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## MOD OBSTRUCTION LIGHTING GUIDANCE

### INTRODUCTION

This is an update to the lighting guidance published in Nov 2012 resulting from changes to lighting products, operations, equipment and feedback from airspace users. It is worth noting that each development is considered on its own merits and for some size will be less important than the layout and other local considerations. Nevertheless in order to give some guidance to developers in the planning stage the table at Appendix 3 was included and please note that this document will be constantly reviewed and updated as required.

1. Wind turbines are rarely subject to a statutory lighting requirement; the CAA does not require obstruction lighting to be fitted to vertical structures less than 150m high (60m offshore) within open UK airspace away from aerodromes<sup>1</sup>. The proliferation of wind turbines across the UK has caused the MOD concern with regard to military night flying training, which is conducted at heights where wind turbines present a significant hazard. Whilst acknowledging that there is no statutory requirement, MOD considers that there is an absolute requirement for the lighting of such large vertical obstructions<sup>2</sup> to enhance the probability of the obstruction being acquired visually by the crew, and therefore mitigating the unacceptable risk of controlled flight into terrain.
2. MOD will request some form of lighting in all but exceptional circumstances. Historically, lighting has not been requested in controlled airspace, since this is not airspace where low flying training is conducted. Experience suggests though, that military aircraft do still transit these areas at low level such as Search and Rescue (SAR) transits into hospitals and civil-military collective training exercises. Therefore minimal lighting is now requested. Clearly this is of flight safety benefit to civilian aircraft as well, such as Police, Coastguard, civilian SAR and Air Ambulance Services.
3. Where lighting is requested the light should be fitted as close as possible to the top of the obstacle. In the context of wind turbines, this should be translated to mean the fitting of a light on the top of the supporting structure rather than the blade tips<sup>3</sup>.

### Onshore Lighting

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<sup>1</sup> CAP168, Chapter 4, Appendix 6A: <http://www.caa.co.uk/cap168>

<sup>2</sup> Allocated (fixed wing) Areas 49m; Night Rotary Regions 29m; TTAs 15m.

<sup>3</sup> CAP764 Chapter 3.

4. MOD's standard aviation obstacle lighting standards are set for aerodromes and their environs at 200cd steady red lights (for obstacles <45m) and 2000cd steady red lights (for obstacles >45m and <150m)<sup>4</sup>. Understandably, with the proliferation of wind turbines, lighting pollution is an issue and so MOD has addressed this public concern for onshore developments by revising the aerodrome standard to suit the en-route requirement.

a. **Infra-Red (IR) Lighting.** MOD is cognisant that the majority of military night low flying is now conducted with the aid of aircrew night vision goggles (NVGs), so the MOD Low Flying Ops Sqn, together with QinetiQ and the RAF Centre for Aviation Medicine, have undertaken a series of trials to determine the suitability of NVG-compatible IR obstruction lights which are invisible to the naked eye. The trials were successful and the specification required is detailed in Appendix 1 to this Annex. When requesting lighting on turbines, MOD will specify IR lighting as an option **wherever possible** in the interests of public amenity.

b. **Visible Lighting.** There are circumstances where IR lighting is incompatible with the military operations in the area concerned and in such cases visible lighting will be requested. In the main these areas are where there is a predominance of training being undertaken by formations who do not routinely use night vision devices (NVD). Where visible lighting is requested, the MOD specifications are a compromise between the statutory requirement (no lighting) and the standard aviation obstruction lighting (2000cd) for structures above 500ft.

(1) MOD will request either 25cd or 200cd flashing red lighting (depending on the circumstances). This is a deviation from ICAO stds<sup>5</sup> but flashing permits visual acquisition at a greater range (in excess of 5nm in the case of 25cd) and compensates for the reduction in intensity. 25cd will be requested wherever circumstances permit,

but in some locations a brighter 200cd (still low intensity) light will be needed. These areas will be close to elementary/basic flying training schools.

