossways to the driver's line of sight is not recommended unless baffles are used.

The lighting of stairs should be such that there is sufficient contrast between the treads and the risers.

11.3 Outdoor car parks

For lighting purposes, outdoor car parks can be regarded either as surface car parks or the open roof level of multi-storey car parks.

In many instances surface car parks are close to properties and roads. Lighting from these may contribute some lighting into the car parking area but, as this lighting cannot be assured in terms of quality and duration, car parks should have independent lighting provisions.

Luminaires should be sited and mounted at such a height so as to avoid glare and obtrusive lighting.

The lighting levels given in table 5 and the uniformities which these would give represent the ideal lighting conditions that should be maintained during the hours of darkness. If it is not possible to achieve these uniformities because of factors such as trees and other obstructions, the average illuminance should be increased to compensate for this drop. The lowest acceptable uniformity is 0.2.

Table 5. Recommended levels of lighting for outdoor car parks[1)]

Type	E_H (average) lx	E_H (minimum) lx
Rural (Environmental zones E1 and E2[2)])	15	5
Urban (Environmental zones E3 and E4[2)])	30	10
Multi-storey open roof level[3)]	30	10

E_H (average) is the maintained average horizontal illuminance on the floor.

E_H (minimum) is the maintained minimum horizontal illuminance at any point within the calculation grid (see figure 2).

1) Illuminance uniformity ratio (E_H (minimum) to E_H (average)) should be as high as possible but no lower than 0.2.

2) Environmental zones are classified as follows:

E1 National parks, areas of outstanding beauty, other dark landscapes;

E2 Areas of low district brightness (e.g. in a rural location but outside a zone E1);

E3 Areas of medium district brightness (e.g. in an urban location);

E4 Areas of high district brightness (e.g. in an urban centre with high night-time activity).

(See *Guidance notes for the reduction of light pollution*, 1994 [1].)

3) For obtrusive light control multi-storey open roof level should be considered as environmental zone E1.

Lighting for open roof level car parks needs careful consideration to avoid visual domination of the skyline by the components used to mount the luminaires during the daytime and by the light sources at night-time. It is necessary to control obtrusive light. Guidance is given in *Guidance notes for the reduction of light pollution*, 1994 [1].

The boundary of open roof level car parks should be well defined by illuminating the perimeter and rails. When selecting the location of luminaires and mounting components access for maintenance should be taken into account.

11.4 Emergency lighting

Emergency lighting in accordance with BS 5266 : Part 1 should be provided in the following circumstances:

a) where car parks are totally enclosed;

b) where the character or layout would present difficulties of access/egress in the event of failure of normal lighting;

c) where the character or layout would present potential danger in the event of failure of normal lighting.

11.5 Calculation of horizontal illuminance

For the purpose of calculations, it is essential that all of the areas, including parking bays, driveways and pedestrian circulation routes, are included in the area under consideration. The area under consideration should be that area of the working plane having a boundary 0.5 m (for enclosed car parks) or 1.0 m (for outdoor car parks) from the wall or perimeter. The working plane to be used should be floor/ground level. The first calculation grid points should be no more than 0.5 m (for enclosed car parks) or 1.0 m (for outdoor car parks) away from the wall or the perimeter of the area.

NOTE. It should be noted that some obstructions can affect the illuminance level and uniformity.

The lighting levels should be as given in table 4 or table 5, as appropriate, when calculated with a grid spacing of no more than 1.0 m (for enclosed car parks) or 5.0 m (for outdoor car parks) over the area under consideration, as shown in figure 1 and figure 2, respectively. Where there are significant obstructions or irregular areas it may be necessary to use a series of grids to ensure that the design illuminance and uniformity are achieved over the whole of the area under consideration. A minimum of 36 points per grid is recommended.

