Chapter 13 Aviation and Other Considerations

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List of Abbreviations

Abbreviation	Description
agl	above ground level
ANO	Air Navigation Order
CAA	Civil Aviation Authority
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EWTR	Electronic Warfare Tactics Range
FL	Flight Level
GPA	Glasgow Prestwick Airport
IFP	Instrument Flight Procedure
JRC	Joint Radio Company
Km	Kilometre
LFA	Low Flying Area
LPA	Local Planning Authority
M	metre
MoD	Ministry of Defence
NAIZ	Non-Auto Initiation Zone
NATS	National Air Traffic Services
NERL	NATS En Route plc
NPF4	National Planning Framework 4
OP	Observation Point
PSR	primary surveillance radar
PWS	Private Water Supplies
RAF	Royal Air Force
SBC	Scottish Borders Council

Glossary

Term	Definition
The Applicant	Fred. Olsen Renewables Limited
Environmental Impact Assessment	Environmental Impact Assessment (EIA) is a means of drawing together by the developer, in a systematic way, a description of the development and information relating to of the likely significant environmental effects arising from a proposed development.
Environmental Impact Assessment Report	A document reporting the findings of the EIA and produced in accordance with the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017
Natural Power	The lead consultant EIA co-ordinator is: Natural Power Consultants Limited
Non-Auto Initiation Zone	A radar data processing technique in which radar returns that are first detected in a specified part of the radar's coverage are not presented on the radar display but returns that track into that part of the radar's coverage from outside continue to be displayed
Primary surveillance radar	A device which transmits pulses of radio energy into the air and records reflections of those pulses from objects in the sky such as aircraft.
Proposed Development	The proposed Lees Hill Renewable Energy Park as described in Chapter 4 of this EIAR.
Proposed Development Site	The project development area within the site boundary as shown in Figure 1.2.
Threat emitter	A replica or simulator of a radar-guided anti-aircraft missile or gun system used to train combat aircrew in evasion tactics

13. Aviation and Other Considerations

13.1. Introduction

13.1.1. This chapter has been prepared by Aviatica and Natural Power Consultants Ltd (Natural Power) and summarises the potential effects of the Proposed Development in respect of Shadow Flicker, Aviation, Telecommunications, Glint and Glare, Public Access and Utilities.

13.1.2. Effects within this section have been scoped out as follows:

- Ice Throw; and
- Lightning

13.1.3. Ice Throw and Lighting were proposed to be scoped out within the Scoping Report (submitted July 2022, see Technical Appendix 1.1, Volume 4). Ice throw was scoped out due to the Scottish Government's Onshore Wind Farm Advice Sheet[1] which states that danger to human or animal life from falling parts or ice is rare. Similarly for lightning as stated in the Scottish Government's Wind Farm Advice Sheet[1], the danger to human or animal life from lightning strike via a turbine is rare since lightning is directed down the turbine to the earth; the turbine itself being earthed.

13.2. Policy Context and Policy Requirements

13.2.1. Table 13.1 summarises planning guidance and policy relevant to potential effects from wind farm development:

Table 13.1: UK and Scottish planning guidance, policy and legislation relating to shadow flicker, aviation, utilities, glint and glare and public access

Document	Policy Text
Scottish Government – Onshore wind turbines: planning advice (2014)[1]	'*Shadow Flicker: developers should provide calculations to quantify the effect. In most cases however, where separation is provided between wind turbines and nearby dwellings (as a general rule, 10 rotor diameters), 'shadow flicker' should not be a problem. However, there is scope to vary layout/reduce the height of turbines in extreme cases.'*
National Planning Framework 4 (NPF4) Policy 11 'Energy' (2023)[2]	*e) in addition, project design and mitigation will demonstrate how the following impacts are addressed:* *i) Impacts on communities and individual dwellings, including, residential amenity, visual impact, noise and shadow flicker.* *iv) impacts on aviation and defence interests including seismological recording* *v) impacts on telecommunications and broadcasting installations, particularly ensuring that transmission links are not compromised*
Scottish Borders Local Development Plan, Policy ED9:	*The assessment of wind energy proposals will include the following considerations:*

