DRAFT LIGHTING STRATEGY

Drax Bioenergy with Carbon Capture and Storage

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 – Regulation 5(2)(q)

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PUBLIC

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1. INTRODUCTION

1.1. PURPOSE OF THE REPORT

1.1.1. This Draft Lighting Strategy has been produced on behalf of Drax Power Limited (the 'Applicant').

1.1.2. This strategy has been prepared in response to the **EIA Scoping Opinion** (document reference 6.3.1.2) received from the Planning Inspectorate (PINS) which stated that:

"The ES should include an assessment of day-time and night-time lighting during construction and operation of the Proposed Development where significant effects are likely to occur". and "the Inspectorate does not agree that heat and light may be scoped out unless it is agreed with relevant consultees and such agreement is evidenced in the ES."

1.1.3. This strategy should be read in conjunction with **Chapter 9 (Landscape and Visual Amenity)** of the ES (document reference 6.1.19) and **Appendix 9.5 (Effects that have been Determined to be Not Significant)** (document reference 6.3.9.5) which provide an assessment of night-time effects on landscape character and visual receptors during the construction and operation of the Proposed Scheme.

1.1.4. This strategy document does not form part of the Environmental Statement (ES) but is a supporting document to the DCO Application. The intention of this supporting document is to provide a framework within which the future exterior lighting design of the Bioenergy with Carbon Capture and Storage (BECCS) facility shall be designed to ensure that International, National and Local standards and guidance documents are embedded within the design process to ensure a compliant and balanced approach to exterior artificial lighting to balance the health and safety needs of Drax Power Station Site operatives and environmental aspects. The **draft Development Consent Order (DCO)** (document reference 3.1) includes a requirement (Requirement 8) in relation to external lighting during operation. A Lighting Strategy (the Lighting Strategy) describing the details of the operational lighting to be installed for the Proposed Scheme will be approved by the relevant planning authority.

1.1.5. A baseline survey was undertaken in March 2018 (WSP, 2018) and the captured data can be considered to be current as conditions presented on the Site, the immediate and the wider surrounding area are not considered to have altered significantly so as to present a material change to the March 2018 recorded baseline conditions. The lighting baseline is summarised within this strategy.

1.2. SITE DESCRIPTION

1.2.1. The Site is approximately 200 ha and is split into the following parcels:

a. Drax Power Station Site – the land occupied by the Drax Power Station;

b. East Construction Laydown Area –area required during the construction phase of the Proposed Scheme for temporary works situated to the east of the Drax Power Station, across New Road. (N.B. There are several parcels of land within the Drax Power Station Site which would be used for construction laydown. These areas have been termed 'Drax Power Station Site Construction Laydown Areas');

c. Habitat Provision Area – the land within the Order Limits that may be used for environmental mitigation for the Proposed Scheme. This parcel is located to the north and north east of the Drax Power Station; and

d. Surrounding road network.

1.3. THE PROPOSED SCHEME

1.3.1. The Proposed Scheme would involve the installation of post-combustion Carbon Capture technology to capture carbon dioxide from up to two existing 660 megawatt electrical ('MWe') biomass power generating units at the Drax Power Station (Unit 1 and Unit 2). The installation of this technology constitutes an extension to the biomass Units 1 and 2 and is referred to as post-combustion Carbon Capture as the carbon dioxide is captured from the flue gas produced during the combustion of biomass in Units 1 and 2. The Proposed Scheme is designed to remove approximately 95% of the carbon dioxide from the flue gas from these two units.

2. IMPACT OF ARTIFICIAL LIGHTING

2.1. GENERAL

2.1.1. A well-designed lighting installation may transform a space after dark, allowing it to be used safely, effectively and for uses that may not be otherwise possible.

2.1.2. There is a general correlation between the complexity of a task, or how hazardous that task is, and the level of illumination required to safely undertake the task. Owners with more complex and hazardous spaces will generally provide greater levels of illumination, in-line with national, international and industry standards and guidance.

2.1.3. The correct level of lighting must be carefully selected to suit the task being undertaken, while ensuring that only the light necessary for the task is brought to bear. Excessive lighting is not only energy inefficient but can also negatively impact the local environment and ecology. In extreme cases poor lighting may make the task it is provided for more difficult and unsafe for site operatives to accomplish.

