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Wind Farm Aviation Lighting and Mitigation Report for Lorg Wind Farm V2.0

Our Reference: WPAC 024/22
Your Reference: Lorg RWE 4300001803-S1-U21

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Reference Documents

A. Civil Aviation Publication (CAP) 764 Civil Aviation Authority (CAA) Policy and Guidance on Wind Turbines Version 6, Feb 2016
B. CAP 764 Version 7 (Draft) issued for comment in June 2020 (to be released shortly)
C. Air Navigation Order (ANO) Article 222
D. CAA Policy Statement: Lighting of Onshore Wind Turbine Generators in the United Kingdom with a maximum blade tip height at or in excess of 150m Above Ground Level dated 01/06/17
E. NatureScot General pre-application and scoping advice for onshore wind farms dated Sep 2020
F. International Civil Aviation Organisation (ICAO) Annex 14 Vol 1 Chapter 6

Scope

1. This report is divided into two parts. Part 1 proposes a lighting design that is compliant with existing and draft (but soon to be ratified) regulations and guidance contained within References A to D and F as discussed with the CAA and the MOD. It explains the rationale behind the lighting design taking into account the requirement to minimise the number of turbines illuminated with aviation obstruction lights whilst maintaining flight safety and provides a detailed assessment of the brilliance of the lighting when viewed from a number of viewpoints provided by the LVIA consultant after consultation with the relevant stakeholders including NatureScot and the Local Planning Authority. Part 2 of the report identifies and explains those mitigation measures that can be utilised to minimise the environmental effect of the lights including an assessment of the historical meteorological data from which to predict the luminous intensity requirements for the lights. The entire report can be considered to fulfil the requirements for an Aviation Lighting Landscape and Visual Impact Mitigation Plan as proposed by NatureScot in their response to a recent Wind Farm Inquiry.

Part 1 Turbine Lighting Layout Design

Introduction

2. WPAC have designed a number of CAA and MOD compliant lighting layouts for wind farms and have also been in constant dialogue with the CAA regarding the proposed change to CAP 764 in terms of aviation lighting requirements. Whilst Reference A is technically the current publication for policy and guidance on this issue, Reference B was released for comment and is already being used by the CAA as the current *de facto* policy. Discussions with the CAA have clarified that the draft regulations will not be changing in terms of the overarching policy but the wording may be slightly amended in the interests of clarity.

Lighting Layout Starting Point and Assumptions

3. RWE has proposed the 15-turbine Lorg wind farm on the Altry and Alwhat Hills in Ayrshire. It is split into two separate groups of turbines located NW-SE of the Water of Ken. This location sits under unregulated airspace which is designated Class G by the CAA.

4. The proposed site is located in MOD Low Flying Area (LFA) 16 and Tactical Training Area (TTA) 20 by day. This converts to Night Allocated Region (NAR) 2B during the hours of darkness. Although primarily a fast jet training area, the airspace is also used by NATO tactical aircraft and helicopters day and night.

- Accordingly, the site will be assessed as Class G 'en-route' insofar as obstruction lighting is concerned in accordance with the latest (still draft) CAA CAP 764.
- To accommodate MOD requirements, the site will be assessed for NVG 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. Potential dispensations by the CAA and MOD will also be shown.
- The Lorg wind turbine proposal is for 15 turbines 200m to tip.

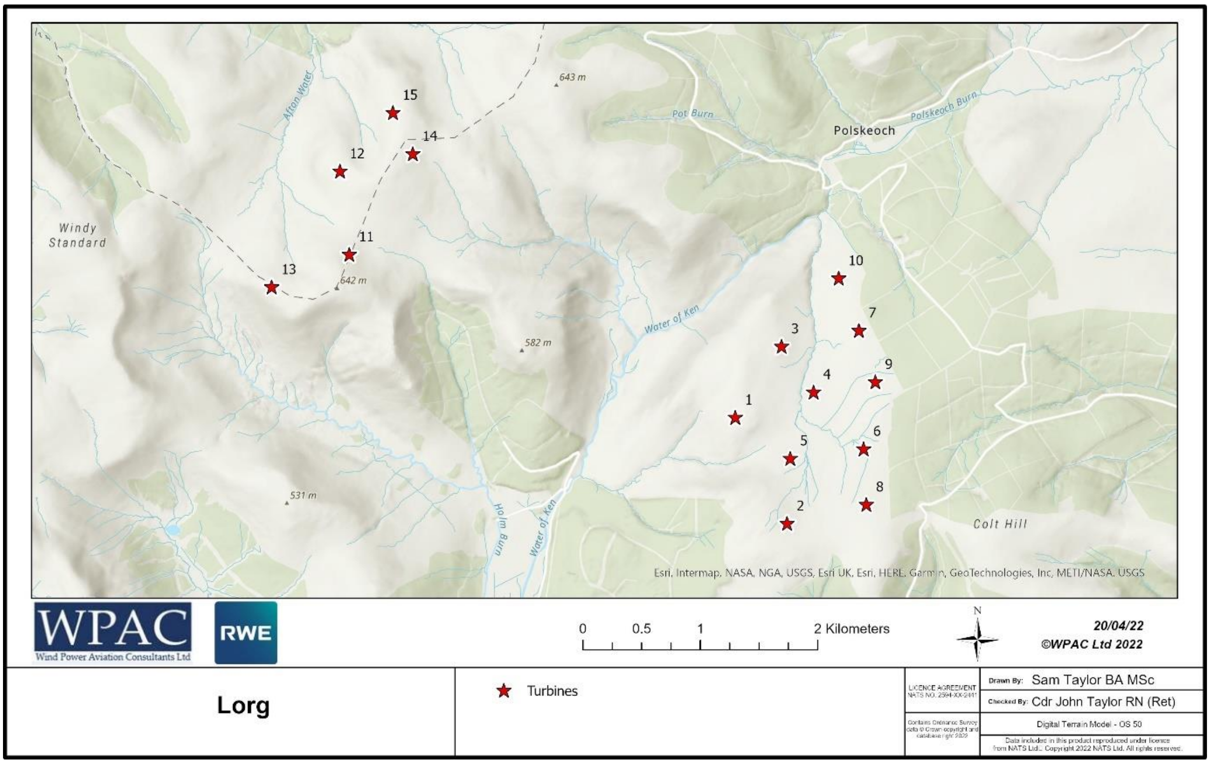

Figure 1 Lorg

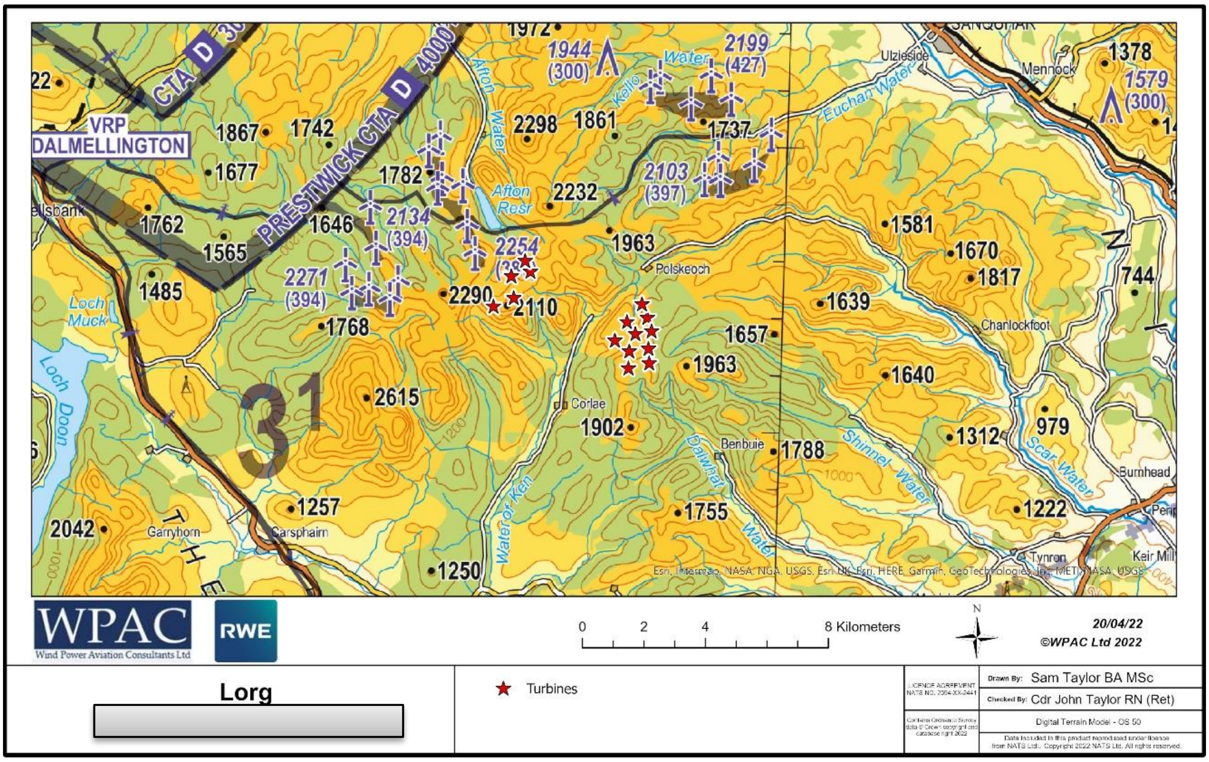

Figure 2 Lorg Wind Farm location on an aviation chart

CAA-ANO Red 2000/200cd Lighting (In compliance with CAA CAP 764 - Draft)

5. In accordance with the CAP 764 (draft) conditions, the CAA requires:

- That all perimeter turbines be lit unless removing a light will leave a gap of less than 900m total between the remaining lit turbines.
- That any turbine within 200m of a 'string perimeter' be lit unless the distance between adjacent turbines is less than 900m total.
- That any unlit turbine does not exceed a 10° up-slope from adjacent lit turbines. Note: the highest turbines on the site are lit. Accordingly, all the non-perimeter turbines do not require lights.

