Tangy IV Wind Farm Section 36C Variation

Technical Appendix 15.1: Tangy IV Wind Farm Aviation Lighting Assessment Report

Wind Farm Low Flying Aviation Consultants Ltd

Tangy IV Basic Lighting Report AL3 - 23/04/26

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Introduction

SSE has proposed a 16 turbine Wind Farm located on the Mull of Kintyre. The turbines themselves will sit on the southwest slopes of Cnocan Gean located to the north of Tangy Burn and west of Tangy Loch. The Tangy IV proposal is for all 16 turbines to be 199.2m or 200m to tip dependent upon turbine type chosen.

Civil Aviation. From a civilian aviation perspective, the Tangy IV site is located 7km north of Campbeltown Airport. Here, Tangy IV is clear of the Controlled Airspace (CTA) associated with the Glasgow, Edinburgh and Prestwick Airports. The airspace around and above Tangy IV, is designated Class G by the CAA (open-unrestricted airspace).

Military Aviation. From a military perspective, Tangy IV is within MOD Low Flying Area (LFA) 14 which is the largest and most used low flying training airspace. At night this area converts to Night Allocated Region (NAR) 2B. Although primarily a fast jet training area, the NAR 2B is also used by MOD and NATO tactical transport aircraft and helicopters for both day and night training. However, this south western corner of LFA 14 is very much less used than the more open eastern, central and northern parts of the LFA.

General Aviation. In addition, this area will be frequented by CSAR, Police, HEMs and Air Ambulance helicopters (some operating from Prestwick and Glasgow) as well as military aircraft by day and night. This type of activity will dictate that the site will require both visible red and infra-red obstruction lighting on its turbines.

Kintyre Goose Roosts Special Protection Area**.** Tangy Loch, which is a component of the Kintyre Goose Roosts Special Protection Area (SPA), is located approximately 380m to the south-east of the Proposed Varied Development (at the closest point). The SPA is designated for its wintering population of Greenland white-fronted goose (*Anser albifrons flavirostris*), which is present in globally important numbers. The SPA is also a Ramsar site and includes Tangy Loch Site of Special Scientific Interest (SSSI), Kintyre Goose Lochs SSSI and Rhunahaorine Point SSSI.

Further details of the SPA are provided in Technical Appendix 6.2: Shadow Habitats Regulations Appraisal Report for Kintyre Goose Roosts Special Protection Area (SPA) within volume 4 of this EIA Report.

Figure 1: The Tangy IV Turbine Site on the Mull of Kintyre

Tangy IV Wind Turbine Site

Tangy IV Turbine Table (Data From: S36C EIA Report 2026)						
Turbine	Northing	Easting	AGL	Tip Ht	Hub Ht	Rotor D
T1	628135	167221	158m	200m	125m	150m
T2	628232	167852	161m	200m	125m	150m
T3	628558	167392	180m	200m	125m	150m
T4	628383	168420	175m	200m	125m	150m
T5	628597	168850	162m	200m	125m	150m
T6	628983	167409	186m	200m	125m	150m
T7	629457	167411	191m	200m	125m	150m
T8	629887	167555	156m	200m	125m	150m
T9	629820	168130	166m	200m	125m	150m
T10	629727	168693	197m	200m	125m	150m
T11	629483	169208	220m	200m	125m	150m
T12	629037	169002	202m	200m	125m	150m
T13	628906	168407	201m	200m	125m	150m
T14	628835	167951	189m	200m	125m	150m
T15	629307	168040	194m	200m	125m	150m
T16	629317	168498	201m	200m	125m	150m

Figure 2: Tangy IV Turbine Details

Starting Assumptions and Lighting Criteria

- This analysis is based upon the 'Proposed Varied Development S36C EIA Report 2026'
- The Tangy IV turbine site will be assessed as below Class G 'en-route' airspace insofar as visible obstruction lighting is concerned.
- Local airspace constraints will be considered for their potential impact on the site.
- Expected CAA and MOD dispensations will be assessed for the site.
- To accommodate MOD requirements, and other night operators, 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 and the Tangy Loch SPA in particular.
- The Tangy IV turbine proposal is for sixteen wind turbines at 199.2m or 200m to tip. This analysis will focus on the 200m turbine option which will also cover the slightly smaller 199.2m turbine option.

CAA and MOD Lighting Assessed in this Report

- The site will be assessed for visible red ANO lights that will conform to the international specification as set-out in ICAO Annex 14 Table 6-3. This will include both turbine hub mounted 2000/200cd lights and 32cd mid mast mounted lights.
- The site will also be assessed for MOD Infra-Red lights as detailed in MOD LFOS Turbine Vertical Obstruction Lighting Specification AL4.

CAA-ANO Red 2000/200cd Lighting

The CAA requires:

- That all 'string' perimeter turbines (black dotted line) 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.
- No turbine is more than 1800m (1nm) from a lit turbine.

Applying these criteria will dictate that twelve of the sixteen Tangy IV turbines will require ANO lighting.

Turbines with 2000/200cd Lights: T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11 and T12

