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Wind Farm Aviation Lighting Design for Glenvernoch Wind Farm

Our Reference: WPAC 058/24
Your Reference: EK Email Tasking

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Introduction

1. EnergieKontor is proposing a thirteen turbine wind farm, named Glenvernoch just to the west of the A714/Rever Cree valley in Dumfries & Galloway. The turbines will be located on the south east slopes of Glenvernoch Fell. All turbines will be 200m to tip.

2. From a civilian aviation perspective, the airspace around Glenvernoch, is designated Class G by the CAA (open-unrestricted airspace). Conversely, from a military perspective, the Glenvernoch turbines will be located well to the east of the West Freugh Weapons Range. The site is also in Low Flying Area (LFA) 16; one of the busiest LFAs in the UK. In addition, and more importantly, the Glenvernoch turbines will be in the co-located Tactical Training Area (TTA) 20 where military fast jet aircraft operate down to 100ft (30m) day and night.

3. In the hours of darkness (evening civil twilight to morning civil twilight) this area converts to Night Allocated Region (NAR) 2B. Although primarily a fast jet training area, the airspace is also used by MOD and NATO tactical transport aircraft and helicopters for night training.

4. In addition, this area will be frequented by CSAR, Police, HEMs and Air Ambulance helicopters as well as military craft by day and night. This type of activity will dictate that the site will require both visible red and infra-red obstruction lighting on the turbines.

