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TECHNICAL REPORT

Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations, 2nd Edition

CIE 150:2017

UDC: 628.931
628.971

Descriptor: Artificial lighting: Design and calculation
Exterior lighting

THE INTERNATIONAL COMMISSION ON ILLUMINATION

The International Commission on Illumination (CIE) is an organization devoted to international co-operation and exchange of information among its member countries on all matters relating to the art and science of lighting. Its membership consists of the National Committees in about 40 countries.

The objectives of the CIE are:

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2. To develop basic standards and procedures of metrology in the fields of light and lighting.
3. To provide guidance in the application of principles and procedures in the development of international and national standards in the fields of light and lighting.
4. To prepare and publish standards, reports and other publications concerned with all matters relating to the science, technology and art in the fields of light and lighting.
5. To maintain liaison and technical interaction with other international organizations concerned with matters related to the science, technology, standardization and art in the fields of light and lighting.

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La Commission Internationale de l'Eclairage (CIE) est une organisation qui se donne pour but la coopération internationale et l'échange d'informations entre les Pays membres sur toutes les questions relatives à l'art et à la science de l'éclairage. Elle est composée de Comités Nationaux représentant environ 40 pays.

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1. De constituer un centre d'étude international pour toute matière relevant de la science, de la technologie et de l'art de la lumière et de l'éclairage et pour l'échange entre pays d'informations dans ces domaines.
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3. De donner des directives pour l'application des principes et des méthodes d'élaboration de normes internationales et nationales dans les domaines de la lumière et de l'éclairage.
4. De préparer et publier des normes, rapports et autres textes, concernant toutes matières relatives à la science, la technologie et l'art dans les domaines de la lumière et de l'éclairage.
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Tous les quatre ans, une Session plénière passe en revue le travail des Divisions et des Comités Techniques, en fait rapport et établit les projets de travaux pour l'avenir. La CIE est reconnue comme la plus haute autorité en ce qui concerne tous les aspects de la lumière et de l'éclairage. Elle occupe comme telle une position importante parmi les organisations internationales.

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Die Internationale Beleuchtungskommission (CIE) ist eine Organisation, die sich der internationalen Zusammenarbeit und dem Austausch von Informationen zwischen ihren Mitgliedsländern bezüglich der Kunst und Wissenschaft der Lichttechnik widmet. Die Mitgliedschaft besteht aus den Nationalen Komitees in rund 40 Ländern.

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1. Ein internationales Forum für Diskussionen aller Fragen auf dem Gebiet der Wissenschaft, Technik und Kunst der Lichttechnik und für den Informationsaustausch auf diesen Gebieten zwischen den einzelnen Ländern zu sein.
2. Grundnormen und Verfahren der Messtechnik auf dem Gebiet der Lichttechnik zu entwickeln.
3. Richtlinien für die Anwendung von Prinzipien und Vorgängen in der Entwicklung internationaler und nationaler Normen auf dem Gebiet der Lichttechnik zu erstellen.
4. Normen, Berichte und andere Publikationen zu erstellen und zu veröffentlichen, die alle Fragen auf dem Gebiet der Wissenschaft, Technik und Kunst der Lichttechnik betreffen.
5. Liaison und technische Zusammenarbeit mit anderen internationalen Organisationen zu unterhalten, die mit Fragen der Wissenschaft, Technik, Normung und Kunst auf dem Gebiet der Lichttechnik zu tun haben.

Die Arbeit der CIE wird durch Technische Komitees geleistet, die in sieben Divisionen organisiert sind. Diese Arbeit betrifft Gebiete mit grundlegendem Inhalt bis zu allen Arten der Lichtenwendung. Die Normen und Technischen Berichte, die von diesen international zusammengesetzten Divisionen ausgearbeitet werden, sind auf der ganzen Welt anerkannt.

Alle vier Jahre findet eine Session statt, in der die Arbeiten der Divisionen berichtet und überprüft werden, sowie neue Pläne für die Zukunft ausgearbeitet werden. Die CIE wird als höchste Autorität für alle Aspekte des Lichtes und der Beleuchtung angesehen. Auf diese Weise unterhält sie eine bedeutende Stellung unter den internationalen Organisationen.