Applying these criteria dictates that all thirteen perimeter turbines of the Lorg site will require ANO visible red lighting. This gives 13 of the 15 total turbines carrying visible ANO lights.

Turbines with 2000/200cd Lights: T1, T2, T3, T6, T7, T8, T9, T10, T11, T12, T13, T14 and T15

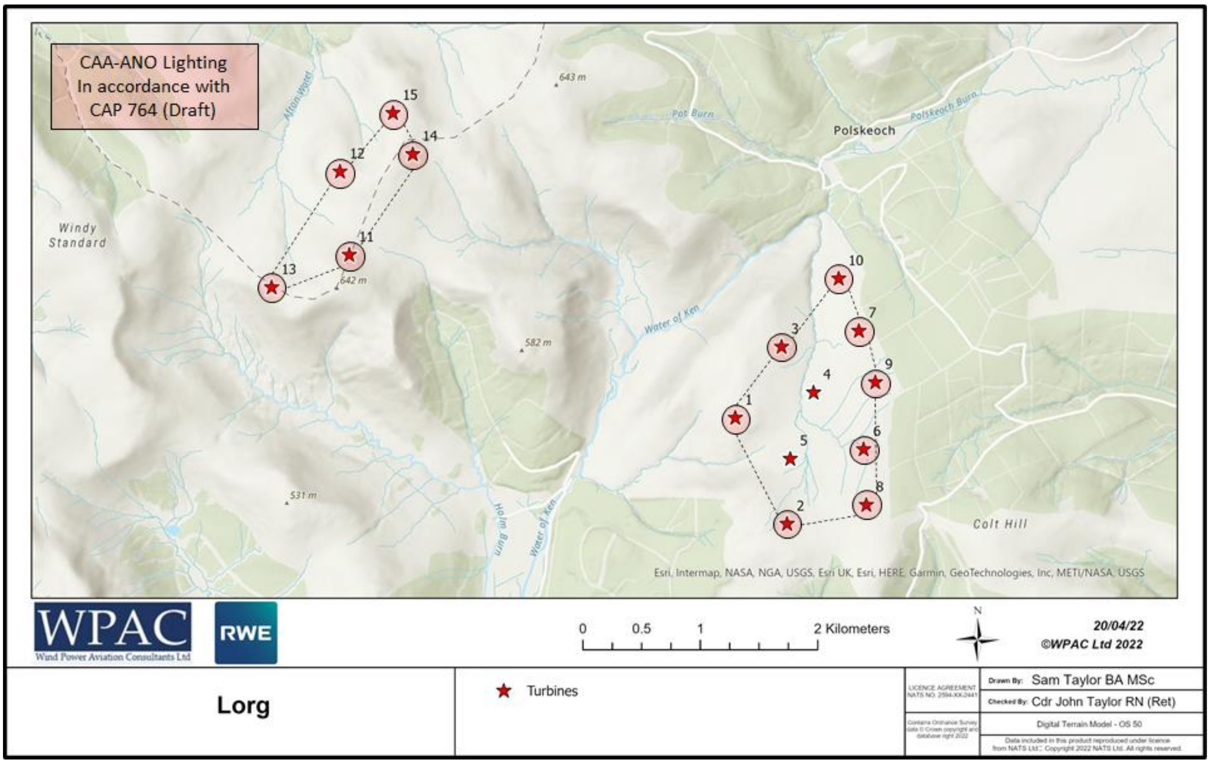

Figure 3 CAA-ANO CAP764 Compliant Lighting Arrangement

CAA-ANO Red 2000/200cd Lighting. (Reduced Lighting Proposal)

The ANO visible lighting proposal at Figure 3 results in a significant visual lighting density. Accordingly, in line with lighting proposals recently accepted by the CAA, a reduced lighting proposal has been generated based upon the following:

- That all perimeter turbine lights be no more than 1.5km apart (largest is 1.43km).

- Because Lorg is in an area that already has a high concentration of wind farms, it is important that enough lights remain to identify the Lorg wind turbine site adequately (i.e. approximately half of the lights to remain).

- That any unlit turbine does not exceed a 10° up-slope from adjacent lit turbines. Note: the highest turbines on both sites are lit.

Applying these criteria and after discussion with the CAA this dictates that nine perimeter turbines of the Lorg site will require ANO visible red lighting. This gives 9 of the 15 total turbines carrying visible ANO lights (slightly over half).

Turbines with 2000/200cd Lights: T1, T2, T8, T9, T10, T11, T12, T13 and T15

Hazards, 38 Hadrian Way, Chilworth, Southampton SO16 7HX

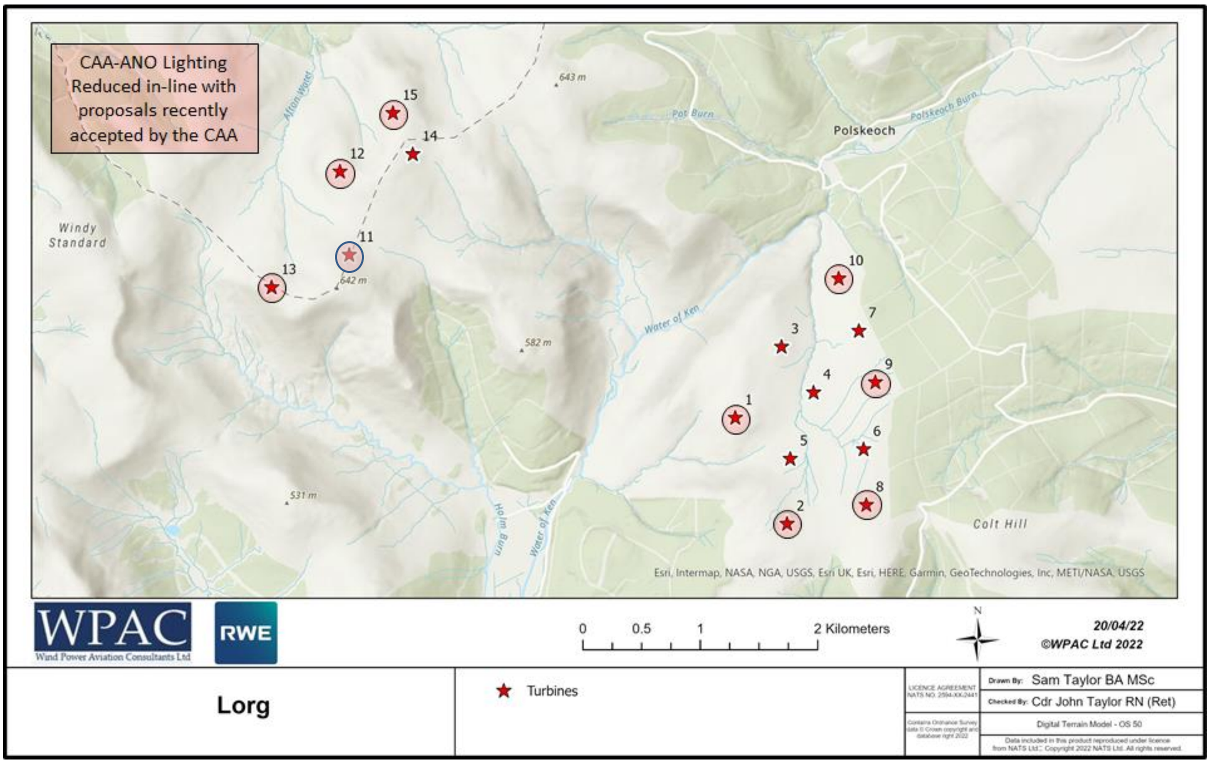

Figure 4 CAA-ANO CAP 764 Modified Lighting Arrangement

MOD Lighting Requirements

6. Early detection is important especially if the aircraft is manoeuvring hard and the air temperature profile causes the turbines to blend into the background. Suitable lighting is necessary for flight safety.

7. MOD IR lights have been developed to be invisible to the public at large but very detectable to aircrew night vision aids. As such the MOD IR lights can have a wide beam width and flash continuously without disturbing the environment.

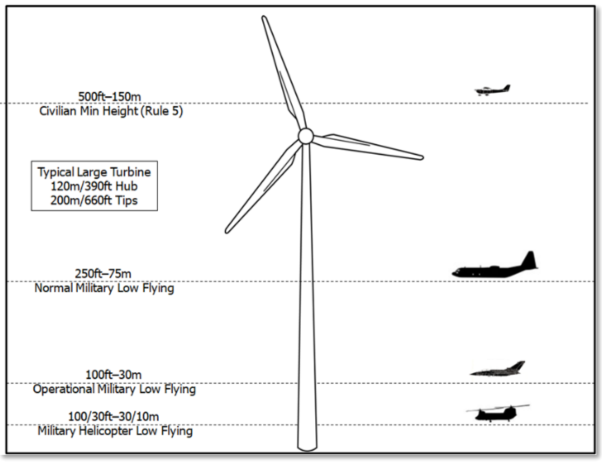

Figure 5 Wind turbine in context with MOD Low Flying

MOD Infra-Red Lighting Layout

8. The MOD requires:

- That all 'compound-perimeter' (see diagram) turbines be lit unless removing a light will leave a gap of less than 500m between the remaining perimeter lit turbines. Note: at this site, the 'string' and 'compound' perimeters differ at turbines 5 and 6.

