ScottishPower Renewables

Harestanes West Windfarm

Environmental Impact Assessment Report

Technical Appendix 14.3:

Aviation Lighting Landscape and Visual Impact Mitigation Plan

Volume 4

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Abbreviations

AGL	Above Ground Level
ALLVIMP	Aviation Lighting Landscape and Visual Impact Mitigation
ANO	Air Navigation Order
CAA	Civil Aviation Authority
cd	Candela
EIA	Environmental Impact Assessment
ICAO	The International Civil Aviation Organisation
LVIA	Landscape and Visual Impact Assessment
m	metres
UK	United Kingdom

1. Introduction

1. This report (the 'ALLVIMP') outlines the available mitigation options, and the mitigation agreed with Civil Aviation Authority, to reduce potentially significant landscape and visual effects caused by the requirement for aviation lighting to be installed at Harestanes West Windfarm (hereafter, 'the proposed Development'). The measures described and proposed in this plan have been used to undertake, Chapter 7: Landscape and Visual Impact Assessment (LVIA), and aviation section of Chapter 14: Other Issues and Technical Appendix 14.4: Aviation Impact Assessment, of the Harestanes West Windfarm Environmental Impact Assessment (EIA) Report. The Aviation Lighting Landscape and Visual Impact Mitigation Plan (ALLVIMP) should be read in conjunction with these assessment chapters and technical appendices.

2. The Civil Aviation Authority (CAA) have been consulted and signed-off the proposed ALLVIMP. It is envisaged that should the proposed Development be consented, the ALLVIMP shall be controlled via a suitably worded planning condition, with condition wording suggested in **Section 5**.

3. All mitigation options proposed within the ALLVIMP utilise procedures or technologies that have previously been successfully deployed elsewhere to mitigate the effects of aviation lighting on landscape and visual environmental receptors.

2. Proposed Development

2.1. Outline

4. The proposed Development comprises of 12 turbines, 6 with a maximum height of 220 m and six with a maximum height of 200 m to blade tip. Full project description can be found within the EIA **Chapter 3: Proposed Development**.

5. Article 222 of the Air Navigation Order (ANO) (SI 2016/765 as amended) requires the visible lighting of 'en-route obstacles' at or above 150 meters (m) above ground level (AGL), to assist their detection by aircraft. The Civil Aviation Authority (CAA) in its 2017 Policy Statement on lighting onshore wind turbines with a maximum tip height at or over 150 m AGL modified the strict application of ANO Article 222 in this context. Applying the regulations to the proposed Development at night would result in medium intensity red lights located on the nacelles, and low intensity red lights on the wind turbine towers, of all proposed wind turbines. As part of the aviation assessment, strategies to minimise the effects of lighting are being considered.

6. It should be noted that all turbines would also include infra-red lighting on the wind turbine nacelles for the benefit of aircraft fitted with night vision devices (e.g., low flying military). Infra-red lights are not visible to the human eye.

7. The focus of this ALLVIMP is on the effects around visible lighting requirements of the proposed Development, together with the options and proposals to mitigate them.

2.2. Aviation Lighting Potential Landscape and Visual Effect

8. New wind turbine developments are typically located in areas with low underlying levels of night-time lighting. Therefore, new wind turbines have the potential to give rise to landscape and visual effects where the turbines require visible lighting. The need for lighting has increased as manufacturers withdraw turbines models below 150 m to tip height from the market as they are not economically viable. As wind energy developments are commonly clustered around areas free from development constraints, there is also potential for cumulative effects to arise across preferred development areas.

2.3. ICAO / Civil Aviation Authority (CAA) Regulations

9. The International Civil Aviation Organisation (ICAO) (a United Nations body) sets international aviation standards (relevantly here Annex 14). Within the United Kingdom (UK), the ICAO requirements for lighting wind turbines are implemented through the Air Navigation Order 2016 ((ANO), SI 2016/765), see also CAP393, and CAA publication 'CAP 764: Policy and Guidelines on Wind Turbines'. The CAA have confirmed that UK policy broadly aligns with the international standards, including insofar as the point at which lights must be switched on at 'Night' rather than 'Twilight'.

10. The proposed turbines, the highest at 220 m to blade tip, would require lighting under ANO Article 222. This requires medium intensity 'steady' red aviation lights (emitting 2,000 candela(cd)) to be fitted at nacelle level. In addition, the CAA requires low intensity steady red lights to be fitted at the intermediate level on the turbine tower (CAA, 2017). The intermediate 'tower' lights will be 32 cd.