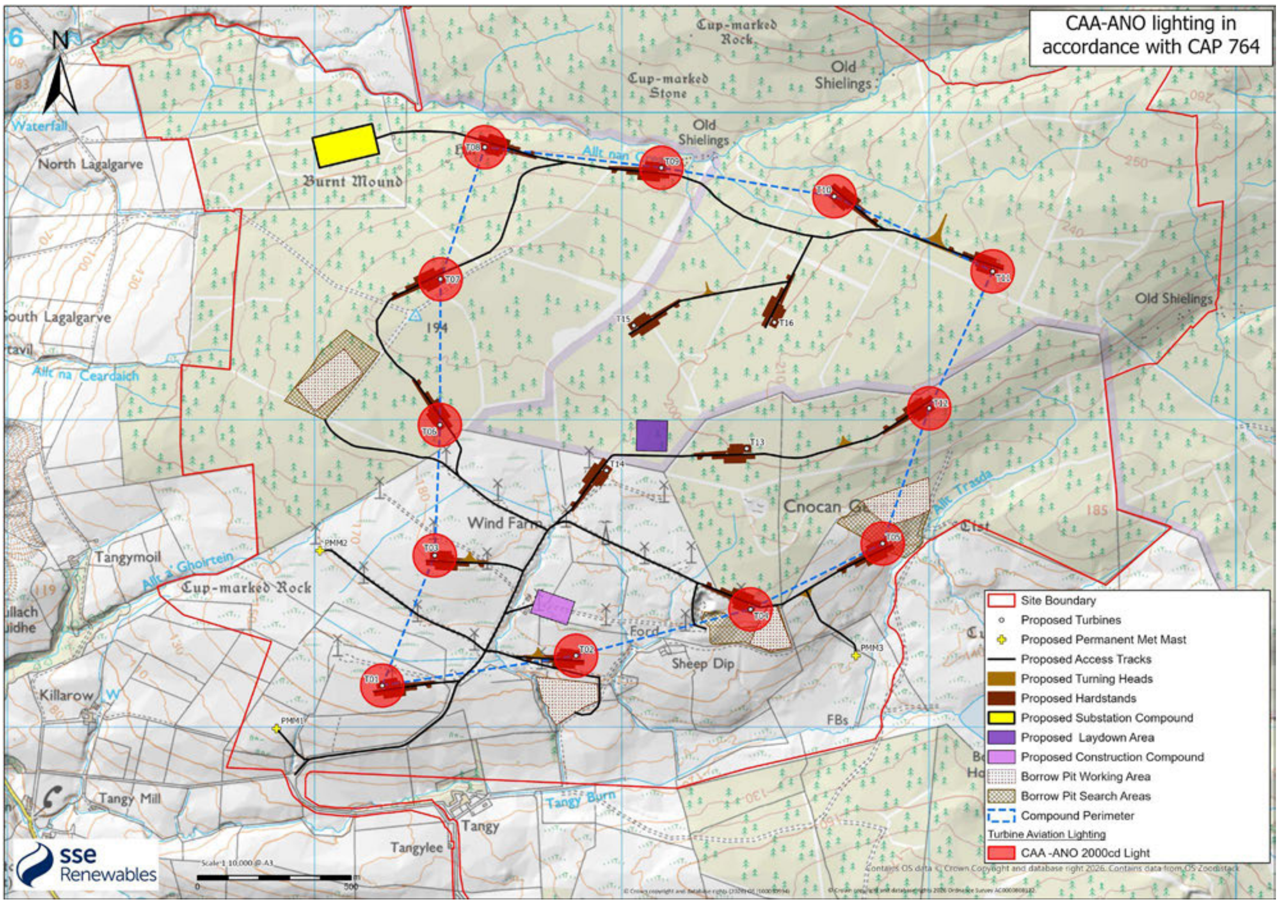

Figure 3: CAA-ANO visible Red Lighting Requirements.

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

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

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

Aircraft operating at safety-altitude or above, and depending upon the protocol adopted or phase of flight, the safety-altitude used will be 1000ft (300m), 1500ft (450m) or 2000ft (600m) above the local terrain/highest obstacle, this includes the turbine tip heights. Aircraft/helicopters flying as such, will only need enough visible lights to define the wind farm and its approximate size/shape/perimeter.

Accordingly, aircraft flying above the Tangy IV turbines, at safety altitude or above, and/or under ATC control, will only require an outline of the Tangy IV site. Such a requirement could be met with five visible red lights on turbines T1, T5, T6, T8 and T11.

Turbines with 2000/200cd Lights: T1, T5, T6, T8 and T11

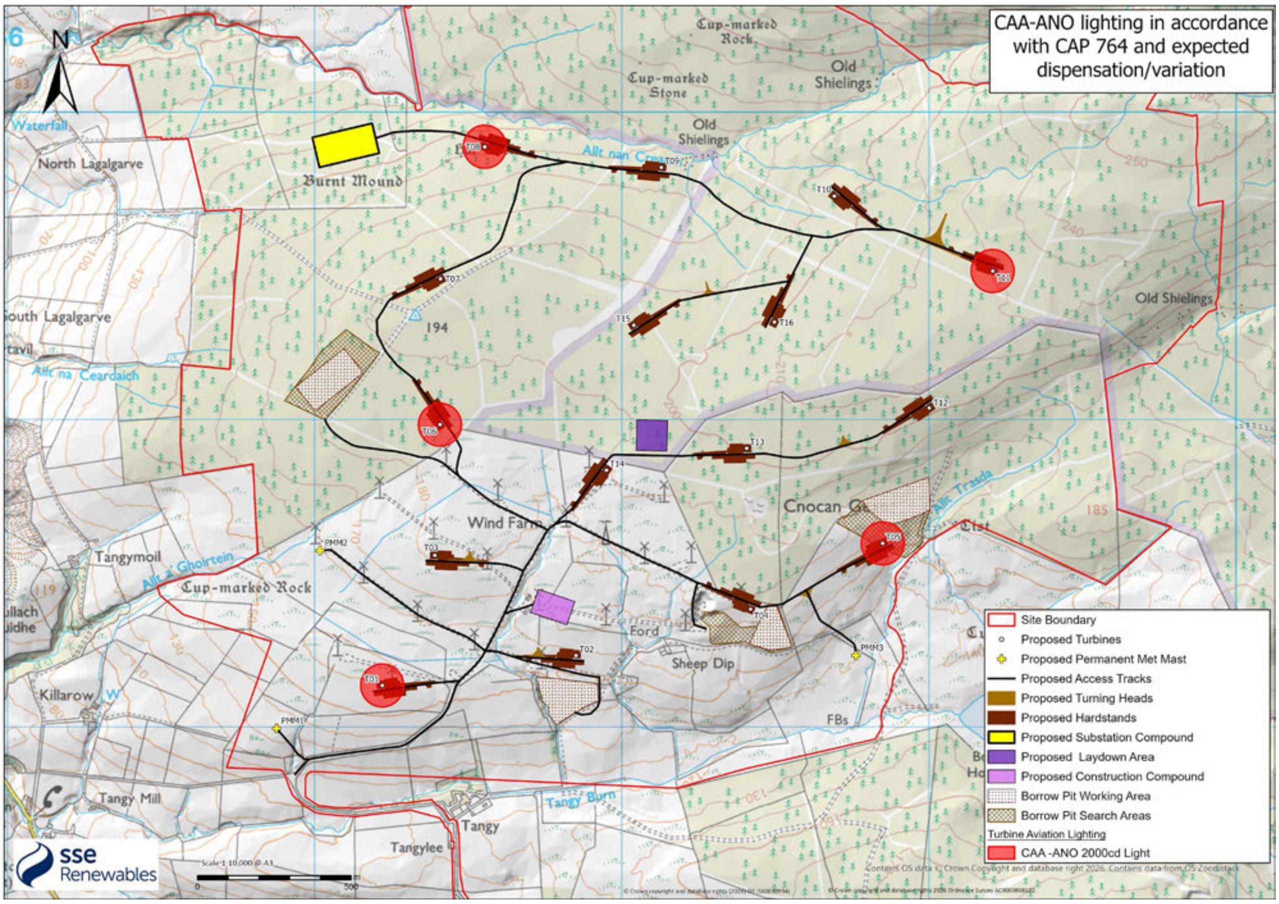

Figure 4: CAA-ANO Visible Red Reduced Lighting.

MOD IR Lighting

The MOD requires:

- That all 'compound-perimeter' turbines (see diagram blue dotted line) 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 CAA string and MOD compound perimeters are very similar.

