

Appendix 6.4 Visual Assessment of Visible Aviation Lighting

This page is intentionally blank.

Appendix 6.4 Visual Assessment of Visible Aviation Lighting

Introduction

This Technical Appendix has been prepared to accompany Chapter 6 in Volume 1 of the Knockcronal Wind Farm (hereafter the Proposed Development) EIA Report. The Civil Aviation Authority (CAA) requires that 'en-route obstacles' at or above 150 m above ground level are lit with visible lighting to assist their detection by aircraft. As such, there is potential that parts of the Proposed Development may need to display visible red lights at night. The effect of the Proposed Development at night would result from visible medium intensity (2,000 candela) red coloured light fittings located on the nacelles and 32 candela red coloured light fittings located on the towers of all proposed turbines. It should be noted that all turbines would also include infra-red lighting on the turbine hubs which would not be visible to the human eye. The focus of this Technical Appendix (6.4) is on the visual assessment of the visible aviation lighting requirements of the Proposed Development. For the assessment of lighting effects, the visual sensitivity and magnitude criteria described in Technical Appendix 6.1 has been applied.

This visual assessment of turbine lighting is supported by a baseline light pollution map (Figure 6.4-1), ZTV map figures (Figures 6.4-2 to 6.4-4), a Lighting Intensity ZTV (Figure 6.4-5) and night-time photomontage visualisations from three viewpoints (See visualisation Figures 6.22, 6.32 and 6.40).

Regulations and Guidance

ICAO / Civil Aviation Authority (CAA) Regulations

ICAO (a UN body) sets international Standards; Recommendations and 'Notes' for aviation lighting in its publication '*Annex 14 to the Convention on International Civil Aviation*' - Volume I Aerodrome Design and Operations (ICAO, Eighth Edition, July 2018).

ICAO Table 6.1 (page 6-4) identifies the international definitions of daylight; twilight and night based on measured background illuminance as follows.

- Daylight: Above 500 cd/m²
- Twilight: 50-500 cd/m²
- Night: Below 50 cd/m²

For 2,000 candela medium intensity steady or fixed red lights, ICAO indicates a requirement for no lighting to be switched on until 'Night' has been reached, as measured at 50 cd/m² or darker.

ICAO Table 6.3 (page 6-5) identifies minimum requirements and recommendations for 2,000 cd aviation lights on wind turbines at 150 m and above. In summary these are:

Minimum requirements:

- 0 to +3 ° from horizontal: 2,000 cd minimum average intensity (or 1,500 cd minimum intensity)
- -1 degree from horizontal: 750 cd minimum intensity

The European Aviation Safety Agency (EASA) implements ICAO in European airspace. In pursuit of international standards for use around the globe, a project team has been established to provide clearer direction to lighting manufacturers, as there is scope for interpretation of ICAO in different ways by manufacturers.

Within the UK, the ICAO/ EASA requirements for lighting wind turbines are implemented through CAA publication 'CAP 764: Policy and Guidelines on Wind Turbines', and 'CAP393: Air Navigation Order 2016'. 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'.

The proposed turbines, at 200 m and 180 m to blade tip, would require lighting under Article 222 of the Air Navigation Order (ANO, 2016). This requires a single, medium intensity, 'steady' red aviation light (emitting 2,000 candela) to be fitted at nacelle level to each turbine. In addition, the CAA requires 3 low intensity lights to be fitted at the intermediate level on the turbine tower (CAA, 2017), to provide 360 degree visibility around the tower. The intermediate 'tower' lights will be 32 candela.

Air Navigation Order 2016 (CAP393) Article 223 (8) states that '*If visibility in all directions from every wind turbine generator in a group is more than 5km the light intensity for any light required by this article to be fitted to any generator in the group and displayed may be reduced to not less than 10% of the minimum peak intensity specified for a light of this type.*' This reduction affords valuable mitigation of light intensity and 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 10 %, or 200 cd, if visibility is greater than 5 km, i.e. in moderate to excellent or 'clear' visibility).

Guidelines for Landscape and Visual Impact Assessment (GLVIA3)

GLVIA3 (page 103) provides the following guidance on the assessment of lighting effects: '*For some types of development the visual effects of lighting may be an issue. In these cases it may be important to carry out night-time 'darkness' surveys of the existing conditions in order to assess the potential effects of lighting and these effects need to be taken into account in generating the 3D model of the scheme. Quantitative assessment of illumination levels, and incorporation into models relevant to visual effects assessment, will require input from lighting engineers, but the visual effects assessment will also need to include qualitative assessments of the effects of the predicted light levels on night-time visibility.*'

GLVIA3 (page 60) also provides the following guidance with regards to mitigation of obtrusive light: '*lighting for safety or security purposes may be unavoidable and may give rise to significant adverse effects; in such cases, consideration should be given to different ways of minimising light pollution and reference should be made to appropriate guidance, such as that provided by the Institution of Lighting Professionals (ILP, 2011)*'.

Institute of Lighting Professional Guidance

Guidance produced by the Institute of Lighting Professionals (ILP) (2011) (GN01:2011)¹ is useful in setting out some key lighting terminology that relates to potential visual effects.

'Obtrusive Light, whether it keeps you awake through a bedroom window or impedes your view of the night sky, is a form of pollution, which may also be a nuisance in law and which can be substantially reduced without detriment to the lighting task. **Skyglow** - the brightening of the night sky; **Glare** - the uncomfortable brightness of a light source when viewed against a darker background; and **Light Intrusion** - the spilling of light beyond the boundary of the property or area being lit, are all forms of obtrusive light which may cause nuisance to others.'

The following key guidance within the ILP GN01:2011 is noted as follows:

- 'The most sensitive/critical zones for minimising sky glow are those between 90° and 100° (note that this equates to 0-10° above the horizontal).

¹ Institute of Lighting Professionals (ILP) - Guidance Notes for the Reduction of Obtrusive Light GN01:2011

- Keep glare to a minimum by ensuring that the main beam angle of all lights directed towards any potential observer is not more than 70°.
- In rural areas the use of full horizontal cut off luminaires installed at 0° uplift will, in addition to reducing sky glow, also help to minimise visual intrusion within the open landscape.
- Upward Light Ratio (ULR) of the Installation is the maximum permitted percentage of luminaire flux that goes directly into the sky. A ULR of 0 (zero) Candela (cd) is suggested for Dark Sky Parks.’

CPRE² also identifies these same broad terms as the three types of light pollution:

- ‘skyglow – the pink or orange glow we see for miles around towns and cities, spreading deep into the countryside, caused by a scattering of artificial light by airborne dust and water droplets.
- glare – the uncomfortable brightness of a light source.
- light intrusion – light spilling beyond the boundary of the property on which a light is located, sometimes shining through windows and curtains’.