[1] *Scottish Government (2014) Onshore wind turbines: planning advice [Online] Available at: Onshore wind turbines: planning advice - gov.scot (www.gov.scot) (Accessed 28/09/2023)*

[2] *Scottish Government (2023) National Planning Framework 4 [Online] Available at: National Planning Framework 4 – gov.scot (www.gov.scot) (Accessed 28/09/2023)*

Document	Policy Text
Renewable Energy Development (2016)[3]	*Impacts on communities and individual dwellings (including visual impact, residential amenity, noise and shadow flicker)* *Impacts on carbon rich soils (using carbon calculator), public access, the historic tourism and recreation, aviation and defence interest and seismological recording, telecommunications and broadcasting installations, and adjacent trunk roads and road traffic.*
UK Government: Guidance on Renewable and Low Carbon Energy (2015)[4]	*'Individual turbines can be controlled to avoid shadow flicker at a specific property or group of properties on sunny days, for specific times of the day and on specific days of the year. Where the possibility of shadow flicker exists, mitigation can be secured through the use of conditions. Although problems caused by shadow flicker are rare, where proposals for wind turbines could give rise to shadow flicker, applicants should provide an analysis which quantifies the impact.'*

Source: Natural Power

13.3. Consultation

13.3.1. Consultation regarding other matters undertaken during the course of the EIA is recorded in Table 13.2. Consultation regarding aviation is included in Section 13.7.

Table 13.2: Consultation table

Consultee	Comments/issues raised/recommendations	Address responses/outcomes
Scottish Borders Council (SBC)	Environmental Health Officer advised that any residential properties within distance of 2 km of each turbine should be assessed for shadow flicker Glint and Glare should be assessed for up to 2 km distance point. In the Scoping Opinion, it was agreed to scope out the impact of glint and glare effects on aviation from the solar PV element of the Proposed Development.	Shadow flicker and glint and glare assessment has been carried out and addressed in EIAR Chapter 13. Further details set out in Section 13.4 and 13.5.
	Council Access Officer has requested a Path Planning Study to be commissioned within the title deed extent of the landowner affected.	Path Planning Study/Access Management Plan has been scoped out as no public rights of way intersect directly with the Proposed Development.
Joint Radio Company (JRC)	JRC objected due to proposed change in blade radius but conducted further analysis and concluded, subject to report and	

[3] *Scottish Borders Council (2016) Scottish Borders Local Development Plan [Online] Available at: Local development plan - adopted \| Local development plan \| Scottish Borders Council (scotborders.gov.uk) (Accessed 28/09/2023)*

[4] *UK Government (2015) Guidance on Renewable and Low Carbon Energy [Online] Available at: Renewable and low carbon energy - GOV.UK (www.gov.uk) (Accessed 28/09/2023)*

Consultee	Comments/issues raised/recommendations	Address responses/outcomes
	micro-siting constraints being adhered to that the project is cleared.	
National Gas Transmission	National Gas Transmission were consulted due to the presence of gas pipeline within the Proposed Development Site.	All infrastructure has been placed at required buffer distances. Track layout has been designed to have minimal crossing points of pipeline.

Source: Natural Power

13.4. Shadow Flicker

13.4.1. Shadow flicker may occur under certain combinations of geographical position and time of day when the sun passes behind blades of a wind turbine and casts a shadow over the neighbouring properties. Shadow flicker can only occur within buildings and is not to be confused with shadow casting. The magnitude of the shadow flicker depends on several environmental conditions coinciding at a given time, including the position and height of the sun, wind speed, wind direction, cloud cover, position of the turbine relative to a sensitive receptor, and the position of any windows together with intervening line-of-sight screening (e.g., trees or buildings).

13.4.2. There is no standard for the assessment of shadow flicker in Scotland and there are no guidelines with which to quantify what exposure levels would represent a significant versus not significant effect. In the absence of specific guidelines, the assessment was based on professional experience and guidance[5].

13.4.3. Receptor locations within 2 km of the Proposed Development (in accordance with Section 18 of the Scoping Opinion at Scottish Borders Council's request) and modelled in the analysis, with 13 locations ultimately selected. Receptor locations were selected to represent a worst-case scenario for the settlements near the Proposed Development.