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This Technical Report has been prepared by CIE Technical Committee 5-28 of Division 5 "Exterior Lighting and Other Applications" and has been approved by the Board of Administration as well as by Division 5 of the Commission Internationale de l'Eclairage for study and application. The document reports on current knowledge and experience within the specific field of light and lighting described, and is intended to be used by the CIE membership and other interested parties. It should be noted, however, that the status of this document is advisory and not mandatory.

Ce rapport technique a été élaboré par le Comité Technique CIE 5-28 de la Division 5 "Eclairage extérieur et autres applications" et a été approuvé par le Bureau et Division 5 de la Commission Internationale de l'Eclairage, pour étude et emploi. Le document expose les connaissances et l'expérience actuelles dans le domaine particulier de la lumière et de l'éclairage décrit ici. Il est destiné à être utilisé par les membres de la CIE et par tous les intéressés. Il faut cependant noter que ce document est indicatif et non obligatoire.

Dieser Technische Bericht ist vom Technischen Komitee CIE 5-28 der Division 5 "Außenbeleuchtung und andere Lichtanwendungen" ausgearbeitet und vom Vorstand sowie Division 5 der Commission Internationale de l'Eclairage gebilligt worden. Das Dokument berichtet über den derzeitigen Stand des Wissens und Erfahrung in dem behandelten Gebiet von Licht und Beleuchtung; es ist zur Verwendung durch CIE-Mitglieder und durch andere Interessierte bestimmt. Es sollte jedoch beachtet werden, dass das Dokument eine Empfehlung und keine Vorschrift ist.

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GUIDE ON THE LIMITATION OF THE EFFECTS OF OBTRUSIVE LIGHT FROM OUTDOOR LIGHTING INSTALLATIONS

Summary

This report is a revision and update of CIE 150:2003 *Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations*. The purpose of this Guide is to help formulate guidelines for assessing the environmental impacts of outdoor lighting and to give recommended limits for relevant lighting parameters to contain the obtrusive effects of outdoor lighting within tolerable levels. As the obtrusive effects of outdoor lighting are best controlled initially by appropriate design, the guidance given is primarily applicable to new installations; however, some advice is also provided on remedial measures which may be taken for existing installations.

This Guide refers to the potentially adverse effects of outdoor lighting on both natural and man-made environments for people in most aspects of daily life, from residents, sightseers, transport users to environmentalists and astronomers. (Astronomers also see CIE 126-1997.)

The daytime appearance of the lighting installation is important. The size and nature of the lighting support structures may be intrusive by day although this subject is not addressed in this Guide.

The publication replaces CIE 150:2003 *Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations*.

GUIDE SUR LA LIMITATION DES EFFETS DE LA LUMIERE INDESIRABLE DUS AUX INSTALLATIONS D'ÉCLAIRAGE EXTÉRIEUR

Résumé

Ce rapport a pour objet la mise à jour du rapport technique CIE 150:2003 *Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations*. Le but de ce guide est d'aider à la formulation de directives pour évaluer l'impact sur l'environnement de l'éclairage extérieur et de recommander des limites pour les paramètres pertinents de l'éclairage afin de maintenir les effets indésirables de l'éclairage extérieur dans des limites tolérables. Comme le contrôle des effets indésirables dus à l'éclairage extérieur est plus efficace s'il est pris en compte dès la conception de l'installation, les directives données s'appliquent principalement aux installations neuves ; cependant quelques conseils sur les mesures correctives qui peuvent s'appliquer aux installations existantes sont également fournis.

Ce guide s'applique aux effets potentiellement néfastes de l'éclairage extérieur sur les environnements naturel et artificiel, et sur les individus tels que les résidents, les touristes, les usagers des transports, les écologistes et les astronomes, dans la plupart des aspects de leur vie quotidienne. (Pour les astronomes voir également CIE 126-1997).

L'aspect visuel des installations d'éclairage dans la journée est important. La taille et la nature des structures supportant les luminaires peuvent être également inopportunes dans la journée, mais ce sujet n'est pas traité dans ce guide.

Le rapport remplace CIE 150:2003 *Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations*.