Plate 2.1 – Example of Various Poorly Controlled Lighting Installations

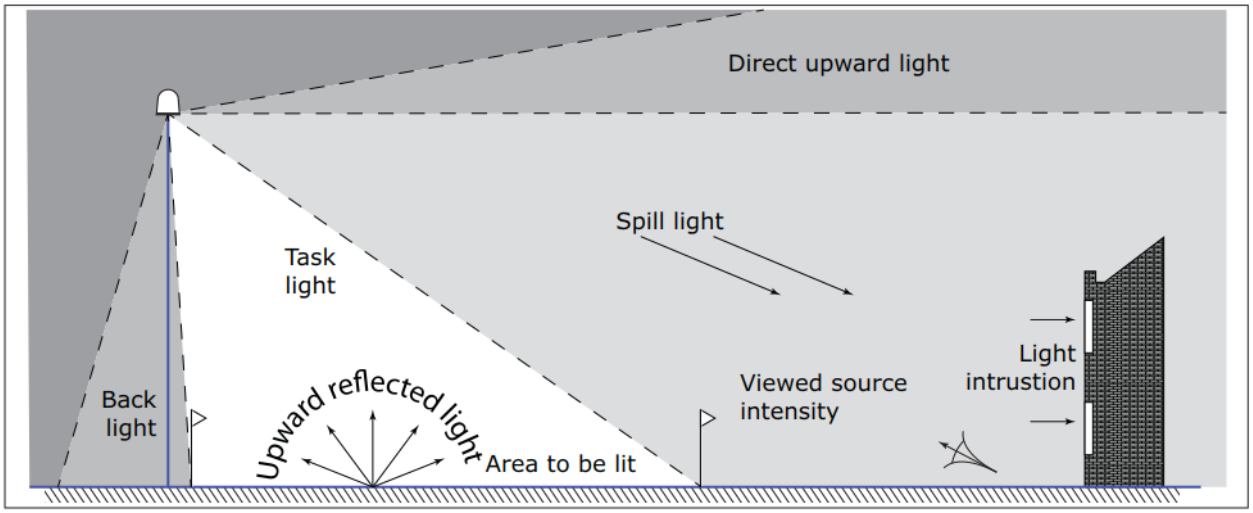
2.1.4. The incorrect application of lighting, as demonstrated in **Plate 2.1**, can have a negative effect on the local environment, in the form of pollution and nuisance. Light Pollution is emitted light that is serving no useful purpose as it falls outside of the area required to be illuminated. This can take the form of spill light outside the extents of a site, building or event, but also includes ‘sky glow’ – the emission of light into the atmosphere as a result of poor control. The cumulative effects of sky glow are most noticeable above urban areas, where a variety of poorly controlled sources combine to create a brightening of the horizon and night sky. In addition to poorly controlled light, a component of sky glow will be formed from upward reflected light.

2.1.5. Nuisance lighting may take the form of localised spill light or glare. Glare occurs where the light source itself proves a distraction or disability to normal vision. Poorly

orientated lighting units may exhibit glare and, while the disabling effects of glare diminish with distance, lighting may still provide a nuisance over several hundred metres.

2.1.6. A graphical representation of types of light nuisance is provided in **Plate 2.2**.

Plate 2.2 - Types of Light Nuisance



GN01 (Institution of Lighting Professionals (ILP), 2021)

2.2. STATUTORY REQUIREMENTS AND POLICIES

2.2.1. Details of pertinent statutory requirements and polices relevant to the Proposed Scheme are included within this section. These requirements and policies are considered further in **Section 4**, which details the existing lighting scenario and lists limitations appropriate for the Proposed Scheme, and **Section 5** which provides lighting proposals and mitigation measures which aim to limit the effects of lighting to the immediate and wider environment.

2.2.2. The following information is not exhaustive and further statutory requirements and polices may be applicable.

2.3. LEGISLATION

2.3.1. The Clean Neighbourhoods and Environment Act 2005 (the 'CNEA') gives local authorities powers to deal with artificial lighting by classifying artificial light emitted from defined premises as a statutory nuisance. The CNEA amends Section 79 of the Environmental Protection Act 1990 to extend the statutory nuisance regime to include light spill and glare (emitted from certain premises) defined as, "*artificial light emitted from premises so as to be prejudicial to health or a nuisance*." Several defined types of premises are exempt from this provision, including premises where higher levels of light are to be expected for the purposes of safety and security associated with transport purposes, such as airports, bus stations, railway premises etc. Such an exemption does not apply to the Proposed Scheme.

2.3.2. Guidance produced by Defra on Sections 101 to 103 of the CNEA (Department for Environment, Food and Rural Affairs, 2015) extends the duty on local authorities to ensure their areas are checked periodically for existing and potential sources of statutory nuisances, including situations where a nuisance arises from the use of artificial lighting. It should be noted that a highway is not deemed to be a premises under the CNEA, therefore light emitted from a highway lighting installation cannot be deemed a nuisance.