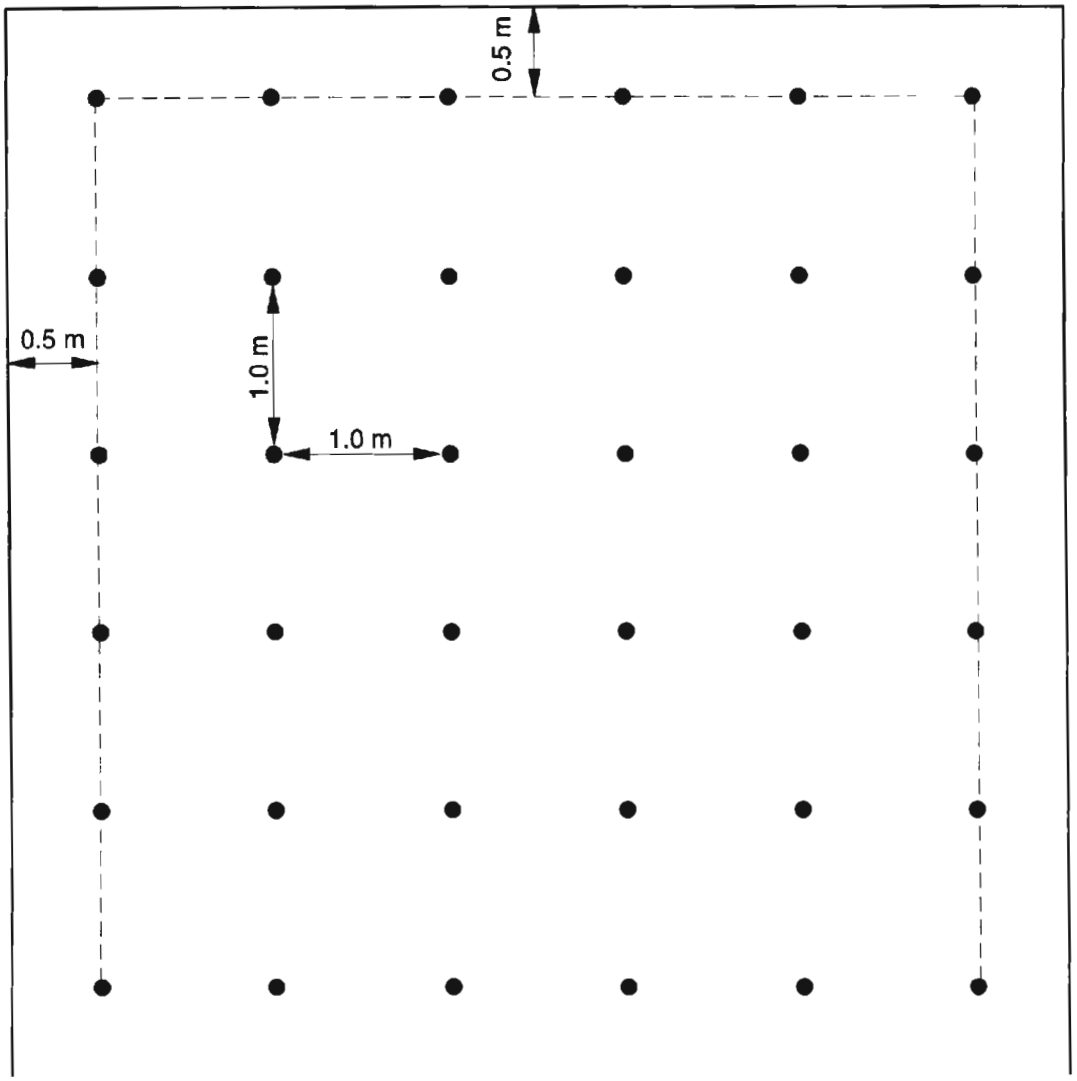

Figure 1. Layout of grid points for illuminance calculation over the area under consideration of the working plane for enclosed car parks

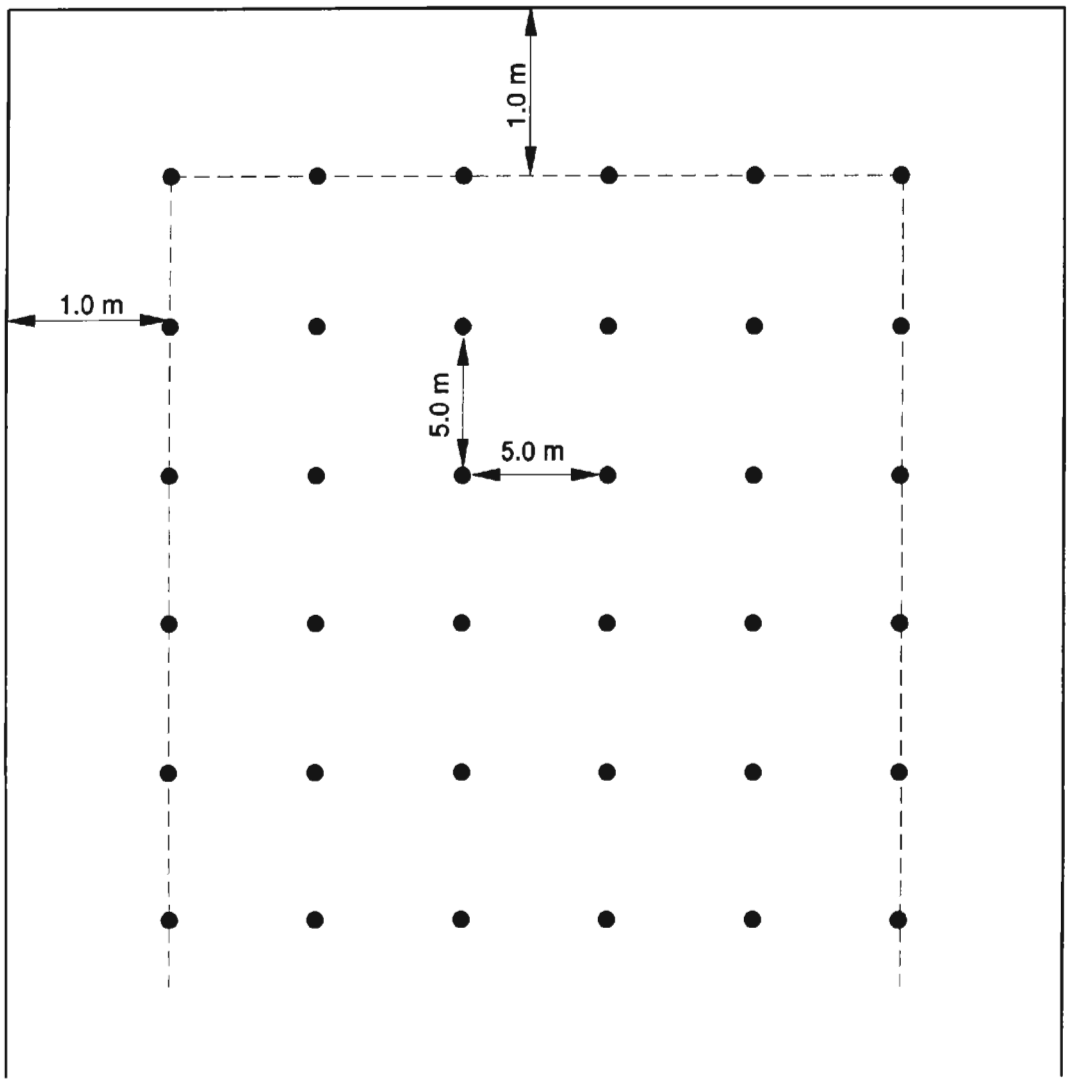

Figure 2. Layout of grid points for illuminance calculation over the area under consideration of the working plane for outdoor car parks

12 Service areas

Advice on service area lighting is included in this Part of BS 5489 because service areas and important parts of central areas may be shared or be in such close proximity that the service area lighting has a visual effect on the more important central area. For recommended lighting levels see table 1.

It is important to recognize the varying needs of service areas and the various conflicts which are likely to occur between types of vehicles and pedestrians. Where tall delivery vehicles are to be expected these are likely to create shadows when parked. The lighting should be designed having regard to this and to the manoeuvring of large vehicles which may be contrary to normal traffic flow.

Where there is a multitude of entrances and access ways to the rear of premises it is possible that local supplementary lighting may be necessary for working and security purposes. The provision of private lighting at these points is to be expected and may be orientated to provide light penetration into long covered delivery vehicles. When vehicles are not present it is important that such lighting is switched off to prevent glare.

Generally, it is better to ensure a good and effective level of publicly provided lighting to discourage the introduction of various privately arranged lighting forms, and thus retain control of the lighting environment.

Where suitable sitings on surrounding buildings can be made this is often preferable and avoids the use of columns. In such circumstances the use of floodlighting luminaires of suitable distribution and wattage can be more effective than road lighting luminaires. If columns are necessary, careful regard should be given to their aesthetic appearance, avoiding the use of long brackets.

Source colour and colour rendering are both very important factors to be considered. Where luminaire combinations are used this may also introduce different lamp types. Subject to satisfactory lighting performance and distribution the use of mixed lamp types can assist in the visual enhancement of the lighting units provided.