LEITFADEN ZUR BEGRENZUNG DER STÖRLICHTWIRKUNGEN VON AUSSEN-BELEUCHTUNGSANLAGEN

Zusammenfassung

Dieser Bericht ist mit dem Ziel erarbeitet worden, die Publikation CIE 150:2003 *Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations* auf den neuesten Stand zu bringen. Dieser Leitfaden dient dem Zweck, Richtlinien zur Bewertung von Einflüssen der Außenbeleuchtung auf die Umwelt formulieren zu helfen und Grenzen für relevante lichttechnische Größen zu empfehlen, damit von der Außenbeleuchtung ausgehende Störungen im tolerierbaren Bereich gehalten werden können. Da von der Außenbeleuchtung ausgehende Störungen am besten von Beginn an durch eine geeignete Planung begrenzt werden können, ist der vorliegende Leitfaden vor allem für neue Anlagen gedacht; es werden daneben aber auch einige Ratschläge für Verbesserungsmaßnahmen gegeben, die an bestehenden Anlagen durchgeführt werden können.

Dieser Leitfaden bezieht sich auf mögliche negative Auswirkungen der Außenbeleuchtung sowohl auf die natürliche als auch auf die vom Menschen geschaffene Umwelt für Menschen in den meisten Bereichen des täglichen Lebens, von Anwohnern, Touristen und Verkehrsteilnehmern bis zu Umweltschützern und Astronomen. (Astronomen siehe auch CIE 126-1997.)

Das äußere Erscheinungsbild der Beleuchtungsanlage bei Tage ist wichtig. Die Größe und Beschaffenheit der die Beleuchtung tragenden Konstruktionen mag zwar bei Tag störend sein, dieses Thema wird jedoch in diesem Leitfaden nicht behandelt.

Die Publikation ersetzt CIE 150:2003 *Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations*.

1 Scope

This Guide is an update of Publication 150:2003 which sets out guidelines for assessing the environmental impacts of outdoor lighting and gives recommended limits for relevant lighting parameters to contain the obtrusive effects of outdoor lighting within tolerable levels. As the obtrusive effects of outdoor lighting are best controlled initially by appropriate design, the guidance given is primarily applicable to new installations; however, some advice is also provided on remedial measures which may be taken for existing installations.

The Guide specifically refers to the potentially adverse effects of outdoor lighting on nearby residents (e.g. of dwellings such as houses, hotels, hospitals), users of adjacent roads (e.g. vehicle drivers, pedestrians, cyclists), sightseers and transport signalling systems (e.g. air, marine, rail), and on astronomical observations.

The effects of lighting on the natural environment can be difficult to quantify. When there are fields, mountains, forests, rivers, lakes and/or coastline, located close to a lighting installation, there is the possibility, depending upon the season, of the lighting having an adverse effect on insects, plants and animals within the area.

This Guide does not deal with the environmental impacts associated with the daytime appearance of outdoor lighting systems, including their support structures.

The Guide is intended for reference by the following:

- (a) Planning bodies, particularly local government authorities, to assist in assessing the potential obtrusiveness of outdoor lighting installations.
- (b) Designers of outdoor lighting as an aid to producing lighting systems which control obtrusive effects to an acceptable degree.

2 Terms and definitions

For the purpose of this Guide, the definitions given in the International Lighting Vocabulary (CIE, 2011a) and the following apply:

2.1

upward light output ratio

ULOR_α

$R_{ULO,\alpha}$

proportion of the total luminous flux of all lamps considered in a luminaire or a lighting installation which is emitted above the horizontal plane passing through the luminaires in their installed position

Note 1 to entry: The index α points out that the installed position on site is defined by the tilting angle, α , of the luminaire which must be taken into account.

2.2

downward light output ratio

DLOR_α

$R_{DLO,\alpha}$

proportion of the total luminous flux of all lamps considered in a luminaire or a lighting installation which is emitted under the horizontal plane passing through the luminaires in their installed position

Note 1 to entry: The index α points out that the installed position on site is defined by the tilting angle, α , of the luminaire which must be taken into account.

