Brecon Beacons National Park Authority

Local Development Plan Policy 12
Light Pollution & Obtrusive Lighting

March 2015

Supplementary Planning Guidance

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1. Introduction

1.1 In considering any scheme which involves the installation of external lighting the Brecon Beacons National Park Authority (BBNPA) will have particular regard to the Adopted Brecon Beacons National Park Local Development Plan (LDP) and in particular Policy 12 (Light Pollution) which can be seen below. This SPG is produced to explain how this LDP Policy should be applied in practice.

1.2 Specifically it seeks to encourage developers, architects and lighting designers to provide non-obtrusive lighting designs when preparing proposals for any development which incorporated an element of out of doors artificial lighting.

1.3 This SPG relates to all exterior lighting situations regardless of the location of the lighting project or whether it is a stand-alone project or part of an overall development. Potential developments and lighting situations include, but are not limited to:-

- Industrial developments
- Retail developments
- Housing developments
- Transport interchanges
- Roads and footpaths (either stand alone or as part of an overall development)
- Exterior sports grounds and arenas
- Feature lighting for civic enhancement
- Illuminated advertisements
- Replacement of existing lighting installations

The BBNPA will seek to prevent statutory nuisances where lighting forms part of a planning permission and may seek to regulate light as part of planning conditions and obligations.

1.4 Pre-application discussions can be particularly useful in helping applicants and agents identify the issues to be covered and information that will be needed to support any application for planning permission, which in turn can help minimise delays in processing the application.

2. The Control of Obtrusive Lighting

2.1 Obtrusive Lighting

2.1.1 Obtrusive lighting or light pollution can be defined as the unnecessary brightening of the night sky as a result of upwardly directed light. Usually light pollution is caused by poorly designed development schemes and inappropriate or poorly installed lighting equipment. Obtrusive lighting can cause nuisance to residents and present safety problems through glare, especially to drivers and waste electricity. The table below details types of obtrusive lighting.

Glare	Glare forms a veil of luminance from poorly controlled and directed lighting which reduces contrast and visibility. To road users, glare can be highly dangerous.
Light Trespass	Light spill into neighboring properties or areas and can be problematic to deal with as it often involves neighbor disputes.
Scenic Intrusion	This is a form of light pollution that can be caused by any light source or reflected glow that is not commensurate with the characteristics of an area of high landscape or townscape value. The colour of a light can be as much a pollution factor as its location, orientations and intensity, as it can alter the character of a place after dark and adversely affect its scenic quality. This is of particular relevance to the Brecon Beacons National park as it is a protected landscape and Dark Skies Reserve.
Sky Glow	This is the glow that is visible around urban areas resulting from the scattering of artificial light. Sky glow is often the most difficult form of light pollution to deal with and required pre-planned measures to be taken over a long period of time to reduce it.

2.2 Why obtrusive lighting needs to be controlled

2.2.1 All living things adjust their behavior according to natural light. Man's invention of artificial light has done much to safeguard and enhance our night-time environment but, if not properly controlled, obtrusive light (commonly referred to as light pollution) can present serious physiological and ecological problems.

2.2.2 There are many reasons why obtrusive light should be prevented for example, cost savings by local authorities, businesses and households through not generating unnecessary light; the benefit to the tourism industry through maintaining the National Park's dark sky; and less carbon emissions from electricity need. However,

the prime objective for adequate control in accordance with Local Development Plan Policy is to minimise the problem it creates for human beings, plants and animals thereby improving amenity and biodiversity.

3. Policy and Designation

3.1 Local Development Plan Policy

3.1.1 The statutory development plan for the area is the Local Development Plan, which was adopted for the determination of planning applications in December 2013. The LDP contains policy relating to the control of lighting within development as follows

Policy 12 Light Pollution

Proposals where lighting is required shall include a full lighting scheme and will be permitted:-

a) where the lighting proposed is appropriate to its purpose; and,

b) where there is not a significant adverse effect individually or cumulatively on

i) the character of the area;

ii) local residents;

iii) vehicle users;

iv) pedestrians;

v) biodiversity; and

vi) the visibility of the night sky.

vii) 'dark corridors' for bats and light sensitive species.

3.1.2 Dark skies are recognised as a key contributor to the sense of tranquility and remoteness which is often cited as a key special quality of the National Park. Policy 12 of the Brecon Beacons National Park Local Development Plan 2013 seeks to protect dark night skies from the impact of lighting and to relate any lighting proposed to its purpose, such as site security floodlighting recreational facilities, so that careful design and the use of appropriate means of lighting and lighting levels minimise the impact on adjoining area.

3.1.3 Proposals which individually or cumulatively have an unacceptable adverse effect on dark night skies will be resisted.

3.2 Dark Skies Reserve

3.2.1 The International Dark Skies Reserve status is a prestigious award given to destinations that can prove that they have an outstanding quality of night sky and provide evidence that it is being protected. The award is given by the International Dark Sky Association whose mission is "to preserve and protect the night-time environment and out heritage of dark skies through quality outdoor lighting."

3.2.2 Whilst large areas of the National Park remain free from light pollution, the gradual encroachment of street, house and security lights means that views to starlight can be spoilt. It therefore essential to take into account the National Parks status as a International Dark Skies Reserve.