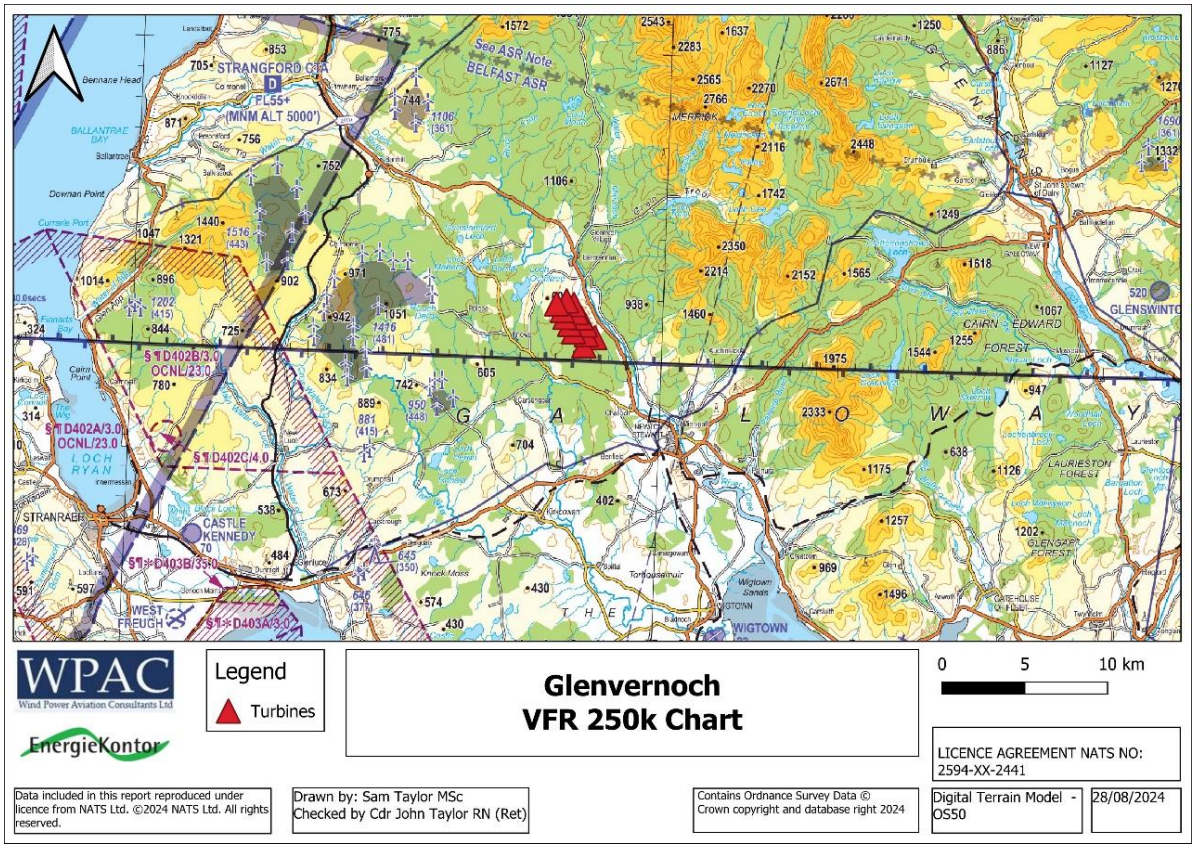

Figure 1: Glenvernoch Turbine Site

Glenvernoch Wind Turbine Site

Glenvernoch Turbine Table			
Turbine	Easting	Northing	Tip Height (m)
1	236168	571679	200
2	235498	571188	200
3	235649	571858	200
4	235584	572437	200
5	234878	572026	200
6	234640	572479	200
7	235346	572861	200
8	235065	573190	200
9	234360	572903	200
10	234908	573677	200
11	234198	573322	200
12	234463	573898	200
13	233856	573713	200

Table 1: Glenvernoch Turbine Details

Starting Assumptions and Lighting Criteria

- Glenvernoch will be assessed as below/in Class G 'en route' airspace insofar as visible obstruction lighting is concerned.
- Local airspace constraints will be considered for their potential impact on the site.
- If applicable, expected CAA and MOD dispensations will be assessed for the site.
- The visible lighting component of the lighting proposal will be developed in accordance with the latest (still draft) CAA CAP 764.
- To accommodate MOD requirements, and other lower airspace night operators, the site will be assessed for Night Vision Equipment compatible lighting in accordance with MOD published obstruction lighting specifications.
- Where possible, the recommended lighting configuration will be optimised to reduce light impact on the local area.
- The Glenvernoch wind farm proposal is for thirteen turbines at 200m to tip.

CAA-ANO Red 2000/200cd Lighting

5. The CAA requires:

- That all 'string' perimeter (black dotted line) turbines be lit unless removing a light will leave a gap of less than 900m total between the remaining lit turbines (This distance is negotiable/extendable by application to the CAA).
- That any turbine within 200m of a 'string perimeter' be lit unless the distance between adjacent turbines is less than 900m total. (Again, this distance/requirement is negotiable by application to the CAA).
- That any unlit turbine does not exceed a 10° up-slope from adjacent lit turbines. All perimeter turbines are lit and conform to this requirement.

Applying these criteria, without expected CAA dispensations, dictates that twelve turbines will require ANO visible red lighting.

Turbines with 2000/200cd Lights: T1, T2, T4, T5, T6, T7, T8, T9, T10, T11, T12 and T13