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

- The Tangy IV turbine site does not meet the MOD small site criteria (Red dotted line) which allows for some turbines to be unlit.

Applying these criteria dictates that all turbines of the Tangy IV site will require IR lighting. Sixteen turbine hub mounted lights in total.

Turbines with I-R Lighting: T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11, T12, T13, T14, T15 and T16

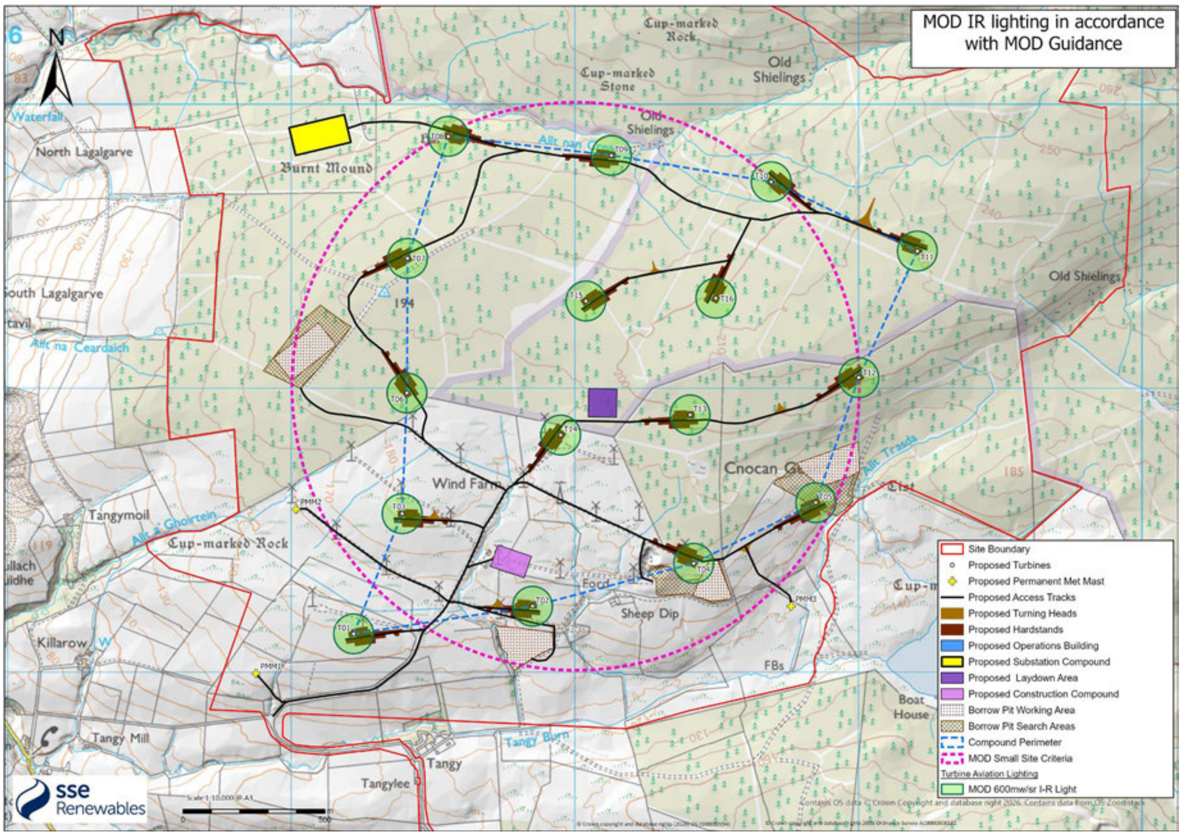

Figure 5: MOD IR Lighting Requirements.

Night vision Goggles/Devices (NVG/D) will adjust their internal-gain if they 'see' a high density of IR light. This prevents 'blooming/flare-up' of the image presented to the pilot. However, turning down the gain means unlit objects fade into the background; this can be terrain, trees, hills etc; most undesirable and clearly gain-down is unhelpful. Nonetheless, pilots/crews train to work through such events. Where there is a high concentration of IR lights, as per the Tangy IV site, the MOD may request fewer IR lights; however, the MOD has not exercised this option for some years now.

Combined CAA ANO and MOD IR Lighting Proposal for Tangy IV

Tangy IV Turbine Lighting Table					
Turbine	Northing	Easting	Tip Ht	CAA-ANO	MOD I-R
T1	628135	167221	200m	2000/200cd	600mW/sr
T2	628232	167852	200m		600mW/sr
T3	628558	167392	200m		600mW/sr
T4	628383	168420	200m		600mW/sr
T5	628597	168850	200m	2000/200cd	600mW/sr
T6	628983	167409	200m	2000/200cd	600mW/sr
T7	629457	167411	200m		600mW/sr
T8	629887	167555	200m	2000/200cd	600mW/sr
T9	629820	168130	200m		600mW/sr
T10	629727	168693	200m		600mW/sr
T11	629483	169208	200m	2000/200cd	600mW/sr
T12	629037	169002	200m		600mW/sr
T13	628906	168407	200m		600mW/sr
T14	628835	167951	200m		600mW/sr
T15	629307	168040	200m		600mW/sr
T16	629317	168498	200m		600mW/sr

Figure 6: Lighting Proposal Table.