3.2.3 The International Dark Skies Reserve identifies 4 distinct regions within and around the National Park, each of which have different constraints on the levels of permanent illumination allowed as follows:-

Core Zone – It is the aspiration that within this area that there will be no additional permeant illumination as a part of new development within this region and that any necessary lighting will not be lit in a manner that increases upward light spill.

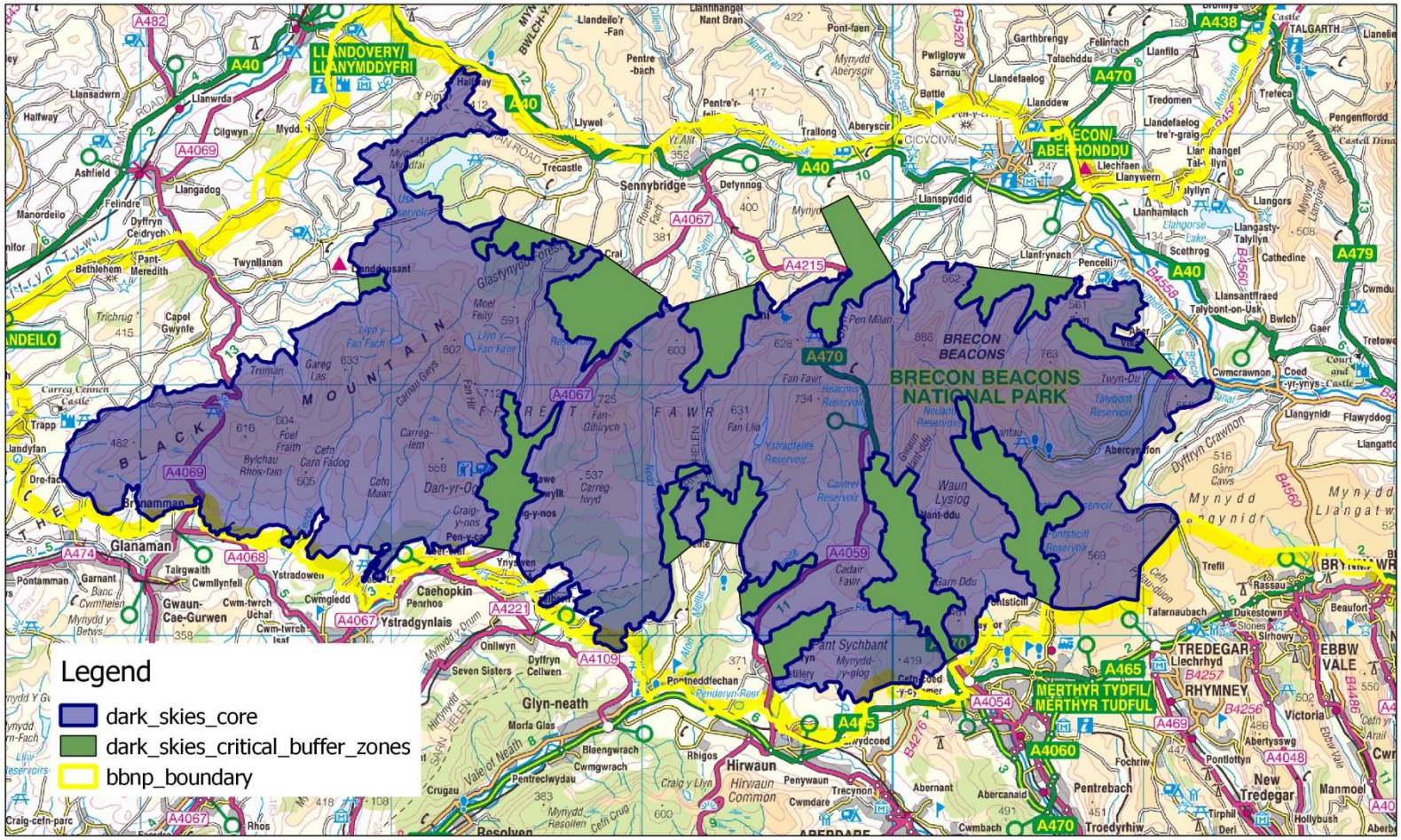
Critical Buffer Zone – It is the aspiration that there will be no lighting projected from the buffer zone into the core zone. Luminaires in the Critical Buffer Zones using lamps greater than 1000 lumens will be expected to be installed as fully shielded.

Buffer Zone (remainder of NP area) All new lighting resulting from development within the Buffer zone will be encouraged to be designed and installed to provide lower glare or intensity values, where possible, than that recommended by the institute of Light Professionals for night time Environmental Zones

External Zone – (outside the NP park area) The NPA will utilise the contents of this guidance note as supported by the *BBNP International Dark Sky Reserve Lighting Management Plan* to provide the basis for discussion with neighboring LPAs on lessening development proposals potential for light pollution.

3.2.4 Of importance within this guidance note is the Core Zone. Within this area there is an expectation that there will be no additional permanent illumination installations as a result of new development. The Lighting Management Plan also states that there will be a curfew in place. For the National Park 22:00 has been adopted as 'exterior light curfew' As such new development within the Core Zone will be expected to extinguish or reduce the quantity of lighting unless there are previously agreed planning conditions which contain an earlier curfew time.