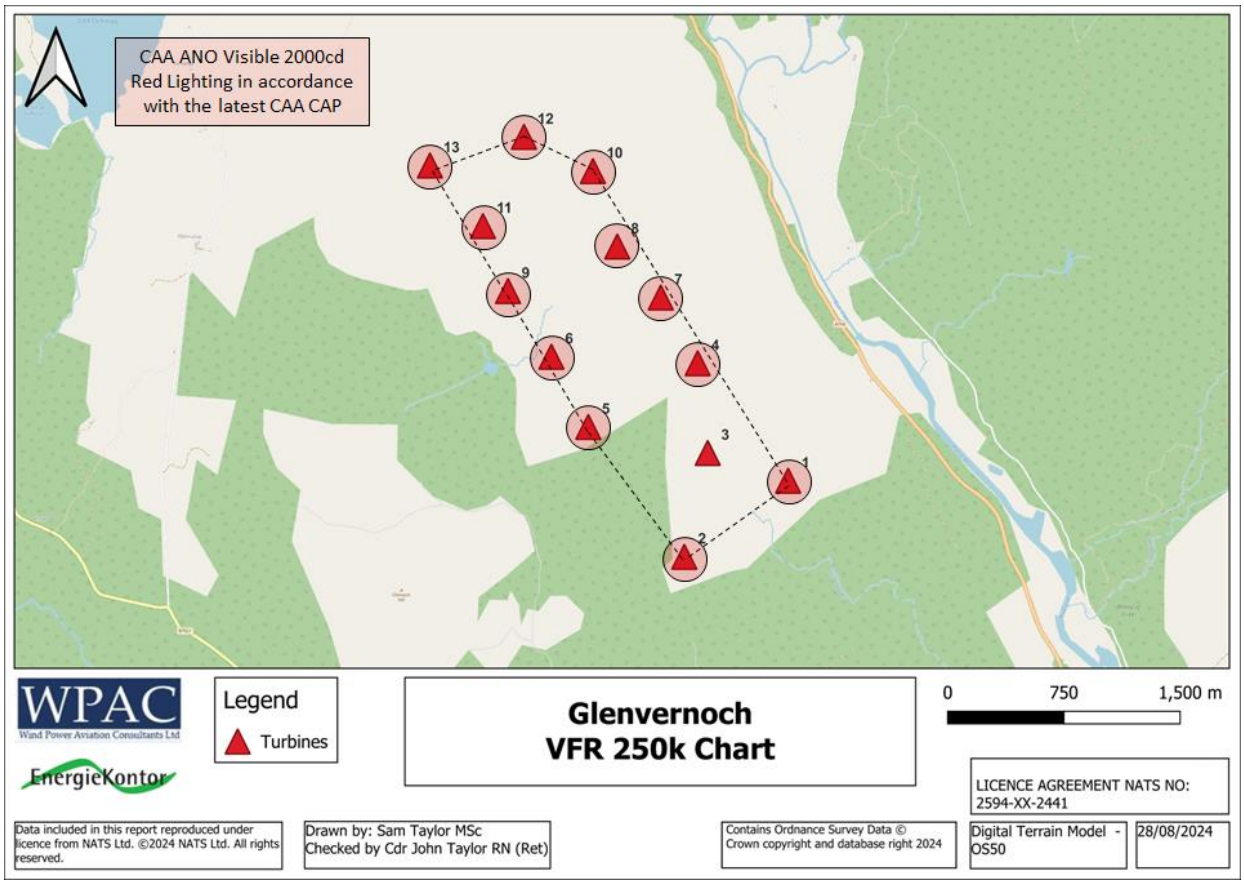

Figure 2: CAA-ANO Visible Red Lighting Requirements.

CAA-ANO Red 2000/200cd Lighting – Reduced and Balanced Option

6. The military have operated at low level at night for many decades now using night vision equipment. In more recent times, the last decade or so, more civilian operators have moved to night low level using suitable night vision equipment: night vision goggles (NVGs) etc. Such civilian operators include Coast Guard (CSAR), Police, Helicopter Emergency Medical Services (HEMS) and Air Ambulance.

7. Although, in the past, some night operators would fly at night at low level without night equipment (on carefully pre-planned exercises pre-flown by day) such events have been overtaken by the ever-widening use of night vision equipment. As a result, operators who now night fly without night vision equipment will fly at or above 'safety altitude' when not under the guidance of Air Traffic Control.

8. Aircraft operating at safety-altitude or above, and depending upon the protocol adopted or phase of flight, the safety-altitude used will be 1000ft (300m), 1500ft (450m) or 2000ft (600m) above the local terrain/highest obstacle, this includes the turbine tip heights. Aircraft/helicopters flying as such, will only need enough visible lights to define the wind farm and its size/shape/perimeter. Accordingly, the regular outline of the Glenvernoch turbine site could be identified with six visible red lights on turbines T1, T2, T6, T7, T10 and T13 forming an irregular trapezoid.