- That any dominant turbine, by location or height, be lit. Note: here, the corner and highest turbines are lit.

- That a central turbine be lit to provide 'depth perception' to approaching aircraft. Note: Lorg meets the MOD small site criteria and does not need the central turbine (T4) to be lit.

Applying these criteria dictates that all of the compound perimeter turbines of the Lorg site will require IR lighting. Thirteen turbine hub lights in total.

Turbines with Infra-Red: T1, T2, T3, T4, T6, T7, T8, T9, T10, T11, T12, T13, T14 and T15

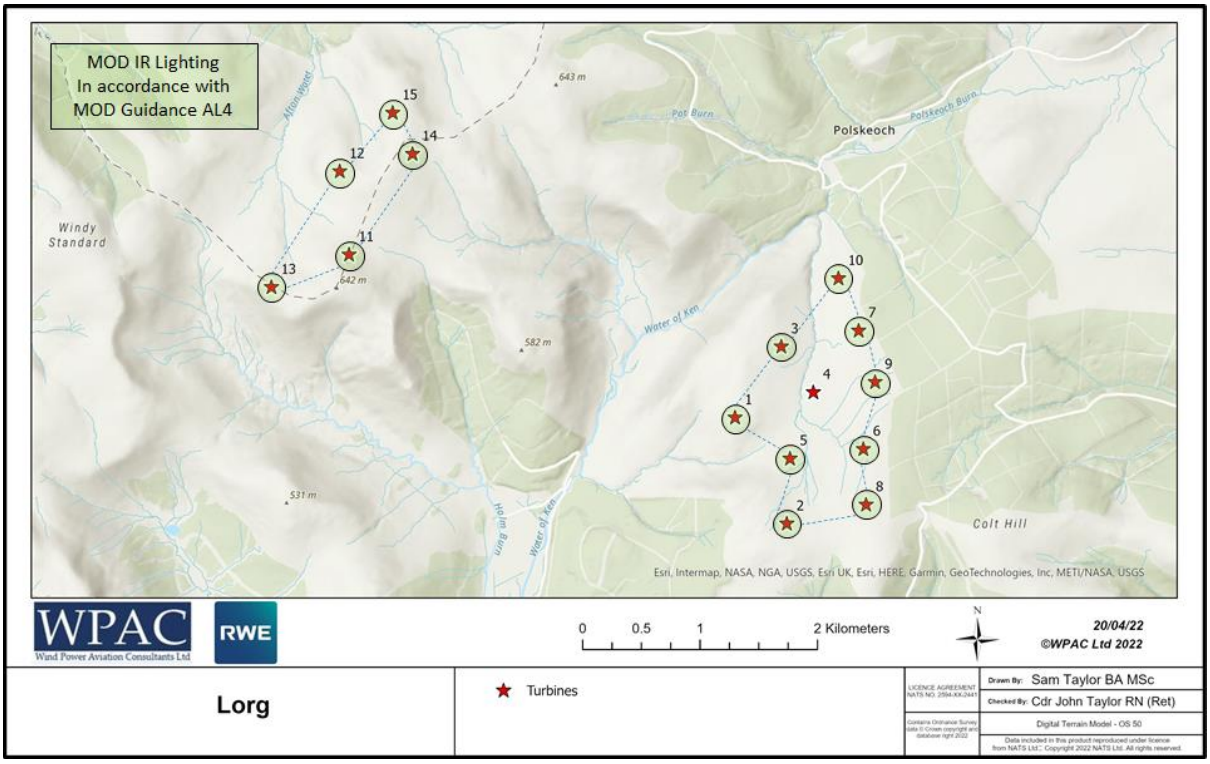

Figure 6 Proposed CAA-ANO Visible Red and MOD Infra-Red Lighting Arrangement

Combined CAA Visible Lighting and MOD Infra-Red Lighting

Lorg Turbine Table					
Turbine	Easting	Northing	Tip Height	ANO Light	IR Light
1	267619	599928	200m	2000/200cd	600mW/sr
2	268060	599026	200m	2000/200cd	600mW/sr
3	268013	600532	200m		600mW/sr
4	268286	600143	200m		
5	268087	599579	200m		600mW/sr
6	268712	599660	200m		600mW/sr
7	268672	600667	200m		600mW/sr
8	268735	599187	200m	2000/200cd	600mW/sr
9	268812	600230	200m	2000/200cd	600mW/sr
10	268500	601112	200m	2000/200cd	600mW/sr
11	264331	601314	200m	2000/200cd	600mW/sr
12	264252	602022	200m	2000/200cd	600mW/sr
13	263670	601037	200m	2000/200cd	600mW/sr
14	264872	602170	200m		600mW/sr
15	264703	602520	200m	2000/200cd	600mW/sr

Table 1 CAA approved and MOD Lighting Arrangement

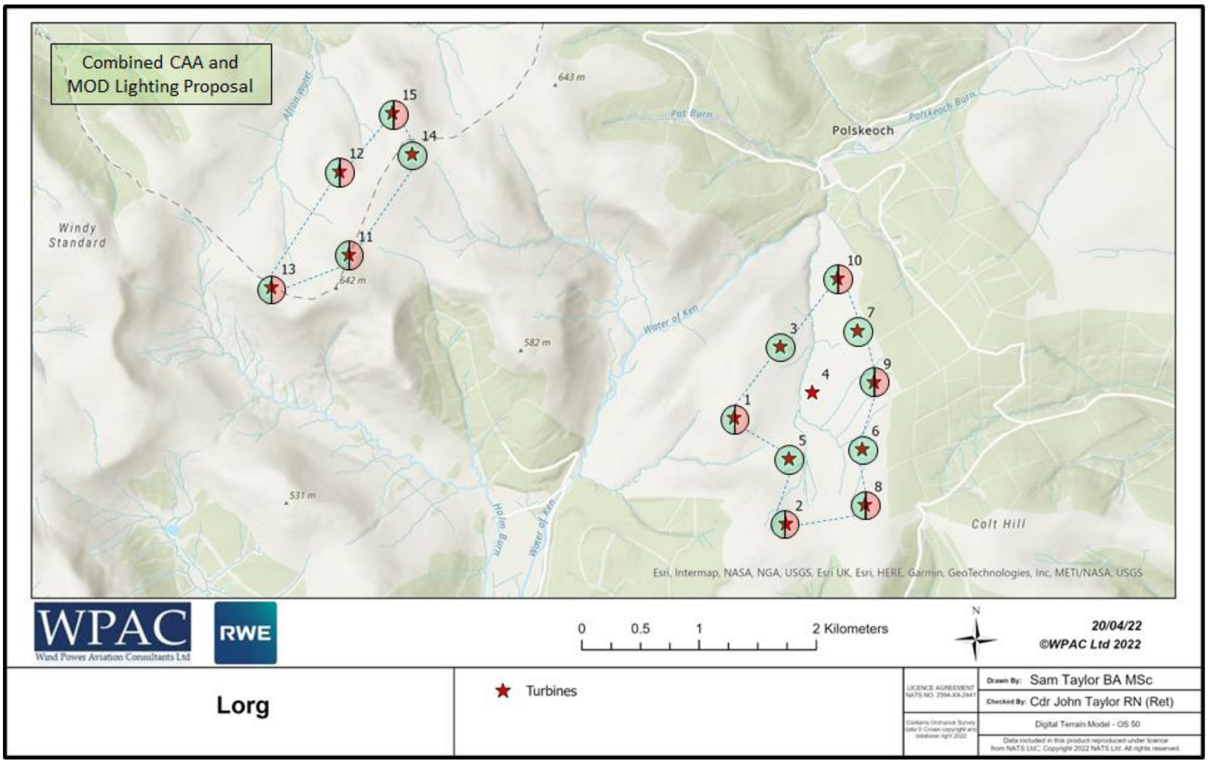

Figure 7

ANO Light Specifications

9. 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 2 ICAO Annex 14 Table 6-3 Medium Intensity Lighting Specifications.

10. **Low Intensity Mid Mast Lights** – Mid mast lighting was originally intended to give an attitude/range reference (horizon indication) to pilots flying at night in the days before NVGs. Tip/hub and mid lights will give a vertical reference (from which a horizontal reference can be gauged) when fitted to a single vertical structure. In contrast, a single light will not be able to give a vertical or horizontal reference or indication of range and range-rate. However, a series of single tip/hub lights, on a group of structures, will provide a good horizon reference together with range and range-rate clues. Accordingly, the requirement for mid-masts lights is much diminished if not made redundant in the case of multiple vertical structures such as wind farms.

11. All of the current commercially available 32cd (supposedly focused) lights are over-engineered (up to 70cd between -30deg and +40deg to fit a multitude of aviation and marine applications) they induce a disproportionately large environmental impact, often significantly more than the focused hub 2000/200cd lights. WPAC requested that the CAA guidance requirement for 32cd (Type B) mid mast lights be removed for Lorg. As shown at Appendix B, the CAA have approved the removal of the requirement for this type of light for the reasons discussed.

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 3 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 and shown below in Table 4.

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 4 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 when averaged over the year.

Assessment of Aviation Lighting and Potential Mitigation Measures Designed into the Lights

14. Having defined a layout of turbines to be fitted with visible lighting, an assessment has been undertaken to calculate the brilliance of the lights when seen from a number of viewpoints. The standard aviation lights to be fitted to the nacelle of the turbines are required to fulfil certain design criteria in terms of brilliance and coverage as per Table 2. They are designated 'medium intensity obstruction lights' and have a minimum luminous intensity of 2000 candela[1] at horizontal and slightly above. The LED lights are also required to be able to shine a beam that reduces in intensity above and below the horizontal. One manufacturer of such obstruction lights, CEL, have tested their light, the CEL MI-2KR[2] in a calibration chamber and produced results showing precisely how much the beam reduces in brilliance at any specified elevation angle. The results are provided to every 0.1°. These lights are already fitted in a number of locations around the UK.