3.2.5 For further information please refer to BBNP International Dark Sky Reserve Lighting Management Plan
http://darksky.org/assets/Night_Sky_Conservation/BBNPA%20LMP%20complete.pdf



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4. Lighting and Development

4.1 General Design Considerations

4.1.1 The best time to consider what lighting is necessary in a development is at the outset of the design process. It is important to think how the development will interact with the night time environment; how it will be used at night and, by design, minimise the need for exterior lighting - for example, by using lighting only where and when it is necessary, using an appropriate strength of light and adjusting light fittings to direct the light to where it is required. Illumination should be appropriate to the surroundings and character of the area as a whole. The Institute of Lighting Professionals (ILP) has produced guidance regarding the reduction of obtrusive light within development schemes. It provides a good starting point for any applicant embarking on designing the lighting element of their development scheme. It is available to download free of charge here https://www.theilp.org.uk/documents/obtrusive-light/

4.1.2 In general all development within the National Park area should aim to avoid over-lighting, and use shields, reflectors and baffles to limit lighting impact, however within the core zone (see map 1) exterior lighting that forms part of a new development proposal is tightly restricted. Within the core zone there should be no permanent illumination installations as part of new development (that is permanently lit, rather than permanently sited). Some exception may be possible where illumination is necessary in the interest of public safety; however such exceptions will need to be supported by robust evidence of their necessity and appropriate assessment will be required.

4.1.3 Regardless of location, in designing a lighting scheme within a new development the National Park Authority will require all applicants to follow a common design process (see section 4.2 below). This will enable the Authority to properly asses the lighting design and impacts on the night time environment of the National Park.

4.2 Application requirements

4.2.1 As set out by LDP Policy 12 all new development within the National Park that proposes exterior lighting will be expected to be supported by a lighting plan. In essence, a lighting plan is a statement of the design process which has been followed in order to arrive at a particular lighting scheme. Figure 4.1 below sets out the steps of the design process which should be employed when formulating the design process, these steps in turn form headings in the supporting lighting plan.

Good Design Practice – 20 Point Checklist

1. Statement of client needs and interested parties' comments
2. **Survey of surrounding area night environment***
3. **Identification of critical viewpoints**
4. Establishment and calculation of existing lighting conditions
5. **Establishment of environmental light control limits**
6. Summary of baseline measurements and/or calculations
7. **Analysis of task lighting level recommendations**
8. **Statement of new lighting design quality objectives**
9. Outline of iterative lighting design methodology
10. **Horizontal Calculation of Task Working Areas and Overspill**
11. **Obtrusive light calculation**
12. **Compare design achievement with baseline values**
13. Designers critique of final design constraints
14. Viewpoint visualisation
15. Virtual walkthrough of illuminated site
16. Schedule of model reflection factors
17. **Schedule of luminaire types, mounting height and aiming angles**
18. Schedule of energy usage and distribution
19. **Schedule of luminaire profiles**
20. **Layout plan with beam orientation indication.**

* Items listed in bold are essential components of lighting design and should be addressed by Lighting Plans provided in support of all applications.

Figure 4.1 Lighting Plan Contents

4.2.2 The level of detail required will vary according to the development proposed, eg a residential development requires the applicant to follow only the 12 step process (those given in bold), whereas a car park requires the full 20 step process. Appendix 1 of this SPG sets out Lighting Plan requirements by application type. Section 4.3 below gives a brief overview of the key elements to be covered within the plan for each essential heading, for more detail, including detail relating to non-essential elements applicants are advised to consult Appendix 2 of this SPG and/or the Scottish Executive's good practice guidance (2007) Controlling Light Pollution and

Reducing Lighting Energy Consumption or for domestic lighting
https://www.gov.uk/government/publications/getting-light-right

4.2.3 Within the core zone where exterior lighting is proposed as part of the development scheme, the lighting plan must provide an additional section, setting out a robust and evidenced justification for the need of the lighting in the interest of public safety.

4.3 Lighting Plan Contents

4.3.1 A basic lighting plan should document the following design process. Please note the numbers given in parenthesis relate to the steps set out in figure 4.1 above. Further guidance is given at Appendices 1 and 2.

(2) *Survey of surrounding area night environment*

The starting point of any study should be a clear understanding of the site within the night time environment based on field analysis. This survey should include the location and identification of all existing lighting equipment in the area.

(3) *Identification of critical viewpoints / sensitive receptors*

Critical viewpoints are determined from site survey and relate to existing receptors within the environment which will be impacted upon by the proposal, such as neighbouring / adjacent residential development. Consideration should also be given to long views into the proposed development site and any potential impacts from the proposal on the wider night time environment. A visual risk analysis should be undertaken in relation to the receptors sensitivity to the light limitation values.(see annex 1 for an example of typical Table of Importance to Sensitive Receptor).

As well as visual impacts this section should give due consideration to all seven sensitive receptors set out in criteria b(i-vii) of policy 12, with particular reference to the potential for impacts on light sensitive species and biodiversity. Where these are identified as an issue due consideration to limiting impacts to acceptable levels should be made throughout the lighting plan.