If pedestrian areas are divided or crossed by service roads there is likely to be fragmentation of both areas by features such as trees and seats to separate the conflicting needs of vehicles and pedestrians. Because of the various formations that can be chosen no precise lighting proposals can be made. It is necessary for the lighting engineer to examine the area or areas both individually and as a complete unit to determine whether separate or combined lighting provisions can be made. The main usage of each area usually indicates the form of lighting to be provided.

13 Conservation areas

The declaration of a conservation area does not necessarily preclude the provision of lighting in a previously unlit area or establish a pre-requisite for period style lighting. Often modern equipment of good functional design is suitable. Conventional lighting forms often prove most economic, both in terms of provision and future upkeep. However, the particular character of the conservation area may demand either an unconventional approach or a blend of various light forms.

The chosen lighting should relate to the needs of vehicular and pedestrian traffic, whilst the engineering considerations should have due regard to aesthetic values and amenity influences.

The daytime appearance of any installation in a conservation area has to relate to all surroundings and so individual appearance, siting and area scale are important factors for consideration. Advice on these points should be sought from planning officers at an early stage.

At night the quality of lighting, observed effect, source colour appearance and colour rendering attributes are all important factors to be considered. Often the best lighting effect can be achieved by careful blending of various lighting measures chosen for individual features within the conservation area.

The execution of all installation work should be to the highest possible quality with particular attention being given to the routeing of all wiring and cables, and location of electricity service equipment to ensure the minimum visual intrusion.

The quality and frequency of maintenance should reflect the importance of the initial provisions and adequate financial and maintenance control parameters should be established and rigorously controlled. Equipment renewals following damage or other causes should be with identical equipment.

14 Parks and landscaped areas

The lighting of parks, gardens and landscaped areas changes what would be a night-time dark zone into an attractive amenity that enhances the environment and encourages use as a source of pleasure in comparative safety and security.

Footpaths and cycle paths should be lit using lighting units to show the direction that the path takes and to ensure the well-being of the user. Care should be taken where necessary to illuminate beyond the boundaries of the path in order to increase the visual area and provide more confidence to people using those routes.

With the availability of a wide variety of luminaires and coloured light sources, the opportunity to create a visual night scene by the subtle use of illumination on foliage and features can produce a dramatic impact comparable to that of a theatre set.

The variation of light, shadow and silhouette can offer a pleasing effect which changes with the direction of view inviting visitors to enjoy the ever changing shape of their surroundings.

Although there has to be an interrelationship for the lighting of flora, features and forms to produce an artistic composition, the specific illumination of foliage can give a spectacular effect. This can be carried out by using projector floodlights remotely positioned to create an effective background if viewed from a distance. If adjacent to trees with descending branches, floodlights can be placed underneath or within the trees.

When the landscaped area includes water features the surface of the water does not respond to direct lighting but does reflect that of its surroundings adding an additional effect to the overall scene.

Although consideration should be given to direct or reflected glare which can have a detrimental effect on passing vehicular or pedestrian traffic, if the installation is well planned with respect to the effectiveness of the luminaires and their locations the resulting visual effect can be beneficial to the night-time scene.

For lighting levels for footpaths and cycle paths see table 1 of BS 5489 : Part 3 : 1992.

15 Lighting of landmarks

At night, imaginative lighting can do much to enhance the scene. This can give pleasure to the public and promote commerce and tourism and, by highlighting well known landmarks, help considerably in traffic orientation.

There are many types of luminaires available, from which the lighting engineer can decide which type is the most suitable for the project, taking into account electrical safety, problems of maintenance, possible vandalism, light spillage and particularly glare to road traffic.

Generally, any floodlighting scheme should be contained within the perimeter of the building to be floodlit.

Luminaires mounted on adjacent buildings are sometimes necessary, and consent may be required. A feature of good design is to conceal the luminaires as well as possible and avoid glare. It is the illuminated effect of the landmark only which is wanted.

There is a large variety of floodlights with various beam distributions e.g. narrow, wide or elliptical. The designer should decide which type is most suitable for the project, care being taken to allow for the minimum of wasted light. (Wasted light is the light which does not fall on the structure.) The amount of light needed on a structure is dependent on the surrounding area, for which guidance is given in table 6.

Design methods for the floodlighting of landmarks, monuments etc. are given in annex B. In many cases the floodlighting need be no more than a spotlight attached to a conveniently positioned road lighting column.

For the lighting of fountains see clause 17.

Floodlights which are mounted at ground level should be made inconspicuous by means of surround screens. If the floodlights are extremely large they can be recessed into concrete or brick pits. The pit should be fitted with drainage to ensure that water does not collect in it.

When floodlights are mounted on structures, extreme care should be taken to avoid damage.

The supply of electricity for any floodlighting scheme needs to be carefully considered for economic reasons. The electrical supply which controls the floodlighting should not be in a conspicuous position, but should be readily accessible for maintenance purposes.

The circuit cables should be concealed wherever possible and, where installed on the surface of the buildings, should be inconspicuous.

Table 6. Lighting levels for floodlighting of structures

Facing material	Luminous environment			For surface condition		
	Dim	Medium	High	Fairly clean	Dirty	Very dirty
	Maintained average illuminance lx			Correction coefficient[1]		
Light stone, white marble	20	30	60	3	5	10
Light yellow brick	35	50	100	2.5	5	8
Medium stone, cement, light coloured marble	40	60	120	2.5	5	8
Light brown brick	40	60	120	2	4	7
Medium brown brick, pink granite	55	80	160	2	4	6
Architectonic concrete	60	100	200	1.5	2	3
Red brick	100	150	300	2	3	5
Dark stone, grey granite, dark marble	100	150	300	2	3	5
Dark brick	120	180	360	1.5	2	3
Natural aluminium	200	300	600	1.5	2	2.5

[1] The maintained average illuminance should be multiplied by the correction coefficient appropriate to the surface condition of the facing material.

16 Decorative and festive lighting

There is increasing use of decorative and festive style lighting within urban centres. The scale can differ from a few traders arranging a small display of festive lights in a village high street to a public authority installing miles of 'illuminations' along a seaside promenade.

It is essential that structural and electrical safety is the first priority in all cases. All relevant approvals need to be obtained from building owners, statutory and highway authorities if wires or equipment are intended to be taken over public highways and/or open areas.