NatureScot Guidance

Visual Representation Guidance

In terms of how lighting is captured in visualisations, the main change in the latest version of the NatureScot guidance ‘*Visual Representation of Wind Farms*’ (Version 2.2, February 2017) is in paragraphs 174-177, which states: ‘*The visualisation should use photographs taken in low light conditions, preferably when other artificial lighting (such as street lights and lights on buildings) are on, to show how the wind farm lighting will look compared to the existing baseline at night’... ‘We have found that approximately 30 minutes after sunset provides a reasonable balance between visibility of the landform and the apparent brightness of artificial lights, as both should be visible in the image.’*

The night time photography has therefore been captured in low light conditions, when other artificial lighting (such as street lights and lights on buildings) is on, to show how the wind farm lighting would look compared to the existing baseline at night.

Existing lights shown in the photographs appear larger and more blurred than those seen to the naked eye in the field when the photographs were captured. The term used in photography to describe this effect is ‘Bokeh’ which has been defined as ‘*the way the lens renders out-of-focus points of light*’. This has proved difficult to avoid when taking photographs of light at varied distances across a view. The blurred nature of the lights is also exacerbated by their movement, particularly on vehicle headlights. Where the lights of the Proposed Development have been added to the night time views this effect has been emulated.

The turbine blades, when they intermittently pass in front of the aviation lights, would cause randomised flickering when the lights are switched ‘on’. The turbines used in the night time visualisations have been positioned so that their blades face away from the viewpoint so that all the lights are visible and on within the visualisations, representing a worst-case impression. The flickering effect caused by the blades interacting with the lights would be most usually apparent from a south westerly direction due to the prevailing south-westerly wind.

² CPRE – ‘What is Light Pollution’ found at webpage - <https://www.nightblight.cpre.org.uk/what-is-light-pollution>

Evolving NatureScot Approaches to Turbine Lighting

Recent NatureScot workshops indicate that a proportionate and pragmatic approach is required, both in terms of the need to assess likely significant effects under the EIA regulations (complying with current civil aviation standards) and also in providing mitigation (on a project and site-specific basis).

Mitigation options to eliminate or reduce the need for, and effects of, visible lighting are evolving quickly and developers are exploring these with consultees and the CAA in relation to specific sites. NatureScot has offered a perspective on the efficacy of different mitigation options, noting that the most effective appears to be radar activated, albeit accepting the considerable cost implications inherent in this potential option.

Ministers and planning authorities are using planning conditions to manage effects. It is recognised that the EIAR should not necessarily specify one mitigation option, as these are evolving rapidly, and developers need flexibility to utilise the most appropriate mitigation once they are ready to start discharging conditions. Conditions provide some flexibility for developers to identify the most appropriate mitigation option(s) post consent and prior to construction, and to agree these with the relevant decision maker.

In terms of visual effects, NatureScot's view (as expressed at a seminar in November 2019) is that lengthy debate about the exact brightness of lights (including in visualisations) is potentially not helpful and that it is better to focus on where they will be visible, how many lights will be visible and the level of change from the baseline situation. This is recognised in the visual assessment in this Appendix. NatureScot has also taken a pragmatic view with night-time visualisations, requesting that decision makers, consultees and communities require visualisations from a small number of relevant viewpoints to understand these effects. NatureScot also recognises the challenges of capturing night time photography and accept that some post photographic manipulation of images to provide a good representation is acceptable.

Assessment Parameters

Overview

A description of the proposed turbine lighting is found within Chapter 3, Chapter 14 and Technical Appendix 14.1, based on this, the following assumptions have been made with regards to visible lighting of the Proposed Development for the LVIA:

- the CAA requires that all obstacles at or above 150 m above ground level are fitted with visible medium intensity lighting (2,000cd) located on the turbine nacelle;
- the CAA requires that a secondary light is fitted to the nacelle for use only when the primary light fails and would not be lit concurrently;
- there is an additional requirement for three lights to be provided at an intermediate level of half the nacelle height. These would need to be fitted around the towers to allow for 360degrees horizontal visibility; and
- The 2,000 cd medium intensity lights may be dimmed to 10 %, or 200 cd, if visibility is greater than 5 km, i.e. in moderate to excellent or 'clear' visibility.

Worst Case Aviation Lighting Scheme

In relation to the Proposed Development, the worst-case scenario for night time effects includes the following parameters:

- all turbines would have red, medium intensity visible lights mounted on the nacelle (122.5 m for turbines 1,2,3,7,8 & 9 and 102.5 m for turbines 4,5 & 6);

- 2,000 cd and 200 cd intensity nacelle lights have been assessed representing two differing worst case situations. 2,000 cd represents the maximum intensity possible. 200 cd represents the maximum intensity that would be used when visibility extending from the wind farm exceeds 5 km;
- all turbines would also have low-intensity lights (32 candela) to be provided on the turbine towers at an intermediate level of half the nacelle height (61.25 m turbines 1, 2, 3, 7, 8 & 9 and 51.25 m for turbines 4, 5 & 6); and
- the steady red lighting fixed to the top of the nacelles and to the turbine towers may appear to flicker on and off with the blade movement. This would occur when the turbine blades pass between the lights and the observers.

On the basis of the CAA requirements, it is evident that the effect of the visible lights of the proposed Development will be dependent on a range of factors, including the intensity of lights used, the clarity of atmospheric visibility and the degree of negative/ positive vertical angle of view from the light to the receptor.

In compliance with EIA regulations, the likely significant effects of a 'worst-case' scenario for turbine lighting are assessed and illustrated in this visual assessment. A worst-case approach is applied which considers the effects of 2,000 cd and 200 cd scenarios during periods of clear visibility. It should be noted however, that as the required medium intensity lights are only likely to be operated at their maximum 2,000 cd during periods of poor visibility, that 2,000 cd intensity actually represents an unrealistic worst-case position, as it is unlikely to ever be experienced at that maximum illumination level.

Proposed Reduced Aviation Lighting Scheme

The Aviation Lighting Report (Appendix 14.1) provides details of the proposed lighting scheme for the Proposed Development. The assessment of night time effects in this scenario is based on the following differing parameters:

- Six of the nine turbines would have red, medium intensity visible lights mounted on the nacelle (122.5 m for turbines 1, 2, 7 and 9 and 102.5 m for turbines 4 and 6);
- As for the worst-case scenario, both 2,000 cd and 200 cd intensity nacelle lights have been assessed; and
- Four of the nine turbines would also have low-intensity lights (32 candela) on turbine towers at half the nacelle height (61.25 m turbines 1 and 9 and 51.25 m for turbine 4 and 6).