11. These should be turned on at 'night'; defined as ambient lighting levels at or below 50 cd/m2. 'Night' is defined in ANO 2016 Schedule 1, as 30 minutes after sunset until 30 minutes before sunrise. The switching on and off of lights would be controlled by a timer, and not by photocells or similar that respond to particular light levels, thereby not incurring effects in the daytime.

12. CAA, Policy Statement: Lighting of Onshore Wind Turbine Generators in the United Kingdom with a maximum blade tip height at or in excess of 150 m AGL, 2017 states that: "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". This allows the minimum intensities identified above to be dimmed to 10% of their values if meteorological conditions permit (i.e. the 2,000 cd minimum intensity may be dimmed to 200 cd, if visibility is greater than 5 km, i.e. in moderate to excellent or 'clear' visibility).

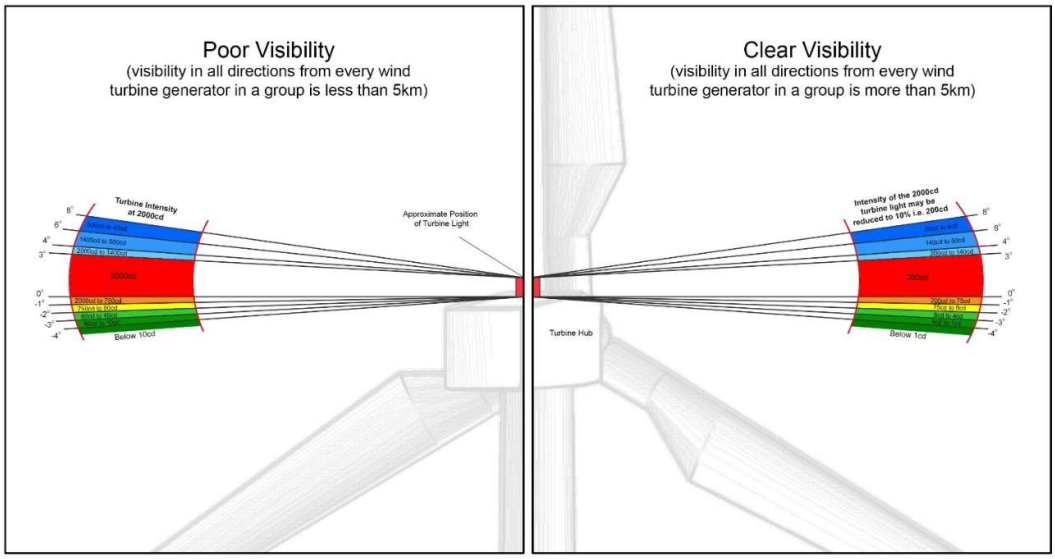
13. ICAO Annex 14 Table 6.3, shown in Image 2.1 below, provides for reduced directional intensity of the nacelle lighting as follows, noting that the final line in the table addresses 2,000 cd red lights:

Image 2.1: Light Distribution for Medium and High Intensity Obstacle Lights According to Benchmark Intensities

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)
200 000	200 000	150 000	75 000	3°	75 000	250 000	112 500	7 500	7°	75 000
100 000	100 000	75 000	37 500	3°	37 500	125 000	56 250	3 750	7°	37 500
20 000	20 000	15 000	7 500	3°	7 500	25 000	11 250	750	N/A	N/A
2 000	2 000	1 500	750	3°	750	2 500	1 125	75	N/A	N/A

14. A diagrammatic interpretation of the minimum requirements set out in ICAO Annex 14 Table 6-3 is shown in **Image 2.2** below. It illustrates the potential light intensity from a medium-intensity nacelle mounted aviation light, required over +3° beam spread from the horizontal (0°). It also provides illustration of the likely light intensity in poor visibility <5 km (2,000 cd) and clear visibility >5 km (200 cd) where CAA policy (CAA, 2017) permits dimming of the lights.

Image 2.2: Diagrammatic interpretation of minimum requirements of ICAO/CAP393 (LuxSolar Medium Intensity Obstruction Light). Note: the turbine light is designed to emit the same light intensity horizontally in 360 °.