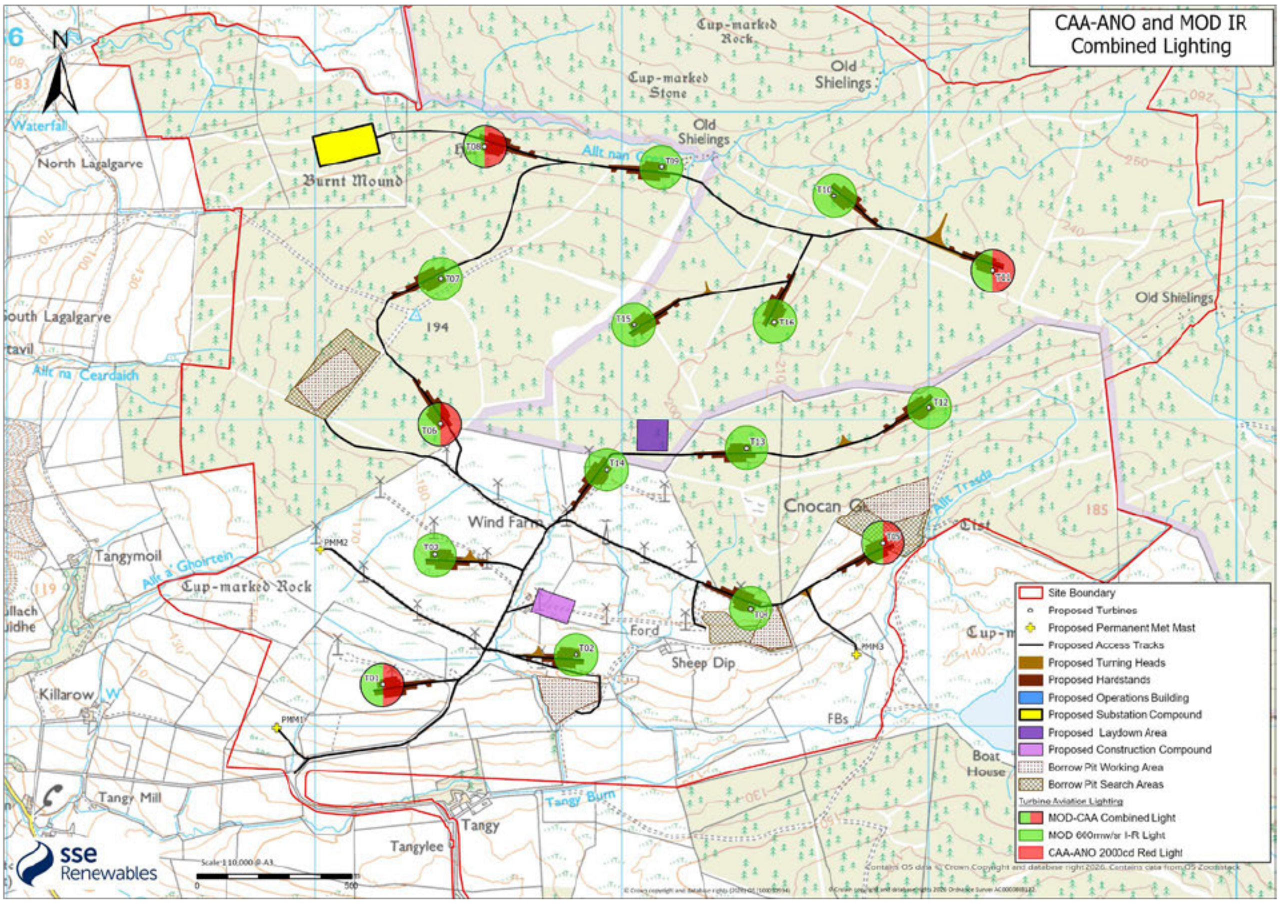

Figure 7: Lighting Proposal Map.

Assessment of the Tangy IV Lighting Proposal Impact on the Kintyre Goose Roosts SPA

Artificial lighting is known to have both positive effects on birds (i.e., increased opportunity for activity that would normally only occur during daylight) and negative effects, including attraction to lights (phototaxis), disruption of photoperiodicity and increased predation due to opportunities for visually active predators (NatureScot, 2020).

Potential impacts of aviation lighting on Greenland white-fronted geese associated with the Kintyre Goose Roosts SPA are fully assessed in Chapter 6: Ornithology within volume 2 of this EIA Report and Technical Appendix 6.2 within volume 4. The assessment concludes that it is unlikely that aviation lighting on the Proposed Varied Development would attract Greenland white-fronted geese or result in any barrier effects.

However, Greenland white-fronted geese use Tangy Loch as an overnight roost site during the winter and are therefore at risk of potential impacts from the aviation lighting, predominantly due to disturbance from the increased visibility of the turbines, and/or from an actual or perceived increase in predation risk.

All other components of the Kintyre Goose Roosts SPA (Loch Garasdale, Loch an Fhraoich, Lussa Loch, Tangy Loch, Black Loch and an area of grassland and heath at Rhunahaorine Point) are located over 750m away from the Proposed Varied Development. Due to the separation distance, there is not considered to be any potential for disturbance to Greenland white-fronted geese roosting or feeding in these areas due to aviation lighting on the Proposed Varied Development.

Reducing the number of ANO obstruction lights (visible red) on the Tangy IV site to five will minimise the impact of this lighting on Tangy Loch. Nonetheless, the proposal requires that turbine T5 (a dominant perimeter turbine by location) carries a visible red light. Located 585m from the edge of Tangy Loch, T5 is the closest turbine to the loch. Moving the light to adjacent turbines will not improve the matter noticeably. Moving the light to more distant turbines will disrupt the perimeter identification function of the lights.

Note: All of the Tangy IV turbines will carry a MOD Infra-Red light. However, as birds including geese, cannot see Infra-Red light, the MOD Infra-Red lights will not be a factor.

The CAA specify light intensity and beam focusing for the ICAO Medium Intensity 2000cd red lights that are used on Wind Turbines. The specification is designed to meet both aviation safety and environmental impact requirements.

Below is a diagram of the beam spread of a popular CEL obstruction light built to match the CAA-ICAO specification. This light has been used for over a decade now on numerous wind turbine sites and vertical obstructions. It shows that the light is predominantly focused level (to the horizon) and up with the full intensity at 0˚ to 3˚ degrees. The light intensity drops off rapidly as the elevation reduces below 0˚ (level). Many companies produce similar aviation lights to meet the published specification. Specifications will vary slightly light to light but all will effectively follow the below illustrated pattern.