Electrical supplies should be low voltage wherever possible. In many instances, road lighting column supplies can be utilized. If this is to be done, consultations with the local electricity board are necessary to ascertain load and tariff levels if the supply to be used is unmetered. If the festive occasion is of a recurring nature, serious consideration should be given to providing permanent supply points in safe locations. Projected light patterns and long range sky-writing can be successfully used in suitable external circumstances to display messages or graphics on large flat vertical facades or gable ends of office blocks and tall buildings. The development of computers and lasers now presents considerable scope for programmed displays of precise quality and form and considerable variety for the purpose of entertainment and commerce.

Much can be made of decorative and festive lighting within urban and amenity centres (see clause **7**) and considerable visual benefits can be gained by aesthetically pleasing promotion of such ideas. Overall planning of specific areas is usually much more successful in both planning and environmental terms than dealing only with the individual scheme. Where local commercial concerns and/or street associations have not been formed the local authority should investigate the setting up of such bodies.

17 Fountain lighting

The lighting for fountains and moving water features is likely to differ from usual floodlighting or features lighting methods.

The flat and calm surface of water acts principally as a reflector and therefore the lighting of such surfaces produces very little direct visual attraction (see clause **14**). Surfaces of disturbed water however create a foil of ever changing lighting effects. This may be exploited by either projecting light along the surface or through the water from submersible lighting units (see table 7).

Variations in water surfaces and profiles, limitations on location of equipment, main viewpoints and the avoidance of vandalism are some of the factors to be considered.

The main problem to be appreciated is that the materials being normally positioned under water need to be of high quality and need to be able to operate in perfect safety. Low voltage transformers should be used to reduce voltage to between 12 V and 24 V. Luminaires for swimming pools and similar applications are specified in BS EN 60598-2-18.

Table 7. Luminous intensity for water effects

Height of water effect m	Total luminous intensity of source at base of fountain cd
1.5	4 000
3.0	11 000
6.0	34 000
9.0	69 000
12.0	115 000
15.0	170 000

18 Installation design

18.1 General

The lighting needs of all users should be identified. Preferably the area concerned should be subjected to detailed, daytime and night-time site appraisal prior to detailed design work.

Lighting is a vital part of the environment and it is important to ensure that lighting is complementary to the surroundings. Multidisciplinary teamwork by planners, architects and engineers can achieve good effective and economic lighting design. Preference should always be given to good quality, well designed equipment with low maintenance needs. It is important when calculating maintenance costs to include all costs, which should include lamp life and replacement costs and luminaire cleaning cycles, rather than simply the energy costs of a lamp.

18.2 Site appraisal

Site appraisals should be carried out before, during and after installation, by day and night, to ensure that all objectives are met. These appraisals should be made from the viewpoint of all users and should examine the effects of any private lighting that could be detrimental to those users and to the area in general. For special or particularly sensitive locations it may be advisable to arrange trial installations to evaluate the worthiness and correct interpretation of objectives. If wall-mounted units are to be used, site appraisals are particularly important in order to ascertain cable runs that are as inconspicuous as possible. During installation, site visits are essential in order to avoid unforeseen problems and to ensure compliance with design objectives.

18.3 Consultation and planning

In environmentally sensitive areas, the lighting engineer should consult with the relevant planning architect to ensure that historical styling and/or location of equipment is correct.

Within the whole visual scene of a lighting scheme under consideration, illuminated advertising signs may be present. The regulation of the display of advertisements in the interests of amenity and public safety is provided for in Section 63 of the Town and Country Planning Act 1971 [2] and regulations (S.I. 1532 of 1969) made thereunder. The term 'advertisement' is given a broad definition in the act and includes all manner of directional signs. Advertisements not visible from a public place (e.g. those inside shopping precincts) are not controlled. Illuminated advertisements however are likely to require the approval of the local planning authority. Those likely to be confused with highway signs and signals, significantly affecting the distribution of light on the highway, or causing distraction, e.g. by flashing, need special consideration.

18.4 Installation work

Installation work should be of good quality, well engineered to keep future maintenance to a minimum. However, this should not be pursued to the detriment of aesthetic considerations, particularly where installation on building facades is concerned. Here the position of luminaires and control boxes adjacent to each other is generally aesthetically unacceptable and the control box needs to be mounted as neatly and inconspicuously as possible joined by an equally inconspicuous cable run.

Wiring systems used in all installations which are exposed to the weather should be designed to withstand such exposure. All metalwork should be made of, or protected by, corrosion-resisting material, or have such a finish, and should not be placed in contact with other metals with which it is liable to set up electrolytic action. To prevent the ingress of moisture, all terminations should be sealed with a suitable material that has adequate insulating and waterproofing properties which are retained throughout the range of temperatures to which the terminations may be subjected in service.

In many urban centres and amenity areas, growing use is being made at festival times of supplementary decorative lighting. It is therefore worth considering the provision of electrical supplies for such events (see clause **16**), at the installation stage of a new general scheme.

19 Light sources and luminaires

19.1 Basic needs

Any lighting equipment needs to be suitable for fulfilling the lighting needs. In urban centres and public amenity areas these are twofold. The first is the ability to illuminate the area and objects concerned in the most effective manner possible. The second is the appearance of the lighting equipment. It should be aesthetically pleasing in itself as well as being in harmony with its surroundings. At all times and especially at night it should add to the attraction of the urban scene.

Colour rendering is important in most aspects of urban centre lighting. In areas of mixed vehicular and pedestrian traffic the ability to distinguish objects is considerably improved by the differentiation of colours. This is a benefit both to the public and to the police. For these reasons light sources which provide good colour rendering should be used.

The different colour appearances of light sources can be exploited by the lighting engineer to bring planned variety to the night-time urban scene. While long life and high efficacy are important economic factors, other characteristics of the lamp are equally important.

Luminaires, together with their supports, should be regarded as a unit and should be chosen to harmonize with the area in which they are to be used. Where older style luminaires are adopted for re-use, it is essential that due regard is given to their optical performance and appearance. If ancillary control gear boxes are necessary, these should be made as inconspicuous as possible.

19.2 Performance

For general traffic route lighting the performance of a road lighting luminaire is measured by its ability to illuminate the road surface to produce a high luminance by which objects on it can be seen clearly. Within urban centres much more visual information is required from surfaces other than the horizontal. In particular the vertical plane is important as this covers not only pedestrians but door entrances, signs and indeed most other objects. Luminaires therefore need to be designed to give light as much as on the vertical as the horizontal, but with care taken so as not to produce glare.

Conventional road lighting luminaires provide a light distribution along the carriageway. In urban centres where lighting the carriageway is not necessarily of prime importance, luminaires with symmetrical light distributions may be preferable.