15. **Image 2.2** illustrates light intensity emission at various vertical angles, with the horizontal plane of the lights represented by 0 degrees vertical angle. This information is in relation to a specific model of Medium Intensity Obstruction Light provided by the manufacturer. Whilst the precise model of light to be used for the proposed Development is not known at this time, the illustration clearly demonstrates that the intensity of the aviation lights is most intense between 0° to +3° from horizontal and that the intensity of emitted light required by IACO is lower below the horizontal. The use of a model of aviation light which

offers a reduced light intensity below the horizontal and above +3° would provide inherent mitigation of the intensity of the lights for receptors viewing them from areas below the horizontal.

2.4. Basis of Aviation Lighting Assessment

16. The basis of the initial night-time landscape and visual assessment reported in **Chapter 7** of the EIA Report, is that the nacelles of 7 of the 12 wind turbines would be fitted with a Medium Intensity Obstruction Light operating to the parameters described above; at night (controlled with a timer), with the light intensity reduced from 2,000 cd to 200 cd during clear conditions (whilst directional intensity is proposed, this was not considered as part of the night-time landscape and visual impact assessment. With the exception of vertical directional intensity, all embedded mitigation is included in the assessment of night-time impacts within the LVIA assessment.

17. The potential night-time landscape and visual effects caused by aviation lighting have been assessed in **Chapter 7** (summarised in **Table 7.16**) of the EIA Report. As a reduced lighting strategy has been agreed with CAA, the LVIA assessment is based upon the agreed reduced lighting scheme where the scenario as outlined in Section 3.6 below.

18. The LVIA determined that impacts on the landscape or visual effects identified at night would be limited to a localised part of the adjacent Southern Uplands LCT, visual receptors in the village of Ae, Ae Bridgend/ Parkgate, Auchencairn/Kirkton Shieldhill, and Templand, as well as recreational receptors in the southern Lowther Hills.

3. Mitigation Options

19. The options for mitigation of visual effects of aviation lighting that are reasonably expected to be available for the proposed Development are outlined in **Table 3.1** below.

Table 3.1: Turbine Lighting Mitigation Options

Mitigation Option	How it Works	Current Status
Reduce intensity of lights from 2,000cd to 200cd	Already provided for in CAA guidance (CAA, 2017). 2,000cd aviation lights may be dimmed to 10% of their intensity (200cd) where visibility conditions permit, when visibility from every turbine within the wind farm group is >5 km. Visibility conditions are measured using a visibility sensor, which can then be dimmed automatically to respond to prevailing meteorological conditions. 2,000 cd lights will therefore only be experienced in visibility of <5 km; and their intensity would be dimmed to 200 cd in visibility of >5 km.	Embedded in Development design
Directional intensity	Established in ICAO (Annex 14) guidance. This focusses the 2,000cd lighting in the horizontal plane (+ or – a few degrees)	Embedded in Development design

	and reduces the intensity of the light from above and from below the horizontal plane. Most current aviation light models on the market will incorporate this as standard, for example, LuxSolar Medium Intensity Obstruction Light and Obelux Medium-Intensity Red Obstruction Light.	
Reduced Lighting Scheme	As per above, ANO Article 222 contains provisions that allow exemption from its lighting requirements where this is agreed by the CAA. The Applicant has prepared a reduced lighting scheme whereby only the cardinal or selected peripheral turbines would be lit. The lighting of cardinal or selected periphery turbines is a mitigation option that has been approved by the CAA. This measure will reduce the density of lights and the level of predicted effects sufficiently to make them unlikely to be significant. It may remove effects completely where a specific receptor, such as a nearby dwelling would no longer have visibility of any lights.	The Applicant has gained approval from the CAA for a reduced lighting scheme whereby only selected peripheral and cardinal wind turbines would be lit.

20. The mitigation options outlined above are given consideration for application in the context of the proposed Development site design, geographic location and the nature of the landscape and visual effects predicted.

4. Consideration of Mitigation Options

4.1. Reduced Intensity

21. It is proposed that visibility sensors are installed on relevant wind turbines to measure prevailing atmospheric conditions and visibility range. Should atmospheric conditions mean that visibility from every wind turbine within the Site is >5 km from the proposed Development, CAA policy permits lights to operate in lower intensity mode of 200 cd (being a minimum 10% of their capable illumination). If visibility is restricted to 5 km or less, the lights would operate at 2,000 cd.