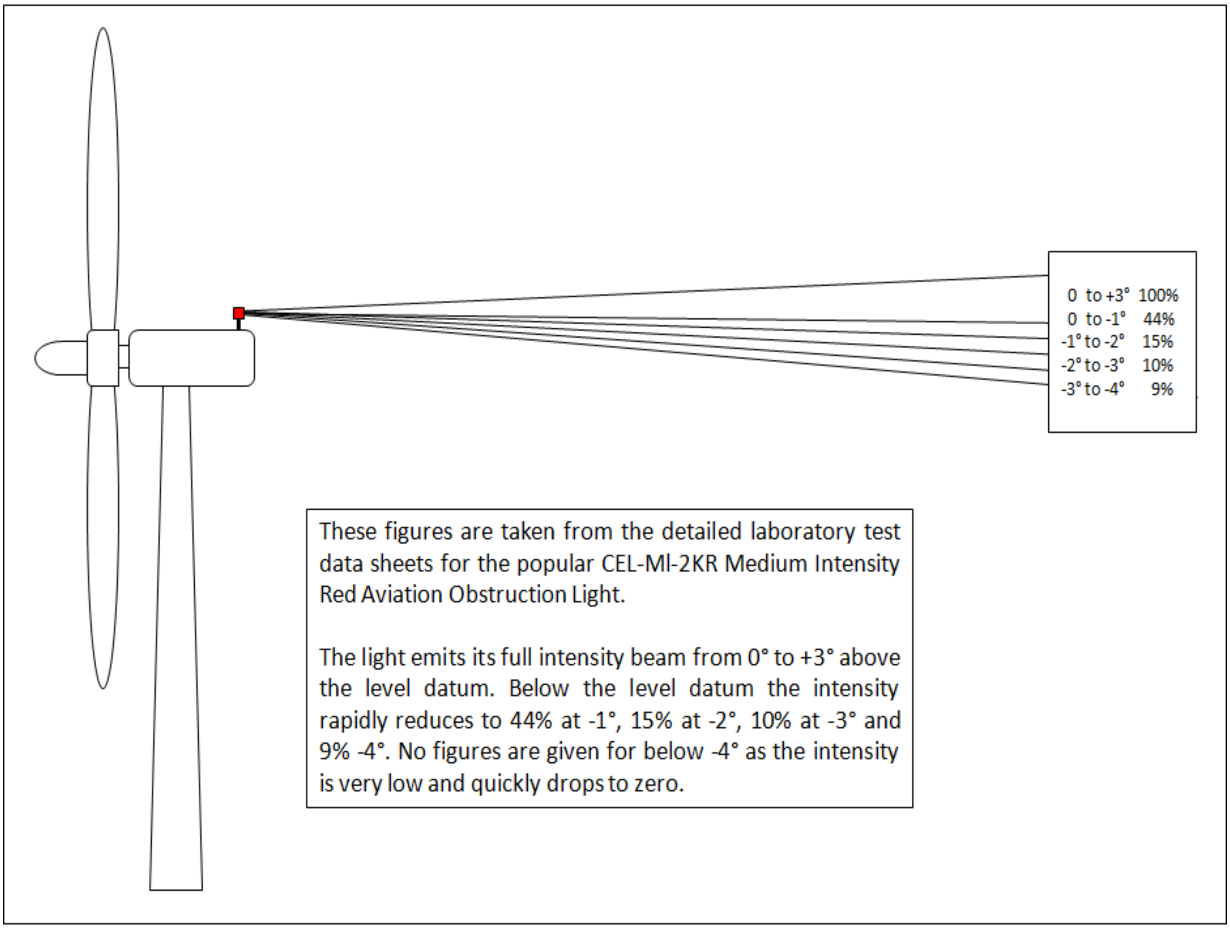

Figure 8: Typical Visible Red Beam Focusing on a typical CAA-ANO Medium Intensity Obstruction Light

The Geometry of Turbine T5 and Tangy Loch

Returning to the Tangy IV site. The focusing of the light, as shown in figure 8, improves the situation since the T5 light will be hub mounted and the turbine stands on a hill above the loch. Looking at these dimensions in more detail:

Height of T5 hub mounted light above sea level = 288m
Height of the Tangy Loch surface above sea level = 136m
Difference in height = 152 m
Range from T5 to the centre of the Loch = 840m

The approximate geometry of this arrangement is shown in Figure 9 below.

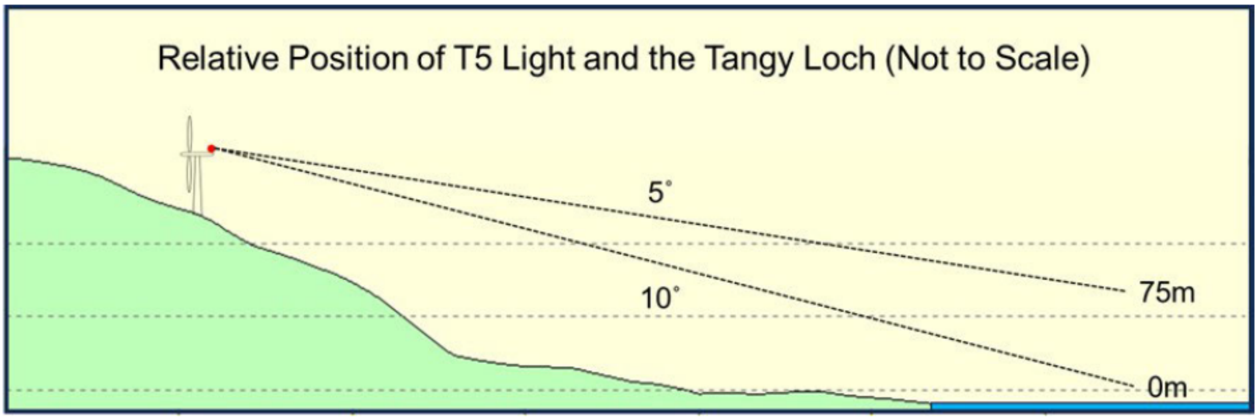

Figure 9: Illustrative relationship of turbine T5 and Tangy Loch shown in vertical profile.

Using the Tan^{-1} function gives the depression (viewing angle) from the hub mounted light on T5 to the surface of the centre of the Loch of slightly more than 10˚. (See diagram above). These will be below typical published lighting intensities that are only reported accurately to a max of 5˚ depression angle.

Looking at a lesser depression angle of 5˚ (again Figure 9 above) results in a height of 75m (250ft) above the loch surface at its centre.

Note: In certain weather conditions the CAA allows for obstruction lighting to be reduced to, not less than, 10% of its normal intensity. Effectively reducing a 2000cd light to 200cd. This CAA dispensation, and its criteria, will be covered in detail later in this report.

The generic table below represents the typical below-horizon (downward) light intensity of current commercially available 2000cd vertical obstruction lights. It is a little more detailed than the illustration at Figure 8 and it states the observed intensities for both 2000cd and the reduced 200cd settings.

Maximum and Minimum Light Intensity Relative to Viewing Angle – Typical 2000/200cd Light				
Observed Angle of Lighting from Hub Mounted Light	Maximum Observed Intensity with Light set to 2000cd	Minimum Observed Intensity with Light set to 2000cd	Maximum Observed Intensity with Light set to 200cd	Maximum Observed Intensity with Light set to 200cd
-1° to 0°	1000 cd	400 cd	100 cd	40 cd
-2° to -1°	400 cd	200 cd	40 cd	20 cd
-3° to -2°	200 cd	130 cd	20 cd	15 cd
-4° to -3°	130 cd	90 cd	15 cd	10 cd
-5° to -4°	90 cd	40 cd	10 cd	5 cd
Below -5°	40 cd	15 cd	5 cd	2 cd

Figure 10: Generic table for a typical commercially available 2000cd vertical obstruction light.

Intensity of the Turbine T5 Light When Observed from Tangy Loch

Combining the information contained in Figure 9 and Figure 10 (on the previous page) Figure 11 (below) can be generated to show the intensity of the turbine light when viewed from Tangy Loch at surface level and at 75m (250ft) above the surface.

The depression angle at 75m over the loch is slightly greater than -5˚. However, the intensity figures for -4˚ to -5˚ will be used to obtain a conservative figure for the reduction in intensity.

Similarly, the depression angle at the loch surface is slightly greater than -10˚. However, the intensity figures for greater than -5˚ will be used, again, to obtain a conservative figure for the reduction in intensity.