Turbines with 2000/200cd ANO Visible Red Lights: T1, T2, T6, T7, T10 and T13

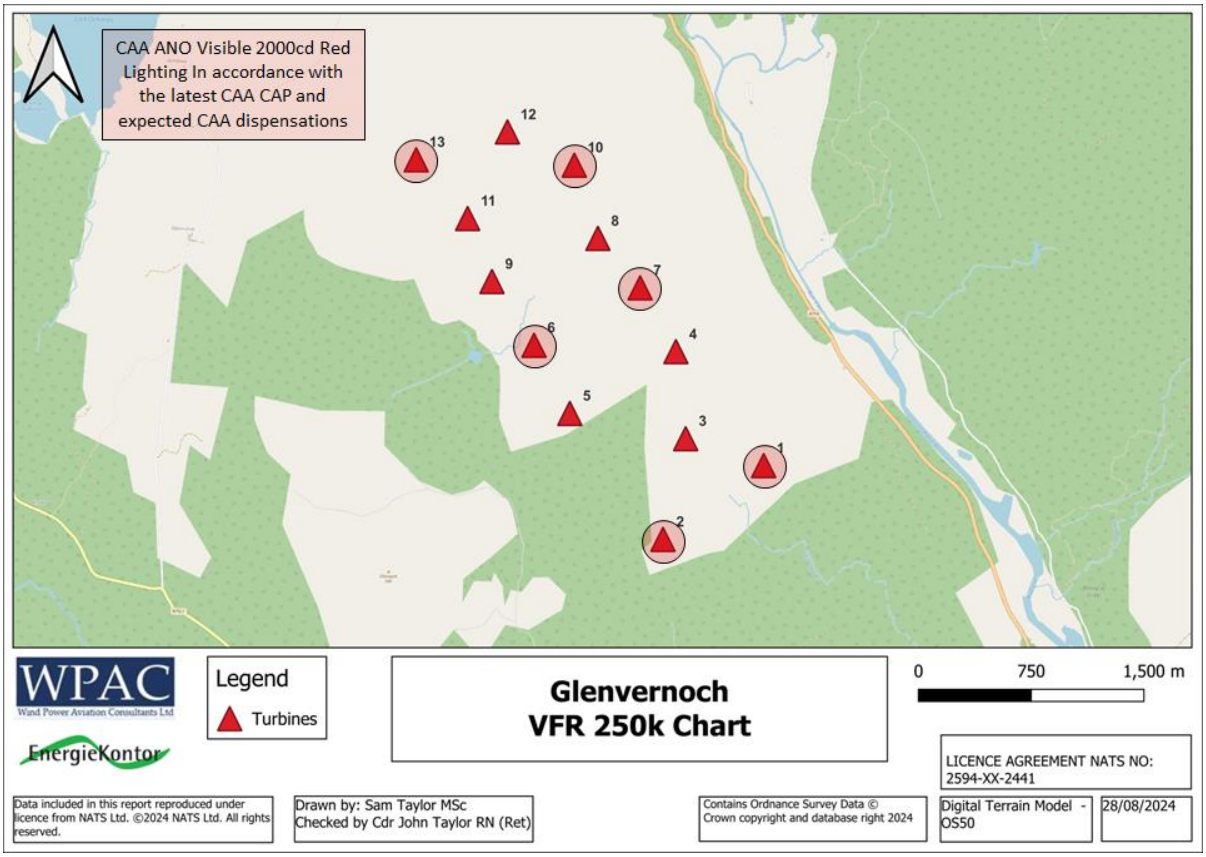

Figure 3: Reduced Visible Red Lighting Proposal.

MOD IR Lighting

9. The MOD requires:

- That all 'compound-perimeter' turbines (see blue dotted line) be lit unless removing a light will leave a gap of less than 500m between the remaining perimeter lit turbines.
- That any dominant turbine, by location or height, be lit. Note: here, all turbines are lit.
- Glenvarnoch does not meet the MOD small site criteria (red dotted circle) which allows for a reduction in IR lights.