19.3 Appearance

Within urban centres and amenity areas the general appearance of lighting equipment is of major importance, not only when illuminated at night, but also its unlit appearance during the day. At night, a luminaire's appearance should for pedestrians contain a degree of sparkle. Its colour appearance is also important as is its shape. Shape plays an important part in its daytime appearance which above all else should complement its surroundings. For this, it is important to consider the luminaire and column/bracket combination as a unit.

Bracket arms should be kept as short as possible, the maximum being as given in BS 5489 : Part 2. Scale is also important as is choice of materials. If an area is totally uninspiring, it is worth considering whether the lighting equipment itself could create the desired attraction.

If period style lanterns are used, care should be taken to match historical periods, for which consultation with local architects and planners is recommended. If a higher level of lighting is required than can be obtained without detracting from the visual appearance a multiple lighting system as described in clause **21** should be considered.

20 Location and mounting heights for lighting equipment

The aesthetic appearance of a lighting installation is largely dependent on the location of the equipment. Wall brackets and columns need to be positioned away from windows and with regard to the overall impression, i.e. where in the urban scene a light would look right, how to show up a particular piece of architecture or define an area, e.g. at the corners of a town square or village green. The night-time appearance of lighting within trees can look most attractive, but care should be taken if lighting tree lined areas that the luminaire is first free to perform its duty to illuminate the horizontal and vertical planes within its vicinity with only its stray light bringing beauty to the trees. In such areas, lower mounting heights than normal can be used to bring luminaires below the tree canopy. Equipment should be located to keep it out of the way of vandalism and possible accidental damage but it should be accessible for maintenance.

The following suggested luminaire mounting heights for the various traffic category areas, (see clause 5), are for general guidance only and in cases such as multiple lighting systems, can be modified to suit individual schemes:

a) primarily vehicular: 8 m to 12 m;

b) mixed vehicular and pedestrian: 5 m to 10 m;

c) wholly pedestrian: 3 m to 5 m.

As far as possible, column mounting heights should be kept at or below the height of adjacent buildings. This is particularly important in conservation areas.

21 Multiple lighting systems

In some areas where user demands can vary during the course of the day, lighting provisions can also be varied by arranging multiple luminaires or lamp switching sequences. This can be advantageous where traffic usage varies, and for security and energy saving purposes.

Also, where an architectural objective may result in the use of a relatively inefficient luminaire at pedestrian level, a further luminaire or luminaires, mounted remotely at a higher location, may be used to provide the necessary ambient lighting level.

Where pathways are parallel to roadways but are screened by intervening trees, consideration should be given to the use of luminaires mounted at lower mounting heights on the rear of road lighting columns.

22 Maintenance and prevention of vandalism

The maintenance of lighting equipment is becoming increasingly expensive and it is therefore important to use equipment that is as maintenance free as possible. Luminaires conforming to BS EN 60598-1 should be used. A long life discharge lamp is recommended. Control gear should be of good quality, and if it is mounted within the luminaire, this can reduce vandalism. Overall quality is important, both of equipment and maintenance levels. The sealing of luminaires and their resistance to the ingress of dirt is indicated by their international protection code (IP) number (see BS EN 60529). Luminaires with an IP number in the range IP 2X to IP 6X should be used. Maintenance factors for these are given in table 8.

In areas prone to vandalism, care should be taken to choose equipment that has been designed to be vandal resistant rather than normal units that have been modified.

Table 8. Luminaire maintenance factors

Cleaning interval	IP code number of lamp housing								
	IP2X minimum [1]			IP5X minimum[1]			IP6X minimum[1]		
	Pollution category			Pollution category			Pollution category		
months	High	Medium	Low	High	Medium	Low	High	Medium	Low
12	0.53	0.62	0.82	0.89	0.90	0.92	0.91	0.92	0.93
18	0.48	0.58	0.80	0.87	0.88	0.91	0.90	0.91	0.92
24	0.45	0.56	0.79	0.84	0.86	0.90	0.88	0.89	0.91
36	0.42	0.53	0.78	0.76	0.82	0.88	0.83	0.87	0.90

NOTE 1. High pollution occurs in the centre of large urban areas and in heavy industrial areas.
NOTE 2. Medium pollution occurs in semi-urban, residential and light industrial areas.
NOTE 3. Low pollution occurs in rural areas.
[1] See BS EN 60529.

23 Installation design procedure

23.1 General

The installation design procedure consists of six main parts as follows:

a) the gathering of preliminary data;

b) the determination of the lighting needs and how best they can be met;

c) the choice of appropriate equipment, desirable mounting height(s), and the possible methods of support best suited to the area concerned;

d) the calculation of the design geometry which ensures conformity to the photometric data;

e) the plotting of luminaire positions, taking into account both the individual features of the area and its future maintenance;

f) the finalization of the installation specification.

NOTE. A work sheet for the installation design procedure is given in annex C.

23.2 Gathering preliminary data

The following list shows the data that needs to be acquired.

a) Type of area (see table 1):

1) city or town centre;

2) suburban shopping street;

3) village centre.

b) Size of area.

c) Average building height.

d) Shape of area.

e) Traffic category (see clause **5**):

1) primarily vehicular;

2) mixed vehicular and pedestrian;

3) wholly pedestrian.

f) Architectural style (see **19.3**):

1) 18th century;

2) 19th century;

3) early 20th century;

4) interwar;

5) post war;

6) modern;

7) other.

g) Special aspects:

1) community needs (see clauses **6**, **7** and **8**);

2) conservation area (see clause **13**);

3) other.

h) Pollution category (see notes 1, 2 and 3 to table 8).

i) Access for maintenance (see clause **22**).

j) Preferred location for luminaires (see clause **20**).

k) Planning and/or listed building consent required (see **18.3**).

23.3 Determination of lighting needs

The following aspects should be considered before determining the lighting needs and how best to meet them.

a) Is the area within the scope of this Part of BS 5489?

b) What is the traffic category? (See table 1.)

c) Photometric data for the area:

1) maintained average road surface luminance, $\overline{L}$

2) overall uniformity, U_O;

3) longitudinal uniformity, U_O;

4) maintained average horizontal illuminance, E_H (average);

5) maintained minimum horizontal illuminance, E_H (minimum).

d) Photometric data for the lamp/luminaire:

1) colour appearance;

2) colour rendering;

3) restraints on light distribution;

4) cleaning interval.

e) Other data:

1) sparkle;

2) conspicuity.