Tangy Turbine T5 Visible Red Light's Impact at the Centre of Tangy Lock				
Turbine Light Setting	2000cd		200cd	
Observed Intensity	Maximum	Minimum	Maximum	Minimum
At 75m (250ft) -4° to -5°	90cd	40cd	10cd	5cd
	Equivalent to modern car stop lights		Below that of old car tail lights	
At Loch Surface > 5°(actually -10°)	40cd	15cd	5cd	2cd
	Equivalent to old car tail lights		This is slightly more than starlight	

Figure 11: Intensity of the Turbine T5 Light When Observed from Tangy Loch.

The stated cd intensity for aviation lights is the intensity at 1 meter (solid angle) based upon measuring lux (lx) at 1 meter range and converting using 1cd = 1 lux/m^2. The observed light intensity is then reduced by the inverse square law for viewing at ranges greater than 1 meter.

The table above shows that at 2000cd the turbine light will be between 90cd and 40cd when viewed from 75m (250ft) above the loch surface and between 40cd and 15 cd when viewed from the loch surface itself. In addition, the light will be significantly attenuated (inverse square law) from these figures, by the observation distance (840m). For comparison, the light will be similar to a modern car LED stop/brake light down to an old car filament tail/side light, both when viewed from 840 meters.

The table above shows that at 200cd the turbine light will be between 10cd and 5cd when viewed from 75m (250ft) above the loch surface and between 5cd and 2cd when viewed from the loch surface itself. In addition, the light will be significantly attenuated (inverse square law) by the observation distance (840m). Accordingly, in both cases, the light will be below that of an old car filament tail/side light when viewed from 840 meters. This will be visible to good eyesight on a clear night but it is approaching the limit of typical human sight. In the specific case of 200cd and loch surface, the light level is approximately 1 to 3 times that of the star Sirius viewed on a clear night away from cultural lighting.

Moving the observation point from the center of the loch, towards the T5 light, will increase the depressed viewing angle further reducing the light intensity (light focusing) which will tend to balance the reduced range. Conversely, extending the range from the light will reduce the viewing angle but the attenuation factor will become significant, again tending to balance the observed intensity. Accordingly, selecting a position at the centre of the loch, was a suitable functional choice for this analysis.

The analysis above indicates that the visible red obstruction light on Turbine T5, when set to 200cd, would have negligible light impact on wild geese roosting on Tangy Loch. Permanently setting the T5 light to 200cd would be a favored solution to accommodate the requirements of the Special Protection Area. The following page sets out the Lighting Proposal including a 200cd red light on Turbine T5.

Combined Visible-Red and Infra-Red Lighting Proposal (Including T5 at 200cd)

Tangy IV Turbine Lighting Table					
Turbine	Northing	Easting	Tip Ht	CAA-ANO	MOD I-R
T1	628135	167221	200m	2000/200cd	600mW/sr
T2	628232	167852	200m		600mW/sr
T3	628558	167392	200m		600mW/sr
T4	628383	168420	200m		600mW/sr
T5	628597	168850	200m	200cd	600mW/sr
T6	628983	167409	200m	2000/200cd	600mW/sr
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T12	629037	169002	200m		600mW/sr
T13	628906	168407	200m		600mW/sr
T14	628835	167951	200m		600mW/sr
T15	629307	168040	200m		600mW/sr
T16	629317	168498	200m		600mW/sr

Figure 12: Lighting Proposal Table (T5 at 200cd)

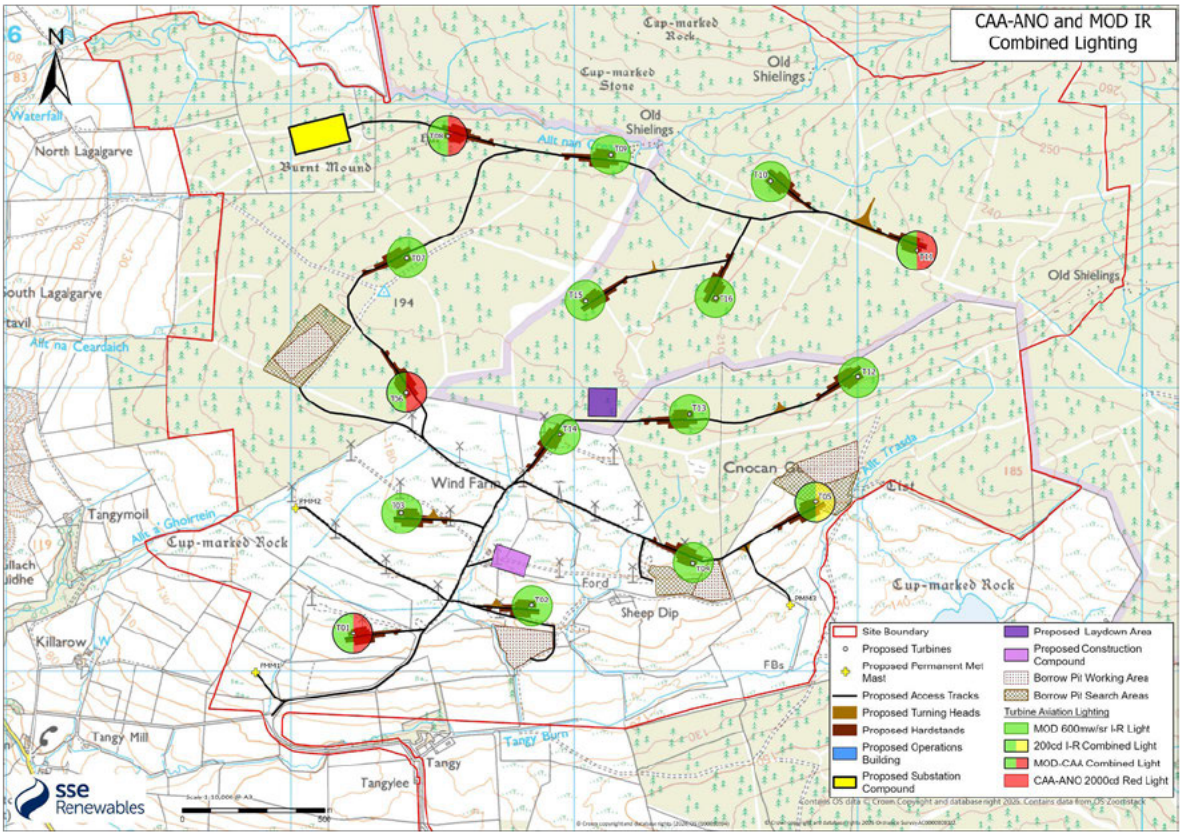

Figure 13: Lighting Proposal Map (T5 at 200cd)

ANO Light Specifications

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).

The CAA currently state: *met visibility should be measured at suitable points around the wind farm*. In the case of the Tangy IV turbines: Visibility Meters on T1, T5, T6, T8 and 11 will meet this criterion.

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.