Applying the MOD criteria dictates that all turbines of the Glenvarnoch site will require IR lighting. Thirteen hub mounted IR lights in total.

Turbines with Infra-Red Lighting: T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11, T12 and T13

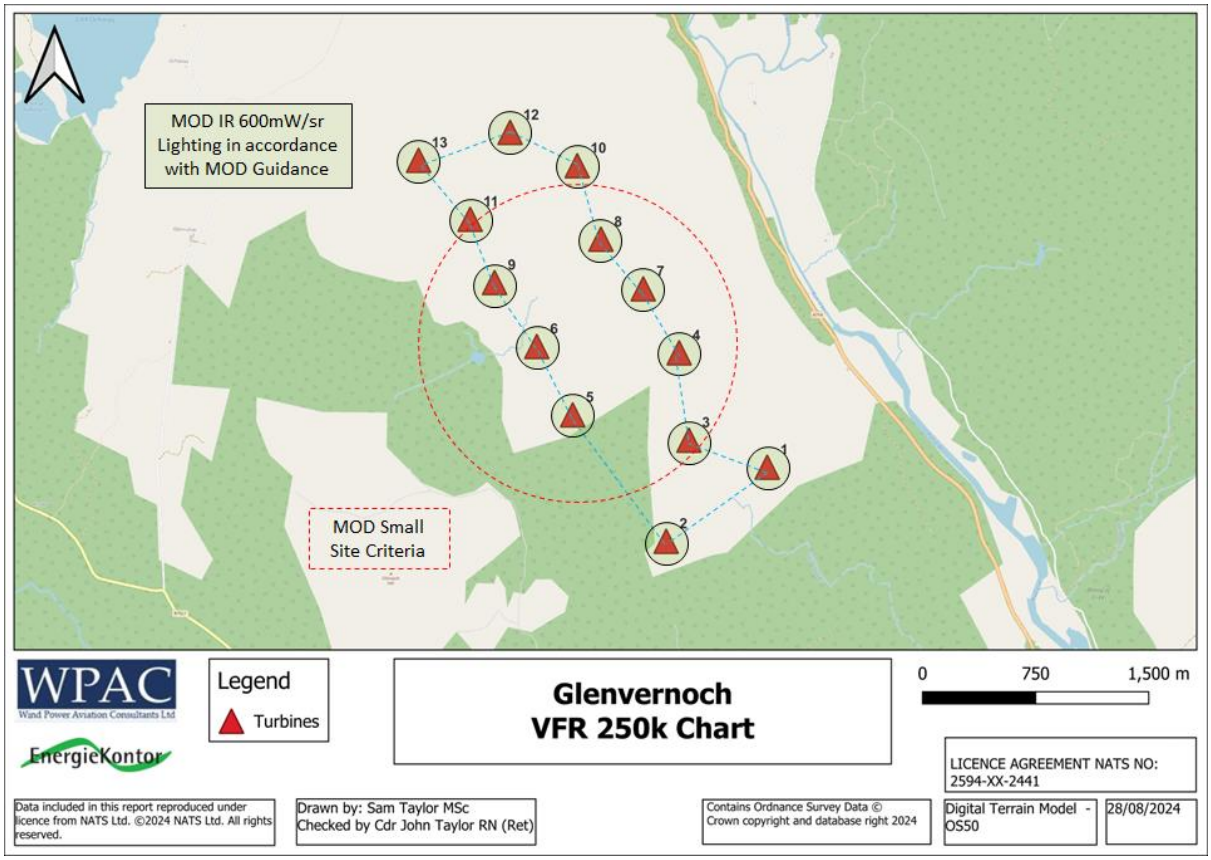

Figure 4: MOD Compliant IR Lighting.