2.3

upward light ratio

ULR

$$R_{UL}$$

proportion of the luminous flux of a luminaire or installation that is emitted, at and above the horizontal, when the luminaire(s) is (are) mounted in its (their) installed position(s)

2.4

upward flux ratio

UFR

$$R_{UF}$$

ratio of the luminous flux above the horizon resulting directly from all the luminaires, reflected from the surface area intentionally lit, and reflected from the surrounding surface areas lit unintentionally because of spill light, to the luminous flux above the horizon in the hypothetical ideal situation where the luminaires have no direct light radiated above the horizon, and all their light is concentrated only to the surface area lit intentionally and that area has exactly the required lighting level

3 Potential obtrusive effects and associated light technical parameters

This clause describes the purposes for which outdoor lighting is provided and the potential effects that such lighting may have on surrounding areas. It also describes how the importance of these effects may be influenced by the nature of the surrounding areas and recommends limits for the relevant light technical parameters which should contain the effects to within tolerable levels.

3.1 The purposes of outdoor lighting

Outdoor lighting is provided for a variety of purposes, examples of which are as follows:

- a) for work or recreation – to enable people to see essential detail, in order that they may undertake the work or recreation activities at night for which the area is intended, e.g. freight yards, sporting fields;
- b) for safety or security – to light the area so as to facilitate the safety or security of persons or property, e.g. lighting of roads, pedestrian pathways, and perimeter lighting;
- c) for amenity – to light features of architectural or historical significance, or to light parks or gardens;
- d) for advertising or display – to promote products or services, e.g. lighting of advertising signs, or to give emphasis to commercial premises by means of lighting.

Irrespective of the purpose for which the lighting is to be installed, consideration should be given to the potential obtrusive effects of the lighting system, both by night and by day.

3.2 Total environmental effects of a development

For any development requiring outdoor lighting, the environmental impact from the lighting will not be the only impact, and may not be the most important one. Other factors relating to the uses which are facilitated by the lighting system could be more significant than the lighting system itself, e.g. noise, traffic or parking. In this case lighting should become part of a wider environmental impact study.

Lighting is often the focus of complaints because it is, by nature, highly visible and is the means by which the conduct of the night activity is made possible. The potential effects of the lighting should therefore be assessed, as part of the overall impacts of a development, by the relevant development approval authority.

The environmental impact of a lighting installation is not limited to obtrusive light. The designers of a lighting installation should be encouraged to utilize luminaires and light sources that efficiently direct the light into the area required, thereby minimizing the energy consumption and waste light.

3.3 Potential effects of outdoor lighting

Outdoor lighting, no matter how well designed, will generally have some effect on the environment in which it is installed.

The objectives of the lighting may be incompatible with the containment of light within the intended area of application. For example, some activities require the illumination of a volume or space, not just of a surface at ground level. The following examples illustrate this point:

- a) lighting for certain sports, e.g. tennis or golf where it is essential to be able to see the movement of the ball in the space above the playing surface to an appropriate height;
- b) lighting a freight terminal where it is necessary to identify containers in multiple container stacks; or
- c) security lighting at or adjacent to the property boundary.

For such applications, light must be directed at high angles to illuminate the space satisfactorily, but this can create difficulties in controlling the light spilled beyond the boundaries of the installation. Restriction of direct views of bright luminaires also becomes difficult. There will also be a general diffusion of light within the lit space resulting from reflection from surfaces and atmospheric scattering.

In the case of amenity lighting, everything needs to be in balance. One over-floodlit building can ruin a total nightscape and lead to an undesirable spiralling of brighter and brighter buildings that in time can raise the overall district brightness to unnecessary and undesirable levels.

In the design and installation of an outdoor lighting system, consideration should be given to the potential effects of the lighting on occupants of surrounding properties and on transport users in the vicinity of the installation. These effects include the following:

- a) changes to the amenity of an area due to the intrusion of spill light into otherwise dark areas, both outdoors and indoors, and to the direct view of bright luminaires and to overlit facades and signs;
- b) a reduction in the ability of transport system users to see essential details of the route ahead, including signalling systems, due to glare from bright luminaires; and
- c) changes to night sky viewing conditions due to a general luminous glow, i.e. sky glow caused by the scattering of light in the atmosphere.

People will have a range of reactions to the installation of outdoor lighting; responses may vary from positive acceptance to outright rejection. The degree of response will depend, in part, on the nature of surrounding developments (see 3.4), past experiences, novelty of the installation, and frequency and times of operation.