2.4. NATIONAL POLICIES

2.4.1. The Habitats Regulations Assessment of the Energy National Policy Statements Review - Main Report (Department for Business, Energy and Industrial Strategy, 2021)Section 4.4 States in relation to Light Pollution:

- Restrict use of artificial lighting in proximity to sensitive receptors;
- Limit operating times to reduce need for artificial lighting; and
- Sensitive lighting design, including low heights and cut-offs for external lights.

2.4.2. *The National Planning Policy Framework (NPPF) July 2021* (Ministry of Housing, Communities and Local Government, 2021), states that:

"Planning policies and decisions should also ensure that new development is appropriate for its location considering the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development."

In doing so they should:

> "c) limit the impact of Light Pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation." (NPPF, Paragraph 185)

2.4.3. The Ministry of Housing, Communities and Local Government provides guidance on Light Pollution (Ministry of Housing, Communities and Local Government, 2019) and details the following:

a. What Light Pollution consideration does planning need to address?

b. What factors can be considered when assessing whether a development proposal might have implications for Light Pollution?

c. What factors are relevant when considering where light shines?

d. What factors are relevant when considering when light shines?

e. What factors are relevant when considering how much the light shines?

f. What factors are relevant when considering possible ecological impacts of lighting?

g. What other information is available that could inform approaches to lighting and help reduce Light Pollution? (Ministry of Housing, Communities and Local Government, 2019).

2.5. LOCAL POLICIES

SELBY LOCAL DISTRICT PLAN 2005 (AS SAVED 2008) AND NOT REPLACED BY CORE STRATEGY LOCAL PLAN 2013 (SELBY DISTRICT COUNCIL)

2.5.1. Policy ENV3 states:

'It is often possible, through good design and time controls, to significantly reduce the detrimental effects of outdoor lighting. By ensuring that lighting is properly directed (with minimum levels of upwards lighting), is only as bright as is absolutely necessary and is only illuminated when required, the negative impacts of outdoor lighting can be significantly reduced.'

2.5.2. It goes on to outline the following criteria to be considered as part of the application process:

Proposals involving outdoor lighting will only be permitted where lighting schemes:

1) Represent the minimum level required for security and / or operational purposes;

2) Are designed to minimise glare and spillage;

3) Would not create conditions prejudicial to highway safety or which would have a significant adverse effect on local amenity; and

4) Would not detract significantly from the character of a rural area.

2.5.3. Further detail around policy is provided in **section 9.2** of **Chapter 9 (Landscape and Visual Amenity)** and **section 5.3** of the **Planning Statement** (document reference 5.2).

2.6. GUIDANCE FOR IMPLEMENTATION

2.6.1. Applicable guidance for lighting designers about Obtrusive Light is predominantly covered by the following international documents:

a. *CIE 150:2017 Guide on the Limitation of the Effects of Obtrusive Light from Outdoor Lighting Installations* (International Commission on Illumination, 2017); and

b. *CIE 126:1997 Guidelines for Minimizing Sky Glow* (International Commission on Illumination, 1997).

2.6.2. National guidance is produced by the Institution of Lighting Professionals (ILP) in the following documents:

a. *Professional Lighting Guide 04 (PLG04) Guidance on Undertaking Environmental Lighting Impact Assessments* (Institution of Lighting Professionals (ILP), 2013);

b. *Guidance Notes for the Reduction of Obtrusive Light (GN01)* (Institution of Lighting Professionals (ILP), 2021); and

c. *Bat Guidance Note 08/18 Bats and artificial lighting in the UK (GN08)* (Institution of Lighting Professionals, 2018).

3. ENVIRONMENTAL CONSIDERATIONS

3.1. GENERAL

3.1.1. There are various environmental parameters that need to be considered when assessing and designing exterior lighting. These include direct energy usage, the visual impact of the lighting equipment during the day, the effect of light spillage on surrounding areas, the spill of light into the night sky, and the effects on animal and plant life.

3.1.2. The above-mentioned factors vary depending on the location of the proposed lighting installation.

3.1.3. The Guidance Note 1 (Institution of Lighting Professionals (ILP), 2021) document and CIE150:2017 (International Commission on Illumination, 2017) establish five Environmental Zones (refer to **Table 3.1** below). Each zone has a different approach to the provision of external lighting. These zones establish 'Obtrusive Lighting Limitations for External Lighting Installations' and include the effects of 'Sky Glow' and light into windows. The document also includes 'source intensity', the potentially obtrusive direction of light outside the area being lit.

Table 3.1 – ILP GN01 Obtrusive Light limitations for exterior lighting installations (compressed version of tables contained in GN01).