Representative Night-Time Viewpoints

A hub height ZTV was used to identify where there could be direct line of sight from the surrounding area to the proposed turbine lights of the 'Worst Case Aviation Lighting Scheme' mounted on the turbine nacelle or hub (Figures 6.4-2 & 6.4-3). This ZTV does not take account of any intervening screening that may arise as a result of forestry or woodland cover. A further ZTV has also been produced showing the theoretical visibility of the tower lights (Figure 6.4-4).

Night-time visualisations have been produced for the three representative viewpoints. These were selected from the LVIA viewpoints and agreed with NatureScot and SAC, as follows:

- Viewpoint 2: Minor road near Craig
- Viewpoint 12: Maybole
- Viewpoint 20: Cornish Hill

Whilst aviation lighting manufacturers must meet the minimum requirements, their products may vary in relation to recommended limits set out in ICAO standards, which makes it difficult producing accurate visualisations as the lighting characteristics of different light fittings, of the same intensity, may vary outside the minimum requirements stipulated by ICAO. The night-time photomontages have been produced to show both 2,000 cd and 200 cd reduced intensity lighting, to inform the assessment of worst-case effects assessed. However, it should be noted that the night-time photography has been captured in periods of good visibility that is greater than 5 km. As a result, the night-time photomontage representations of the 2,000 cd lights are therefore an unrealistic over-representation of the likely visibility of visible aviation lighting. This is because visibility on the site (and likely at the viewpoint itself) is very likely to be much poorer (<5 km) when they operate at that intensity.

In addition to visualisations of both 2,000 cd and 200 cd lighting intensity for the 'Worst Case Aviation Lighting Scheme', visualisations have also been produced to illustrate the 'Proposed Reduced Aviation Lighting Scheme'. A cumulative lighting visualisation has also been produced from Viewpoint 20 illustrating the 'Worst Case Aviation Lighting Scheme'.

Assessment of Effects

Types of Effect

The visual assessment of turbine lighting is intended to determine the likely effects that the Proposed Development will have on the visual resource i.e. it is an assessment of the effects of visible aviation lighting on views experienced by people at night.

The assessment of turbine lighting in this Appendix does not consider effects of aviation lighting on landscape character (i.e. landscape effects). For visible medium intensity steady or fixed red aviation warning lights, ICAO indicates a requirement for no lighting to be switched on until 'night' has been reached, as measured at 50 cd/m² or darker. This is helpful as it does not require them to be on during 'twilight', when landscape character may be clearly discerned. It is considered that visible aviation lighting will therefore not affect the perception of landscape character, which is not readily perceived at night in darkness, particularly in rural areas. The assessment of visible lighting is solely a visual effect. While aviation lighting will be visible and result in visual effects, as assessed in this Appendix, the effects of aviation lighting on the perception of landscape character are scoped out of this assessment. This decision to scope out landscape effects reflects the Scottish Ministers' recent finding in the Crystal Rig IV Wind Farm Public Inquiry.

Baseline Lighting

The existing baseline lighting levels have been mapped for the surrounding landscape (see Figure 6.4-1) based on Open Source data of Light Pollution across the UK. This Open Source data has been used to help understand and illustrate the existing baseline lighting levels of the Study Area.

Each pixel in the mapping shows the level of radiance (night lights) shining up into the night sky, which have been categorised into nine colour bands to distinguish between different light levels, from low level light pollution colour band one (darkest) to high level light pollution nine (brightest). Along with the vast majority of the surrounding plateau landscape, the Proposed Development is located in an area within the lowest level of light pollution (darkest). The map also clearly identifies the main concentrations of night-time lights, creating light pollution that spills up into the sky. Most notably, this is in and around the main settlements, particularly the Girvan/Prestwick area and Newton Stewart, but also other smaller settlements on the coast such as Turnberry and Ballantrae. Smaller villages are also shown as having concentrations of night-time lights, including Straiton and Barr. In addition, the map also identifies transport infrastructure such as parts of the A714 as having lower levels of light, particularly where they pass through settled areas.

Cumulative Assessment of Visible Turbine Lights

Whilst there are no visible turbine lights currently operating in the Study Area for the Proposed Development, it is recognised that other planned developments within the Study Area have proposals for visible aviation lighting and that these lights could be seen in conjunction with the proposed lighting for the Proposed Development.

When considering the representative viewpoints to assess the visual effects of lighting for the Proposed Development, the Craiginmoddie application would be seen from viewpoint 12 Maybole and viewpoint 20 Cornish Hill. The Carrick scoping stage development was included in the LVIA due to its close proximity to the Proposed Development and so is also considered in this Appendix. The visible aviation lighting of Carrick Windfarm would be seen from all three of the representative viewpoints. Cumulative effects are considered in detail for the representative night-time viewpoints.

It is also worth noting that there are other proposed developments that would require lighting within the Study Area including at Arecleoch Extension and Clauchrie. However, it is considered that the cumulative interaction of the lighting of these schemes is restricted from the majority key views of the Proposed Development. Where there is cumulative interaction of the Proposed Development and these schemes it is limited to remote hills such as Shalloch on Minnoch which would not be easily visited in the hours of darkness, or from Auchensoul Hill which is not as remote but would only have very limited views of the Proposed Development in a successive view with Clauchrie Windfarm.

Detailed Assessment

Visual Receptors in the Study Area

The Aviation Lighting and Mitigation Report (Technical Appendix 14.1) provides details of the potential light intensity which would be emitted at different vertical angles from a medium-intensity nacelle mounted aviation light (see Figure 10 within this report). It also details the likely light intensity in poor visibility <5 km (2,000 cd) and clear visibility >5 km (200 cd) for each of the LVIA viewpoints.

With specific relevance to the Proposed Development, Figure 6.4-5 - Lighting Intensity ZTV, illustrates where the different intensities (depending on different vertical angles from the nacelle mounted aviation light) would be visible within the surrounding landscape. Figure 6.4-5 also illustrates the corresponding intensity reductions for each of the 2,000 cd and 200 cd situations.