13.4.4. A full summary of the results can be found in Technical Appendix 13.1, Volume 4.

Method of Assessment

13.4.5. Assessment of the impact of shadow flicker can be split into the following two possible conditions:

- Worst case – This determines the maximum number of theoretical hours of shadow flicker that can occur, not accounting for the likelihood of direct sunshine occurring in the region, coinciding with periods where shadow flicker is possible. Outside of these periods, irrespective of the cloud cover and sunshine status, flicker cannot physically occur. This process then leads to the maximum number of hours (per annum) at which flicker could, in theory occur.
- Real-case – This takes the worst-case scenario and adjusts the duration of the total potential flicker events by the likelihood that direct sunshine occurs in a region. Typically, this uses sunshine data from ground-based meteorological station to apply monthly scaling factors to the worst-case scenario results. This provides a more accurate representation of the number of hours per year, that a receptor location may experience shadow flicker.

[5] *Update of UK Shadow Flicker Evidence Base Final Report [Online] Available from - Update of UK Shadow Flicker Evidence Base (publishing.service.gov.uk) Accessed 22/03/2024*

The turbines are still modelled as though they are yawed perpendicularly to the line between the receptor and sun, inducing the maximum shadow effect possible.

13.4.6. The following assumptions have been made for this assessment:

- The turbines are always rotating;
- The sun can be presented by a single point;
- The turbine rotor is modelled as a sphere around the hub to account for all possible turbine yaw directions relative to the line of sight with the position of the sun;
- Terrain effects are considered although this is assumed to be bare terrain and therefore surface effects from cover such as forestry or other buildings are not considered.
- The calculation is purely geometric and does not account for the sensitivity or perception of the observer;
- The likelihood of wind direction and speed is not taken into account;
- Shadow flicker is calculated for a height of 2 m Above Ground Level (AGL) to represent an observer at a ground floor window.
- The shadow receptors are simulated as mounted vertical plates always facing directly at each turbine simultaneously, representing the worst-case scenario (glasshouse) while real windows would be facing towards a particular, selective direction.
- The simulations have been carried out with a resolution of 1 minute.
- The shadow flicker effects have been calculated for the area within 2041 m from the centre of each turbine. This area based on a calculated length the shadows are likely to persist. This is calculated from the average thickness of the turbine blade from a turbine specifications database, however this should be confirmed with formal documentation from the turbine manufacturer.

13.4.7. The significance of shadow flicker is typically defined as a function of the sensitivity of a receptor with the magnitude of change. A methodology for the establishment of the magnitude of change has been derived based on professional experience and policy. All receptors are considered as high sensitivity.

Table 13.3: Significance criteria

Significance of Effect	Description
Significant (High)	The assessment demonstrates shadow flicker to occur >30 minutes/day or > 30 hours/year at a property.
Not Significant (Low)	The assessment demonstrates shadow flicker to occur <30 hours/year and <30 minutes/day.
No effect (Nil)	No shadow flicker will occur at a property.

13.4.8. Full details of the methodology and results of the assessment can be found in Technical Appendix 13.1, Volume 4. In summary the methodological approach implemented the worst-case scenario.

Assessment of Potential Effects

13.4.9. Of the 13 receptors assessed, from the real-case scenario Receptor 1 (R1), R2, R3 and R9 had the potential to exceed the maximum allowance of the 30 minutes/day. R2 had the potential to exceed the 30 minutes per day and 30 hours/year allowance.

13.4.10. R2 is adjacent to the landowner's property at Langtonlees Farm. The turbines contributing to shadow flicker at this location are T4, T5 and T6.

Mitigation and Residual Effects

13.4.11. It is important to note that not all properties within a study area will experience shadow flicker. In order for it to occur, the weather must be sunny, and the blades must also be rotating. The effect is also reduced if the turbine rotors are perpendicular to the location experiencing flicker, so will be dependent upon wind direction. This is because turbines turn to face into the wind when operating. Vegetation such as trees, hedgerows or intervening buildings, and the topography of the land itself, will also have a screening effect. Finally, the absence of windows facing the direction of relevant turbines, and the nature of use of any affected rooms, may mitigate any impacts.