Environmental Zone	Sky Glow ULRi [Max %]	Light Intrusion (into windows) Ev[ii] [lux]		Luminaire Intensity I[iii] [cd]		Building Luminance Pre-curfew
		Pre-curfew	Post-curfew	Pre-curfew	Post-curfew	Average L [cd/m2]
E0	0	0	0	0	0	0
E1	0	2	0 (1[iv])	2,500	0	0
E2	2.5	5	1	7,500	500	5
E3	5	10	2	10,000	1,000	10
E4	15	25	5	25,000	2,500	25

Notes:

i ULR (Upward Light Ratio) = Maximum permitted percentage of luminaire flux that goes directly into the sky

ii EV = Vertical Illuminance in Lux

iii I = A measure of light intensity in Candelas (cd)

iv Acceptable from public road lighting installations only

GN01 (Institution of Lighting Professionals (ILP), 2021)

3.1.4. The limits published within these documents set upper performance levels above which the lighting would be considered as a nuisance within each Environmental Zone. Curfews are normally applied after an hour agreed with the local authority as part of the planning application process, when the lighting levels may be reduced or switched off.

3.1.5. In general, the effect of distance from the lighting source / installation has the effect of reducing the lighting levels falling on a surface but has little effect regarding source intensity which tends to be more affected by the background against which it is viewed. In basic terms a bright torch shining towards an observer will appear brighter when the background it is viewed against is darker than it would, say, in a town or city centre which is likely to have high background lighting levels.

3.1.6. The five Environmental Zones are defined as detailed in **Table 3.2** below.

Table 3.2 – ILP Environmental Zones Classification

Zone	Surrounding	Lighting Environment	Examples
E0	Protected	Dark (SQM 20.5+)	Astronomical Observable dark skies, UNESCO starlight reserves, IDA dark sky places.
E1	Natural	Dark (SQM 20 to 20.5)	Relatively uninhabited rural areas, National Parks, Areas of Outstanding Natural Beauty, IDA buffer zones etc.
E2	Rural	Low district brightness (SQM ~15 to 20)	Sparsely inhabited rural areas, village or relatively dark outer suburban locations.
E3	Suburban	Medium district brightness	Well inhabited rural and urban settlements, small town centres of suburban locations.
E4	Urban	High district brightness	Town / City centres with high levels of night-time activity.

GN01 (ILP, 2021)

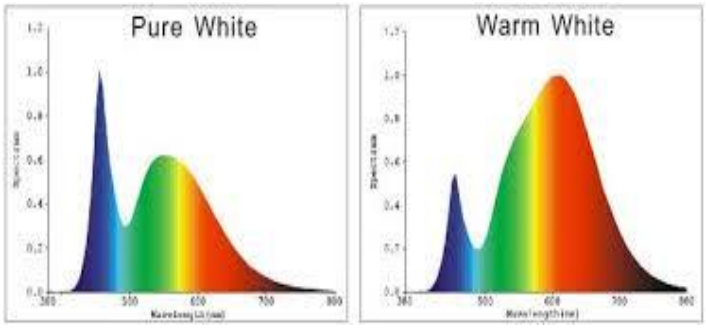
3.1.7. The March 2018 baseline survey outlined in ***Environmental Statement - Appendix 3.1 Baseline Lighting Survey Report*** (WSP, 2018) was undertaken and benchmarked against the Environmental Zones outlined in **Table 3.2** above. The results of the baseline survey are summarised in **Section 4**.

3.2. WILDLIFE AND LIGHTING

3.2.1. The increasing pressure on local authorities and the private sector to demonstrate year-on-year energy and carbon savings, due to decreasing energy budgets and UK Government targets for Net Zero, has led to the emergence of Light Emitting Diodes (LEDs) as an energy efficient alternative to other conventional light sources more commonly associated with lighting installations. LED technologies with higher energy efficiencies, long life and colour rendering properties are a viable and cost effective alternative. However, research into the effects of such light sources on flora and fauna is ongoing, with bats representing particular light sensitive species. Research is continually being undertaken and no definitive answers can be formed as to how light produced by an LED light source affects bats. It is known that bats are affected by light sources that have high Ultra Violet (UV) levels and broad spectrum lights, particularly those with high blue light content, and these should be avoided or their use kept to a minimum where practicable to minimise the effects on flora and fauna.

3.2.2. It should be noted that very few light sources utilised in exterior lighting emit UV, UVa or UVb. Those that may have some low content are normally filtered out by the lamps' glass envelop or the glazing on the lantern / optics. Focus is therefore being considered from the point of view of the blue content within the spectrum of a light source and what effect this may have. Other research carried out by many others has indicated that the disturbance of insects in relation to the use of artificial lighting has a knock-on effect to the 24 hour patterns of other wildlife, such as birds and bats.