It is clear from Figure 6.4-5 that the full intensity of the lights would only theoretically be experienced from a small proportion of the Study Area when on similar or more elevated terrain. As described in the LVIA baseline, the ZTV itself is contained, firstly by the immediately surrounding topography of the upland area in which the site is located and then further by more distant hills to the south in the Merrick range, the long ridge of west facing hills of the Carsphairn Forest to the north-east and by the Brown Carrick Hills to the north-west. From these hills and ridges, the terrain is at a similar elevation to the nacelle aviation lighting and Figure 6.4-5 illustrates a vertical angle of between 3 and -1 degrees, which would result in an approximate range of lighting intensity of between 2,200 cd to 980 cd - when visibility <5 km and 220 cd to 98 cd when visibility >5 km.

Across much of Middle Dale and the lower Water of Girvan valley to the north of the Proposed Development, theoretical visibility of the nacelle lights is quite restricted. Figure 6.4-5 illustrates that these small patches of visibility (where intervening landscape elements allow views) have a vertical angle of between -1 and -3 degrees, which would result in an approximate range of lighting intensity of between 980 cd to 220 cd - when visibility <5 km and 98 cd to 42 cd when visibility >5 km.

The upper Water of Girvan valley is below the elevation of the Proposed Development and has a vertical angle of between -2 to -4 with much of the valley floor recorded as below -4. This would result in an approximate range of lighting intensity of between 420 cd to 170 cd - when visibility <5 km and 42 cd to 17cd when visibility >5 km, with much of the upper Water of Girvan valley floor at below 170cd - when visibility <5 km and 17cd when visibility >5 km.

Table 6.4.1 below provides a summary of the potential visibility of nacelle lights for each of the LVIA viewpoints, this is based on the nacelle light ZTV and tower light ZTV, and details how many lit turbines will be theoretically visible from each of the viewpoints included in the LVIA.

Table 6.4.1 – Turbine Lighting Visibility from LVIA Viewpoints

VP No	Viewpoint	Distance nearest turbine (km)	Lighting Visibility									
			1	2	3	4	5	6	7	8	9	
1	Minor Road near Tairlaw	2.4	0	0	0	0	0	0	0	0	0	0
2	Minor Road near Craig	2.7	Xx	Xx	Xx	Xx	X	Xx	X	Xx	X	X
3	Minor Road near Stinchar Bridge	3.5	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx
4	Craigengower Monument	4.1	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx
5	NCN7, near Palmullan Bridge	3.8	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx
6	Straiton, minor road south of settlement	4.7	0	0	0	0	X	Xx	0	0	0	0
7	Straiton	5	0	0	0	0	0	0	0	0	0	0
8	Shalloch on Minnoch	8.7	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx
9	Craigengillan GDL, Shear Hill	9.4	0	X	X	X	X	Xx	Xx	X	X	X
10	B7045, west of Kirkmichael	9.5	0	X	X	Xx	Xx	Xx	X	X	X	0
11	Auchensoul Hill	11.5	0	0	0	0	0	0	X	X	0	0
12	Maybole	11.8	0	0	0	X	X	X	0	0	0	0
13	A713 Eriff	13.6	0	0	0	X	X	0	X	X	X	0
14	B741 near Clawfin	14.2	0	0	X	X	X	Xx	Xx	X	X	0
15	Merrick	14.3	0	0	0	0	0	0	0	0	0	0
16	A713 and B742 Road Junction	16.6	X	X	X	X	X	Xx	X	X	X	X
17	Brown Carrick Hill	18	0	X	Xx	Xx	Xx	Xx	Xx	Xx	X	0
18	Cairnsmore of Carsphairn	21.3	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx
19	A77, Ayr	22.9	0	0	0	0	0	0	0	0	0	0
20	Cornish Hill	5.2	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx	Xx

VP No	Viewpoint	Distance nearest turbine (km)	Lighting Visibility									
			1	2	3	4	5	6	7	8	9	
21	B741 nr Largs Farm	4.8	O	X	Xx	Xx	Xx	Xx	Xx	Xx	Xx	X
22	B7023 north of Gartlea Farm	9.1	O	O	O	O	O	O	O	O	O	O
23	Loch Girvan Eye	6.9	X	X	Xx	Xx	Xx	Xx	Xx	Xx	Xx	X
Key												
Xx	Theoretical visibility of nacelle and tower lights											
X	Theoretical visibility of nacelle lights											
O	No lights visible											

Viewpoint Lighting Intensity

Many of the representative viewpoints within the areas closest to the Proposed Development, including those found within the upper Water of Girvan valley will have reduced intensity as a result of the negative vertical angle in which the nacelle lights would be viewed. Table 6.4.2 below provides a summary of the reduced intensity for the nacelle lights based on the calculations presented in The Aviation Lighting and Mitigation Report (Technical Appendix 14.1).

Table 6.4.2 –Viewpoint Lighting Intensity Summary

VP No	Viewpoint	Distance to nearest turbine with proposed lighting (km)	Vertical Angle from Horizontal plane of light location to viewpoint location (degrees)	Light intensity at each viewpoint allowing for vertical angle (cd)	
				2000cd Scenario	200cd Scenario
1	Minor Road near Tairlaw	2.4 @ T4	-6.2	105	11
2	Minor Road near Craig	2.7 @ T4	-5.8	105	11
3	Minor Road near Stinchar Bridge	3.8 @ T6	-0.8	1192	119
4	Craigengower Monument	4.2 @ T4	-1.1	902	90
5	NCN7, near Palmullan Bridge	3.8 @ T1	-1.1	902	90

6	Straiton, minor road south of settlement	4.7 @ T4	-3.5	194	19
7	Straiton	No Lights Visible			
8	Shalloch on Minnoch	8.7 @ T6	2.3	1350	135
9	Craigengillan GDL, Shear Hill	9.6 @ T4	-0.8	1192	119
10	B7045, west of Kirkmichael	9.5 @ T2	-1.9	448	45
11	Auchensoul Hill	12.2 @ T7	-0.5	1582	158
12	Maybole	12.5 @ T4	-1.5	622	62
13	A713 Eriff	13.5 @ T6	-0.6	1443	144
14	B741 near Clawfin	14.9 @ T4	-0.6	1443	144
15	Merrick	No Lights Visible			
16	A713 and B742 Road Junction	16.8 @ T4	-1.1	902	90
17	Brown Carrick Hill	18.3 @ T2	-0.4	1721	172
18	Cairnsmore of Carsphairn	21.3 @ T6	1	2503	250
19	A77, Ayr	No Lights Visible			
20	Cornish Hill	5.2 @ T6	0.4	2429	243
21	B741 nr Largs Farm	5.3 @ T4	-2.9	228	23
22	B7023 north of Gartlea Farm	No Lights Visible			
23	Loch Girvan Eye	7 @ T6	0.5	2452	245

Whilst it is noted that the actual intensity of light perceived at assessment viewpoints (and within the Study Area) is likely to be less intense than the maximum intensity of the light (2,000cd in visibility <5km and 200cd in visibility >5km), this Technical Appendix assesses the maximum possible intensity of light observed at each of the viewpoints considered and represents this maximum intensity in corresponding visualisations.