15. Figure 8 demonstrates the reduction in luminous intensity below the horizontal and also above 1° in elevation. The various coloured lines are the candela measured from different angles in the horizontal in order to measure the performance all around the light.

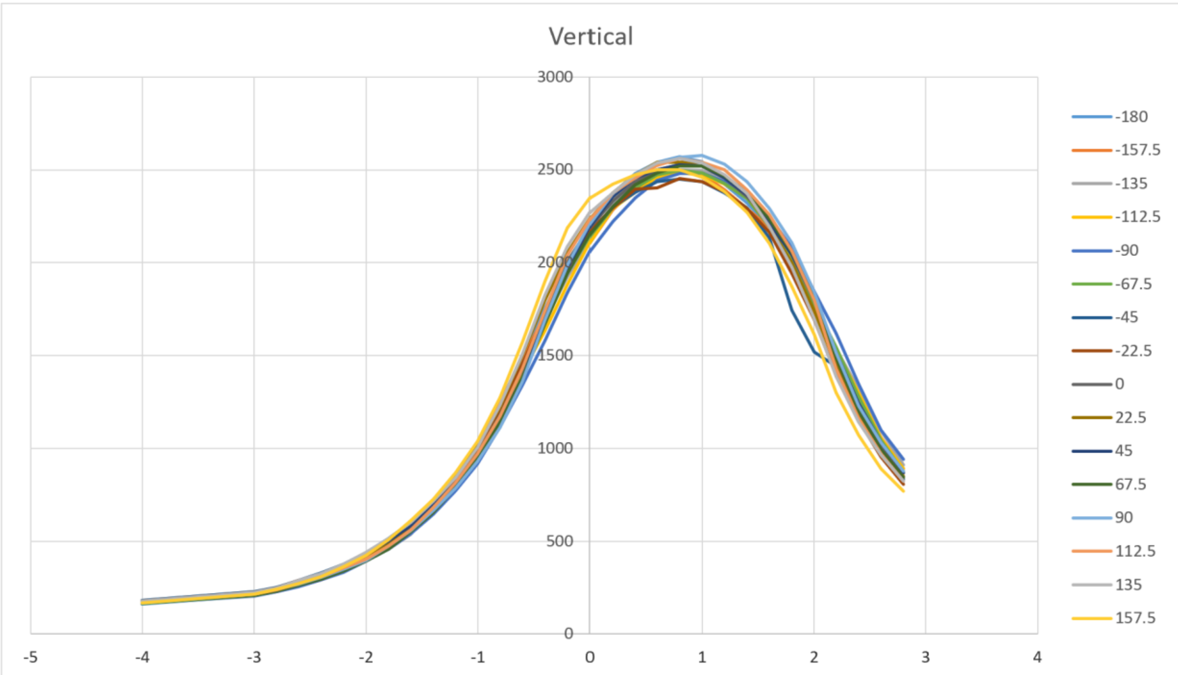

Figure 8 (MI GAM Light Measurement Results)

[1] Candela is the SI Unit of luminous intensity and refers to the amount of light emitted in a particular direction.

[2] The Technical Specification is at: https://www.contarnex.com/led-obstruction-lighting/medium-intensity-led-obstacle-warning-lighting.php

16. WPAC have utilised their propagation modelling system (Rview) to calculate the precise angle of elevation between the turbine light and a viewpoint assuming a height of eye of 1.5 metres and a turbine hub height of 119.5 metres. The system utilises a standard atmospheric model and an earth model that uses actual earth curvature between the turbine light and the viewpoint. Ordnance Survey OS50 DTM is used as the terrain model. The calculations have been undertaken for each designated lit turbine against all designated Lorg Wind Farm viewpoints. The locations of the viewpoints are shown in Figure 9 and Table 5. The assessment has been undertaken utilizing the turbine lighting layout shown in Figure 4 and Table 1. It is possible that one or two viewpoint locations may be moved very slightly when the on site photography is undertaken, but for all practical considerations, the results for each point will remain the same.

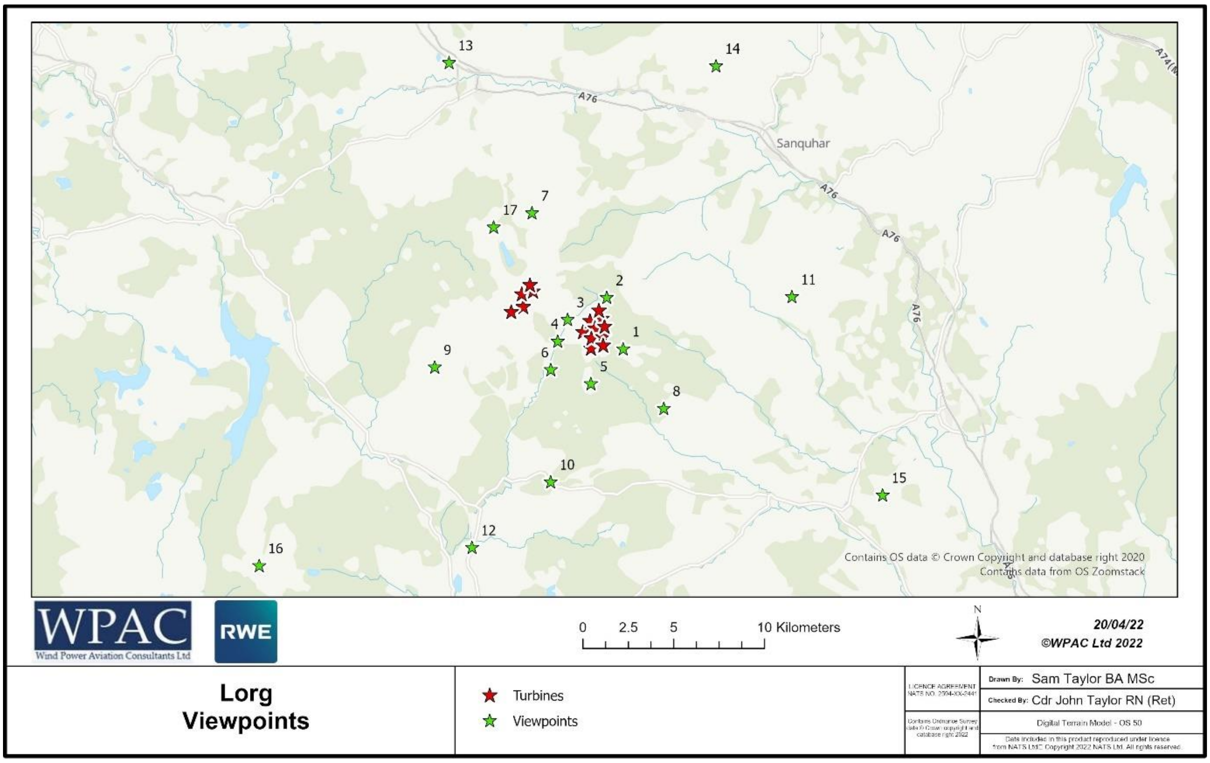

Figure 9 Viewpoint Locations

Viewpoint Number	Viewpoint Name	Easting	Northing
1	The Striding Arches - Colt Hill	269837	598995
2	Southern Upland Way Adjacent to Lorg Site	268932	601829
3	Lorg Bridge	266778	600612
4	Approach to Lorg (Lorg Trail)	266229	599414
5	The Striding Arches - Benbrack	268058	597078
6	Minor road from Smittons Bridge to Lorg Bridge	265850	597849
7	Blackcraig Hill South of New Cumnock	264814	606484
8	The Striding Arches - Bail Hill	272075	595716
9	Cairnsmore of Carsphairn	259456	597994
10	B729 East of Carsphairn	265840	591670
11	Cairnkinna Hill	279133	601871
12	B7000	261508	588060
13	Lochside Hotel	260246	614757
14	Guffock Hill	274952	614577
15	Keir Hills	284127	590943
16	Corserine	249787	587060
17	Afton Filter Station	262700	605700

Table 5 Viewpoints

17. The next stage in the process is to take the candela figures radiated towards a viewpoint and taking into account the distance, calculate the lumens per square metre (also known as Lux) that will be experienced by the human eye at the viewpoint. The figure produced is in micro-lumens per square metre or lumen$^{(10\text{-}6)}$/m^2) or lux$^{(10\text{-}6)}$. These are perfect clear-air figures and therefore worst case results from an LVIA perspective. Figures obtained by this method enable comparisons to be made with commonly understood light sources such as stars or planets. In practice the light intensity at the observation points will be further attenuated by scatter and absorption by airborne dust, droplets and aerosols in the atmosphere. This attenuation is typically in the order of 10 to 20% but can be as high as 75% at the more distant observation ranges. The results for every lit turbines from all of the viewpoints are shown in the results tables in Appendix A to this report. Viewpoints where lights are obstructed by terrain are shaded in green, when the viewpoint is too close to a turbine to get an accurate assessment it is shaded red. **To take into account any limitations within the terrain model we have highlighted in purple any viewpoints where the line of sight is under 5 metres above ground level but above 1.5 metres and should therefore, still be screened by terrain but may be visible within the vicinity of the viewpoint**.