(5) *Establishment of environmental light control limits*

Setting out the policy control and its implications over the location of development scheme, eg is it located within the Core Zone, within or adjacent to an area of statutory environmental designation (eg SAC/SSSI)

(7) *Analysis of task lighting level recommendations*

In this instance 'task' relates to the purpose of the lighting scheme, eg, residential security lighting, sports pitch lighting. Most tasks have a particular lighting quality objective published as a recommended value. At this stage the NPA will be seeking to determine whether the lighting objectives are appropriate through comparison to accepted standards. The plan should clearly state compliance with stated lighting quality objectives, and the published source of these objectives.

(8) *Statement of new lighting design quality objectives*

Lighting design quality objectives should be detailed in brief, setting out the predicted 'lighting technical parameters' the lighting scheme will be designed to achieve.

(10) *Horizontal Calculation of Task Working Areas and Overspill*

It is essential that all applications contain details of the light level calculations showing a horizontal grid of predicted values of not only the task area but also for the overspill area beyond the site limits.

(11) *Obtrusive light calculation*

The applicant should demonstrate how the scheme has been designed to limit obtrusive light to those considered within acceptable levels for the relevant environmental zone in accordance with recognised standard limits [1] This calculation should be done for at least the following items both before and after curfew time (if relevant).

Direct line of sight from the light emitted

Light intruding through property windows

Upward light ratio

(12) *Comparison with baseline*

The NPA will expect the lighting plan to carry out the assessments above as part of an iterative process during the formulation of the design.

It will also expect designers to give due consideration to the cumulative impacts of lighting, it will be necessary to demonstrate that new design overspill does not impinge or provide excess values when added to the existing night time

[1] *Guide on the Limitation of Effects of Obtrusive Light from Outdoor Lighting Applications* CIE Report 150:2003
Guidance notes f

environment.

(17) *Schedule of luminaire types*

The luminaire schedule forms an essential element in both the approval and the subsequent construction stage of the development. The schedule should contain, as a minimum, the items listed below

- Luminaire light distribution type and bowl type
- Lamp type and wattage
- Mounting height
- Orientation direction
- Luminaire tilt.

(19) *Schedule of luminaire profiles*

Provided in pictorial format showing the luminaire types to be utilised onsite together with design reference number, manufacturer's catalogue number, lamp type and watts and the reflector beam width classification.

(20) *Layout plan with beam orientation indication*

The plan should show all the new lighting column and luminaire positions together with a reference number for each location in order to provide a relationship with the column and luminaire schedule described in point 17. Luminaire orientation should be shown by an extended line from the mounting location.

Layout plans should be provided to detail surrounding landscape, property and existing lighting arrangements to assist appropriate assessment of the scheme.

4.3.2 Where a lighting plan is submitted in support of a planning application the NPA will ensure it is adhered to within the finalised development through use of appropriate planning condition and/or where necessary planning obligation.

Appendix 1: Lighting Plan Requirements by Application Type

Methodology Plan	**Distribution Warehouse**	**Sports Complex**	**Building (including residential development)**	**Car Park**	**Road Light**
Statement of interest parties comments	✓	✓			
Survey of surrounding area night environment	✓	✓		✓	✓
Identification of critical viewpoints	✓	✓		✓	
Establishment and calculation of existing lighting conditions	✓	✓			
Summary of baseline measurements and/or calculations	✓	✓			
Analysis of task lighting level recommendations	✓	✓		✓	✓
Statement of new lighting design quality objectives	✓	✓		✓	✓
Outline of iterative lighting design methodology	✓	✓			
Calculated measurement of task working area(s)	✓	✓		✓	✓
Overspill areas	✓	✓		✓	
Obtrusive light calculation of property intrusion	✓	✓		✓	
Viewed Source	✓	✓		✓	

intensities					
Nominal glare assessment	✓	✓		✓	
Direct upward light ratio	✓	✓		✓	
Building luminance	✓	✓			
Combined upward luminance grid	✓	✓			
Compare design achievement with baseline values	✓	✓		✓	✓
Designer critique of final design constraints	✓	✓	✓		
Viewpoint visualisation	✓	✓	✓		
Virtual walkthrough of illuminated site	✓	✓	✓		
Schedule of model reflection factors	✓	✓	✓		
Schedule of luminaire types, mounting height and aiming angles	✓	✓	✓	✓	✓
Schedule of energy usage and distribution	✓	✓	✓	✓	
Schedule of luminaire profiles	✓	✓	✓	✓	✓
Layout plan with beam orientation indication	✓	✓	✓	✓	✓

Appendix 2 Lighting Plan Contents

NB this section is taken from the Brecon Beacons National Park Lighting Management Plan. The full text of which can be viewed at http://darksky.org/assets/Night_Sky_Conservation/BBNPA%20LMP%20complete.pdf

In addition to the ILP rationale covering the process of carrying out Lighting Impact Assessments the Scottish Executive have published a complementary Planning Guidance Note (Controlling Light Pollution and Reducing Energy Consumption) which provides a rationale to all lighting design proposals.

Again reference to the full document will provide energy saving advantages in providing a robust design, however, this LMP should encourage Development Control Committees, both within the Authority and adjacent Local Authorities, to insist on a thorough design process by the developer's lighting engineer before submitting proposals. Although only 12 points are included in the LMP these should be treated as an absolute minimum requirement for small projects and there are no reasons why the full 20 point plan is not set as a standard requirement. The 20 point plan and the reasoning, with lighting performance indicators expected in a Dark Sky area, are included here for the completeness of this Appendix.