In reality, it is extremely unlikely that 2,000cd will ever be experienced at its full intensity as it will only operate when visibility is reduced by climatic conditions. Reduced visibility will also affect someone's perception of the intensity of the light fitting. More than half of the viewpoints are beyond 5 km from the Proposed Development, therefore, the worst case intensity experienced at these viewpoints would likely be represented by the 200 cd scenario. This is because the 2000cd intensity

lights would only be in operation when visibility is less than 5km and in this situation they would appear far less intense due to the poor visibility surrounding the Proposed Development.

The majority of residential properties within the RVAA 2 km Study Area (except the properties south of Tairlaw which are more elevated) would have a vertical angle of below -4° resulting in an approximate range of lighting intensities of below 170 cd - when visibility <5 km and 17 cd when visibility >5 km.

From elevated areas to the south between 5 and 10 km there tends to be theoretical visibility of a higher number of the nacelle lights, including in views from the elevated northern parts of the core area of DSP such as Cornish Hill (VP20) and Shalloch on Minnoch (VP08) however, due to the distance of these viewpoints, the worst case intensity of the aviation lights will likely be 200 cd in 'clear' visibility because in the 2000cd scenario, reduced visibility will reduce the perception of the intensity of the light fitting.

In long distance views, over 20 km, the aviation lights are still likely to be visible, based on experience of other operational wind farm aviation lights viewed in the field, however the distance and reduced intensity are mitigating factors with increasing distance.

Representative Viewpoints

Viewpoint 2: Minor Road near Craig.

Nearest Visible Turbine Light: 2.7 km

Night-Time Baseline Condition and Sensitivity

This viewpoint represents the views of road users from within the upper Water of Girvan valley at night when in reasonably close proximity to the Proposed Development (2.7 km).

Views to the south and west during the day are across a foreground landscape of the valley floor which is mainly in grazing use which is part wooded along the Water of Girvan, Palmullan Burn and Balbeg Glen. The fields are medium scale and largely bounded by hedgerows. At night, however, individual landscape elements that create different landscape patterns in the view are difficult to discern. The baseline night photography is captured at a time where the shape of the hills and ridgelines of the western valley sides can be distinguished against the sky. In the evening the contrast between land and sky on the west skyline can be seen beyond dusk as the setting sun maintains a low glow against the skyline to the west for a sustained period. The effect of this is more prolonged in summer months, however, the effect quickly changes in this contained valley setting becoming much less apparent against the darkness of the night sky.

There is some existing lighting in this view at the isolated properties of Linfairn, Dalmorton, Dalrowan and Balbeg. Occasional vehicle lights are seen either crossing the view from these properties or along the minor road in close proximity to the viewpoint. Whilst these lights can be seen from this location, they are a small part of the overall baseline lighting level which is considered to be dark overall.

The value and visual susceptibility of receptors at night differs when compared to the assessment carried out for daytime conditions. During the night the landscape has a diminished scenic quality and receptors would not have the same appreciation of the landscape which is dark and muted compared with the landscape scenery evident during the day. However, the position of the viewpoint in relation to the Proposed Development is such that the susceptibility to change in this instance remains at a similar level. Taking these factors into account, the night-time sensitivity of this location is considered to be Medium-High.

Night-Time Effect Worst Case Aviation Lighting Scheme

2,000 cd Light Intensity

In the worst-case scenario, all of the nine nacelle lights would be visible from this location and six of the tower lights would also be visible. The location of the viewpoint relative to the prevailing south-westerly wind would mean that the lights on the hubs would at most times be seen in front of the rotors and would not be intermittently obscured by intervening blades. On this basis they would not appear to flicker as the turbine blades pass the hub and tower lights. The intensity of the nacelle lights in the 2,000 cd scenario, allowing for the vertical angle between this viewpoint and the closest nacelle is calculated to be 105 cd.

The Proposed Development lights would be seen as an introduction of lights to a part of the view where there are very few other lights visible. The lights would affect the current sense of seclusion experienced within the upper Water of Girvan valley. The proximity of the Proposed Development combined with the overall dark baseline lighting levels would tend to increase the visual impression that the turbine lights would have on receptors at this location. It is considered therefore that these lights would form a substantial addition to the existing baseline and the magnitude of change is assessed as **Medium-High**. The effect on road users at this viewpoint is considered to be **Moderate-Major and Significant**. A similar effect would be experienced between this viewpoint and the Craigenallie property to the south. Beyond this roadside vegetation, topography and/or distance moderate the effect and reduce its significance.

200 cd Light Intensity

The description of lights visible for 2,000 cd also applies to the 200 cd reduced intensity scenario. The intensity of the nacelle lights in the 200 cd scenario, allowing for the vertical angle between this viewpoint and the closest nacelle is calculated to be 11 cd. The effect differs slightly, reducing the intensity of light experienced, but given the close proximity of the Proposed Development, the reduction in intensity to 200 cd in this instance would not result in a notably reduced magnitude of change. It is considered that the 200 cd lights would also form a substantial addition to the existing baseline and the magnitude of change is assessed as **Medium-High** resulting in a **Moderate-Major and Significant** effect.

Proposed Reduced Aviation Lighting Scheme

In this scenario, six of the nine turbines would have nacelle lights and all six would be visible. Three of the four proposed tower lights would also be visible. The visible lighting in this scenario would still affect the sense of seclusion experienced from the upper Water of Girvan valley and at close proximity the fewer number of lights visible only slightly reduces the magnitude of change experienced at this location.

2,000 cd Light Intensity

The magnitude of change is predicted to remain **Medium-High** for this scenario resulting in a **Moderate-Major and Significant** effect.

200 cd Light Intensity

The reduction in intensity combined with fewer lights visible is predicted to reduce the magnitude of change to **Medium** for this scenario resulting in a **Moderate and Significant** effect.

Cumulative Lighting

At this location there are no consented or application wind farms visible and therefore no cumulative interaction. As a result, there is no cumulative change or cumulative effect predicted for the consented and application scenarios.

Scoping stage Carrick Windfarm would be visible from this location, including nine nacelle aviation lights spread across the south west horizon. The Proposed Development would increase the number of lights seen from this viewpoint but would not be responsible for introducing lighting as a new feature of this view. On balance the cumulative magnitude of change would **Medium** resulting in a **Moderate and Significant** effect.