(2) Occasionally, these lights will also be required to mark the corners/cardinals of large wind farm sites where circumstances might reduce the pilot's ability to quickly identify the full size of the site if marked with less intense lights. The specification recommended for visible lighting is detailed in Appendix 1 to this Annex.

c. **Combi Lighting.** In some locations<sup>6</sup> it may be appropriate to combine IR and 25cd elements. The combination increases the probability of early detection. Combi lighting is appropriate in low flying choke points or on the cardinal turbines of large wind farms where circumstances might reduce the pilot's ability to quickly identify the full size of the site if marked with less intense lights. These lights may also be specified where SAR helicopters conduct intensive night training.

## Offshore

5. The MOD minimum standard for offshore developments is a 200cd flashing red light on wind turbines and, because MOD aircraft operate to lower altitudes over-sea (using altimeters) without night vision devices/systems, offshore developments therefore require both visible and IR lighting. In the majority of cases though, this MOD requirement is exceeded by the CAA, Maritime and Coastguard Agency and Trinity House statutory requirements.<sup>7</sup>

<sup>4</sup> Military Manual of Aerodrome Design and Safeguarding (MADS) Chapter 7 para 18b. [link?](#)

<sup>5</sup> Volume 1 (Aerodrome Design and Operations) of Annex 14 (3<sup>rd</sup> Ed Nov 1999) to the Chicago Convention [link?](#)

<sup>6</sup> For example, where 200cd red lights would represent too much of an environmental intrusion.

<sup>7</sup> As detailed in CAP764

6. As Maritime requirements for obstruction lighting differ from Aviation requirements, a multi-lateral air-sea trial<sup>8</sup> was conducted to assess lighting that would satisfy these diverse air and sea requirements. The resulting specification is at Appendix 1. MOD will not stipulate this lighting specification since it far exceeds the minimum for aviation, but it is the preferred solution.

### **Meteorological Masts**

7. As wind farms are developed, meteorological masts may be deployed to ascertain the wind resource characteristics. When consulted (if proposed mast falls within a Statutory safeguarding zone), MOD will approve construction of such masts with the condition that they are notified to DGC for charting. With the exception of masts within controlled airspace, and dependent on the height of the mast, lighting will also be requested: within TTAs lighting is requested for masts over 15m; outside TTAs over 50m.

### **Lighting Layouts**

8. For sites of more than 2 turbines it may not be necessary to light all turbines. Indeed, on the larger sites it may only be necessary to light the perimeter turbines or, for tightly packed sites with smaller turbines, every other perimeter turbine. Combi lights will be requested to define the 'ends' of turbine lines or the cardinal/corner turbines on the largest sites. Full details of lighting layout requirements are at Appendix 3.

### **Testing**

9. Visible lighting should conform to the specification at Appendix 1 incorporating to the ICAO standard.

10. IR lighting requires testing to ensure compatibility with military NVGs. When asked, the MOD will only formally accept/approve lights that have been independently tested against military NVGs.

11. QinetiQ can provide a test service and detailed spectrum/radiation report, charged to the lighting manufacturer, for previously untested IR lights offered for use on wind turbines. Such a service is available from other accredited laboratories. Once a compatibility report has been received by the MOD, an acceptance letter will be issued that will be lodged with MOD DIO Safeguarding, DECC and Renewables UK. A list of lights that have been demonstrated to meet the criteria is at Appendix 2. This list is exhaustive, and will be updated as necessary. The list is NOT an endorsement of particular lights; any manufacturer is free to have a product added on production of the appropriate test reports. The list will be published on the RESTATS website for the wind industry's information.

12. MOD will not approve lighting specifications for individual developments. If the light selected by a developer is not listed in Appendix 2, then the developer should be advised to approach the manufacturer/supplier.