Combined CAA ANO and MOD IR Lighting Proposal for Glenvernoch

Glenvernoch Turbine Lighting Table					
Turbine	Easting	Northing	Tip Height	CAA ANO	MOD IR
1	236168	571679	200	2000/200cd	600mW/sr
2	235498	571188	200	2000/200cd	600mW/sr
3	235649	571858	200		600mW/sr
4	235584	572437	200		600mW/sr
5	234878	572026	200		600mW/sr
6	234640	572479	200	2000/200cd	600mW/sr
7	235346	572861	200	2000/200cd	600mW/sr
8	235065	573190	200		600mW/sr
9	234360	572903	200		600mW/sr
10	234908	573677	200	2000/200cd	600mW/sr
11	234198	573322	200		600mW/sr
12	234463	573898	200		600mW/sr
13	233856	573713	200	2000/200cd	600mW/sr

Table 3: CAA ANO & MOD IR Lighting Layout.

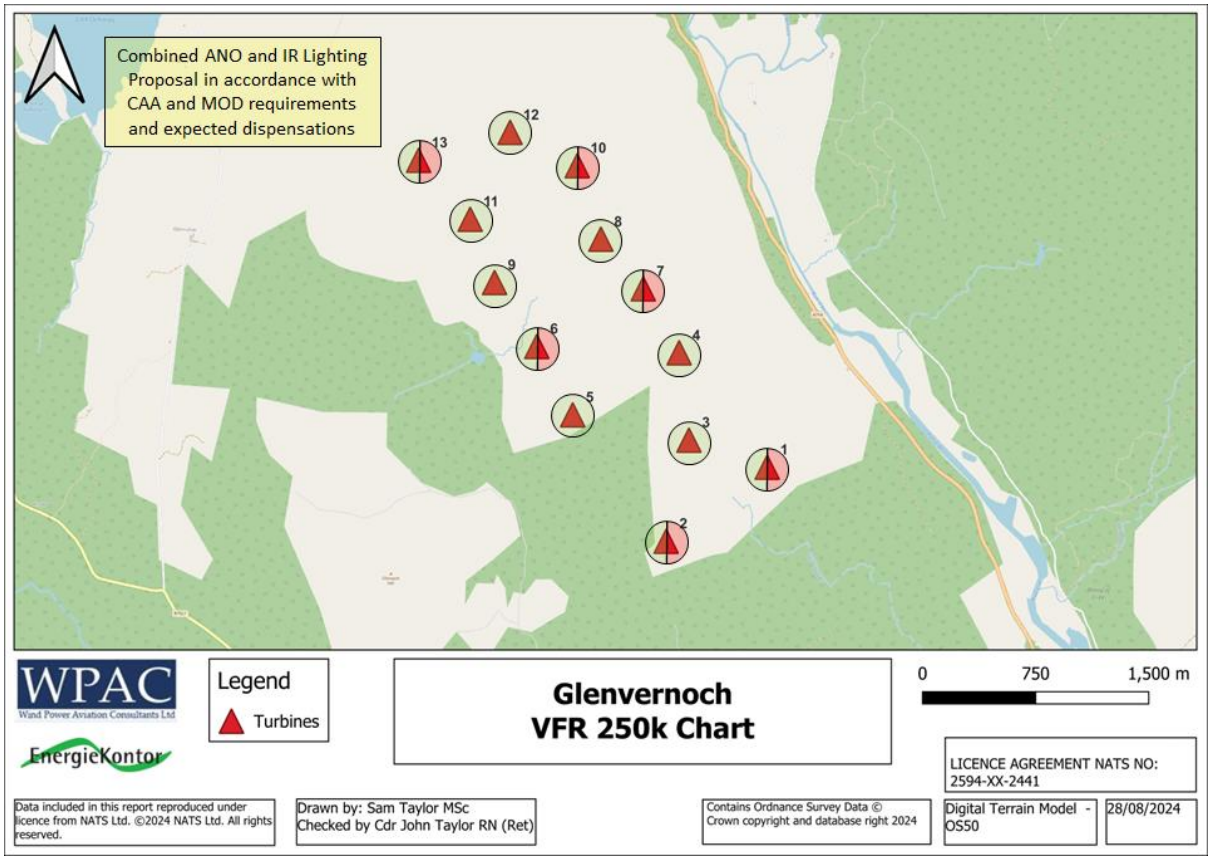

Figure 5 Combined Lighting Layout

ANO Light Specifications

Medium Intensity Hub Mounted Lights

10. The ANO 2000/200cd Lights will conform to the ICAO specification as set-out in Annex 14 Table 6-3. The lights will also be controlled such that when the met visibility is greater than 5km in all directions from all turbine hubs, the lights will be reduced to 200cd (10% of normal power). This reduction in power will not apply to MOD IR Lights.

ICAO Annex 14 Table 6-3 (excerpt)

Benchmark intensity	Minimum requirements					Recommendations				
	Vertical elevation angle (b)			Vertical beam spread (c)		Vertical elevation angle (b)			Vertical beam spread (c)	
	0°		-1°			0°	-1°	-10°		
	Minimum average intensity (a)	Minimum intensity (a)	Minimum intensity (a)	Minimum beam spread	Intensity (a)	Maximum intensity (a)	Maximum intensity (a)	Maximum intensity (a)	Maximum beam spread	Intensity (a)
2000	2000	1500	750	3°	750	2500	1125	75	N/A	N/A

a) 360° horizontal. All intensities are expressed in Candela. For flashing lights, the intensity is read into effective intensity, as determined in accordance with the Aerodrome Design Manual (Doc 9157), Part 4.
b) Elevation vertical angles are referenced to the horizontal when the light unit is levelled.
c) Beam spread is defined as the angle between the horizontal plane and the directions for which the intensity exceeds that mentioned in the "intensity" column.