Cumulative effects are applicable to both the 'worst case' and 'proposed lighting' scenarios.

Viewpoint 12: Maybole

Nearest Visible Turbine Light: 11.8 km

Night-Time Baseline Condition and Sensitivity

This viewpoint represents the views from the Maybole settlement at night, 11.8 km from the Proposed Development. The elevation of the settlement on east facing slopes and above an area of open space on Welltrees Street, creates a particular vantage point in views east from the settlement.

Views to the east during the day are across a foreground of edge of settlement including the Maybole football club, large industrial warehousing and other residential parts of eastern Maybole. Daytime views also include the undulating agricultural landscape that surrounds the Maybole settlement and that extends across the lower Water of Girvan. The distant view east is of the hills and ridgeline that follows the Foothills and Forest with Windfarm LCT with the hill form of Glenalla Fell forming part of this distant upland ridgeline.

At night, however, individual landscape elements that create different landscape patterns in the view are difficult to discern. The baseline night photography is captured at a time where the distant ridgeline of hills is discernible against the skyline, however, the intervening landscape is not readily visible. There is a notable level of existing lighting in this view associated with the edge of settlement in the foreground, particularly the bright lights associated with the industrial units. Other lights can be seen in the intervening landscape including the front and rear car lights of distant cars and the lights of isolated properties.

During the night the landscape has a diminished scenic quality and receptors would not have the same appreciation of the landscape which is dark and muted compared with the landscape scenery evident during the day. Taking these factors into account, the night-time sensitivity of this location is considered to be **Medium**.

Night Time Effect Worst Case Aviation Lighting Scheme

2,000 cd Light Intensity

In the worst-case scenario, only three of the nine nacelle lights would be visible from this location and none of the tower lights would be visible. The Proposed Development lighting would appear as distant features of the night skyline to the east sitting close to the distant ridgeline of hills that forms the horizon. The location of the viewpoint relative to the prevailing south-westerly wind would mean that the lights on the nacelles would rarely be intermittently obscured by intervening blades. On this basis they would rarely flicker as a result of turbine blades passing the nacelle lights. The intensity of the nacelle lights in the 2,000 cd scenario, allowing for the vertical angle between this viewpoint and the closest nacelle is calculated to be 622 cd.

It is considered that the visible lights would form a new feature in the night-time view, however, they would be experienced at distance and within a foreground context of edge of settlement lighting which further moderates the effect. The magnitude of change is therefore assessed as **Negligible**. The effect at this viewpoint, and for the settlement of Maybole is considered to be **Minor and Not Significant**.

200 cd Light Intensity

The description of lights visible for 2,000 cd also applies to the 200 cd reduced intensity scenario only differing slightly, with a reduced intensity of light experienced at distance. The intensity of the nacelle lights in the 200 cd scenario, allowing for the vertical angle between this viewpoint and the closest nacelle is calculated to be 62 cd.

The magnitude of change is predicted to be **Negligible**. It is considered therefore that for the 200 cd lights the effect at this viewpoint, and for the settlement of Maybole is considered to remain **Minor and Not Significant**.

Proposed Reduced Aviation Lighting Scheme

In this scenario six of the nine turbines would have nacelle lights and only two would be visible. None of the four proposed tower lights would be visible. The description of visibility for the worst-case scenario would slightly differ as a result of the fewer number of lights visible. The magnitude of change is predicted to remain to **Negligible** resulting in a **Minor and Not Significant** effect. This applies to both the 2,000 cd and 200cd scenario.

Cumulative Lighting

At this location the theoretically visible consented wind farms are not tall enough to require visible aviation lighting. As a result, there is no cumulative change or cumulative effect predicted for the consented scenario.

In relation to the application scenario, the eastern end of the Craiginmoddie Windfarm would appear at 10.1 km to the south east. Between three and four Craiginmoddie nacelle lights would potentially be visible with a further ten just out of view that would be visible from nearby properties close to this location. In this scenario Craiginmoddie would introduce lighting to the south-eastern horizon at closer proximity. The Proposed Development would introduce a very small amount of additional lighting further east on the same horizon. The magnitude of change is considered to **Low** resulting in a **Minor and Not Significant** effect.

Scoping stage Carrick Windfarm would be visible from this location, including five nacelle aviation lights that would appear to spread the visible Craiginmoddie lights further across the horizon to the south-east. The Proposed Development would increase the number of lights seen from this viewpoint and slightly extend the effect further along the horizon but would not be responsible for introducing lighting as a new feature of this view in the direction of the site. On balance the cumulative magnitude of change would **Medium-Low** resulting in a **Moderate-Minor and Not Significant** effect.

Cumulative effects are applicable to both the 'worst case' and 'proposed lighting' scenarios.

Viewpoint 20: Cornish Hill

Nearest Visible Turbine Light: 5.2 km

Night-Time Baseline Condition and Sensitivity

This viewpoint represents views from Cornish Hill at night and is representative of views seen by hill walkers at night. Cornish Hill is a remote location but benefits from the path that leads to the summit from the Stinchar Bridge Car Park. The viewpoint lies within the Core Zone of the Dark Sky Park (DSP), overlooking the northern part of the DSP buffer zone in views north towards the site it therefore also represents views from the northern parts of the DSP.

Views during the day are panoramic including - views towards Loch Doon and Glenkens to the east; the ridge of Shalloch on Minnoch to the south; the distant summits of Mullwharchar and Craignaw to the south-east; and the expansive moorland and forestry of Carrick Forest to the west. Views north towards the site also include extensive plantation forestry and moorland but with the Ayrshire lowlands in the distance beyond the large scale uplands. The hills of Arran can also be seen in the distance in clear visibility to the north west. At night, however, individual landscape elements that

create different landscape patterns in the view are difficult to discern. There is no existing lighting context in the view to the south and west and very little discernible lights to the east except for distant lights of cars.

In the view north, distant lights of the settled Ayrshire lowlands can be seen punctuating the coastal edge. These are difficult to discern at distance and are not immediately apparent in the baseline photography as a result. They do however tend to draw the eye at night when observed from the viewpoint.

The contrast between land and sky on the northern skyline can be seen beyond dusk as the setting sun maintains a low glow against the skyline for a sustained period. The effect of this is more prolonged in summer months and is particularly notable at this location due to its elevation overlooking a distant coastline. The distant coastal lights seen from this location will appear more distinct in periods of darkness, however, the intervening upland plateau will not be distinguishable from the night sky. A balance has been sought in the photography provided. Nevertheless, the overall impression of the night time view at this location, particularly when considering its immediate context is of a very dark upland landscape.