1. Statement of Interested Parties' Comments

Not all clients of lighting designers have a clear outline of lighting requirements and sometimes the original objectives of a scheme are explained in very open terms. A short formal statement should not include technical details but could include possible alternatives, described in non-technical terms. Likewise external parties may raise concern or early objections to a new development created by a perceived vision, based on pictures or personal knowledge of examples of poor lighting control in adjacent developments. Special interest groups may also be required to be included.

The collection of interested parties' comments is a way of providing background material, which acts as an early approach to carrying out a lighting risk assessment. The outcome of this risk assessment can be explained in the lighting design methodology as each objection, or restriction, is technically assessed.

2. Site Survey (essential)

Lighting design proposals are often incorrectly, for various reasons, carried out without visiting the development site. Even with a site survey it is not always possible, the first time round, to identify all the potential lighting problems, however, to ignore the surrounds, by not visiting the site, **does not** provide good and thorough design methodology. More importantly failure to carry out a site survey can create a serious deficiency in risk management terms. The site survey should be the starting point for a **Baseline Study** from which various visual and technical elements can be identified.

Where there are any existing lighting units close to the new development the magnitude of the existing lighting effect requires to be measured, or calculated, especially with respect to obtrusive light control, or lack of it. Light is additive and any overspill from the new development will amplify existing levels. (see later in point 4)

3 Critical Viewpoints (essential)

Most new developments today are overlooked to some extent by residential property, and some may be assessed as containing a more sensitive receptor than others. From each critical viewpoint a Landscape Architect will produce an assessment of the new development impact using a non-technical language to quantify the visual day-time magnitude. This planning guidance methodology plan will assist the lighting designer to use a similar approach but substituting a replicable calculation, or measurement, of physical magnitudes of light, to complement the non-technical, subjective, approach provided by others. However, luminaire orientation considerations can sometimes provide different night-time visual priority to those produced by day-time visual aesthetic techniques and it is important to identify alternative viewpoints and installation options at this early stage.

Whenever the lighting statement is required to be carried out in conjunction with a landscape impact assessment it is important to maintain the same critical landscape viewpoints but additional points may require to be included, depending on the final design orientation of luminaires, where found to be night-time sensitive.

Residential property close to the new development always forms the most important viewpoint since there are recommended illuminance limits on windows. However, distant viewpoints, with a clear view of the development often require the need for glare limiting assessments. It is often the magnitude of this viewed light intensity, which provides the source of complaint. If there is only one critical viewing direction the lighting designer can use this to direct light away from the observer but not at the expense of other, less critical, viewpoints.

From each critical viewpoint the importance of each of 5 light limitation objectives, described later in point 11, but namely overspill, sky glow, light into bedroom windows, line of sight source intensity and building brightness will vary, relative to different viewpoints and human interest. The inclusion of a table of importance, exampled below, in the lighting design report will show the designer's first approach to visual risk analysis with respect to the critical sensitive receptors.

able 3.1 Typical Table of Importance to sensitive receptor

Receptor Location	**Overspill**	**Skyglow**	**Light into Windows**	**Source Intensity**	**Building Luminance**
Adjacent to site	High	Nil	High	High	High
Close to site	Medium	Low	Medium	High	Medium
Near to site	Low	Medium	Low	High	Low
Distant to site	Nil	High	Nil	High	Nil

4. Existing Lighting

The calculation or measurement of existing lighting conditions has a twofold implication.

A. Some light limitation values are based on maximum permissible limits. Lighting effects are accumulative and if an adjacent residential window illuminance

has already reached its maximum recommended limiting objective, the new development should show that it has been designed to provide for a zero increase in illumination on the adjacent property. If the site has not been visited this important element will be missed.

It is therefore sometimes inappropriate in a planning application to merely state that the limit will not be exceeded without stating the existing baseline criteria. Each planning application should therefore assume that there is no record kept of existing illuminance values and make submissions relative to site measured, or calculated, magnitudes.

B. Unless the local planning authority has produced a night time environmental zone boundary plan (see following point 5) it is necessary for the lighting designer to assess the existing ambient luminance condition of the area so that the new design can be shown to be better than or commensurate with and not exceeding existing conditions.

5. Establish Environmental Setting (essential)

This section is equivalent, in landscape design terms, to the landscape character assessment and the Scottish Natural Heritage provides zone maps of day-time value of importance to society.

All Dark Sky designated award schemes have well defined environmental zone boundaries as follows

E0: New lighting excluded - eg Dark Sky Core

E1: Intrinsically dark Areas - eg Dark Sky Buffer Zone, Area of Outstanding Natural Beauty and National Parks

E2: Low district brightness - eg Dark Sky External Zone - Rural or small village locations

E3and E4 (in CIE150:2005) do not relate to conditions expected in or close to a Dark Sky designated award area

6. Baseline Condition Summary

A summary table showing calculated or measured values at defined locations are easiest to understand and monitor, however, if there is no existing lighting in the area prior to the new development being implemented there is no need to undertake this measurement.

When measurements are undertaken values of illuminance should show whether they have been measured horizontally or vertically, providing the height from ground level at which they were taken.

7. Task Analysis (essential)

Most exterior tasks have a particular lighting quality objective published [5] as a recommended value but it is sometimes necessary to compare new tasks with similar

existing published operations. The essential point at this stage is to show that the lighting design quality objectives are not excessively high by comparing the design objectives with other similar task lighting recommendations.