13.4.12. The visual setting of the receptor locations have been detailed in Technical Appendix 6.6: RVAA and summarised in Technical Appendix 13.1, Volume 4 highlighting the potential screening from vegetation, buildings and having primary views away from the Proposed Development is apparent.

13.4.13. Prior to commissioning of the Proposed Development, a shadow flicker protocol to reduce effects to below 30 minutes a day and/or 30 hours per annum for any relevant properties existing or with planning permission at the time of consent will be agreed by means of a deemed planning permission condition with the local planning authority (LPA). In the event of a substantiated complaint to the LPA from owners of the aforementioned properties, this protocol would be enacted. Suggestions of mitigation include screening planting, installation of blinds within affected residents' homes or a control programme whereby turbines would shut down automatically when Shadow Flicker occurs. With this measure in place, no significant shadow flicker effects would arise from the Proposed Development.

Conclusions

13.4.14. The Proposed Development has the potential to have a significant impact on receptor R1, R2, R3 and R9 through the Real-case scenario. The visual setting of R1, R2, R3 and R9 have screening either from vegetation, buildings or primary views looking away from the Proposed Development and therefore are likely to obscure most views from the receptors. The use of mitigation measures including control programmes and screening will reduce the effects of shadow flicker. In addition, R2 and R9 are both financially involved with the Proposed Development.

13.4.15. The effects on all other receptors assessed would not be significant.

13.5. Glint and Glare

13.5.1. Ground mounted solar has the potential to cause glint and glare onto the surrounding landscape and so effects on the surrounding residential properties and road network must be reviewed. There are 13 residential properties, observation points (OP), within a 2 km range of the solar arrays and four stretches of road, route receptors, as described in table 10.3 below. The solar arrays are separated into five sections (Arrays 1-5), shown in table 13.4 below. A full summary of the results can be found in Technical Appendix 13.2, Volume 4.

13.5.2. There are currently no specific national guidance policy for determining the impact of glint and glare for residential amenity or road safety. Pager Power has guidance which reviews general existing planning guidelines which defines its own glint and glare assessment guidance and methodology[6]. This methodology has been referenced and the assessment based on the guidelines provided as it defines the process for determining the impact upon road safety and residential amenity.

Method of Assessment

13.5.3. Glint and glare will vary from each receptor type, however, general significance criteria for glint and glare is described below in Table 13.4 using the impact significance table from relevant guidance[6]. The potential for after image is the likelihood that a solar reflection will continue to appear in the vision of a human receptor after exposure to the original image has ceased. The levels of intensity are shown in Table 13.4 below.

Table 13.4: Significance of Impact

Level of Effect	Description	Mitigation Requirement
High	Solar reflection is geometrically possible and visible under worst-case conditions that will produce a significant impact given individual receptor criteria.	Mitigation will be required if the Proposed Development is to proceed.
Moderate	A solar reflection is geometrically possible and visible however it occurs under conditions that do not represent a worst-case given individual receptor criteria.	Mitigation recommended.
Low	A solar reflection is geometrically possible however any impact is considered to be small such that mitigation is not required e.g. intervening screening will limit the view of the reflecting solar panels significantly.	No mitigation recommended.
No Impact	A solar reflection is not geometrically possible or will not be visible from the assessed receptor.	No mitigation required.

13.5.4. Guidance suggests that a similar assessment to shadow flicker should be considered for glint and glare in which 60 minutes of persistent glare over a day for three or more months of the year should be considered significant and mitigation should be implemented[6].

13.5.5. Glare can be further categorised into levels of intensity as shown in table 13.5 below:

Table 13.5: Intensity of Glare

Level of Effect	Description	Mitigation Requirement
Red Glare	Permanent retinal damage.	Mitigation will be required if the Proposed Development is to proceed.
Yellow Glare	Potential for after-image.	Mitigation recommended.
Green Glare	Low potential for after-image.	No mitigation recommended.
No effect (Nil)	No potential for temporary after-image.	No mitigation required.