The value and visual susceptibility of walkers at this location differs at night when compared to the assessment carried out for daytime conditions. During the night the landscape has a diminished scenic quality and walking receptors would not have the same appreciation of the landscape which is dark and muted compared with the landscape scenery evident during the day. It is also the case that few people would be walking in darkness in this remote area, despite the path available to them. However, given the location of the viewpoint within the DSP core area the sensitivity is predicted to remain Medium-High.

Night-Time Effect Worst Case Aviation Lighting Scheme

2,000 cd Light Intensity

In the worst-case scenario, all of the nine nacelle lights would be visible from this location and nine of the tower lights would also be visible. The location of the viewpoint relative to the prevailing south-westerly wind would mean that the lights on the hubs would mostly be intermittently obscured by intervening blades so that they would appear to flicker as the turbine blades pass the hub and tower lights.

The intensity of the nacelle lights in the 2,000 cd scenario, allowing for the vertical angle between this viewpoint and the closest nacelle is calculated to be 2429 cd. The Proposed Development lights would be seen as an introduction of lights to a part of the upland horizon to the north at 5.2 km where there is very little existing lighting.

The nacelle lights would be seen in a part of the panorama that has relatively high levels of darkness to the west of the distant coastal lighting. Due to the elevation of the viewpoint above the Proposed Development, the nacelle lights would be backdropped by either the intermediate horizon of the upland plateau or the more distant horizon created by the Ayrshire coastal landscape. This is important to the assessment at this location, since the aviation lights will be below the skyline and they will not interrupt the view of the night sky. The nacelle lights would not therefore be detrimental to the overall experience of the dark skies within this part of the DSP.

Whilst they would be visible as points of light in the view and increase the influence of human/man made elements, the lights are not expected to result in obtrusive light that impedes the view of the night sky, nor result in brightening of the night sky (skyglow) that might be of detriment to the overall experience of the dark skies in this view.

Taking all of this into account, the magnitude of change is assessed as **Medium** resulting in a **Moderate and Significant** effect. The effect is significant due to the intensity of light experienced within an otherwise dark part of the horizon combined with the relative proximity when viewed from

this elevated location. Importantly, the visual effect of the aviation lights will not result in obtrusive light that impedes the view of the night sky.

200 cd Light Intensity

The description of lights visible for 2,000 cd also applies to the 200 cd reduced intensity scenario. The intensity of the nacelle lights in the 200 cd scenario, allowing for the vertical angle between this viewpoint and the closest nacelle is calculated to be 243 cd.

The effect differs slightly, reducing the intensity of light experienced from the viewpoint and so moderating the magnitude of change. On balance, the magnitude of change is predicted to remain **Medium** for this scenario. However, the reduction in magnitude alters the resulting assessment of significance which in this scenario is considered to result in a **Moderate and Not Significant** effect.

Proposed Reduced Aviation Lighting Scheme

In this scenario six of the nine turbines would have nacelle lights and all six would be visible. The four proposed tower lights would also be visible. The visible lighting would still affect the upland horizon to the north, however, the fewer number of lights visible would slightly moderate the magnitude of change experienced.

On balance however, the magnitude of change is predicted to remain **Medium** for both 2,000 cd and 200 cd scenarios. This results in a **Moderate and Significant** effect for the 2,000 cd scenario and a **Moderate and Not Significant** effect for the 200 cd scenario.

Cumulative Lighting

At this location the theoretically visible consented wind farms are not tall enough that would require then to have visible aviation lighting. As a result, there is no cumulative change or cumulative effect predicted for the consented scenario.

The Craiginmoddie Windfarm would appear at 8.8 km to the north-west including 14 nacelle lights. In this scenario Craiginmoddie would introduce lighting to the upland horizon. The Proposed Development would add further turbine lighting to the view north, at a similar proximity to Craiginmoddie. There would be a degree of separation between the Craiginmoddie scheme and the Proposed Development, however, the further addition of turbine lights would have an intensifying effect at the viewpoint location. The magnitude of change is therefore considered to increase to Medium-High in this application scenario resulting in a Moderate-Major and Significant effect.

The Scoping stage Carrick Windfarm would be visible from this location, including 13 nacelle aviation lights that would appear to spread the visible Craiginmoddie lights further across the horizon to the north-east. The Proposed Development would increase the number of lights seen from this viewpoint, however, the Proposed Development lights would only appear within the horizontal extent of the Carrick lights. The Proposed Development would not be perceived as introducing lighting as a new feature of this view and the additional lights in the view would appear a relatively modest addition in comparison with the lights already visible within the Craiginmoddie and Carrick developments in the context of this scenario.

The cumulative magnitude of change would therefore reduce to **Medium-Low** resulting in a **Moderate and Not Significant** effect.

Galloway Forest Dark Sky Park

The Galloway Forest Park was awarded status as a Dark Sky Park (DSP) in 2009 and was subsequently extended to land to the north and east in 2012 to include an area outside the GFP. The DSP is composed of two zones, namely a Core and Buffer Zone. The conditions for DSP status require stringent lighting guidance for the Core Zone. The Buffer Zone is required around the Core Zone to protect the status of the Core but does not in itself need to reach to the same dark sky class in order for the DSP to keep its status. The Galloway Forest Dark Sky Park is located approximately 3 km to

the south of the nearest Proposed Development turbine with the Dark Sky Park Buffer Zone boundary lying immediately to the south, west and east of the Proposed Development. The DSP is considered to have High sensitivity to visible aviation lighting of the type proposed.

The park attracts people wishing to appreciate the night-time sky with an absence of night time light pollution. Forestry Land Scotland (FLS) promotes ten viewing locations in the DSP buffer zone which offer stopping points to view the night sky. The sensitivity of the ten viewing locations to the potential effects of the turbine lights is higher than other areas of the DSP, as visitors will come to these sites with the express intention of viewing the night sky and this experience could be affected by other sources of light. Of the ten Viewpoints promoted by FLS for the DSP, none would have visibility of the Proposed Development.

While these ten viewing locations are identified as being suitable viewing sites, people could feasibly be viewing the night sky from any part of the Dark Skies Park. Parts of the Core Zone of the DSP around the Merrick uplands, which offer visibility of the Proposed Development are remote upland area and they are not generally places that people are likely to go at night to view the night sky (in general, people would tend to use the viewing locations).