23.4 Choice of equipment and installation

The choice of appropriate equipment, desired mounting height(s) and the possible methods of support best suited to the area concerned should be decided as follows.

a) Desired mounting height.

b) Luminaire type:

1) road lighting luminaire;

2) floodlight;

3) other.

c) Lamp type:

1) high pressure sodium;

2) high pressure mercury;

3) tubular fluorescent;

4) low pressure sodium;

5) other.

d) Luminaire style:

1) contemporary;

2) period;

3) other.

e) Column/wall bracket style:

1) contemporary;

2) period;

3) other.

f) IP rating of luminaires.

g) Column or wall bracket?

h) Planning and/or listed building consent obtainable?

23.5 The calculation of design geometry

For areas of primarily vehicular traffic, roads should be lit for this traffic rather than for pedestrians. In this case reference should be made to BS 5489 : Part 2 for the method of calculation.

For mixed vehicular and pedestrian traffic, or wholly pedestrian traffic, the calculation method given in BS 5489 : Part 3 should be used. Manufacturers should be consulted for appropriate luminaires, uniformity values and isolux diagrams.

23.6 Plotting of luminaire positions

It is at this stage that details are finalized to ascertain that the luminaire positions are physically achievable and aesthetically acceptable. If they are not, it will be necessary to re-examine and repeat the whole design procedure thus far.

23.7 Finalization of installation specification

The design procedure thus far has been special and particular to the areas to be lit. It is therefore essential that the final installation specification is carefully written to ensure that the desired result is achieved.

Annexes

Annex A (informative)

Calculation of semi-cylindrical illuminance

Figure A.1 illustrates the concept of semi-cylindrical illuminance. The formula for its calculation is as follows:

$$E_{sc} = \frac{I}{\pi d^2} (1 + \cos \alpha) \sin \beta$$

where

E_{sc} is the semi-cylindrical illuminance (in lx);

I is the luminous intensity (in cd);

d is the distance between light source and point of calculation (in m);

α is the angle between the vertical plane at right-angles to the flat surface of the semi-cylinder and the vertical plane passing through the luminaire and the calculation point (in degrees);

β is the angle between the direction of light incidence and the vertical (in degrees).

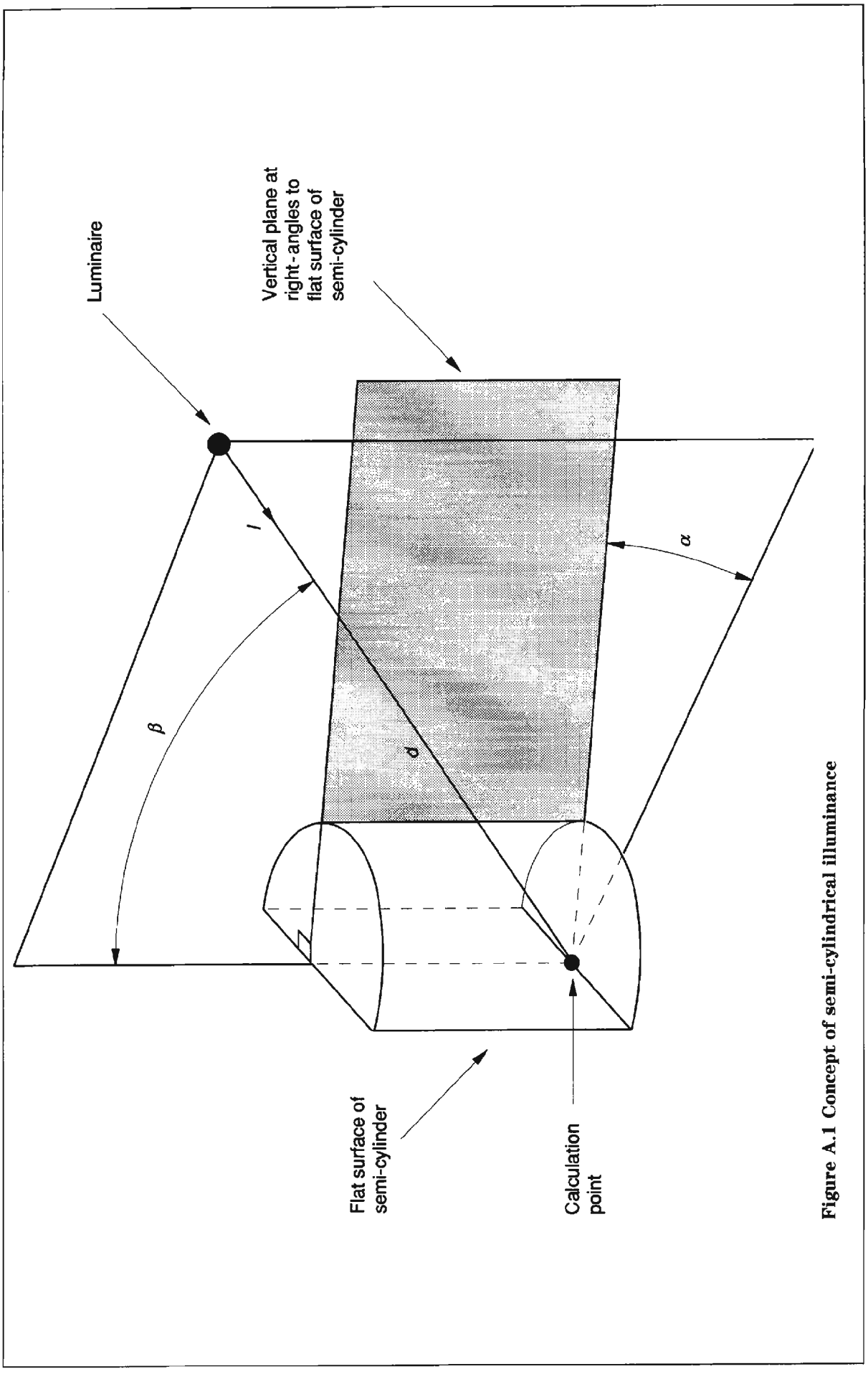

Figure A.1 Concept of semi-cylindrical illuminance

Annex B (informative)
Design methods for floodlighting landmarks

B.1 General

For an initial indication of the number of luminaires needed the lumen method described in **B.2** can be used.

For a more specific design the luminous intensity method described in **B.3** can then be applied.