13.5.6. The categories assume a typical blink response from the observing receptor. Retinal burn is typically not possible for PV glare since PV modules do not focus reflected sunlight.

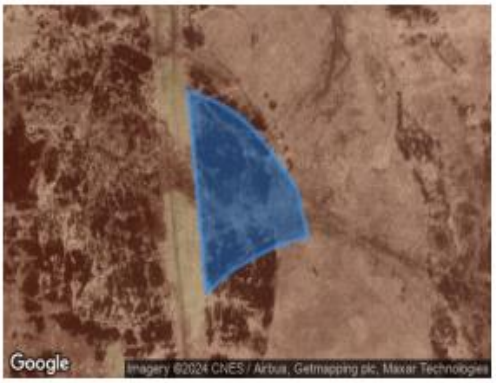
[6] *Pager Power (2022) Solar Photovoltaic and Building Development – Glint and Glare Guidance [Online] Available at: https://www.pagerpower.com/wp-content/uploads/2022/09/Solar-Photovoltaic-Glint-and-Glare-Guidance-Fourth-Edition.pdf (Accessed 18/02/2024)*

13.5.7. A standard geometric model has been used for this assessment which includes the following assumptions:

- The Earth's orbit around the Sun;
- The Earth's rotation;
- The Earth's orientation;
- The location of the solar PV arrays including the solar panel area;
- The orientation of the solar PV arrays relative to north and south and the angle of elevation (tilt); and
- Local topography, including receptor and panel heights above sea level.

13.5.8. Table 13.6 below provides the arrangement of the arrays assessed.

Table 13.6: Solar PV Arrays

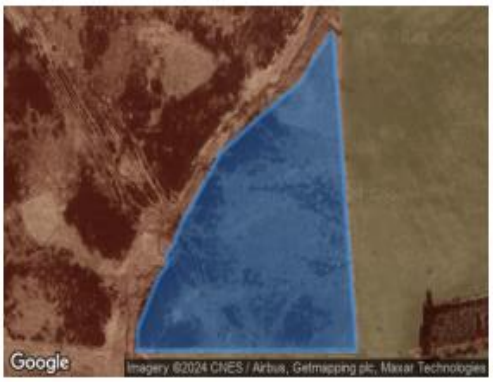
Array	Description	
1	**Name**: PV array 1 **Axis tracking**: Fixed (no rotation) **Tilt**: 19.0° **Orientation**: 180.0° **Rated power**: - **Panel material**: Smooth glass without AR coating **Reflectivity**: Vary with sun **Slope error**: correlate with material	
2	**Name**: PV array 2 **Axis tracking**: Fixed (no rotation) **Tilt**: 19.0° **Orientation**: 180.0° **Rated power**: - **Panel material**: Smooth glass without AR coating **Reflectivity**: Vary with sun **Slope error**: correlate with material	
3	**Name**: PV array 3 **Axis tracking**: Fixed (no rotation) **Tilt**: 19.0° **Orientation**: 180.0° **Rated power**: - **Panel material**: Smooth glass without AR coating **Reflectivity**: Vary with sun **Slope error**: correlate with material	

4

Name: PV array 4
Axis tracking: Fixed (no rotation)
Tilt: 19.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

5

Name: PV array 5
Axis tracking: Fixed (no rotation)
Tilt: 19.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



13.5.9. The arrays shown above do not rigorously represent the detailed geometry of the final design. Features such as spaces between arrays, variable heights of the PV array, and support structures may impact actual glare results. The simulation uses a footprint filled with small panels reflecting sunlight in the trajectory of the tilt and orientation.