The parts of the core area of the DSP which demonstrate the highest overall darkness are within the lower-lying 'interior', where the ZTV illustrates that the Proposed Development has restricted visibility and for the most part the nacelle lights would not be visible. More elevated hill tops to the south and east where limited nacelle light visibility occurs are more distant and the effects of turbine lighting are diminished therefore by distance and visibility extents. It is considered therefore that the potential visual effects of aviation lighting arising from the Proposed Development are largely contained to the northern parts of the core area of the DSP. This can be summarised as the area to the north of the Shalloch on Minnoch summit and ridgeline. This is a remote area and accessing potential locations within this area at night in order to view the night sky is challenging and as such is not considered to be an activity that attracts many observers at night.

Viewpoint 20 – Cornish Hill is one of the representative night-time viewpoint locations and lies within the Core Zone of the DSP, overlooking the northern part of the DSP buffer zone in views north towards the site. Cornish Hill is a remote location but benefits from the path that leads to the summit from the Stinchar Bridge Car Park.

Whilst the visual effect is assessed as Significant (for the 2,000 cd scenario) at this location (VP20), the assessment from this viewpoint found that due to the elevation of the viewpoint above the Proposed Development, the nacelle lights would be backdropped by either the intermediate horizon of the upland plateau or the more distant horizon created by the Ayrshire coastal landscape. This is important to the assessment of the DSP, since the aviation lights will be below the skyline and they will not interrupt the view of the night sky. Whilst they would be visible as points of light in the view and increase the influence of human/man made elements, the lights are not expected to result in obtrusive light that impedes the view of the night sky, nor result in brightening of the night sky (skyglow) that might be of detriment to the overall experience of the dark skies in this view. It is considered therefore that the nacelle lights would not therefore be detrimental to the overall experience of the dark skies within this part of the DSP.

Taking all of the above into account the overall effect of the Proposed Development turbine lights on the DSP is considered to be of a **Low** magnitude change resulting in a **Moderate – Minor and Not Significant** effect.

This is due to the following key moderating points -

- The majority of receptors within the DSP being largely unaffected, including the ten recommended DSP viewing locations;
- Visibility within the DSP largely occurs within remote locations which are not places people are likely to go to at night;

- Where visible, the visible aviation lights would appear as points of light, located at a low elevation and seen against landform;
- For locations where visibility does occur receptors visiting the DSP with the express intention of viewing the night sky would not have their view of the sky interrupted by the Proposed Development lighting as the lights would tend to appear close to or below the sky; and
- The visible aviation lights are not expected to result in obtrusive light that impedes the view of the night sky, nor result in brightening of the night sky (skyglow) that might be of detriment to the overall experience of the dark skies.

It should be noted that whilst the overall effect on the DSP is considered to be Not Significant, the visual effect at viewpoint 20 is considered to be Significant.

Conclusion

At night the turbines would not in themselves be conspicuous during times of darkness. Nevertheless, the assessment of night-time effects for the Proposed Development has predicted significant effects for two of the three agreed representative night-time viewpoints, summarised as follows:

Viewpoint 2 – Minor Road near Craig is predicted to experience Moderate-Major and Significant effects for both the 2,000 cd and 200 cd ‘worst-case’ scenarios. Reducing to Moderate in the ‘proposed lighting’ 200 cd scenario but remaining significant. This is due to the introduction of the aviation lights at close proximity which would affect the sense of seclusion experienced at this location and within the upper of Water of Girvan valley.

Viewpoint 12 – Maybole is predicted to experience Minor and Not Significant effects from the viewpoint and settlement. This effect applies to both the ‘worst case’ and ‘proposed lighting’ scenarios for both 2,000 cd and 200 cd light intensities.

Viewpoint 20 – Cornish Hill is predicted to experience Moderate and Significant effects for both the ‘worst case’ and ‘proposed lighting’ scenarios 2,000 cd light intensities. Whilst a Moderate effect is also predicted for the 200 cd intensity for both the ‘worst-case’ and ‘proposed lighting’ scenarios, the effect is assessed as Not Significant.

The duration of the effect of the lights on receptors is likely to be over a relatively short period, more commonly experienced during evening and morning hours of darkness, around dusk and sunrise. The ICAO standard requires the lights to be switched on 30 minutes after sunset, and 30 minutes before sunrise, removing the likelihood of visible lighting during twilight. The visual effects of the Proposed Development at night would also be limited by the activity of receptors at night. Receptors that experience views at night are generally limited to residents of settlements, rural properties and motorists using the road network. Views from within properties are likely to be restricted by the use of window coverings, particularly in winter.

Views from remote rural / coastal locations, beaches, mountains and footpaths etc. are visited infrequently at night therefore numbers of receptors affected will be low. Whilst receptors within the DSP would also be affected i.e. at viewpoint 20 Cornish Hill, these are much less frequented locations within the DSP than the 10 recommended viewpoint locations from which to observe the night sky.

The assessment of night-time effects is also based on clear night time viewing conditions. At dusk and sunrise, it may be possible to identify the formation of the turbines with the lighting switched on, but only in conditions of good and excellent visibility. At sunrise it may also be possible, in views from the west, to see the turbines with lights switched on whilst backlit by the rising sun.

References

- Civil Aviation Authority (2016). CAP393: The Air Navigation Order 2016 (SI 2016 No.765).
- Civil Aviation Authority (2016) CAP 764: Policy and Guidelines on Wind Turbines.
- Civil Aviation Authority, Safety & Airspace Regulation Group (2017). 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.
- Council for the Protection of Rural England (CPRE) (2016). England's Light Pollution and Dark Skies.
- ICAO (2018). Annex 14 to the Convention on International Civil Aviation - Volume I Aerodrome Design and Operations (ICAO, Eighth Edition).
- Institute of Lighting Professionals (2011). Guidance Notes for the Reduction of Obtrusive Light (GN01:2011).
- Institute of Lighting Professionals (2019). Night-time Photography.
- Landscape Institute with the Institute of Environmental Management and Assessment (2013). Guidelines for Landscape and Visual Impact Assessment, Third Edition (GLVIA3).
- Landscape Institute (2019). Visual representation of Development Proposals: Landscape Institute Technical Guidance Note 06/19.
- NatureScot (2012). Assessing the Cumulative Impact of Onshore Wind Energy Developments.
- NatureScot (2020). Assessing impacts on Wild Land Areas - Technical Guidance.
- NatureScot (2017). Visual Representation of Wind Farms, Version 2.2.
- NatureScot (2017). Wild Land Area Descriptions, Merrick Wild Land Area (01).
- South Ayrshire Council (2014). South Ayrshire Local Development Plan (Adopted).
- South Ayrshire Council (2016). Supplementary Guidance: Dark Sky Lighting.
- South Ayrshire Council (2017). Approved Replacement South Ayrshire Local Development Plan (PLDP2).