B.2 Lumen method

Calculate the number of lamp lumens to be directed onto the structure in order to obtain a certain illuminance level by means of the following formula:

$$\varphi_{total} = \frac{AE}{U_F M_F}$$

where

φ_{total} is the total number of lamp lumens, i.e. the total initial luminous flux produced by all lamps (in lm);

A is the surface area of the structure to be illuminated (in m^2);

E is the desired maintained average illuminance on the structure (in lx);

U_F is the utilization factor which takes into account the efficiency of the floodlight and the light losses;

M_F is the maintained factor which is the product of the lamp flux maintenance factor and the luminaire maintenance factor.

NOTE 1. Not all the lamp lumens are projected onto the structure.

NOTE 2. The floodlight reflector system produces some loss. If the initial lamp output is 100 % lamp lumens, 60 % to 75 % are projected through the lighting equipment and 25 % to 40 % are lost due to interruptions in the reflector and absorption by other parts of the floodlight.

NOTE 3. A percentage of the losses can be attributed to wasted light (light which leaves the floodlight but does not fall on the structure).

NOTE 4. An average utilization factor could be 0.35 to 0.50.

NOTE 5. The utilization factor and maintained factor should be obtained from the manufacturer's supplied photometric data.

The total number of floodlights needed (N) can be calculated from the following equation:

$$N = \frac{\varphi_{total}}{\varphi_{floodlight}}$$

where

φ_{total} is the total number of lamp lumens needed, i.e. the total luminous flux (in lm);

$\varphi_{floodlight}$ is the number of lamp lumens per floodlight i.e. the luminous flux from each floodlight (in lm).

B.3 Luminous intensity method

Calculate the luminous intensity (in candela), radiated by a luminaire in a particular direction by means of the following formula (see figure B.1):

$$I = \frac{Eh^2}{\sin^2 a \cos a}$$

where

I is the luminous intensity in the direction shown in figure B.1 (in cd);

E is the desired illuminance on the vertical face of the structure (in lx);

h is the height above or below the level on which the floodlight is arranged at which the centre of the light beam is aimed on the structure (in m);

D is the horizontal distance from the vertical through the point to be illuminated and the floodlight (in m);

a is the angle at which the light beam strikes the normal on the place to be illuminated (in degrees) ($\tan a = h/D$).

The luminous intensity may be derived from the floodlight isocandela diagram or from a manufacturer's I-table.

Example

An historic monument has to be illuminated. Its width is 2 m and its height is 6 m above ground level. The luminaire can be attached to a lamp column 8 m above the ground situated 25 m from the memorial (see figure B.2).

a) The area of the monument is 12 m^2. The desired illuminance (see table 6) is 50 lx. The utilization factor is estimated at 0.25 and the maintenance factor at 0.8. Using the equation given in **B.2**:

$$\varphi = \frac{12 \times 50}{0.25 \times 0.8} = 3000$$

where

φ is the initial luminous flux of the lamp (in lm).

The monument can, therefore, be adequately lit using a floodlight equipped with a lamp of 3000 lm.

b) Using the equation given in **B.3**, and given that the desired illuminance E is 50 lx, $h = 8 - 3 = 5$ m and $a = 11°$, then:

$$I = \frac{Eh^2}{\sin^2 a \cos a}$$

$$I = \frac{50 \times 5^2}{0.035 \times 0.981}$$

$$= \frac{50 \times 25}{0.037} = 33\,784$$

The luminous intensity in the beam centre should be approximately 34 000 cd.

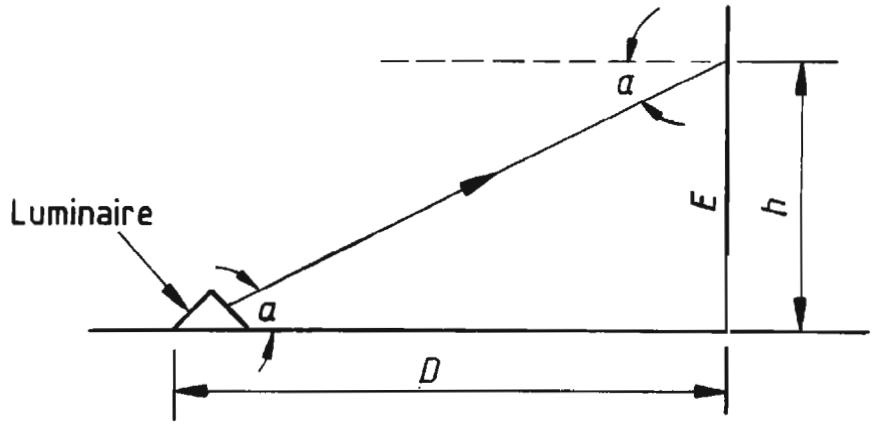

Figure B.1 Luminous intensity diagram

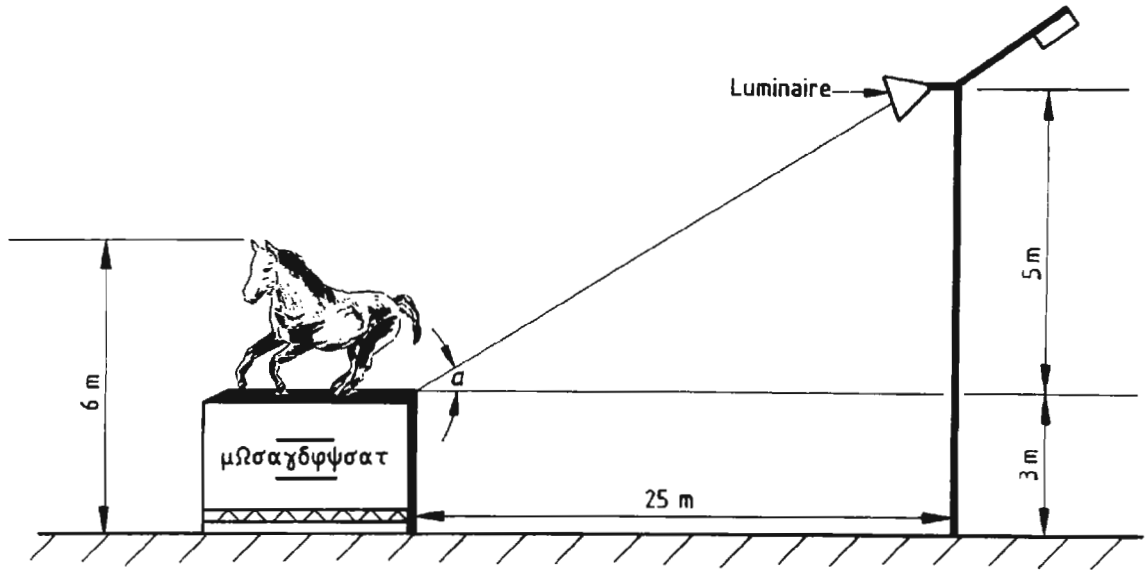

Figure B.2 Example of floodlighting a monument

Annex C (informative)

Work sheet for the installation design process

Figure C.1 shows a work sheet for the installation design process. It may be photocopied and used for design purposes.