A regular planning example of this is found in lighting for sports where there are recommendations for different playing levels of individual games. Planning applications often show the average illuminance the design has achieved without declaring the playing requirement and thereby possibly using more energy than is needed.

8. Lighting Design Objectives (essential)

This should take the form of a short section where the designer creates a technical picture of the predicted "light technical parameters" which the development will be designed to achieve. The lighting quality will be described in terms of illuminance (volume) and sometimes luminance (brightness) and should be compared with a professionally published recommended lighting quality objective.

The lighting designer has access to many sources of published data and should state the source document(s) from which the data has been extracted. A good design will compare lighting quality recommendations with other publications and other equivalent task related recommendations when an exact task fit has not been found in published data.

9. Lighting Design Iterative Methodology

There is often more than one method of achieving the same lighting quality objectives and the lighting designer will often consider different methods as a mental assessment at pre-design stage. The various options are often not considered worthy of documenting and only one option is usually presented in the planning application to assist in simplifying the planning approval stage. It is now very important to show alternative considerations especially where there are electrical energy implications and this point is reinforced in a later point (see 13 - Designer's Critique).

In large projects small areas are sometimes used for trial calculations to show typical lighting levels for different options and for each option the designer should be assessing the likely implications of creating potentially obtrusive situations for adjacent residencies. CIE Report 150:2003 has a generalised flowchart showing a matrix of known pitfalls and benefits of different design options and luminaire mounting height features strongly in the matrix.

As the design develops this process of part design and part appraise can identify the need to modify the design at an early stage and mitigate abortive design work which is often required if the obtrusive light process is carried out at the end of the design. Again the process of change as the design progresses is not often documented to avoid presenting a perceived weakness in the design methodology but if this is documented correctly it can show planners that external concerns have been allowed for and how the design has been constrained to accommodate the concerns.

10. Horizontal Illuminance Predictions (essential)

No design should be considered worthy of starting a planning application assessment if light level calculations have not been carried out. It is one of the simplest tasks in the lighting design process and should show a horizontal grid of predicted values on not only the task area but also the overspill beyond the site limits. Although there are no nationally published

limitations values of horizontal illuminance at the site boundary many local authorities prescribe a locally determined value in development restrictions. Although the boundary limitation value is simple to monitor and measure, post development stage, it should not take precedence to the nationally defined limitation techniques because it may, if used in isolation, hide other more important obtrusive light issues described in point 11 (following).

There are many computer programs available today which can perform simple horizontal illuminance predictions, however, very few have integrated all the processes necessary to calculate and display potential obtrusive light impact values as outlined in point 11. Additionally, in order to assist in visual recognition of the task area relative to adjacent residential properties, the computer software should be able to import suitable mapping of the area and display the external critical observer locations from which predictions have been assessed.

Calculated assessments are normally based on laboratory measured intensity values radiating at various angles from the luminaire. Each luminaire has a unique photometric fingerprint of light distribution and calculated predictions are only correct for the particular luminaire make and type selected for the calculation. Care should therefore be taken at planning approval stage to ensure that the same make and type of luminaire is installed as that proposed in the design. Substitute luminaires cannot be assumed to produce the same effect and planning consent should always be conditional on the luminaire type, mounting height, quantity, lamp type and wattage and luminaire orientation as calculated in the prediction. (Importance repeated in point 17 - Luminaire Schedule)

11. Obtrusive Light Calculations (essential)

The CIE:150:2003 and ILP guidance notes provide lighting designers, planners and environmental health officers with national and internationally recognised technical limitations on stray light. These limitations can be considered as the technical equivalent to visual magnitude and values in excess of the recommendations could be assessed as causing a "nuisance". The design should therefore be carried out in conjunction with monitoring these calculated limits as an iterative test and try process as the design progresses. Sometimes the obtrusive light calculations are carried out at the end of the design process, however, regardless of the point in time these checks are made no planning application should be accepted which does not outline calculated values for all, or at least the first three, of the following.

A Direct line of sight light intensity from luminaires is probably the principal source of potential complaint since it often produces offensive glare. This is light radiated from a luminaire in a particular direction and the limits quoted[3&4] relate to intensity values viewed externally into the site. It is normal practice to calculate that the design mitigates the recommended limiting values from the prime viewpoints identified in the EIA and any additional viewpoints selected by the lighting designer. The table below shows the intensity limit for four night time environmental zones, site pre-determined in point 5.

Expected performance indicators

Source Intensity	E0	E1	E2

Maximum Pre Curfew(cd)	0	2500	7500
Maximum Post Curfew (cd)	0	0	500

B Light intruding into property windows can be predicted by calculating values on a vertical grid representing a window, or series of windows. The recommended limits are additive to what is already being experienced, pre development. If the pre development limits are already exceeded the new design will be required to show, by calculations, that zero additional light intrusion will be provided by the new development.

Expected performance indicators

Intrusion Control	**E0**	**E1**	**E2**
Maximum Pre Curfew(lux)	0	2	5
Maximum Post Curfew (lux)	0	0	1

Both **A** and **B** above are essential elements in proving that the new development proposal will mitigate the majority of residents' concerns. In the case where the development requires the use of all night lighting the more onerous "**post curfew**" limiting values should be chosen as the maximum limit.