Assessment of Potential Effects

13.5.10. The full results of the model are provided in Technical Appendix 13.2: Glint and Glare Assessment, Volume 4. Figure 6.36, Volume 3b shows the relevant residential receptors 1-13. The total glare results of the assessment are shown in Table 13.7 below:

Table 13.7: Total Glare Results

Receptor	Annual Green Glare		Annual Yellow Glare	
	Minutes	Hours	Minutes	Hours
Route 1	1,240	20.7	1	0.0
Route 2	0	0.0	0	0.0
Route 3	9,499	158.3	2,546	42.4
Route 4	7,752	129.2	0	0.0
OP 1	2,212	36.9	1,294	21.6
OP 2	1,211	20.2	1,858	31.0

OP 3	1,251	20.9	1,438	24.0
OP 4	0	0.0	0	0.0
OP 5	1,561	26.0	0	0.0
OP 6	1,691	28.2	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	937	15.6	14	0.2
OP 10	3,654	60.9	331	5.5
OP 11	1,543	25.7	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0

13.5.11. The total glare received by each receptor, may include duplicate times of glare from multiple surfaces.

13.5.12. Table 13.8 below provides details on each of the receptors and the potential glare predicted at each receptor. The Zone of Theoretical Visibility from Figure 6.4, Volume 3b and Technical Appendix 6.6: Residential Visual Amenity Assessment, Volume 4 has been used alongside Technical Appendix 13.2, Volume 4 to assess whether affected areas have visibility to the solar PV arrays.

Table 13.8: Effect on receptor

Receptor	**Description**	**Effect/Mitigation Required**
Route 1	Route 1 receptor is situated on the northern boundary of site mostly running in an east-west direction. A maximum of up to 20.7 hours of Green Glare and a single minute of Yellow Glare has been predicted from arrays 1, 2 and 4 at this location. Figure 6.4, Volume 3b shows that much of this receptors area would not theoretically be visible and therefore the total impact upon the receptor will likely be lessened.	Low – No mitigation recommended.
Route 2	No glare observed at this receptor.	No Impact – No mitigation required.
Route 3	Route 3 receptor is southeast of the site running mostly in northeast and southwest directions. A maximum of up to158.3 hours of Green Glare and 42.4 hours of Yellow Glare have been predicted at this location. All 5 arrays are sources of glare towards the totals predicted. Much of this receptor stretches out with the 2km range where the effects of glare lessen. The majority of glare including all Yellow glare is focussed around the stretch of road west of Gavinton. On comparison with Figure 6.4, Volume 3b it can be assessed that much of the area will likely not have visibility of the arrays and therefore the total glare observed will be significantly lessened.	Low – No mitigation recommended.
Route 4	Route 4 receptor is directly adjacent to the southern boundary of site and runs in an east-west direction. A maximum of up to	Low – No mitigation recommended.

	129.2 hours of Green Glare and no Yellow Glare has been predicted at this location, with all 5 arrays as sources. The stretch of road between Kettelshiel and White Knowe Cairn is where the majority of the glare is focussed which is further than the 2 km range from the solar arrays and the total effect is likely to be lower.	
OP1	Receptor OP1 is situated to the southeast of the arrays. A maximum total of up to 36.9 hours of Green Glare and 21.6 Hours of Yellow Glare have been predicted at this receptor. TA 6.6 suggests that the main views from here are to the south-east with filtered views to the west which would likely reduce the effects and likelihood of observing glare.	Low – No mitigation recommended.
OP2	Receptor OP2 is directly east of the main arrays and is suggested to observe a maximum of up to 20.2 hours of Green Glare and 31 hours of Yellow Glare. TA 6.6 states there are open views to the south but farm buildings adjacent likely leading to a reduction of observed glare through the screening by other buildings.	Low – No mitigation recommended.
OP3	OP3 is near OP2 and directly east of the arrays. A maximum of 20.9 hours of Green Glare and 24 hours of Yellow Glare. There are open views to the south with farm buildings nearby as described in TA 6.6. This will likely lead to a reduction of observed glare through the screening by other buildings.	Low – No mitigation recommended.
OP4	No glare observed at this receptor.	No Impact – No mitigation required.
OP5	Receptor OP5 is southwest of the solar arrays and is predicted to have up to a maximum of 26 hours of Green Glare and no Yellow Glare. TA 6.6 suggests this receptor is entirely enclosed with mixed woodland and therefore it is likely the total glare observed will be significantly lower.	Low – No mitigation recommended.
OP6	OP6 is near to OP5 to the southwest of the arrays and similarly has filtered views of the arrays through mixed woodland but views are possible. It is predicted to have a maximum of 28.2 observed hours of Green Glare and no Yellow Glare. Similar to OP5 this is likely to be reduced from the filtering of views provided by woodland	Low – No mitigation recommended.
OP7	No glare observed at this receptor.	No Impact – No mitigation required.
OP8	No glare observed at this receptor.	No Impact – No mitigation required.
OP9	Receptor OP9 is situated to the east of the solar arrays and is predicted to observe 15.6 hours of Green Glare and 0.2 hours of Yellow Glare. TA 6.6 suggests the receptor is within mixed woodland with possible filtered views which means the total glare is likely to be reduced.	Low – No mitigation recommended.
OP10	OP10 is to the east of the arrays and is predicted to have a maximum of up to 60.9 hours of Green Glare and 5.5 of Yellow Glare. TA 6.6 suggests there are filtered views to the west which is reinforced by figure 6.4, Volume 3b showing areas where the solar is not visible. It is likely the total number of hours glare observed at this property is lower than predicted.	Low – No mitigation recommended.