22. This feature has been assumed to be part of the proposal as embedded mitigation. It is likely to reduce the magnitude of landscape and visual effects particularly for distant receptors, however this feature will not remove visibility of aviation lighting completely for any nearby receptors. It will work in conjunction with other measures proposed/approved to lessen effects.

4.2. Directional Intensity

23. The inherent directional intensity of 2,000 cd lights can be used to reduce vertical downwards lighting impacts at elevations less than -1° degree vertical angle from the horizontal plane from the aviation light. By ensuring that the lights installed comply with the ICAO recommendations set out in Annex 14 **Table 6-3**, it is possible to attenuate the vertical downwards light to a level that reduces the visual impact from receptors at ground levels below the lights. Implementing the ICAO recommendations, at -1 degrees the aviation lights should only be 1,125 cd and at -10 degrees should only be 75 cd (when visibility is > 5 km).

24. This has potential to reduce visual effects at nearby receptors located at elevations below the turbine nacelles. An indication of the locations where this could be effective is illustrated on the Aviation ZTVs in Figures **7.11** and **7.12**.

4.3. Reduced Aviation Lighting Scheme

25. ANO Article 222 contains provisions that allow exemption from its lighting requirements where this is agreed by the CAA.

26. Article 222 (6) provides that: A permission may be granted for the purposes of this article for a particular case or class of cases or generally.

27. Article 222 (7) adds: This article does not apply to any enroute obstacle for which the CAA has granted a permission to the person in charge permitting that person not to fit and display lights in accordance with this article.

28. The Applicant has reviewed the potential to implement a reduced aviation lighting scheme at Harestanes West Windfarm and considered the extent to which this could reduce the landscape and visual effects of the lights. Reduced aviation lighting schemes typically consist of cardinal or perimeter turbines being lit and dispensation not to light certain turbines in between. This can substantially reduce the density of turbines being illuminated.

29. The Applicant has agreed a reduced aviation lighting scheme with the CAA whereby a single 2000 candela steady red light will be mounted on nacelle of 7 of the 12 turbines (T1, T3, T6, T7, T8, T9, and T12). Visible lights on all towers are not required.

4.4. Mitigation Measures Proposed

30. The Applicant is committed to reducing significant environmental effects predicted during the development of its sites and therefore propose that the following mitigation measures are deployed at the proposed Development as part of the ALLVIMP, in addition to the standard use of reduced intensity lighting.

31. The Applicant has gained approval from the CAA (see signed letter in Appendix 1) to implement a reduced lighting scheme inclusive of:

- Medium intensity steady red (2000 candela) lights on the nacelles of seven of the twelve turbines: T01, T03, T06, T07, T08, T09 and T12;
- a second 2000 candela light on the nacelles of the above turbines to act as an alternative in case of failure of the main light (note that both lights should not be lit at the same time)

- 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 5 km; and
- infra-red lights to MoD specification installed on the nacelles of turbines T01, T02, T03, T04, T05, T06, T07, T08, T09, T10, T11 and T12. Note that dimming permission is applicable only to visible lights, not infra-red lighting.

32. The Applicant shall also deploy lights that reduce directional intensity below zero degrees of horizontal to reduce the intensity of light at close proximity ground-based receptors.

5. Suggested Aviation Lighting Condition Wording

33. Whilst the Applicant has gained regulatory approval for a suite of mitigation measures, it is recognised that ministers may wish to control the implementation of such through the imposition of conditions within a Section 36 consent. The wording below is proposed as a suggestion for a suitable planning condition(s):

"(1) No wind turbines shall be erected until a scheme for aviation lighting for the Development has been submitted to, and approved by, the Planning Authority in consultation with the Civil Aviation Authority. The scheme shall include details of aviation lighting which is to be applied.

(2) No later than the first, third and fifth anniversary of the date of First Commissioning and every five-year anniversary thereafter, the Company shall submit a written review of the Aviation Lighting Scheme to the Planning Authority. Each review shall include:

a) An assessment of options available for the reduction in the number of visible lights installed on turbines and the time period when lights are visible;

b) An assessment of the potential for installation of an Aircraft Detection Lighting System ("ADLS"), including a statement setting out the current and anticipated regulatory environment in relation to ADLS; and

c) An assessment of whether, in the Company's view, it is reasonably practicable to install an ADLS at the Development.