Plate 3.1 - Colour spectral charts for cool and warm LEDs (note the difference in blue content)



4. BASELINE

4.1. SITE CLASSIFICATION

4.1.1. The criteria used to provide a baseline for the impact of lighting on the surrounding environment are drawn from *ILP GN01* (Institution of Lighting Professionals (ILP), 2021), based on the derived Environmental Zone as outlined in **Section 3, Table 3.2.**

4.1.2. The March 2018 baseline survey recorded ambient levels of illumination in terms of lux at 14 locations.

4.1.3. It was noted in the baseline report that the land uses present within the survey area and the varied lighting installations, resulted in a lighting environment that is variable.

4.1.4. The lighting conditions within the Survey Area outlined in ***Environmental Statement - Appendix 3.1 Baseline Lighting Survey Report*** (WSP, 2018) closest to the Existing Drax Power Station along New Road / A645 were considered to be indicative of an E3 Environmental Zone ('medium district brightness'). To the west of the Existing Drax Power Station along the A645, the lighting conditions were more representative of an E2 Environmental Zone ('low district brightness'). The lighting conditions within Drax village were considered to be indicative of an area on the border of Environmental Zones E2 / E3 ('low / medium district brightness'). Within the landscape surrounding Drax village, the lighting environment was indicative of an E2 Environmental Zone ('low district brightness').

4.1.5. Given the location of the Existing Drax Power Station within a predominantly low district brightness landscape, it would be prudent to determine that any future lighting is designed and assessed against the parameters associated with an E2 Environmental Zone.

5. LIGHTING STRATEGY

5.1. THE NEED FOR LIGHTING THE PROPOSED SCHEME

5.1.1. Artificial lighting would be used during the hours of darkness to adequately illuminate the Proposed Scheme for the safety of site personnel undertaking complex tasks during the hours of darkness and site security.

5.1.2. The distinct lighting duties for the Proposed Scheme are as follows:

a. Functional area lighting;

b. Road lighting;

c. Emergency lighting (not covered in this strategy due to requirements being applicable for interior settings only);

d. Escape lighting (not covered in this strategy due to requirements being applicable for interior settings only); and

e. Aviation lighting (not covered in this strategy as no new lighting is proposed or required).

5.2. DESIGN RECOMMENDATIONS

5.2.1. Lighting should be designed by competent designers and in accordance with publications listed in this document, as well as other industry and site-specific documents dealing with lighting. Pertinent standards and guidance include (in addition to those detailed in **Section 2.6**):

a. BS EN 12464-2:2014 Light and lighting – Lighting of work places – Part 2: Outdoor work places (BSI, 2014).

5.2.2. Where there are no conflicts with the codes of practice and standards, the following documents shall be utilised to inform the design for good lighting practice:

a. *SLL Lighting Handbook 2018* (Society of Light and Lighting (SLL), 2018)

b. *SLL Lighting Guide 1: The Industrial Environment (2018)* (Society of Light and Lighting (SLL), 2018); and

c. *SLL Lighting Guide 6: The Exterior Environment (2016)* (Society of Light and Lighting (SLL) , 2016).

5.2.3. The lighting levels and equipment parameters suggested in this strategy are subject to change and will be developed further as part of the detailed proposals.

CONSTRUCTION

5.2.4. During the construction phase of the Proposed Scheme there will be a need to provide temporary lighting for construction tasks and security.

5.2.5. Lighting provided during construction would generally be standard fixings and equipment. Working areas may be surrounded by hoarding onto which lighting may be attached. Such lighting may perform directional and security tasks. Cranes, where

required, may be lit for safety and lighting may be provided within buildings during internal fit-out activities. Construction works are likely to be limited to agreed working hours and works during the hours of darkness may be required during the winter months. Limitations on working hours are subject to agreement outside the remit of this strategy document.

5.2.6. All proposed lighting associated with construction, compound areas and security will be detailed within the Construction Environmental Management Plan (CEMP) to be approved prior to the start of construction.

5.2.7. Specifically, construction related lighting would:

a. Be required to provide the correct levels of lighting to ensure the safety of workers and general users of the Site;

b. Be designed such that, where practicable, all luminaires are installed internal to the Site (such as on the inside of hoarding where used) and are directed towards the working area;

c. Be operational only during construction works, except where lighting is required for out-of-hours security or safety reasons;

d. Adhere to industry best practice, including guidance from industry bodies (such as the Construction Industry Research and Information Association (CIRIA)). CIRIA guidance, for example, notes that lighting on construction sites is typically required for security and safety, while at the same time being required to minimise impact on surrounding receptors in accordance with current best practice;

e. Be mindful of temporary impact on sensitive flora and fauna and limit the intensity and duration of lighting to the minimum required e.g. aim lighting away from sensitive areas and utilise lower output and if required shielded luminaires; and

f. Ensure that lighting on construction compounds would not be located near to sensitive areas, where possible.