C The upward light ratio can vary between individual luminaires depending on their respective tilt angles and light distribution in their intended installed arrangement. Although the evaluation covers the direct upward component of light from the complete installation it does not include the light reflected upwards from the ground. Neither the ILP nor the CIE have defined or quantified this reflective element since no two developments have the same ground cover. As a general rule the darker the building or ground cover surfaces are, the lower the upward reflected component.

Sky Glow Control	**E1**	**E2**
Upward Light Ratio	0%	2.5%

In areas external to a Dark Sky designated area the direct upward light ratio calculation is for the complete installation the proposal application should state the individual luminaire elevations against which the calculation is based. Many good quality luminaires produce a 0% upward light ratio at zero degrees tilt but it only requires a vertical tilt of 10^0 to produce an evaluation of 2.5% upward light ratio.

NP Zone Dark Sky Requirements	Glare Class	Maximum luminous intensity in cd/klm				Non technical description of luminaire light control in installed condition
		At 70 ^{0az}	At 80 ^{0az}	At 90 ^{0az}	At 95 ^{0az}	
Between Core Zone and nearest population cluster > 900	G6*	350	100	0	0	Fully cut-off installation in environmental zone E1
Residential buffer between town centre and rural remainder (or centre of town with < 900)	G5-derivative	350	100	5	0	Cut-off installation
Town Centre with population > 900 (excluding heritage style streets)	G4	500	100	10	0	Part Cut-off installation
Heritage bowl style	G4	500	100	10	0	
Heritage gas style	G4+	500	100	20	0	
External for 5 miles beyond Park boundary (lamps < 20,000 lumens)	G3	.	100	20	2.5%	Semi-Cut-off installation in environmental zone E2
All luminaires with lamps greater than 20,000 lumens between Core Zone boundary and 5 miles distant	G6**	350	100	0	0	Fully cut-off installation regardless of night time environmental zone

D The effect of glare, as viewed by an external observer, is controlled by limiting the viewed intensity as described in A, however, sometimes it is necessary to carry out a second glare assessment in sports lighting to protect the interests of spectators and players. This calculation process is additional to that carried out in A and not a substitute evaluation.

Another additional glare evaluation may also be required to protect the interest of vehicle drivers. The term Threshold Increment has been limited to street lighting quality assessment

calculations for at least 15 years but its use is now being expanded to ensure that vehicle drivers do not exceed a threshold increment limit of 15% from off-road installations situated adjacent to the public highway. Again this is an additional assessment and not a substitute for the requirements described in A and should be carried out as a cumulative process with the existing street lighting provision included in the calculation.

E Building luminance is normally only carried out for structures, which are architecturally transformed at night by the application of illuminating techniques. Different surface textures and colours reflect light in different proportions and a luminance calculation should include a schedule of surface colours and reflection factor characteristics assumed in the calculation process.

F The calculation of the combined effect of direct and upward reflected light is generally un-necessary since there are no national or international recommended limits on which to judge success or failure in the proposed lighting design. There are also very few software algorithms which provide this calculation facility. It can, however, be used with good effect to show a visual comparison between old and new lighting installation technique. It can also be used to show the difference in upward reflections when the new lighting has been designed in conjunction with landscaping techniques to soften the effect of upward reflected light by reducing the area allocation of hard landscaping. Some all weather sports fields can reflect more upward light than that from natural grass due to the high proportion of sand fill in the mesh. In cases like this the increase in upward light should **not** be wholly associated with poor lighting design. If the direct upward component has been shown to be less than the recommended percentage limit for the particular environmental zone then the increase in upward aura can be assessed as a consequence of the development surface treatment.

12. Comparing Design with Baseline (essential)

A robust design methodology will carry out those assessments previously described in point 11 as part of an iterative process during the formulation of the design. This iterative process involves providing trial assessments of the likely outcome of different lighting arrangements in small trial pockets in very large projects. In this way the impact assessment, in technically calculated magnitudes, can be formulated as the design progresses.

Since some of the spill light control values are based on cumulative lighting results it is important to carry out calculations or take varied measurement assessments of the existing lighting arrangement to show that the new design overspill does not impinge or provide excess values when added to the existing arrangement.

If the existing lighting arrangement has been calculated or measured to be providing excessive obtrusive light values and does not form part of the new development it may be judged unfair to over-constrain and penalize the new development for a previous generations' over lighting technique. However, it may be possible to encourage the new development to enlarge the scope of the lighting assessment to provide alternative arrangements for the existing lighting to reduce the impact where the combined lighting values are found to be over the obtrusive limit recommendations.

13. Designer's Critique

A robust design will often consider different elements and applications during the formulation stage but the planning application may only have one final version to approve or reject. In providing a critique, in the form of an appendix, the designer can outline some or

all of the lighting options, which have been considered together with lighting technique reasons for not progressing with some of the options. This can sometimes help the planning officer come to a decision without referring the proposal back to the designer to try something different.

14. Viewpoint Visualisation

In addition to the calculations necessary to prove that the design does not produce obtrusive light towards the critical viewpoints the production of a lit environmental model can add visual simplicity to what can be, for many, a very complicated technical presentation.