3.4 Influence of surrounding developments

The perception of the lighting system may be significantly influenced by the following factors:

- a) The zoning of the area abutting the proposed development. There is a greater potential for complaints where the area is zoned for residential development.
- b) The state of development of the area described in Item (a), i.e. whether the area is sparsely settled or fully built-up.
- c) The topography of the area surrounding the lighting installation. Residential developments which are at a lower level than that of the lighting installation should be particularly considered, where a direct view of the luminaires is possible.
- d) Physical features such as adjacent tall buildings, trees and spectator stands, which may be effective in restricting light spill beyond the boundaries of the development.
- e) The presence or absence of other lighting in the immediate area and the type of lighting involved. The effect of the proposed lighting will be lessened where the surrounding area is reasonably well lit by, e.g. an arterial road lighting or lighting from adjacent commercial developments.

- f) The location of the proposed development relative to:
 - (i) areas of special significance, e.g. areas having cultural, historical or scientific importance;
 - (ii) harbours, airports, waterways, roads or railway systems where spill light from the proposed development may interfere with the visibility of signalling systems; or
 - (iii) community and scientific optical observatories where upward light from the proposed development because of resulting sky glow may interfere with astronomical observations.

3.5 Specific effects and relevant light technical parameters

3.5.1 Effects on residents

Effects on residents generally involve a perceived change in amenity arising from one or more of the following:

- a) The illumination from spill light being obtrusive, particularly where the light enters rooms of dwellings that are normally dark, e.g. bedrooms. The illuminance on surfaces (E), particularly vertical surfaces, is an indicator of this effect.
- b) The direct view of bright luminaires from normal viewing directions causing annoyance, distraction or even discomfort. The luminance of a luminaire, in a nominated direction, is an indicator of this effect. However, because luminance data are usually not provided by luminaire manufacturers', recommendations in this Guide are expressed in terms of luminous intensity (I) in specified directions.
- c) The tolerable levels of each of these light technical parameters will be influenced by the ambient lighting existing in that environment. This will be determined largely by the degree and type of the development of the area and by the lighting in place.
Values of the light technical parameters that are acceptable during the earlier hours of the evening may become intolerable if they persist at later times when residents wish to sleep. This leads to the concept in this Guide of a curfew; a time after which more stringent controls should be applied. This could include turning off unnecessary lighting, dimming, lighting when higher levels are no longer needed, etc.
- d) The sky glow caused by upward-directed light that lights up the environment, increases the illuminance on surfaces on top of the effect mentioned already under (a), and impedes visibility of stars and thus decreases the pleasure to see the stars.

3.5.2 Effects on transport system users

Effects on road users (e.g. motorists, cyclists, pedestrians) normally involve a reduction in the ability to see caused by disability glare from bright light sources. The apparent contrast of objects against their backgrounds will be lowered, rendering them less visible or even invisible, especially if the environment is intrinsically dark. The magnitude of the effect will depend on the level of lighting to which the user is adapted. The relevant indicator is the threshold increment (TI), which is also used to specify the limitation of glare in road lighting - see CIE 031-1976 (CIE, 1976) and CIE 115:2010 (CIE, 2010).

Where transport systems operate in the proximity of a proposed outdoor lighting installation, the relevant transport authority (i.e. road, marine, waterway, rail or air) should be consulted.

Statutory requirements may apply; for example, regulations issued by the Aviation Authority apply to the effect of outdoor lighting on air navigation.

Effects on transport signalling systems will normally involve a reduction in the visibility of the signals either by:

- a) disability glare, as described above; or
- b) visual clutter, where signals are viewed against a competing background of other lights; the effect is made worse if these lights are coloured.

3.5.3 Effects on sightseers

The effects on sightseers of over-bright or unsuitably-coloured decorative lighting and signage will be to regard the overall lighting effects as obtrusive rather than enhancing the night-time scene. Good guidance on decorative floodlighting techniques is given in CIE 094-1993 (CIE, 1993). The relevant indicator will be the luminance (L) of the surfaces. The acceptable luminance of signs will depend on the size of the surface viewed.

3.5.4 Effects on astronomical observations

Effects on astronomical observations will generally involve the modification of night sky viewing conditions by:

- a) brightening of the dark sky caused by the scattering of light from the installation in the atmosphere, producing a luminous glow (i.e. sky glow);
- b) the spectral characteristics of the sky glow, so that the light from the glow is not readily filtered out by optical means at the telescope and overlaps with the spectrum of starlight; or
- c) direct light from the installation falling on the observatory.