Table 4: ICAO Annex 14 Table 6-3 Medium Intensity Obstacle Lighting Specifications.

Low Intensity Mid-Mast Lights

11. WPAC will request that the CAA set aside the CAP 764 guidance requirement for 32cd (Type B) mid mast lights on the Glenvernoch turbines.

Table 6-2. Light distribution for low-intensity obstacle lights

	Minimum intensity (a)	Maximum intensity (a)	Vertical beam spread (f)	
			Minimum beam spread	Intensity
Type A	10 cd (b)	N/A	10°	5 cd
Type B	32 cd (b)	N/A	10°	16 cd
Type C	40 cd (b)	400 cd	12° (d)	20 cd
Type D	200 cd (c)	400 cd	N/A (e)	N/A

Note.— This table does not include recommended horizontal beam spreads. 6.2.1.3 requires 360° coverage around an obstacle. Therefore, the number of lights needed to meet this requirement will depend on the horizontal beam spreads of each light as well as the shape of the obstacle. Thus, with narrower beam spreads, more lights will be required.

Table 5: ICAO Annex 14 Table 6-2 Low Intensity Obstacle Lights.

IR Light Specifications

12. The IR lights will conform to the MOD specification as set-out in MOD Lighting Guidance below.

MOD Specification IR.

IR wavelength – 750 to 900nm.
But ideally concentrated within 800 to 850nm for optimum detection by all military NVG types.

IR intensity – 600mW/sr minimum at peak flash but not above 1200mW/sr.
(Note: Typically a 300mW/sr steady burn LED IR light will generate 600mW/sr at peak flash)
This will generate a 7-8 nm NVG pick-up range - remaining above 5nm as the light ages.

Horizontal Pattern – unrestricted 360 deg.

Vertical Pattern – Minimum flash intensity of 600 mW/sr between +30 deg and -15 deg elevation.
– up to 50% reduction between +25 to +30 deg and -10 to -15 deg is acceptable.
– Maximum intensity of 1200 mW/sr for all angles of elevation.
– Vertical overspill is acceptable.

Flash Pattern – 60 flashes per min at 100-500 ms duration (ideally 250ms)

Synchronisation – all lights to be visually synchronised across a wind farm site

Table 6: MOD Specification for IR Obstacle Lights.