OPERATIONAL

5.2.8. The Lighting Strategy for the Proposed Scheme, that will be approved by the relevant planning authority, will include measures to be implemented for operational lighting. The Lighting Strategy would follow the principles described in the following sections.

5.2.9. As the Proposed Scheme becomes operational, lighting will be required during hours of darkness to provide a safe environment for users to aid safe movement and provide a feeling of security and well-being. There will be a need to strike a balance between providing suitable levels of illumination to working task areas; for example where loading / unloading activities will be undertaken during the hours of darkness; and minimising the effects associated with such task lighting to the surrounding environment.

5.2.10. Lighting should only be provided within areas where safety or security is a concern such as vehicle, pedestrian routes and work task areas. Where lighting is deemed

necessary, areas should not be over lit and specified in line with the minimum requirements of the applicable lighting standards.

5.2.11. BS EN 12464-2:2014 (BSI, 2014) provides recommendations and lighting levels for the majority of areas that make up the Proposed Scheme. It is likely that some areas of the Site where specific tasks require alternative levels, will require illuminating appropriately but may not be covered by the standard and should be discussed as part of the detailed design phase to determine appropriate levels of illumination and suitable mitigation measures, particularly if levels are required to be high.

5.2.12. **Table 5.1** of BS EN12464-2:2014 outlines typical levels applicable to areas exclusive to the use of pedestrians (see reference 5.1.1 in **Table 5.1** below) and road / vehicular access areas (see references 5.1.2 and 5.1.3 in **Table 5.1** below) and are recommended as the base levels for application for the Proposed Scheme.

Table 5.1 – Table 5.1 extracted from BS EN12464-2:2014

Table 5.1 — General requirements for areas and for cleaning at outdoor work places

Ref. no.	Type of area, task or activity	$\overline{E}_m$ lx	U_o –	R_{GL} –	R_a –	Specific requirements
5.1.1	Walkways exclusively for pedestrians	5	0,25	50	20	
5.1.2	Traffic areas for slowly moving vehicles (max. 10 km/h), e.g. bicycles, trucks and excavators	10	0,40	50	20	
5.1.3	Regular vehicle traffic (max. 40 km/h)	20	0,40	45	20	At shipyards and in docks, R_{GL} may be 50
5.1.4	Pedestrian passages, vehicle turning, loading and unloading points	50	0,40	50	20	
5.1.5	Cleaning and servicing	50	0,25	50	20	All relevant surfaces

5.2.13. Table 5.9 of BS EN12464-2:2014 outlines typical levels applicable to vehicular parking areas. Appropriate levels should be selected at the detailed design phase that are appropriate to the level of use of any proposed car parks.

Table 5.2 – Table 5.9 extracted from BS EN12464-2:2014

Table 5.9 — Parking areas

Ref. no.	Type of area, task or activity	$\overline{E}_m$ lx	U_o –	R_{GL} –	R_a –	Specific requirements
5.9.1	Light traffic, e.g. parking areas of shops, terraced and apartment houses; cycle parks	5	0.25	55	20	
5.9.2	Medium traffic, e.g. parking areas of department stores, office buildings, plants, sports and multipurpose building complexes	10	0,25	50	20	
5.9.3	Heavy traffic, e.g. parking areas of major shopping centres, major sports and multipurpose building complexes	20	0,25	50	20	

5.2.14. Table 5.11 of BS EN12464-2:2014 (**see Table 5.3**) outlines typical levels applicable to task areas. It is recommended that Table 5.11 is utilised as the base levels for application for the working task areas of the Proposed Scheme, but final levels should be refined at the detailed design phase.

Table 5.3 – Table 5.11 extracted from BS EN12464-2:2014

Table 5.11 — Power, electricity, gas and heat plants

Ref. no.	Type of area, task or activity	$\overline{E}_m$ lx	U_o –	R_{GL} –	R_a –	Specific requirements
5.11.1	Pedestrian movements within electrically safe areas	5	0,25	50	20	
5.11.2	Handling of servicing tools, coal	20	0,25	55	20	
5.11.3	Overall inspection	50	0,40	50	20	
5.11.4	General servicing work and reading of instruments	100	0,40	45	40	
5.11.5	Repair of electric devices	200	0,50	45	60	Use local lighting

5.3. ENVIRONMENTAL PRINCIPLES

5.3.1. The following environmental principles should be applied to both the construction and operational phases of the Proposed Scheme.