### **Adjacent Developments**

13. In some cases, the request for lighting may be on a development adjacent to others that remain unlit. The lighting status of surrounding turbines is irrelevant; they may have been erected prior to the introduction of lighting policies, or the LPA may have elected not to act on the MOD request for a planning condition. MOD will maintain its stance on flight safety grounds; lighting is essential mitigation of the risk of controlled flight into terrain. In these cases, it is for the LPA to balance the lighting requirement against other conflicting considerations.

### **Retrospective Lighting**

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<sup>8</sup> MOD LF, CAA DAP, Trinity House, The Lighthouse Board, Crown Estates and RUK.

14. Retrospective addition of lighting will not normally be requested, although if a development is re-submitted for further planning, lighting may be added as a condition when it was previously not requested.

15. Where a development is extended, MOD considers that lighting the additional turbines is a necessary enhancement to flight safety. Retrospective lighting on the existing development will not be requested but would be welcomed. MOD would also accept a lighting plan revised across the entire development to properly reflect its full dimensions.

### **Dark Skies Parks**

16. MOD recognises that requesting visible lighting elements within National Dark Skies Parks (DSP) conflicts with other national policies. Visible lighting, where requested in these areas, will almost exclusively be a 25cd element on combi lights fitted to selected turbines of a large site.

17. Because the two existing DSPs are located in areas where operational SAR missions frequently transit, whilst MOD still retains the SAR capability the visible lighting element will still be required. This element provides valuable additional visual acquisition range in the poor weather conditions frequently encountered by helicopters on operational missions.

18. From April 2015, the UK SAR capability will be contracted out and MOD will no longer have any authority to request visible lighting in support of this task. From this date therefore, the MOD lighting requirement for DSPs can be reduced to IR only; this will be reflected in lighting requests to LPAs.

19. This reduction in requirement for the DSPs should not be interpreted as a precedent for other lighting reductions. The reduction in these specific areas will require careful management by establishment of navigation warnings and some aircraft will have to avoid the areas. To extend reduced lighting to the wider low flying system would significantly reduce available training areas and will not be countenanced.

## APPENDIX 1

### IR LIGHTING SPECIFICATION REQUIREMENTS

#### 1. Onshore Lighting Specification

	25cd Red	200cd Red	25cd or 200cd/IR Combi	IR
				<b>7-8nm pickup range</b>
<b>IR wavelength</b>			As per IR specification	<b>750-900nm</b> ideally concentrated 800- 850nm for optimum detection.
<b>Intensity</b>	Equal or better than 25cd.	Equal or better than 200cd.	As per visible and IR specifications.	<b>600mW/sr min at peak flash</b> <b>1200W/sr max</b> Typically a 300mW/sr steady burn LED IR light will generate 600mW/sr at peak flash.
<b>Horizontal Pattern</b>	<b>360° unrestricted</b>			
<b>Vertical Pattern</b>	25cd minimum intensity between +15 deg and level (0 deg).	200cd minimum intensity between +15 deg and level (0 deg).	As per visible and IR specifications.	600 mW/sr Min flash intensity between +30 deg and -15 deg elevation. Up to 50% reduction between +25 to +30 deg and -10 to -15 deg is acceptable.
<b>Overspill</b>	Upwards overspill is acceptable. Downwards overspill is to be minimised such that the red light intensity is no more than 10% of the intensity at 0 deg.			Vertical overspill is acceptable.
<b>Flash Pattern</b>	60 flashes per min at 100-500ms duration (ideally 250ms).			
<b>Synchronisation</b>	All lights to be visually synchronised across a windfarm site.			

Further guidance on visible lighting specifications is given by ICAO in Volume 1 (Aerodrome Design and Operations) of Annex 14 (3<sup>rd</sup> Ed Nov 1999) to the Chicago Convention.

#### 2. Offshore Specification IR + Red (Combi Light)

Minimum specification is 200cd/IR combi light as above.

Recommended specification is 2000cd/IR combi light where the 2000cd light conforms to ICAO specification and the IR element is the MOD standard as above<sup>9</sup>.

Lights set to flash Morse Code W over a continuous 6 second cycle. All lights (visible and IR) to be visually synchronised over the whole windfarm.