Interpreting the Results

18. The results show that there is a significant decrease in the luminous intensity (candela) of the light emanating towards those viewpoints which are at lower angles of elevation in relation to the turbine hub, this is especially relevant for viewpoints 3 and 4. However, when considering the perception of the light from a viewpoint in general, the distance between the light and the viewpoint is the dominant factor and the resultant figure in micro-lumens is the most relevant figure to consider. This report provides the results and anticipates that the Landscape and Visual Impact Assessment (LVIA) consultants will be able to put them into the correct context for visualisations in terms of background environmental lighting and atmospheric conditions. Table 6 shows the turbine with the greatest potential perceived luminous intensity expressed in micro-lumens at each viewpoint.

Viewpoint	Brightest Lit Turbine	Distance (km)	microlumens per m² (lux$^{10-6}$)	Microlumens at 10%	Obscured
1	9	1.605	769.4	76.9	
2	1	2.31	19.7	2.0	
3	**1**	**1.084**	**63.8**	**6.4**	
4	**1**	**1.482**	**34.1**	**3.4**	
5	1	2.884	206.9	20.7	
6	2	2.504	12.9	1.3	
7	15	3.966	109.4	10.9	
8	1	6.132	31.7	3.2	
9	13	5.198	92.9	9.3	
10	2	7.684	3.9	0.4	
11	10	10.66	19.2	1.9	
12	1	13.349	2.5	0.3	
13	12	13.35	1.9	0.2	
14	9	15.606	5.9	0.6	
15	10	18.644	3.8	0.4	
16	13	19.7	6.0	0.6	
17	12	3.992	6.6	0.7	

Table 6 Brightest Turbine Hub Light from each Viewpoint (measured in micro-lumens)

NB The results for Viewpoints 3 and 4 are highlighted in blue to draw attention to the fact that they are deep in the Water of Ken Valley and at -16° and -13° in relation to the turbine lights. It is likely that the viewpoints are so far below the lights that they will appear so dim as to be virtually invisible, however, the calibrated results only go down to -5° which will over-assess the effect

19. In order to place the values in microlumens per m² (lux$^{10-6}$) in context, Table 7 provides some examples of approximate values placed on a number of environmental comparators, however these are just an illustration to place the results in a real world environment. The actual perceived brightness will depend upon a number of factors including bulb manufacturer, bulb type, specific construction (single/multiple colour LEDs etc) atmospheric conditions, absorption spectrum, individual eye characteristics and capabilities.

Comparison Object	Approximate Illuminance (micro-lumens per m²)
Car Halogen main beam approaching 1km	Up to 1,000,000 (can vary significantly between cars)
International Space Station (400km up)	1000 (depends upon relative position of sun)
Car Brake Light at 0.5km	400
Car Brake Light at 0.7km	200
Car Brake Light at 1.0km	100
Car Brake Light at 2.0km	25
Car Brake Light at 5.0km	4
Car Brake Light at 10km	1
Front Cycle Light at 0.5km	140 (Modern high power white LED)
Front Cycle Light at 0.7km	70
Front Cycle Light at 1.0km	35
Front Cycle Light at 2km	9
Front Cycle Light at 5km	2
White LED Street Light at 0.5km	500 (Viewed from the horizontal)
White LED Street Light at 0.7km	250
White LED Street Light at 1.0km	120
White LED Street Light at 2.0km	30
White LED Street Light at 5.0km	8
Sodium Street Light at 0.5km	300 (Viewed from the horizontal)
Sodium Street Light at 0.7km	150
Sodium Street Light at 1.0km	75
Sodium Street Light at 2.0km	20
Sodium Street Light at 5.0km	5
Brightest Star in the Sky (Sirius)	13
Airliner flying at 30,000ft)	Nav Lights 0.4 to 5; anti-collision lights 2 to 20
Typical bright star (e.g. Orion)	0.5 to 2.0
Faintest light visible from street lit area	0.4
Visible limit for fully dark-adapted eyes	0.02

Table 7 Comparisons of approximate micro-lumens values

20. If there is a requirement to consider the brightest turbine in terms of emitted candela rather than micro-lumens, Table 8 provides data on which turbine emits the most candela towards each viewpoint but takes no account of the distance between light and viewpoint.

Viewpoint	Brightest Lit Turbine	Distance (km)	Candela	Candela at 10%	Obscured
1	10	2.504	2439	244	
2	1	2.31	105	11	
3	1	1.084	75	7.5	
4	1	1.482	75	7.5	
5	10	4.058	2452	245	
6	15	4.81	105	11	
7	1	7.131	2435	244	
8	1	6.132	1192	119	
9	13	5.198	2509	251	
10	15	10.909	291	29	
11	10	10.66	2185	219	
12	9	14.194	484	48	
13	13	14.141	357	36	
14	1	16.382	1582	158	
15	10	18.644	1317	132	
16	10	23.402	2475	248	
17	13	4.68	126	13	

Table 8 Brightest Turbine Hub Light measured in Candela emitted towards a viewpoint

NB The results for Viewpoints 3 and 4 are highlighted in blue to draw attention to the fact that they are deep in the Water of Ken Valley and at -16° and -13°. It is likely that the viewpoints are so far below the lights that will appear so dim as to be invisible, however, the calibration results only go down to -5° which will over-assess the effect

Part 2 Mitigation

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

21. The lights (IR and visible red lights) 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.

22. The primary mitigation consideration in addition to the already described reduction in brilliance due to elevation angle, is taken from Reference D which states:

> *'If the horizontal meteorological visibility in all directions from every wind turbine generator in a group is more than 5 km, the intensity for the light positioned as close as practicable to the top of the fixed structure required to be fitted to any generator in the windfarm and displayed may be reduced to not less than 10% of the minimum peak intensity specified for a light of this type'*.

23. It is therefore 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 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. It should be noted that this does not apply to any low intensity 32cd lights installed halfway up the turbine towers.
Note: This concession is not applicable to MOD specification IR lighting, which is covered separately.

24. It will be necessary to calculate how much time the lights would spend at 2000cd and at 200cd. To assess historical visibility on this west coast area, the closest meteorological station to Lorg is at Prestwick Airport. The visibility will not be identical at the two locations but similar. Below is a table of visibilities throughout the year and averaged over a 30-year period.

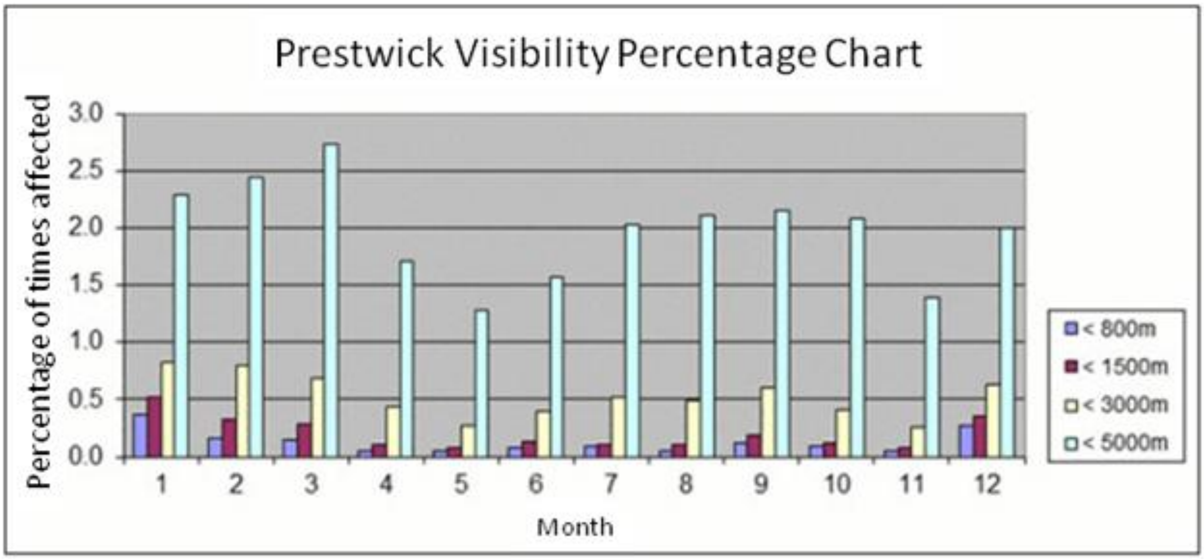

Table 9 Visibility Table for Prestwick Airport (Light Blue is 5km Indicator)

25. This Met Office table shows us that the visibility is below 5km for an average of 2% of the time. This suggests that the lights will be at **2000cd for 2% of the time and 200cd for 98% of the time**.

26. Whilst Prestwick is not Lorg, met visibility improves with height since the concentration of particles (dust, haze) and liquid droplets (water, aerosols) reduces with height and the air also becomes thinner. It could be argued that the Lorg visibility would be better than that at Prestwick and the lights would spend more time at 200cd as opposed to 2000cd.

Obstruction Light: Weather (Cloud) Obscuration.

27. On occasion, the visibility in the area of Lorg will reduce significantly due to the presence of cloud on the hills. If the Lorg turbines are in cloud, then the obstruction lights will not be seen. In a similar vein, if the turbines are partially shrouded in cloud, then the light intensity will be much reduced.

28. The average height at the base of the Lorg turbines is around 1500-2000ft above mean sea level (amsl). The hub heights will be around 1800-2300ft amsl. (Note: the obstruction lights are turbine hub mounted and all the turbines are sited on similar height terrain).

29. It is now possible to compare these two heights: **turbine base average 1500-2000ft** amsl and **turbine hub average 1800-2300ft** amsl with the actual cloud bases recorded by the Met Office at Prestwick airport, again, over a 30-year period, shown in Table 10. The light blue columns (400-500ft) indicate that, on around 80 occasions a month, the cloud-base will be more than 1000ft below the turbine base and hub heights. The lights will be completely obscured and not be seen.