Where outdoor lighting installations are proposed in the vicinity of community or scientific optical observatories located in suburban environments, the limitations of spill light, illuminance level, lamp spectral emission and luminance of luminaires in nominated directions (in accordance with 3.6.1) will help mitigate the adverse effects of a lighting installation.

If the location of an optical observatory is more than say 20 km from a lighting installation, the largest impact of light (in clear sky conditions), is that radiated in directions close to the horizon (mainly 90° – 110°) since it travels over a long, near horizontal path through the atmosphere, and scattered light over this long path causes sky glow over a long distance. (Cinzano and Diaz-Castro, 2000; Falchi, 2011; Garstang, 1986; 1989; 1991; Luginbuh et al., 2009).

The problem of sky glow may be mitigated if exterior lighting in the immediate vicinity of the observatory, including local road lighting, utilizes low pressure sodium lighting or LEDs with similar spectral emission. When the observatory is located much further away from the lighting installation (say more than 50 km to 100 km) then other more flexible measures could be taken such as using lamps with limited emissions under 550 nm (high pressure sodium lamp or similar). It is known that sky glow is mainly inversely proportional to the fourth power of the wavelength, so red light will be better than blue and warm light better than cold light. If this measure is to be implemented, close consultation will be needed between all the parties involved, i.e. observatory, local community and electricity utility.

Finally, the overall impact will, of course, depend on the size of the lighting installation and its distance to the observatory or reference point. For example, for a city of 20 000 inhabitants 20 km from the observatory will have a similar adverse effect to a city of one million inhabitants 100 km away, both having the same lighting limitations.

Where a major scientific optical observatory is involved, the above points are still pertinent. However, limitations of light installation may be imposed over a considerable area surrounding the observatory as part of a long-term plan to maintain satisfactory night sky viewing conditions. Such plans should be based on guidelines set out by the International Commission on Illumination and the International Astronomical Union, see CIE 001-1980 (CIE, 1980). There may be specific local government ordinances in this regard; consequently, both the local council and the managing body of the observatory should be consulted.

The majority of the light that is emitted directly from luminaires near to or above the horizontal causes sky glow. This, in its simplest form, can be controlled by limiting the upward light ratio (ULR) of the luminaire. ULR is a luminaire parameter, defined for the actual mounting or tilting angle of the luminaire. If luminaire manufacturers make the luminaire ULR value(s) available on their documentation for the most relevant mounting position(s), it facilitates the selection of luminaires that could be suitable for an actual, upward light controlled installation.

While ULR takes account of the direct upward luminous flux emitted from the luminaire, it does not take account of the light from the luminaires reflected upwards from the surface to be lit. The upward flux ratio (UFR) takes this into account.

As mentioned above, light emitted just above the horizon in a zone between 90° and 110° is extra-critical for sky glow in the far surroundings of observatories. Therefore, around observatories, luminous intensities in the zone between 90° and 110° ($I_{90^\circ-110^\circ}$) should be limited as well as the ULR and UFR.

3.6 Recommended limits for light technical parameters

3.6.1 Basis of recommendations

The light technical parameters identified in 3.5 as indicators of potential obtrusive effects are listed in 3.6.5 together with recommended maximum values for various situations on the basis of present knowledge, experience and precedent. Although these values should control the obtrusive effects, they will not necessarily ensure that a complying installation will receive no adverse reaction whatsoever from those affected by the spill light, as annoyance levels are subjective.

The limiting values recommended for the control of obtrusive effects have been developed taking account of the following:

- a) the level of brightness existing in the area;
- b) the times that the proposed lighting is to operate;
- c) the type of lighting technology available to light the activity; and
- d) the use of readily available and easily understood technical data on the lighting installations that can easily be verified at the design and assessment stages.

For installations that are to operate during both pre-curfew and post-curfew hours, no assessment of illuminance, E , and luminous intensity, I , need to be made for compliance with pre-curfew limits provided compliance can be demonstrated with the limits for post-curfew hours.

For the reasons stated in this clause, two sets of limits are given in 3.6.5 for the parameters E and I , based on the times that the lighting system is to operate. For determining which set of limits applies, post-curfew hours should be taken as being between (not later than) 23:00 h and 06:00 h, unless otherwise specified by the controlling authority.