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

WFLFAC will request that the CAA set-aside the guidance requirement for 32cd (Type B) mid mast lights for the Tangy IV turbines.

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

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

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

Figure 15: ICAO Annex 14 Table 6-2 Low Intensity Obstacle Lights.

IR Light Specifications

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

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

Figure 16: MOD Specification for IR Obstacle Lights.

Timings

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. Alternately, the lights can be switched-on by a suitable Lux Meter when the sun light falling on a vertical surface, drops below 500 Lux. This will also average 11 hours per day over a calendar year.

Mid-Mast Lighting

Mid mast lighting was originally intended to give an attitude/range reference (horizon indication) to pilots flying at night in the days before NVGs. A tip/hub light with a mid/mast light 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 on a single structure will not be able to give a vertical or horizontal reference or indication of range, range-rate and sight-line spin values or changes. However, a series of single tip/hub lights, on a group of structures, will provide a good horizon reference together with range, range-rate and sight line spin clues to a pilot. Accordingly, the requirement for mid-mast lights is much diminished if not made redundant in the case of lit multiple vertical structures such as wind farms.

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. As a result, they induce a disproportionately large environmental impact, often significantly more than the focused hub 2000/200cd lights. Although several lighting manufacturers have indicated that they will investigate closely matching the aviation standard, little has happened. For the vast majority of aviation and maritime applications for these 32cd lights, a minimum power is specified so overpowered lights are produced to ensure compliance. WFLFAC will request that the CAA guidance requirement for 32cd (Type B) mid-mast lights be removed for Tangy IV.

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

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

Note: As stated earlier, this concession is not applicable to MOD specification IR lighting.

Accordingly, if it is possible to assess how much time the met visibility will be below 5km, it will be possible to assess how much time the lights would spend at 200cd as opposed to 2000cd. To assess historical visibility on this west coast region, the closest meteorological station is at Prestwick Airport. The visibility will not be identical at these two locations, but similar as they will invariably sit in the same air-mass and are both located on the west coast of Scotland.

Prestwick issues historical meteorological data in the Met-Office format which makes use of block graph tables. Below is a Met Office table of visibilities at Prestwick Airport across the year and averaged over a 30-year period.

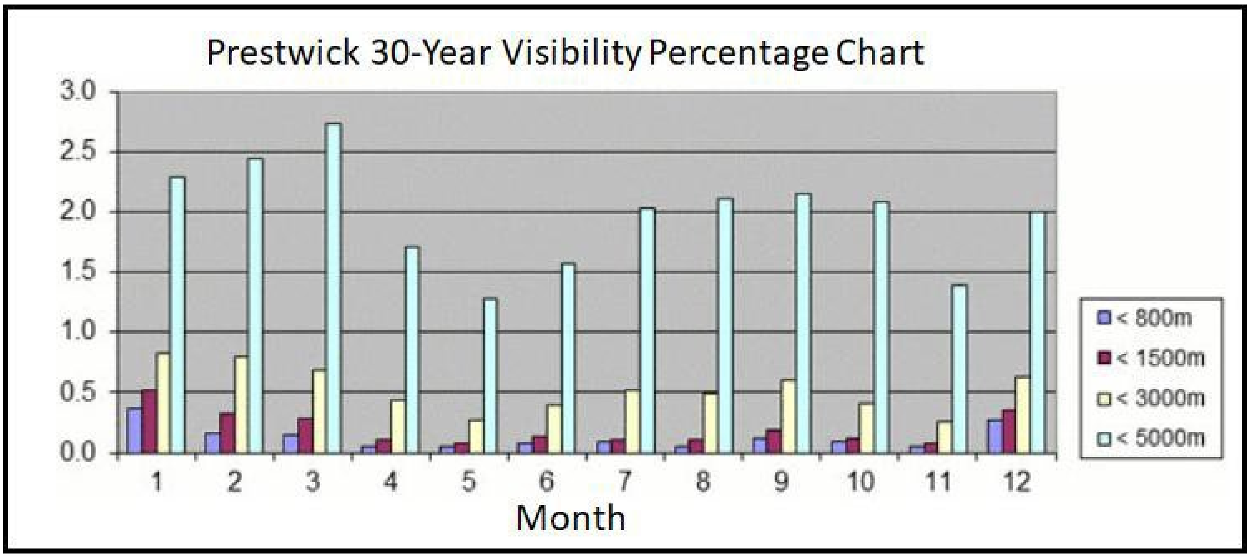

Figure 17: 30 Year visibility Table for Prestwick Airport (Light Blue is 5km Indicator)

This Met Office table shows us that the visibility is below 5km for an average of 2% of the times measured.

This suggests that the lights will be at **<u>2000cd for 2% of the time and 200cd for 98% of the time</u>**.

Moreover, met visibility improves with height since the concentration of particles (dust, haze) and liquid droplets (water) reduces with height and the air also becomes thinner. It could be argued that the Tangy IV visibility would be better than that at Prestwick; less time spent at 2000cd. In addition, cloud will play its part in the observability of the obstruction lights at Tangy IV. This can also be obtained from Met Office data.

Weather Obscuration.

On occasion, the visibility in the area of Tangy IV will drop significantly due to the presence of cloud on the hills. If the Tangy IV 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.

Note: All heights and elevations in aviation are measured and presented in feet and not metres.

The turbines will carry the CAA/ANO lights on the turbine hub. From the Data Table at Figure 2, the hub heights, for the proposed turbines, will be around 950-1150ft amsl.

Using these heights, it is possible to compare the altitude (amsl) of the obstruction lights with the actual cloud bases recorded by the Met Office at Prestwick recorded over a 30-year period as shown below in Figure 18.

The darker red columns (600-1000ft amsl) indicate that, on around 600 occasions a month, the cloud-base will be at or below the turbine hub heights. In addition, the combined blue, red and yellow columns indicate that on a further 500 times a month the weather would be such that the cloud would be so low that the turbines/lights would only be visible to people on the hills when very close to the turbines.