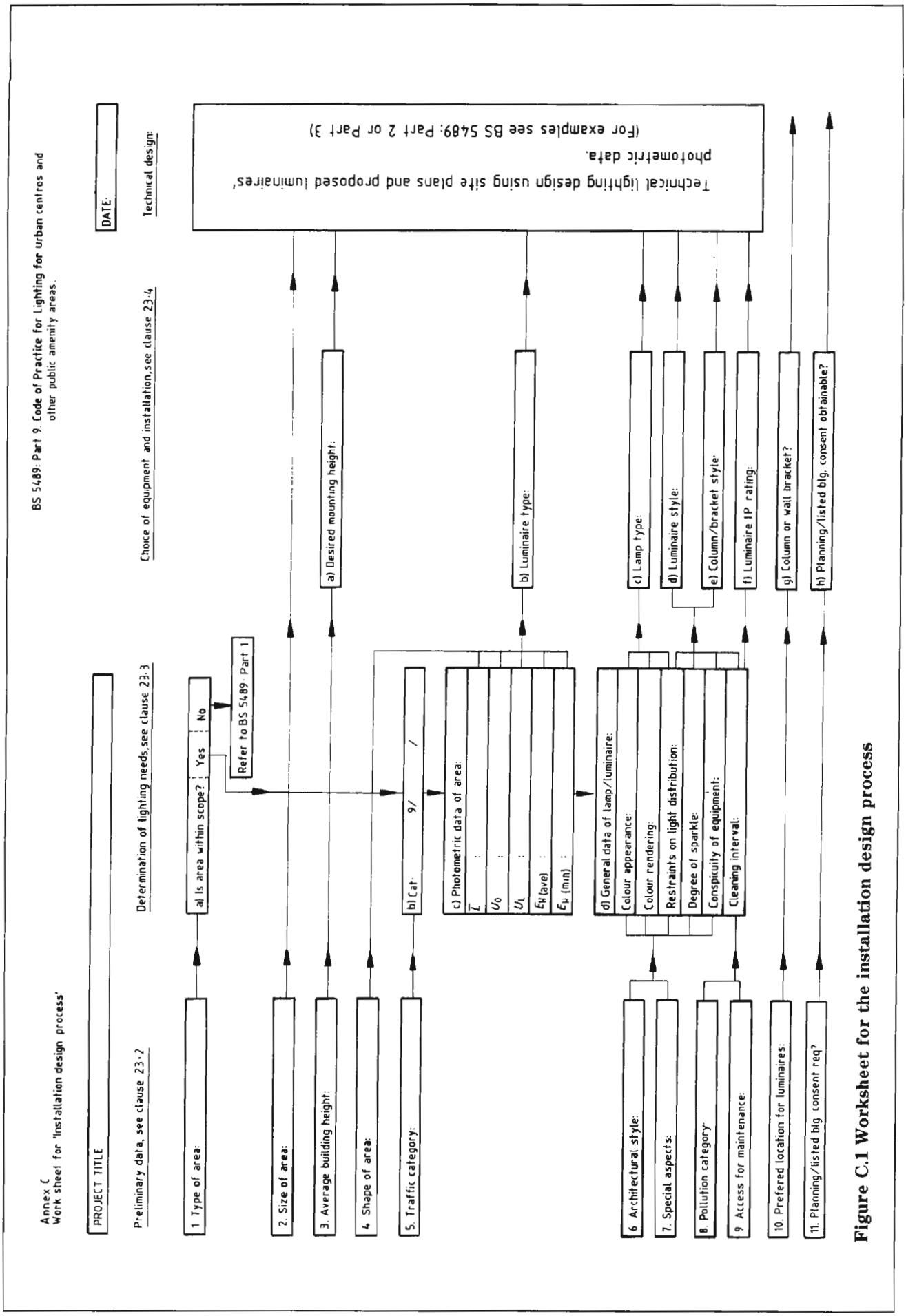

Figure C.1 Worksheet for the installation design process

List of references (see clause 2)

Normative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 5225 :	*Photometric data for luminaires*
BS 5225 : Part 1 : 1975	*Photometric measurements*
BS 5266 :	*Emergency lighting*
BS 5266 : Part 1 : 1988	*Code of practice for the emergency lighting of premises other than cinemas and certain other premises used for entertainment*
BS 5266 : Part 3 : 1981	*Specification for small power relays (electromagnetic) for emergency lighting applications up to and including 32 A*
BS 5489 :	*Road lighting*
BS 5489 : Part 1 : 1992	*Guide to the general principles*
BS 5489 : Part 2 : 1992	*Code of practice for lighting for traffic routes*
BS 5489 : Part 3 : 1992	*Code of practice for lighting of subsidiary roads and associated pedestrian areas*
BS 5489 : Part 7 : 1992	*Code of practice for the lighting of tunnels and underpasses*
BS 5489 : Part 8 : 1992	*Code of practice for lighting of roads near aerodromes, railways, docks and navigable waterways*
BS 6100 :	*Glossary of building and civil engineering terms*
BS 6100 : Part 2 :	*Civil engineering*
BS 6100 : Section 2.4 :	*Highway, railway and airport engineering*
BS 6100 : Subsection : 2.4.1 : 1992	*Highway engineering*
BS EN 60598 :	*Luminaires*
BS EN 60598-1 : 1993	*General requirements and test*

Informative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 5775 :	*Specification for quantities, units and symbols*
BS 5775 : Part 6 : 1993	*Light and related electromagnetic radiations*
BS EN 60529 : 1992	*Specification for degrees of protection provided by enclosures (IP code)*
BS EN 60598 :	*Luminaires*
BS EN 60598-2 :	*Particular requirements*
BS EN 60598-2-18 : 1994	*Luminaires for swimming pools and similar applications*

Other references

[1] INSTITUTION OF LIGHTING ENGINEERS *Guidance notes for the reduction of light pollution*, 1994[1)].

[2] GREAT BRITAIN. Town and Country Planning Act 1971 and regulations (S.I. 1532 : 1969). London : HMSO.

[1)] Available from the Institution of Lighting Engineers, Lennox House, 9 Lawford Road, Rugby, CV21 2DZ.

BS 5489
Part 9 : 1996

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