OP11	OP11 is to the southeast of the arrays. There is a maximum of 25.7 hours of Green Glare predicted at this location and no Yellow Glare. TA 6.6 suggests there are filtered views from this receptor towards the northwest which would look towards the arrays. As these views are filtered it is likely the total glare observed will be lower.	Low – No mitigation recommended.
OP12	No glare observed at this receptor.	No Impact – No mitigation required.
OP13	No glare observed at this receptor.	No Impact – No mitigation required.

13.5.13. The periods of observed glare mostly occur in the summer months but are predicted overall between April through to September. The predicted time of occurrence is predominantly between 10-11am but there are also periods where the glare could occur between 9-10pm.

13.5.14. There is only one interaction where glare is observed for more than 30 minutes a day between array 5 and receptor Route 4. There are no exceedances predicted over 40 minutes per day and the majority of predicted glare is less than 20 minutes per day.

Mitigation and Residual Effects

13.5.15. Not all receptors within a study area will experience the effects of glare. In order for it to occur, the weather must be sunny and there must be an uninterrupted view of the array to the receptor. Vegetation such as trees or hedgerows or intervening buildings, and the topography of the land itself, will also have a screening effect if it obstructs the view to the panels.

13.5.16. For residential receptors the absence of windows facing the direction of relevant panels, and the nature of use of any affected rooms, may mitigate any impacts. As there are no days predicted with glare over 60 minutes a day there are no significant effects and mitigation should not be required.

13.5.17. Regarding route receptors, the visibility and size of a reflecting panel area from an assessed road will in part, determine the duration of a solar reflection. The speed of a vehicle as it passes will be the main determining factor which determines the duration of the solar reflection. The type of road and the origin of the reflection in respect to the direction of the road travel would determine the need for mitigation. As there are no days predicted with glare over 60 minutes a day and all routes assessed do not travel in a direct line of sight towards the arrays there will be no significant effects and mitigation should not be required.

Conclusions

13.5.18. The periods of observed glare mostly occur in the summer months but are predicted overall between April through to September. The predicted time of occurrence is predominantly between 10-11am but there are also periods where the glare could occur between 9-10pm.

13.5.19. There is only one interaction where glare is observed for more than 30 minutes a day between array 5 and receptor Route 4. There are no exceedances predicted over 40 minutes per day and the majority of predicted glare is less than 20 minutes per day.

13.5.20. As such, the Proposed Development twill have no significant effects on receptors in regard to glint and glare.

13.6. Utilities – Electricity, Water & Gas

Overhead Lines

13.6.1. There are no overhead electricity lines within proximity of the Proposed Development and so this section was taken no further.

Water Supply

13.6.2. Chapter 9: Hydrology, Geology and Hydrogeology presents the relevant hydrological assessment relating to water supply.

Private Water Supplies (PWS)

13.6.3. Increased sediment erosion as a result of wind farm construction and decommissioning can have impacts on the quality, quantity, and continuity of water supply to the properties.

13.6.4. SBC provided information on PWS within 3 km of the Proposed Development and letters were issued to all identified properties so that further assessment could be undertaken to identify any potential effects on private water supplies and appropriate mitigation.