5.3.2. All lighting should be designed under the most efficient principles practicable. This means:

a. Right Light: Look to the correct application of the lighting standards, defining the required lighting levels dependent on the task being undertaken and the level of activity and risk. Right light refers to the correct selection of light source, with due consideration of the most energy efficient modern sources, such as LED. Balanced against these requirements is the need to consider the impact of lighting on local sensitive flora and fauna, especially bats;

b. Right Time: The lighting standards permit levels to be adjusted dependent on the use of an area, such as when traffic or pedestrian activity falls. Lowering levels to the minimum required for safety and security, or even full switch-off regimes, may be considered at certain times. Such an approach may be across the Proposed Scheme or suitably zoned;

c. Right Place: Ensure that only the areas required are illuminated. Reductions in spill and Obtrusive Light to at least the constraints imposed by the applicable Environmental Zone should be achieved, through the careful consideration of luminaires and how they are installed; and

d. Right System: The most energy efficient lighting installations require a suitable control system. Dependent on the operator and operating regime, a system that allows monitoring and control may be considered.

EQUIPMENT

5.3.3. The selection of equipment is critical to controlling light distribution and reducing the installation's impact on the surrounding environment. Good quality equipment should be proposed that restricts light to the areas required and does not contribute to excessive levels of spill, intensity or upward output.

5.3.4. The following specific design requirements to mitigate the impact of lighting should be followed:

a. The extent of lit sections should be constrained to the minimum required for safety;

b. Selected lighting levels should be reduced to the minimum required for safety;

c. LED luminaires should be specified so that light distribution is easily controllable to reduce spill light and other obtrusive parameters;

d. Luminaires to be specified so that no light is emitted directly upward above the horizontal where practicable;

e. Luminaires with a minimum luminous intensity class of G4 (refer to (BSI, 2015) Table A.1) should be utilised, to remove any light emission above the horizontal and to reduce source intensity over greater distances where practicable;

f. Luminaires should be installed at 0° to the horizontal to preserve their luminous intensity class;

g. Luminaires with maximum colour temperatures of 3,000 Kelvin (K) should ideally be used, to minimise the blue-light component and the Proposed Scheme's impact on fauna populations;

h. Other colour temperatures up to 5,000 K where higher colour rendering is required for specific visual tasks, can be utilised but should be kept to a minimum where practicable;

i. A more limited range of spectral power distribution is used, with predominance in the longer wavelength end of the spectrum, to aid environmental mitigation;

j. A system of control and operation should be considered that allows;

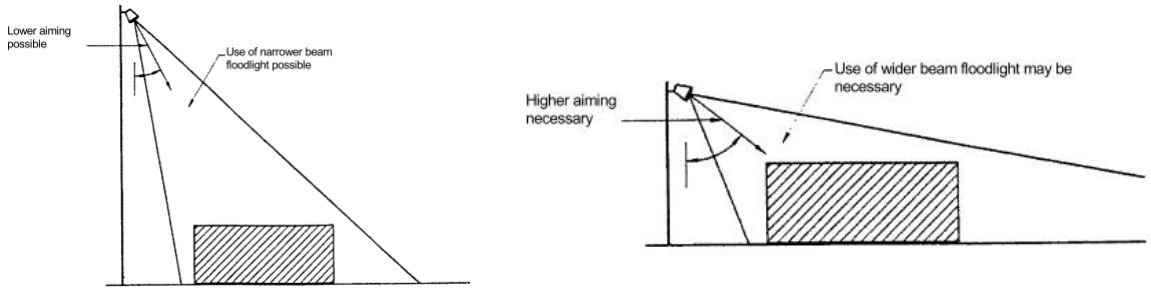
i. Dimming of lighting to a lower level during periods of low use or switch-off when areas are not in use;

ii. The use of detection-operated lighting should be considered where appropriate and / or zonal switching i.e., lighting is only operational when tasks are being performed and is activated locally by the operative or via the Site control room;

k. Shield and baffles to be used where levels of Obtrusive Light cannot be limited through good design and where issues may arise post-installation; and

l. The choice of luminaire with the right distribution at the right height is critical to minimising light spill and Obtrusive Light effects yet providing the right lighting performance on the task area. It should be noted that a lower mounting height is perhaps not better as can be seen from **Plate 5.1** below. A lower mounting height can create a higher level of light spill and require more columns.

Plate 5.1 - Luminaire Mounting Height



(a) Higher mounting heights – less spill and glare

(b) Lower mounting heights – more spill light and glare

COLOUR TEMPERATURE

5.3.5. All light sources have an associated colour temperature. This is a measure of how cool or warm the colour appears when viewed and is measured in Kelvin. Lighting which appears warm – hints of red, orange or amber – has a lower colour temperature, usually from around 1,800 K to 2,000 K. As the colour temperature increases the light appears to become more neutral, ~3000 K to 4000 K. Finally, the light will begin to take on a blue tinge and appear cooler; these colour temperatures are in the region of 5000 K and above.