30. The burgundy columns (600-1000ft) indicate that the cloud base will range from approximately 800ft to 1300ft below turbine hub heights on around 500 occasions a month. Again, the hub mounted lights will be obscured, even when the cloud base is towards the upper level (1000ft amsl).

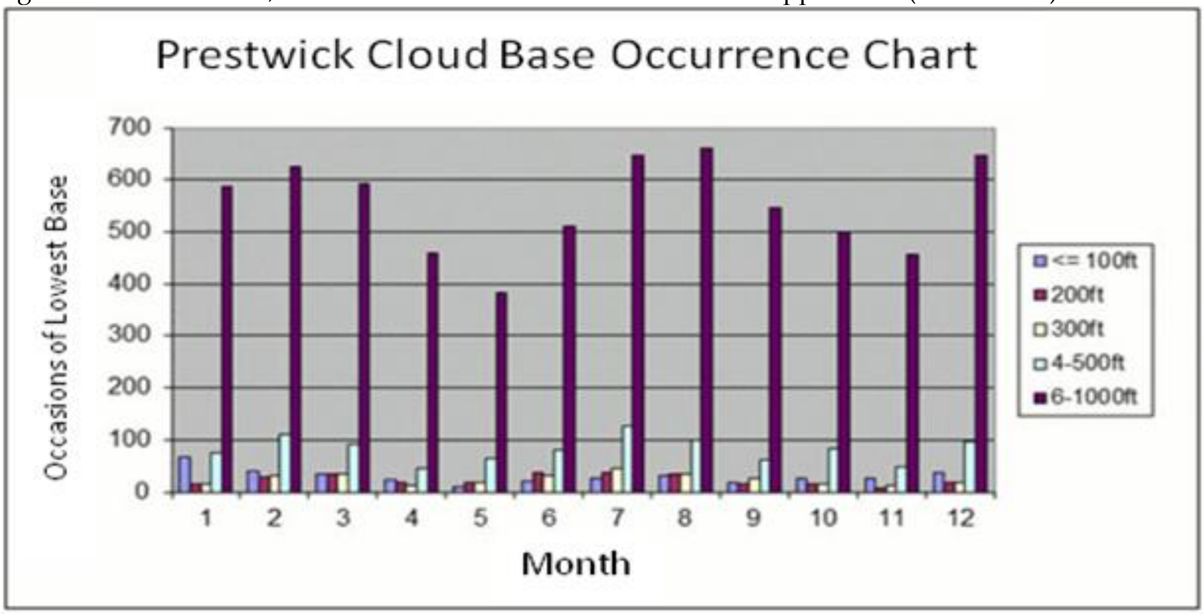

Table 10 Cloud Base Table for Prestwick Airport

31. Whilst Prestwick is not immediately adjacent to Lorg, met office statistics show that cloud-bases reduce in the region of hills. It could be argued that at Lorg the cloud-base would, on the whole, be lower than at Prestwick thus providing an even greater degree of light obscuration on more occasions per month than predicted by the weather data.

Weather Obscuration Conclusion

32. It is most important not to try and combine the two different observations, visibility and cloud-base, into a single statement. Informal advice direct from Met Office and Airport forecasters indicate that the information so gathered, should be presented as follows:

> *Meteorological observations suggest that the turbine hubs will be obscured on several hundred occasions a month by cloud. (Obstruction lights not visible by the public)*
>
> *When not obscured by cloud, the visibility in the area of the turbines can be expected to exceed 5km for up to 98% of the time. (Obstruction lights switched down to 200cd for 98% of the time)*

Conclusion

33. The Lorg site does not benefit appreciably from the requirements in the latest CAA CAP 764 resulting in a high density of visible obstruction lighting. To reduce the number of visible obstruction lights required at the turbine site, WPAC have proposed a reduced lighting scheme which is in concert with recent CAA lighting approvals at other wind turbine sites. Cognisant of the high wind-farm density in the area of Lorg, and the proximity of Prestwick Airport regulated airspace, WPAC have proposed a reduction from 13 to 8 ANO lights. This leaves a 15-turbine site with 8 visible and 14 IR lights

34. In addition, the site is in an area where it will positively benefit from the weather obscuration of its visible ANO lighting. This obscuration benefit is potentially quite significant. Moreover, when the lights are not obscured by cloud, they can expect to be set at 200cd for 98% of the time.

Technical Mitigation

35. One other form of potential mitigation commonly discussed is the installation of an Aircraft Detection Lighting System (ADLS). There are two possible methods of detecting an aircraft approaching a wind farm that will automatically turn on the aviation obstruction lights, firstly through the use of a suitable primary surveillance radar (PSR) or secondly, the use of aircraft installed Electronic Conspicuity (EC) equipment with a suitable receiver at the wind farm. There are some significant technical and regulatory issues to be overcome before any such system can be installed and operated in the UK.

36. In the case of PSR, this is already in use at wind farms in Europe; as an example the Terma Scanter 5002 radar is installed at a number of sites as shown in Figure 10. The main regulatory constraint is that although such systems are in use in Europe, in the UK, where airspace tends to be shared to a much greater extent between users, the CAA have yet to mandate the performance parameters that such a system must be capable of fulfilling. For example, the coverage requirement will need to be

defined in terms of maximum range of detection and activation (which may vary depending upon the speed of the aircraft), base of cover (above ground level) and almost certainly a maximum height coverage to avoid unnecessary activations, which a PSR on its own cannot ascertain. An initial set of draft requirements was promulgated in 2018 but these were for discussion with aviation stakeholders and the wind industry and it cannot be assumed that these are going to be the final criteria. Even if the standards are defined, it may be that any single radar will not be capable of delivering the required coverage where, for example, a wind farm is located on a hill and aircraft may approach below the wind farm from any direction. It may then become necessary to install multiple radars in order to achieve the required coverage at low level. This in itself may lead to limitations due to mutual interference in what is already a crowded part of the electro-magnetic spectrum, (although the Terma radar does have some anti-interference capabilities) but the additional radars may affect other systems working in the same frequency band. There would also be additional planning issues to consider, such as the visual impact of additional aerials, and rotating arrays. Technical constraints also mean that it will be necessary to position the radars some distance outside the windfarm as shown in the example below in order to avoid turbines screening the radar and to provide the required height coverage.

Figure 10 Terma 5002 Radar at a Wind Farm in Germany

37. The one major advantage of PSR is that it will detect any aircraft, both those transponding and those that are not, known as non-co-operative targets. Depending upon how the regulatory process moves forwards, this may have a major effect on which systems to use for ADLS. In response to a recent planning inquiry paper the CAA responded stating in a letter dated 21 April 2021: *For the UK, there are some challenges to be resolved. The cost/benefit of the use of primary surveillance radar for the active detection of aircraft, spectrum availability, incentive pricing cost and geographical separation required before frequencies can be re-used potentially makes this a less than optimal solution.*

38. The alternate system is one based upon a reliance on aircraft carried Electronic Conspicuity (EC) transponders. Currently light aircraft flying clear of regulated airspace in the UK below 10,000ft are not required to carry a transponder (one example being Secondary Surveillance Radar or SSR). Most aircraft do, but not all. The CAA has been encouraging fitment by all aircraft and hope to have a regulatory system in place within the next few years requiring all flying machines to be fitted. Unfortunately this is not as simple a process as one might imagine. This issue has been running for at least 20 years so far, however some limited progress is now being made. In the same response to a recent planning inquiry paper the CAA stated: *'At the same time, the lack of interoperability between the*

wide variety of electronic conspicuity devices currently available may require careful consideration of the specification of any passive system receivers and how they are deemed compliant to be deployed and operated. ' The letter goes on to state: '*We concur that not every situation may require ADLS to be fitted and operated; Article 222 or 223 requirements of the Air Navigation Order will remain, and the CAA may agree a specific solution under Section 7 of Article 222 and Section 11 of Article 223. However, ADLS could potentially provide an acceptable means of compliance that could provide greater certainty for developers when developing planning proposals on CAA acceptance and assist with discussions with communities during planning consultation.'* What this letter is saying is that ADSL using EC is technically feasible but that until the regulatory actions concerning the mandatory carriage of a compatible EC system have been completed and signed into law, and the coverage requirements agreed, nothing can be done unless a planning condition to require the retrospective installation of a system is considered appropriate. The length of time that this is likely to take is difficult to estimate, however, realistically it is likely to be within a two to five year timeframe as it is a small part of a much wider airspace modernisation programme currently under way. Additionally, the CAA also issued a Guidance Notice dated 26/10/21 entitled: '*Electronic continuity specifications: enabling interoperability between airspace users*'. This announced the establishment of a task force to jointly develop electronic conspicuity specifications to enable interoperability between airspace users. It goes on to state: '*The adoption of EC specifications will not be mandated UK wide. Users of other systems can continue to benefit from the functionality that those products offer*'. This does not mean that an EC triggered ADLS system will not be feasible, but the regulatory challenges mentioned above may take longer to resolve.

39. What is clear is that once the carriage of compatible transponders is mandated and all aircraft fitted with them, this is likely to be a realistic way of triggering an ADLS system. Such systems are passive at the wind farm and will not, therefore cause any interference. As shown in Figure 10 they require unobtrusive small aerials, approximately 1.2 metres long that are very reliable and relatively inexpensive to install and operate.