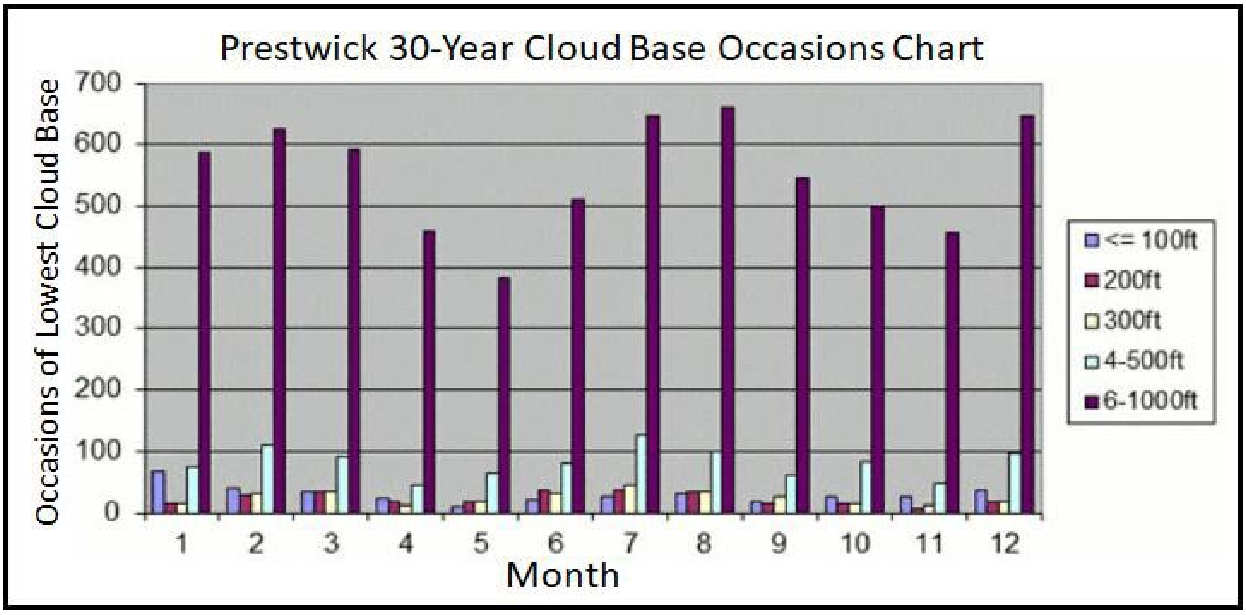

Figure 18: Thirty Year Average Cloud-Base Table for Prestwick Airport

Again, whist Prestwick is not Tangy IV, meteorological statistics and science show that cloud-bases reduce in the region of hills. It could be argued that at Tangy IV 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.

Weather Obscuration Conclusion

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 indicates the information so gathered, should be presented as follows:

> *Meteorological observations suggest that the turbine hubs/lights will be obscured on around a thousand occasions a month by cloud.*
>
> *When not obscured by cloud, the visibility in the area of the turbines can be expected to exceed 5km for 98% of the time and the lights will be switched down to 200cd.*

200cd Light Justification Summary.

MOD Operations. The Mull of Kintyre is part of MOD Low Flying Area 14 which is the busiest and largest LFA. However, the area of the Mull is a quiet corner of the LFA (from a military aviation perspective) and seldom used by fast jet traffic, particularly at night. Day and Night military traffic, operating at low-level (turbine height) in this area tends to be the occasional rotary-wing (helicopter) flight operating with night vision equipment. Accordingly, MOD I-R lighting, on every turbine, will ensure flight safety is maintained.

Civilian Operations. From the civilian perspective, aircraft operating in the immediate area of Tangy IV at turbine heights, will be limited to Coastguard (CSAR), Police and Helicopter Emergency Medical Service (HEMS). Again, these operators will be using night vision devices. Aircraft operating from Campbeltown Airport (7km to the south) will follow established/published procedures to ensure that they remain clear of vertical obstructions. Campbeltown Airport itself is part of the Highlands and Islands Airports Ltd (HIAL) who tend to request 200cd visible lighting on local vertical obstructions including wind turbines.

Turbine Lighting. The lighting proposal set-out in this report identifies the requirement for 5 visible red lights, that conform to the CAA/ICAO specification, to be installed on 5 dominant/corner turbines to identify the windfarm perimeter: T1, T5, T6, T8 and T11. Turbine T5 is the closest lit turbine to the Tangy Loch Special Protection Area. As a result, T5 will have the greatest effect on the Geese roosting areas around the loch; a Site of Special Scientific Interest (SSSI).

Reduction Proposal. A detailed analysis of the position of the T5 hub mounted light (elevated on a hill) to observation positions on the loch, suggests the following solution: Set the T5 light to 200cd permanently, as opposed to the more normal 2000/200cd weather dependent switchable. This would result in very minimal light intrusion to the night sky observed from the loch. Geese roost at ground level; at this height, and up to 75m (250ft) above the surface, the observed T5 light would range from the equivalent of an old-car (Morris 1000) tail/side light, viewed from 800+meters, down to a little brighter than individual stars.

Tangy/Kintyre SPA & SSSI. The Tangy IV wind turbine site is proposed close to a unique wildlife protection area. Accordingly, to accommodate this unique setting, a dispensation is sought to minimise the impact of Tangy IV turbine lighting on roosting geese and other wildlife in the area of Tangy Loch. The Tangy IV visible red lights are expected to be set to 200cd for up to 98% of the tine. The further dispensation requested is that the hub light on turbine T5 only be set to 200cd permanently.

Conclusion

The Tangy IV site benefits from the dispensations available from the CAA to reduce the number of visible obstruction lights required at the turbine site. Conversely, the site is in a designated low flying area from a MOD perspective and is not expected to warrant infra-red lighting dispensations.

> ***Accordingly, the 16-turbine site potentially requires 5 visible-red and 16 infra-red hub mounted obstruction lights. With the request that one visible light (T5) be permanently set to 200cd.***

Fortunately, the site is in an area where it will benefit from weather obscuration of its visible ANO lighting. This obscuration benefit is potentially quite significant.

> ***The lights will be regularly obscured by cloud and when not obscured set at the lower 200cd for up to 98% of the time.***

The proposed lighting scheme is fully compliant with published MOD lighting requirements with no dispensations requested.

Conversely, the proposed lighting scheme will require dispensation from the CAA. WFLFAC will request that the CAA accept the proposal and issue a variation under the Air Navigation Order (ANO) Article 222 Section 6.

[redacted]

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The Author

Mike Hale has spent over 45 years flying both civilian and military aircraft around the world. During 40 years as a military pilot, he filled the posts of operational low level fast jet pilot, fighter pilot, flight commander, air combat leader, instructor pilot (fast jet and basic training), senior instructor, principal examiner, test pilot and squadron commander. For his last 8 years in the military, and in concert with his continued flying duties, Mike held the position of OC the MOD Low Flying Operations Squadron. In this post, as well as overseeing the management and safe operation of the UK LFS and Weapons Ranges, he wrote, and had approved, the MOD guidance to wind energy developers for the integration of wind turbines, masts and infrastructure into low flying systems. He was also responsible for safeguarding military flying schools, gliding and parachute centres into the wider civilian lower airspace environment and accommodating the civilian equivalents into the military low flying system. Moreover, between 2008 and 2012, Mike proposed, set-up and ran a series of MOD, CAA, Trinity House, vertical obstacle lighting flight trials to clear the use of infra-red and low intensity red lights for use in low flying areas. This was followed by compiling the detailed specifications for such lights, relaying the results to other military authorities and assisting aviation lighting companies, in several countries, to start production of these lights.