Plate 5.2 - Colour Temperature

5.3.6. Generally, the higher the colour temperature the more blue light (shorter wavelength) that is present in the distribution. The amount of power emitted at each wavelength by a light source is known as the spectral power distribution and is discussed in more detail below.

5.3.7. It is generally preferable to use warmer light sources when trying to limit short wavelength (‘blue’) output, to create a more comfortable environment for humans and an acceptable installation ecologically. While cooler sources have generally been more efficient, advances in technology continue to reduce the discrepancy.

ECOLOGICAL MITIGATION - SENSITIVE LIGHTING DESIGN

5.3.8. Artificial lighting may affect sensitive habitats, including impacting roosts, commuting routes and established and created dark corridors. It is useful in most situations to establish primary mitigation by assessing the impact of lighting proposals on bats. If a lighting scheme can be developed that is sensitive to bats, then it is likely that the proposed installation will not be presenting any additional harm to other species.

5.3.9. Different species of bat are affected by lighting in different ways. Reducing the spectral output of proposed units will limit the number of species that may be affected. In addition, shorter wavelength sources should be avoided as much as possible. Therefore, the use of warmer white LED sources, which may inherently have a more limited spectral distribution and naturally limit shorter wavelength output, is recommended.

5.3.10. In addition to the equipment requirements detailed above, the presence of bat and other sensitive populations in the area would necessitate specific design requirements to mitigate the impact of lighting:

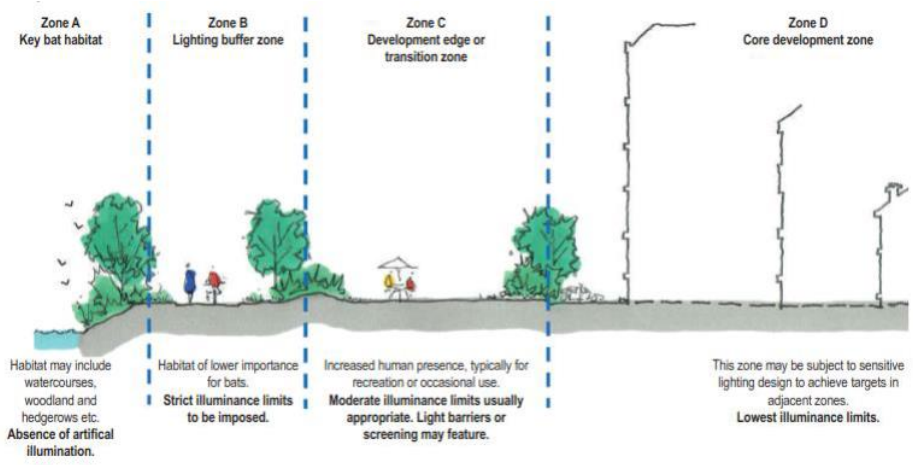
a. Light spill onto confirmed, suspected or introduced roosts, boxes and the like is prohibited and should be avoided primarily through good design and secondarily by physical shields where necessary;

b. Light spill onto trees and hedgerows should be minimised through good design, with physical shields installed where necessary;

c. A ‘buffer zone’ of very low illuminance (if any) should be created adjacent to established or proposed key habitats, such as adjacent to treelines. In accordance with ILP GN08 (Institution of Lighting Professionals, 2018) a wider system of zoning may be employed to mitigate against artificial lighting (example shown in **Plate 5.3**); and

d. Landscaping measures in the form of shrubs and tree planting to further act as secondary mitigation to screen and soften the effects of installed artificial light sources should be considered.

Plate 5.3 - ILP GN08 Buffer Zone Illustration



GN08 (ILP, 2018)

5.3.11. To minimise effects on foraging and commuting bats (and other nocturnal species) as a result of light spill, a lighting design for the Proposed Scheme would be prepared at the detailed design phase incorporating measures to reduce the effects of lighting on fauna and flora. This would be reviewed by a suitably qualified ecologist to ensure that effects on sensitive habitats are avoided.

5.3.12. The detailed lighting strategy will be informed by Lux modelling of any proposed lighting. This will support achieving a maximum increase of 1 lux onto habitats beyond the northern boundary of the Power Station Site (habitats in and adjacent to the Habitat Provision Area) arising from Proposed Scheme operational lighting.

5.3.13. Further advice on limiting the impact of lighting on bats is provided in *Bat Conservation Trust and ILP Guidance Note 08/18 Bats and artificial lighting in the UK (ILP GN08 2018)* (Institution of Lighting Professionals, 2018)

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