Figure 10 ADSB/SSR Passive Aerial

40. Bearing the above in mind, it would be prudent to ensure that lighting installed on the turbines is compatible with any future EC triggered ADSL system, so that when the regulatory process and aircraft equipage has been completed, it will be a relatively cheap and simple exercise to retro-fit such a system. Alternately, the ADSB/SSR aerials and system could be installed when the wind farm is constructed, ready for activation when required. It may therefore be suitable for use as the basis of a planning condition requiring the activation of the system once the regulatory and equipage hurdles have been overcome.

41. An ADSL system may not be suitable for every location, depending upon the nature of aviation operations at night in the area around the wind farm and the activation criteria that are finally mandated by the CAA. If located close to the approach for a major airport for example, the lights might be required to be turning on and off continuously, however, in a location like Lorg, with limited night low level civilian traffic, the number of times the lights will activate is likely to be so small. The EC activated ADLS system will be able to differentiate between civil traffic and SAR/HEMS/military traffic using NVD and not therefore activate when these types of aviation operations are taking place within the activation zone for the system. The infra-red lights that these types of operations rely on will always be on at night, but of course are invisible to the naked eye and will have no effect on the visual impact of the development.

Comment

42. In recent months various briefing documents have been in circulation suggesting that visible obstruction lights are not required in the current aviation environment. The CAA have briefed WPAC that they do not support this regulatory change and would consider prosecuting organisations that do not follow the existing guidance and regulations. However, change will come; this will be led by the CAA and be centred on the new draft CAP 764 (as adhered to in this report) and the future development of ADLS.

43. From the direct experience of WPAC staff who have over 40 years of day/night low flying over land and sea both with and without NVG/Ds, the inclusion of adequate visible red lighting is important to cater for both routine operations and the inevitable unplanned outcome. Pilots uncertain of their location together with emergency situations and system failures of critical night low flying equipment are circumstances that require a degree of visible obstruction lighting on large wind turbines.

44. In addition, future green energy aircraft (hydrogen/electric and battery powered) will fly considerably lower and slower than current aircraft and will be significantly limited in track variation by much shorter ranges. Good visible obstruction lighting will become more, not less important in this low direct flight environment.

45. Finally, an aircraft colliding with a wind turbine is thankfully an extremely rare event but one with enormous consequences. A standard risk assessment as part of an aviation safety case would conclude that even a very low probability of a significant dangerous event is still unacceptable and must be mitigated, in this case by the fitting of visible obstruction lights.

Conclusion

46. This report has assessed the requirements for both visible, CAA approved aviation lighting and MOD approved Infra-Red lighting for the Lorg Wind Farm. The resulting layout is set out in Figures 4 and 6 and makes use of both CAA/ANO Red lights and MOD IR lights. The proposed layouts were sent to the CAA and MOD DIO for approval. The MOD will approve the IR lighting layout as there is no significant concession required and the CAA have responded approving the layout as shown in Appendix C.

47. The report also provides the brilliance of lights that will be visible taking into account the elevation angle between the turbine hub obstruction light and the viewpoints and the distance between each turbine and each viewpoint. The report shows that for up to 98% of the time, the lights will only be required to operate at 10% luminous intensity, which will significantly reduce obstruction light effects in the area. Further interpretation of these results can be undertaken by a Landscape and Visual Impact Assessment expert.

48. The report then identifies additional mitigation options that, should the regulatory process allow, enable the visible medium intensity turbine lights to be switched off for the vast majority of the time and activated only on those rare occasions in this location when an aircraft activates the system. A suitably worded planning condition will enable the future lighting effects to be mitigated to the extent of becoming almost non-existent.

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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Appendix A Lighting Results Tables

Turbine	Distance (km)	Elevation Angle	Candela	Candela at 10%	Microlumens per square metre (lux$^{10-6}$)	Microlumens per square metre (lux$^{10-6}$) at 10%	Obscured
1	2.406	-0.1	2083	208	359.8	36.0	
2	1.777	-1.3	756	76	239.4	23.9	
8	1.119	-2.8	239	24	190.9	19.1	
9	1.605	-0.2	1982	198	769.4	76.9	
10	2.504	1.2	2439	244	389.0	38.9	
11	5.97	-1.0	982	98	28.0	2.8	
12	6.353	-1.1	902	90	22.3	2.2	
13	6.496	-1.0	982	98	23.3	2.3	
15	6.228	-1.1	902	90	23.3	2.3	

Viewpoint 1 The Striding Arches - Colt Hill

Turbine	Distance (km)	Elevation Angle	Candela	Candela at 10%	Microlumens per square metre (lux$^{10-6}$)	Microlumens per square metre (lux$^{10-6}$) at 10%	Obscured
1	2.31	-5.3	105	11	19.7	2.0	
2	2.936	-4.7	112	11	13.0	1.3	M
8							X
9							X
10							
11							X
12							X
13							X
15							X

Viewpoint 2 Southern Upland Way Adjacent to Lorg Site

Turbine	Distance (km)	Elevation Angle	Candela	Candela at 10%	Microlumens per square metre (lux$^{10-6}$)	Microlumens per square metre (lux$^{10-6}$) at 10%	Obscured
1	1.084	-16.4	75	7.5	63.8	6.4	
2							X
8							X
9							X
10							X
11							X
12							X
13							X
15							X

Viewpoint 3 Lorg Bridge

Turbine	Distance (km)	Elevation Angle	Candela	Candela at 10%	Microlumens per square metre (lux10-6)	Microlumens per square metre (lux10-6) at 10%	Obscured
1	1.482	-13.0	75	7.5	34.1	3.4	
2	1.872	-11.4	75	7.5	21.4	2.1	
8							X
9							X
10							X
11							X
12							X
13							X
15							X

Viewpoint 4 Approach to Lorg (Lorg Trail)

Turbine	Distance (km)	Elevation Angle	Candela	Candela at 10%	Microlumens per square metre (lux10-6)	Microlumens per square metre (lux10-6) at 10%	Obscured
1	2.884	-0.4	1721	172	206.9	20.7	
2	1.948	-1.7	530	53	139.7	14.0	
8	2.215	-1.8	484	48	98.7	9.9	
9	3.241	-0.4	1721	172	163.8	16.4	
10	4.058	0.5	2452	245	148.9	14.9	
11	5.64	-1.2	822	82	26.1	2.6	
12	6.239	-1.2	822	82	21.1	2.1	
13	5.91	-1.3	756	76	21.6	2.2	
15	6.393	-1.3	756	76	18.5	1.8	

Viewpoint 5 The Striding Arches – Benbrack

Turbine	Distance (km)	Elevation Angle	Candela	Candela at 10%	Microlumens per square metre (lux10-6)	Microlumens per square metre (lux10-6) at 10%	Obscured
1	2.73	-7.4	87	8.7	11.7	1.2	
2	2.504	-8.9	81	8.1	12.9	1.3	
8							X
9							X
10							X
11	3.78	-6.8	75	7.5	5.0	0.5	
12	4.469	-6.0	99	9.9	5.0	0.5	
13	3.862	-6.9	93	7.5	6.2	0.6	
15	4.81	-5.6	105	11	4.5	0.5	

Viewpoint 6 Minor road from Smittons Bridge to Lorg Bridge

Turbine	Distance (km)	Elevation Angle	Candela	Candela at 10%	Microlumens per square metre (lux10-6)	Microlumens per square metre (lux10-6) at 10%	Obscured
1	7.131	0.7	2435	244	47.9	4.8	
2	8.134	0.4	2429	243	36.7	3.7	
8	8.284	0.3	2379	238	34.7	3.5	
9	7.423	0.7	2435	244	44.2	4.4	
10	6.515	1.3	2393	239	56.4	5.6	
11	5.19	-0.1	2083	208	77.2	7.7	
12	4.497	-0.3	1851	185	91.5	9.2	
13	5.566	-0.2	1982	198	64.0	6.4	
15	3.966	-0.4	1721	172	109.4	10.9	

Viewpoint 7 Blackcraig Hill South of New Cumnock

Turbine	Distance (km)	Elevation Angle	Candela	Candela at 10%	Microlumens per square metre (lux10-6)	Microlumens per square metre (lux10-6) at 10%	Obscured
1	6.132	-0.8	1192	119	31.7	3.2	
2	5.203	-1.4	691	69	25.5	2.6	
8	4.817	-1.6	576	58	24.8	2.5	
9							X
10							X
11	9.56	-1.1	902	90	10.0	1.0	
12	10.048	-1.2	822	82	8.1	0.8	
13	9.948	-1.2	822	82	8.3	0.8	
15	10.032	-1.2	822	82	8.2	0.8	

Viewpoint 8 The Striding Arches - Bail Hill

Turbine	Distance (km)	Elevation Angle	Candela	Candela at 10%	Microlumens per square metre (lux10-6)	Microlumens per square metre (lux10-6) at 10%	Obscured
1	8.389	1.3	2393	239	34.0	3.4	
2	8.666	1.0	2503	250	33.3	3.3	
8	9.355	0.9	2509	251	28.7	2.9	
9	9.619	1.1	2471	247	26.7	2.7	
10	9.566	1.5	2276	228	24.9	2.5	
11	5.90	0.9	1087	109	31.2	3.1	
12	6.263	0.7	2435	244	62.1	6.2	
13	5.198	0.9	2509	251	92.9	9.3	
15	6.929	0.6	2475	248	51.6	5.2	

Viewpoint 9 Cairnsmore of Carsphairn

Turbine	Distance (km)	Elevation Angle	Candela	Candela at 10%	Microlumens per square metre (lux10-6)	Microlumens per square metre (lux10-6) at 10%	Obscured
1							X
2	7.684	-2.9	228	23	3.9	0.4	
8							X
9							X
10							X
11	9.76	-2.7	254	25	3.0	0.3	
12	10.473	-2.6	273	27	2.5	0.2	
13	9.615	-2.8	239	24	2.6	0.3	
15	10.909	-2.5	291	29	2.4	0.2	