Timings

13. The lights (IR and ANO) will be switched-on between Evening Civil Twilight and Morning Civil Twilight in accordance with the UK Almanac. Approximately 11 hours per day averaged over the year. Conversely, the lights can be switched-on by a suitable Lux Meter when the sun light falling on a vertical surface drops below 500 Lux.

Intensity Reduction (ANO Lighting: 2000cd down to 200cd)

14. It is possible to take advantage of the CAA SARG Policy Statement dated 01/06/2017 and incorporate the option to reduce the hub height lighting to not less than 10% of the of the minimum peak intensity specified for the installation in good weather. In essence, reducing the 2000cd obstruction lights to 200cd in meteorological visibilities greater than 5km.

Note: This concession is not applicable to MOD specification IR lighting.

15. The CAA currently state: met visibility should be measured at suitable points around the wind farm. In the case of Glenvernoch turbines Visibility Meters on T2, T7 and T13 will meet this requirement.

Conclusion/Notes

16. The purpose of this Lighting Brief is to identify an obstruction lighting arrangement that is environmentally friendly but at the same time is a safe design for night low level operators. This has been accomplished by using a combination of CAA ANO and MOD IR lights.

17. Applying the CAP 764 criteria, for visible red obstruction lighting, and allowing for current CAA dispensations, results in a solution that requires five turbines to carry an ANO visible red light. In addition, applying the MOD requirements and dispensations for IR lighting results in all turbines carrying an IR light.

6 x ANO Visible Red 2000cd lights and 13 x MOD IR 600mW/sr lights.

Authors

Cdr John Taylor RN (Ret) – after a career in the Royal Navy specialising in Air Traffic Control (ATC), Airspace Management and Air Defence which culminated in leading both the ATC and Fighter Control Specialisations, John worked for Lockheed Martin UK for three years as a Principal Consultant and Business Area Manager responsible for Air Traffic Management Consultancy, including the provision of advice to wind farm developers. In 2008 he founded WPAC Ltd and since then he and his team have provided aviation advice in relation to over 2000 wind farm and wind turbine sites, given evidence at a number of planning inquiries and enabled many sites to overcome aviation objections where it was feasible to do so. He and his team have also provided advice to a number of Local Planning Authorities, Renewable UK and the Aviation Fund Management Board, including organising workshops and the provision of guidance documents. John also advises planners and developers in relation to physical and technical safeguarding of non-wind farm developments in the vicinity of aviation facilities.

Sqn Ldr Mike Hale RAF (Rtd) has over 45 years, piloting, instructing and examining experience on numerous military fast jet aircraft through to a range of civilian and military general aviation training aircraft and gliders. He has held many posts including Flying Instructor, Training Officer, Flight Commander, Squadron Commander and Principal Tornado AD Force Examiner. He has amassed over 10,000 flying hours of experience when operating at many locations around the world. In parallel to his flying duties, Mike held the post of Officer Commanding the MOD Low Flying Operations Squadron (OC LFOS). In this post he was both Low Level Airspace Manager for the MOD & Wind-Farm Subject Matter Expert for the Defence Infrastructure Organization (DIO). During that period, he assessed over 14,000 wind-farm pre-applications and 2000 full applications against low flying, weapons range, specialist airspace, local community and aerodrome safeguarding criteria. Mike also instigated two Qinetiq ground based Infra Red obstruction lighting trials. These were followed by instigating and managing the MOD Infra Red/Low Intensity (Henlow) flight trials and the CAA/MOD/Trinity-House/RUK off-shore IR/Morse (North Hoyle) flight trials. In conjunction, Mike organised numerous and various supporting trials including night vision equipment compatibility and detailed lighting beam overspill analysis (where light is emitted outside the required specification envelope). In 2012, he was awarded an MBE for generating a proactive and mutually successful working relationship between the Wind Power Industry and the MOD Air Staff.

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