3.6.2 Applicable limits

The more restrictive values, applying after the curfew hour, are predicated on the maintenance of amenity and environmental integrity being the dominant considerations. The spill light at these times should be such that it will not be obtrusive to the majority of recipients. To achieve this goal, the need for the proposed lighting and its use during curfew hours should be considered in the first instance. If the lighting is to operate during curfew hours then careful attention needs to be given to the limitation of spill light, including consideration of the type of lighting system to be used, the type of floodlights (i.e. light distribution) and their specific location and aiming, and the need for the fitting of louvres, baffles or shields. Compliance with the recommendations of 3.6.5 will require a detailed analysis of the situation with the identification of actual potential problem locations, see Figure 1.

The less restrictive values are predicated on dark hour activity taking place whilst giving passive recipients of spill light relief from it being excessively obtrusive. The limiting values are based on the use of conventional lighting technology but with good practice being employed through the selection of appropriate lighting levels, floodlighting equipment and aiming practices.

Therefore, two sets of limiting values are given dependent on the levels of lighting already in the area. One, with higher values, is for application before a nominated or curfew hour set by the controlling authority and one, with lower values, is for application after that hour.

Studies have shown that intensity of bright light sources necessary to satisfy the majority of people as being at all times unobtrusive are rather low. Furthermore, these values can easily be exceeded with conventional lighting practice, especially if the area of activity being lit is large and the required light level is relatively high. Thus, the potentially conflicting requirements for dark hours activity and the maintenance of amenity and environmental integrity have to be resolved.

These criteria have been employed to ensure that the Guide is both credible to the interested parties and pragmatic in application.

Where a different curfew time applies for other reasons (e.g. noise control), consideration should be given to the co-ordination of the curfews, i.e. allowing sufficient time of operation for the lighting after the conclusion of the activity to facilitate crowd dispersal, particularly where large numbers of spectators are involved.

3.6.3 Determination of compliance

It is recommended that the procedures set out in Clause 4 and summarized in Figure 2 be used in the process of determining whether a particular lighting installation complies with 3.6.5. Compliance with the limiting values recommended in 3.6.5 should be assessed on the basis of calculations of the applicable light technical parameters in accordance with Clause 6.

The values recommended in 3.6.5 refer to the installation alone. When evaluating a proposed lighting installation for compliance, account should be taken of existing obtrusive light. If there is already significant obtrusive light from existing lighting, the designer of the installation should endeavour to achieve values of light technical parameters that are well within the recommended limits.

If there is likely to be a significant addition to the vertical illuminance as a consequence of reflected light (see 4.2.5), the designer should endeavour to achieve values of E_v that are well below the recommended maximum.

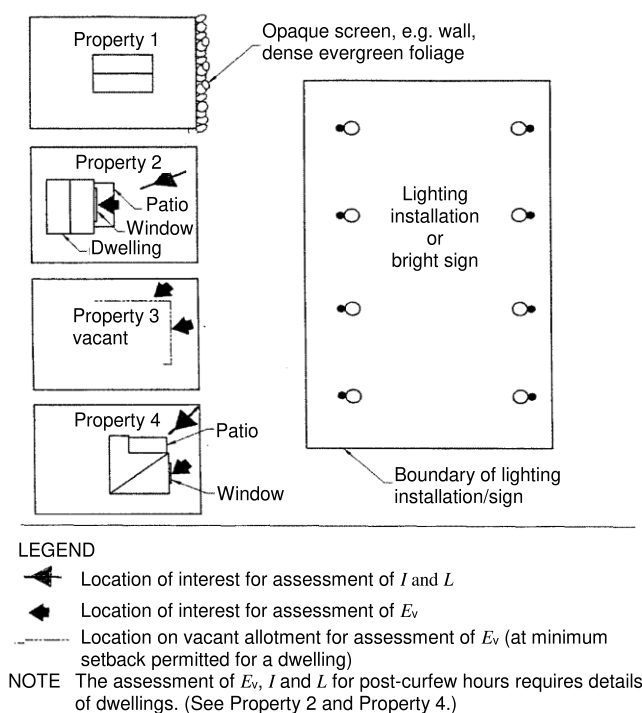


Figure 1 – Example showing application of limits for E_v and I (and, in the case of bright signs, L)