Viewpoint 10 B729 East of Carsphairn

Turbine	Distance (km)	Elevation Angle	Candela	Candela at 10%	Microlumens per square metre (lux10-6)	Microlumens per square metre (lux10-6) at 10%	Obscured
1	11.677	-0.3	1851	185	13.6	1.4	
2	11.433	-0.5	1582	158	12.1	1.2	
8	10.739	-0.6	1443	144	12.5	1.3	
9	10.451	-0.3	1851	185	16.9	1.7	
10	10.66	0.0	2185	219	19.2	1.9	
11	14.81	-0.6	1443	143	7.0	0.7	
12	14.882	-0.7	1317	132	5.9	0.6	
13	15.485	-0.7	1317	132	5.5	0.5	
15	14.445	-0.7	1317	132	6.3	0.6	

Viewpoint 11 Cairnkinna Hill

Turbine	Distance (km)	Elevation Angle	Candela	Candela at 10%	Microlumens per square metre (lux10-6)	Microlumens per square metre (lux10-6) at 10%	Obscured
1	13.349	-1.9	448	45	2.5	0.3	
2	12.774	-2.1	385	39	2.4	0.2	
8	13.268	-2.1	385	39	2.2	0.2	
9	14.194	-1.8	484	48	2.4	0.2	
10							X
11	13.55	-2.3	333	33	2.0	0.2	
12	14.229	-2.2	357	36	1.8	0.2	
13	13.156	-2.4	309	31	1.8	0.2	
15	14.809	-2.2	357	36	1.6	0.2	

Viewpoint 12 B7000

Turbine	Distance (km)	Elevation Angle	Candela	Candela at 10%	Microlumens per square metre (lux10-6)	Microlumens per square metre (lux10-6) at 10%	Obscured
1							X
2							X
8							X
9							X
10							X
11	14.05	-2.1	385	39	2.0	0.2	
12	13.35	-2.3	333	33	1.9	0.2	
13	14.141	-2.2	357	36	1.8	0.2	
15	13.023	-2.4	309	31	1.8	0.2	

Viewpoint 13 Lochside Hotel

Turbine	Distance (km)	Elevation Angle	Candela	Candela at 10%	Microlumens per square metre (lux10-6)	Microlumens per square metre (lux10-6) at 10%	Obscured
1	16.382	-0.5	1582	158	5.9	0.6	
2	17.01	-0.6	1443	144	5.0	0.5	
8	16.598	-0.7	1317	132	4.8	0.5	
9	15.606	-0.6	1443	144	5.9	0.6	
10							X
11	16.99	-0.8	1192	119	4.0	0.4	
12	16.496	-0.9	1087	109	4.0	0.4	
13	17.624	-0.9	1087	109	3.5	0.3	
15	15.824	-1.0	982	98	3.9	0.4	

Viewpoint 14 Guffock Hill

Turbine	Distance (km)	Elevation Angle	Candela	Candela at 10%	Microlumens per square metre (lux10-6)	Microlumens per square metre (lux10-6) at 10%	Obscured
1							X
2	17.986	-1.0	982	98	3.0	0.3	
8	17.461	-1.0	982	98	3.2	0.3	
9	17.911	-0.9	1087	109	3.4	0.3	
10	18.644	-0.7	1317	132	3.8	0.4	
11	22.35	-1.0	982	98	2.0	0.2	
12	22.754	-1.0	982	98	1.9	0.2	
13	22.812	-1.0	982	98	1.9	0.2	
15	22.612	-1.0	982	98	1.9	0.2	

Viewpoint 15 Keir Hills

Turbine	Distance (km)	Elevation Angle	Candela	Candela at 10%	Microlumens per square metre (lux10-6)	Microlumens per square metre (lux10-6) at 10%	Obscured
1	21.99	0.5	2452	245	5.1	0.5	
2	21.842	0.4	2429	243	5.1	0.5	
8	22.496	0.3	2379	238	4.7	0.5	
9	23.139	0.4	2429	243	4.5	0.5	
10	23.402	0.6	2475	248	4.5	0.5	
11	20.360	0.3	2379	238	6.0	0.6	
12	20.811	0.2	2330	233	5.4	0.5	
13	19.7	0.2	2330	233	6.0	0.6	
15	21.483	0.2	2330	233	5.0	0.5	

Viewpoint 16 Corserine

Turbine	Distance (km)	Elevation Angle	Candela	Candela at 10%	Microlumens per square metre (lux10-6)	Microlumens per square metre (lux10-6) at 10%	Obscured
1							X
2							X
8							X
9							X
10							X
11	4.68	-4.3	126	13	6.0	0.6	
12	3.992	-5.2	105	11	6.6	0.7	
13							X
15							X

Viewpoint 17 Afton Filter Station

Appendix B – Abbreviations and Definitions

ADSB……………………………………..………Automatic Dependent Surveillance Broadcast
AGL..Above Ground Level (Height)
ANO...Air Navigation Order
AMSL...Above Mean Sea Level (Elevation)
ASG...Aviation Steering Group
CAA...Civil Aviation Authority
CAP...Civil Aviation Publication (Referrers to Specific Documents)
cd..Candela, a measure of light intensity
DIO...Defence Infrastructure Organisation
HNTA..Helicopter Night Training Area
In Flight Visibility...................The distance a pilot can see ahead to fly & navigate the aircraft
IR..Infra-Red
Kts..Knots: a measure of airspeed (10 kts = 12mph = 19 kph)
LED...Light Emitting Diode
MOD...Ministry of Defence
mW/sr.............milliWatts per steradian: electromagnetic energy output related to solid angle
Nm...Nautical Mile
NVD ....Night Vision Devices - Aircraft Mounted
NVG...Night Vision Goggles - Operator Worn
Radar Altimeter........An altimeter that uses radar to accurately measure height above ground
QFE ....Setting on Altimeter that gives Height above Airfield
RoAR..Rules of the Air Regulations
Rule 5...The Low Flying Rule – part of RoAR
Rule 28..VFR Rules Outside Controlled Airspace – part of the RoAR
ReUK...Renewables UK – The UK Wind Industry Body
SAR Box..Night Training Area for Search and Rescue Helicopter Units
SSA...Sector Safety Altitude
SSR……………………………………………………………….Secondary Surveillance Radar
UKAB...............................United Kingdom Air Prox Board – Investigates Aircraft Near Misses
VFR...................................Visual Flight Rules (Flight without ATC on a see-and-be-seen basis)
VMC..................................Visual Meteorological Conditions (Weather suitable for VFR flight)

Appendix C CAA Response

Safety and Airspace Regulation Group
Safety and Business Delivery

Civil Aviation Authority

Mike Hale
Aviation Consultant
Wind Power Aviation Consultants Ltd.
38 Hadrian Way
Chilworth
Southampton
SO16 7HX

9 September 2022
Ref Windfarms/Lorg

Dear Mike,

Proposed Obstacle Lighting Scheme for Lorg Wind Farm

Reference: Lorg Wind Farm Obstacle Lighting Review Report e-mailed 31 March 2022

1. Thank you for the report at reference, discussing the proposed obstacle lighting plan for the Lorg wind farm.

2. The proposed 15-turbine wind farm on the Altry and Alwhat Hills in Ayrshire is split into two separate groups located NW-SE of the Water of Ken; the first (easterly group) with ten turbines (turbine numbers T01 to T10), with the second group of 5 turbines to the west (turbine number T11 to T15). The turbines are proposed to have tip heights of 200 metres above ground level (AGL), which brings them within scope of the Air Navigation Order (ANO) Article 222.

3. We have considered the report carefully and take note of the intent to address concerns relating to the night-time visual impact of such aviation lighting while ensuring that the lighting installed on the turbines meets air safety requirements.

4. We note the local terrain aspects and additional mitigation provided by the provision of infra-red lighting for those operators who carry Night Vision Device capability.

5. We note the reduced lighting scheme proposed and largely accept the reasoning set out in the document. However, given the turbine location and layout associated with the western group, we will require an additional light on turbine 11.

5. As a result, the CAA agrees a variation to the lighting requirements specified in the ANO Article for the Lorg wind farm, under provisions given in the Air Navigation Order (ANO) Article 222 section 6, as per the following:

Civil Aviation Authority
2W Aviation House City Place Gatwick Airport South West Sussex RH6 0YR www.caa.co.uk
Telephone 0330 138 3166 andy.wells@caa.co.uk

• medium intensity steady red (2000 candela) lights on the nacelles of turbines T01, T02, T08, T09, T10, T11, T12, T13 and T15;
• a second 2000 candela light on the nacelles of the above turbines to act as alternates in the event of a failure of the main light;
• the lights on these turbines to be capable of being dimmed to 10% of peak intensity when the lowest visibility as measured at suitable points around the wind farm by visibility measuring devices exceeds 5km;
• infra-red lights to MoD specification installed on the nacelles of turbines T01, T02, T03, T05, T06, T07, T08, T09, T10, T11, T12, T13, T14 and T15.

6. Intermediate level 32 candela lights are not required to be fitted on the turbine towers.

7. If the proposed design of the wind farm changes (other than variations due to micrositing etc.) this is likely to require a revision to this aviation obstacle lighting variation.

8. Please let me know if you have any further queries.

Yours sincerely

AWells

Andy Wells, Manager Rulemaking and Safety Publications

Hazards, 38 Hadrian Way, Chilworth, Southampton SO16 7HX