<sup>9</sup> The trial to determine this specification was conducted at the North Hoyle windfarm; these lights are often referred to as the North Hoyle Lights.

## APPENDIX 2

### LIGHTS CERTIFIED AS MEETING MOD CRITERIA

#### 1. MOD 'Approved' IR Lights

The following IR lights have been certified as meeting the MOD specification for IR lighting and have been tested against military NVDs. **These lights are not the only lights available nor are they endorsed by MOD.** Other lights may meet the criteria set and lighting manufacturers can have their product added to this list on production of the appropriate certification.

Dialight BT2100 IR

Contarnex CEL-IR850-xxx-CST (also marketed as REETEC and Obelux)

Contarnex CEL-IR850-R-xxx-CST (also marketed as REETEC and Obelux)

ORGA L450-IR-G

ORGA L450-LIB-IR-G

Quantec MOD/TraFi IR 24V DC

Tradewinds MB17E-IR

#### 2. Offshore Combi (North Hoyle) Lights

Orga L450-CDW-IR-G Aviation Obstruction Light

## APPENDIX 3

### LIGHTING LAYOUTS

Location	Individual (1-2 turbines)	Small Sites (3-10 turbines)	Medium Sites (11-15 turbines)	Large Sites (15+ turbines)
<b>Standard Request</b>	25cd <b>or</b> IR on individual turbines	25cd <b>or</b> IR on perimeter turbines	25cd <b>or</b> IR on perimeter turbines	25cd/IR <b>COMBI</b> on cardinal turbines. 25cd <b>or</b> IR on remainder of perimeter turbines
<b>Vicinity of SAR trg</b> (within 20nm of SAR bases or HNTAs)	25cd <b>VISIBLE</b> on individual turbines	25cd <b>VISIBLE</b> on perimeter turbines	25cd <b>VISIBLE</b> on perimeter turbines	25cd/IR <b>COMBI</b> on cardinal turbines. 25cd <b>VISIBLE</b> on remainder of perimeter turbines
<b>Vicinity of RW fg trg</b> (see note 4)	200cd <b>VISIBLE</b> on individual turbines	200cd <b>VISIBLE</b> on perimeter turbines	200cd <b>VISIBLE</b> on perimeter turbines	200cd <b>VISIBLE</b> on perimeter turbines
<b>Flow choke area</b>	25cd/IR <b>COMBI</b> on lead turbine. Other lighting std.	25cd/IR <b>COMBI</b> on lead turbine. Other lighting std.	25cd/IR <b>COMBI</b> on lead turbine. Other lighting std.	25cd/IR <b>COMBI</b> on lead turbine. Other lighting std.
<b>Offshore</b>	200cd/IR <b>COMBI</b> on individual turbines.	200cd/IR <b>COMBI</b> on perimeter turbines		
<b>Dark Skies Parks</b>	25cd <b>or</b> IR on individual turbines	25cd <b>or</b> IR on perimeter turbines	25cd <b>or</b> IR on perimeter turbines	Current: 25cd/IR <b>COMBI</b> on cardinal turbines. 25cd <b>or</b> IR on remainder of perimeter turbines.  Turbines constructed after Apr 15: 25cd <b>or</b> IR on perimeter turbines

#### Notes:

- Where perimeter turbines are located close together, alternate turbines only may be lit, provided the distance between lit turbines does not misrepresent the layout, eg a large gap that might indicate a space between 2 different developments. As a guideline this gap should be no more than 500m.
- The lead turbine is the first turbine to be encountered in the flow choke point. Traffic flow may be one way or 2 way and this will determine which turbines should be lit.
- For offshore turbines, MOD requirement is far exceeded by CAA and Trinity House requirements. Developers should ensure that the selected lighting meets all stakeholder requirements.
- Visible lighting will be requested around Shawbury in all cases to support use of field landing sites (down to surface) and general LF (down to 150' agl).