There are several visualisation software packages now available, however, the construction of an electronic model is a labour intensive process and not all projects warrant this overhead cost.

15. Virtual Walkthrough

The production of a walkthrough is only the "icing on a cake" and can only be provided as a result of producing an electronic model as described in 14. However, its main advantage is that different viewpoints, other than the critical ones, can be considered and "visualised".

16. Surface Colour Schedule

All electronic virtual artwork relies on the construction of electronic model surfaces and some software produces very lifelike images. Lighting calculation software, which uses the light distribution fingerprint particular to an individual luminaire manufacturer's production model, does not have as wide a range of surface textures to visualisation software which has no lighting calculation facilities. Lighting calculation software relies on the designer creating a natural daytime colour match and a night-time reflection factor to create the model.

A general analysis of the electronic model surfaces should be provided in the form of a schedule containing all the surface colours, in terms of the general colour description, the red / yellow / blue co-ordinate reference and the light reflection factor characteristics.

At planning application stage this information not necessary to analyse compliance with most common light control analysis but it does become important when building luminance requires to be analysed. It also becomes important in showing which version of the colour scheme has been used in the calculation, especially if there has been several building material changes been made during the structure design stage.

17. Luminaire Schedule (essential)

This schedule forms an essential element in both the planning and the subsequent construction stage of the development. The schedule should contain a minimum of 5 items which indicate each individual luminaire's light beam potential in terms of the following:-

A **Luminaire light distribution type** (often included in a manufacturer's catalogue number)

B **Lamp type and wattage**

C **Mounting height**

D **Orientation direction** (between 0 and 359^0 with 0^0 relative to a declared point in the development plan. Some software calculation algorithms use North and others use East as 00 but all use an anti-clockwise direction as the angle increases.)

E **Luminaire tilt** (between 0 and 90^0 and the greater this angle the greater the

potential for producing obtrusive light)

In some calculation software the orientation and tilt is given as a composite x,y,z co-ordinate relative to the main calculation grid, eg on a sports field, and this sometimes makes it difficult to make a quick visual assessment of the luminaire orientation and elevation relative to distant property outside the site boundary. Most software calculation processes have an automatic conversion process and although the designer may have used an x,y,z co-ordinate to accurately aim each floodlight, relative to the playing surface, the software can automatically convert this 3 dimensional number into a 2 angle notational representation of the same positional aim without additional design work. The 2 angle system is easier to visualise at planning application appraisal stage. Even the simplest of analysis could not proceed if any one of these items was missing from the schedule.

Column and luminaire schedules are often constructed separately from information contained in the calculation process to assist in the presentation of contract drawings. These schedules often contain information relating to the electrical distribution circuits but should contain the same 5 way matrix information described above as an absolute minimum for contract construction.

18. Energy Usage

There is currently no government legislation covering the limitations on the electrical load for external lighting, equivalent to that which exists in Building Regulations for new interior lighting projects. Regardless of the lack in recommended limits there are two values, which a good design methodology could show the efficiency of the proposed lighting, especially when the installation is planned to replace an old existing arrangement. Both values are relative to the square area of the development with the first and foremost showing the electrical load distributed over the area of the site in watts per square metre. This value is likely to become the key measurement of the installation efficiency in the same way that the current Building Regulations attempt to limit the use of less efficient light sources.

The second method may be to show the total lamp lumens per square metre of development in an attempt to prove that the use of less distribution efficient luminaires has been mitigated in the design.

Neither of these two methods can show direct obtrusive light mitigation and should not be used in isolation to the direct methods previously described as a controlling light factor since their main function is only to show an energy control factor and an example of recent landmark projects results, using luminaires with high quality light control, are shown below. Budget priced luminaires will return higher watts per square meter.

Exterior lighting designers are well equipped to using energy efficient discharge light sources and, unlike interior lighting design, low efficiency light sources, like tungsten halogen, are only used externally, with the exception of domestic installations, on very rare occasions. Discharge lamp wattage should, however, be totaled with the associated power consumed by the discharge control gear. A reference list of lamp wattages and associated circuit watts can be found at www.lcads.com

19. Schedule of Luminaire Profiles (essential)

On large projects it is often necessary to utilise different types of luminaires to light an area effectively and efficiently. Most of the material produced so far has been very technical and this schedule is one of the few, which can be presented in a very simple and visual manner.

The schedule should show a pictorial image together with design reference number, manufacturer's catalogue number, lamp type and watts and the reflector beam width classification.

Luminaire manufacturers usually produce composite data sheets for their range but this can sometimes be too general to be included in a planning application and are not precise enough to itemise exact model and beam distribution proposed for each luminaire type included in the design.

20. Layout Plan (essential)

This is the last item of a 20 point good design methodology plan and **it is sometimes the only item considered essential** by some developers when submitting a planning application. It is just as essential as all the calculation presentations previously described and it is another form of visualisation as far as the planning application is concerned but a contractual document at construction stage.

The plan should show all the new column and luminaire positions together with a reference number for each location in order to provide a relationship with the column and luminaire schedule described in point 17 and each luminaire orientation should be shown by an extended line from the mounting location.

Layout plans are often only made to cover the site limits but for obtrusive lighting or environmental assessment studies it is important to include surrounding landscape, property and existing lighting arrangements to assist in creating a wider picture to assist in making a measured judgment possible at the planning application stage.

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