(3) The review may propose amendment of the Aviation Lighting Scheme. If a review assesses that it is reasonably practicable to install ADLS, provided that such installation shall not require planning permission, such review shall also include the Company's proposals for installation of ADLS together with a proposed timetable for installation. Any proposed amendment shall be compliant with the then current aviation lighting requirements of the Civil Aviation Authority and the Ministry of Defence.

(4) Any proposed amendment to the Aviation Lighting Scheme shall be subject to the written approval of the Planning Authority in consultation with the Civil Aviation Authority and the Ministry of Defence and shall thereafter be installed in accordance with the approved details.

(5) The Aviation Lighting Scheme, or such alternative scheme as may be approved under part (4), shall thereafter be maintained throughout the operational life of the Development.

(6) No lighting other than that described in the approved scheme for aviation lighting shall be applied within the site, other than that required for health and safety purposes, unless otherwise approved in writing by the Planning Authority or required by law.

(7) The Development shall be operated in accordance with the approved scheme, or any alternative scheme as may be approved under part (4), unless otherwise approved in writing by the Planning Authority in consultation with the Civil Aviation Authority and the Ministry of Defence as a result of a periodic review.

Reason: In the interests of aviation safety and to minimise visual effects of the Development.

References

Civil Aviation Authority (2017). Lighting of onshore wind turbine generators in the United Kingdom with a maximum blade tip height at or in excess of 150 m Above Ground Level. Available at: https://publicapps.caa.co.uk/docs/33/DAP01062017_LightingWindTurbinesOnshoreAbove150mAGL.pdf.

Civil Aviation Authority (2018). Airspace Modernisation Strategy – CAP1711. Available at: https://publicapps.caa.co.uk/docs/33/CAP%201711%20Airspace%20Modernisation%20Strategy.pdf.

Civil Aviation Authority (2020). Airspace Modernisation – 2020 Progress Report – CAP2016. Available at: https://publicapps.caa.co.uk/modalapplication.aspx?catid=1&pagetype=65&appid=11&mode=detail&id=9990.

The Air Navigation Order (2016). Available at: https://www.caa.co.uk/General-aviation/Safety-information/Air-Navigation-Order 2016/#:~:text=%20Air%20Navigation%20Order%202016%20%201%20Key,%28rather%20than%20EASA%29%20flight%20crew%20licensing%2C...%20More%20

UK Government (1989). The Electricity Act 1989. Available at: https://www.legislation.gov.uk/ukpga/1989/29/contents.

Cyrrus (30 December 2020) Windfarm Lighting Strategy Paper. Available at: https://www.dpea.scotland.gov.uk/Document.aspx?id=750325.

Appendix 1: Proposed Obstacle Lighting Scheme

Strategy and Policy Group
Windfarm Policy

Civil Aviation Authority

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15 October 2024
Ref Windfarms / Harestanes West

Dear Jim,

Proposed Obstacle Lighting Scheme for Harestanes West Wind Farm

Reference: Harestanes West Wind Farm Aviation Lighting Plan Drawing HSTW-I-024 revision D, dated 14 August 2024

1. Thank you for the information at reference, which proposes an obstacle lighting plan for the Harestanes West Wind Farm, located in the Forest Estate of Ae, within Dumfries and Galloway.

2. The proposed Harestanes West Wind Farm consists of 12 turbines, with blade tip heights of up to 220m above ground level, which brings them within scope of the Air Navigation Order (ANO) Article 222 obstacle lighting requirements.

3. We have considered the proposed reduced lighting scheme carefully and take note of the intent to address concerns relating to adverse visual impacts of aviation lighting on non-aviation receptors while ensuring that the lighting installed on the turbines meets air safety requirements. This includes some mitigation is proposed to be provided by the provision of infra-red lighting for those operators who carry Night Vision Device capability.

4. Under provisions given in the Air Navigation Order (ANO) Article 222 section 6, the CAA provides for the following variation:

- Medium intensity steady red (2000 candela) lights on the nacelles of turbines T01, T03, T06, T07, T08, T09 and T12;
- a second 2000 candela light on the nacelles of the above turbines to act as an alternative in case of failure of the main light (note that both lights should not be lit at the same time);

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• 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, T04, T05, T06, T07, T08, T09, T10, T11 and T12. Note that dimming permission is applicable only to visible lights, not infra-red lighting.

5. 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.

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

Yours sincerely,

Andy Wells
Manager Aviation and Wind Farm Policy

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