13.6.5. Non-statutory consultation has been undertaken with local residents and landowners in relation to private water supplies as part of a private water supply risk assessment where the Proposed Development is considered to have potential for impact on such identified supplies.

13.6.6. SBC PWS map shows properties which have registered PWS (<10 m3 per day abstraction rate). The database does not show the location of the source of the supply, nor does it provide an exhaustive list of all private water supplies in the area as those that are not registered will not be shown. The PWS properties have been identified within 3 km of the Proposed Development are shown in Figure 9.1, Volume 3a.

13.6.7. Further details are available in Technical Appendix 9.1: Private Water Supply Risk Assessment, Volume 4.

Public Water Supplies

13.6.8. Scottish Water were consulted in relation to public water supplies and confirmed there are no Scottish Water assets or abstractions within the site. The Proposed Development is also not within a Drinking Water Protected Area and therefore Scottish Water assets were not considered further.

Buried Infrastructure and Underground Assets Including Gas

13.6.9. There are no underground cables running through the Proposed Development and therefore it is not considered further in this chapter.

13.6.10. There is a National Gas pipeline that runs through the site, parallel to Turbine One (T1) and then bends to the north and lies between T3 to T6 and T4 to T5. This can be seen on Figure 3.1, Volume 3a. The design process minimised the impact on the gas pipeline using as few crossing points as possible. There are two access tracks that cross the pipeline branching from T4 to T5 and T6 individually. The two crossings will reduce the number of vehicles on each crossing point. The tracks were aligned to be as perpendicular as possible with the pipeline from discussion with National Gas. The distance between turbines and the gas line was also used as a constraint factor in the design process. On discussion with National Gas a minimum distance of 1.5x the hub height was to be maintained by all turbines.

13.7. Public Access

13.7.1. There are no core paths and one right of way within the Proposed Development Site. The right of way is the Langtonlees Farm road and is situated close to the eastern boundary of the

Proposed Development Site and as such will not be impacted by any proposed infrastructure or access tracks. Neither construction or operational traffic associated with the Proposed Development will use the farm road.

13.8. Population and Human Health

13.8.1. The assessment of potential health effects will be covered under individual aspect chapters of the EIAR and brought together in Chapter 15: Mitigation and Synergistic Effects, Chapter 11: Noise, Chapter 14: Socioeconomics, Chapter 13: Aviation and other Considerations, within Volume 2 with associated Technical Appendices 13.1: Shadow Flicker Summary Report and 13.2 Glint and Glare assessment and Technical Appendix 13.3: in Volume 4.

13.9. Aviation

13.9.1. This section, prepared by Aviatica, sets out:

- the aviation baseline;
- the assessment methodology used in completing the impact assessment;
- the potential effects, including direct, indirect and cumulative effects;
- the mitigation measures proposed to address likely significant effects; and
- the residual effects remaining following the implementation of mitigation.

13.9.2. Wind turbines have the potential to affect the performance of radars used for air traffic control, air defence and meteorological forecasting, and of aeronautical radio navigation aids. They can also present an obstacle hazard to aircraft flying at low altitude. They may affect the specified minimum altitudes for aircraft flying instrument approach procedures at airports. Aviation obstruction lighting on wind turbines may generate adverse night time visual impacts on non-aviation receptors.

13.9.3. In view of the absence of airfields in the vicinity of the Proposed Development Site and in line with Civil Aviation Authority (CAA) policy on the effects of solar photo-voltaic (SPV) developments on aviation, it is concluded that there are no potential adverse effects on aviation from the SPV element of the Proposed Development. Therefore, this element of the development is scoped out of the assessment in this chapter.

Legislation Policy and Guidance

13.9.4. The aviation assessment has been carried out in accordance with the following legislative, policy and guidance documents:

- The Air Navigation Order (ANO) 2016;
- The Town and Country Planning (Safeguarded Aerodromes, Technical Sites and Military Explosives Storage Areas) (Scotland) Direction 2016;
- CAA Policy and Guidelines on Wind Turbines (CAP 764);
- CAA, Air Traffic Services Safety Requirements (CAP 670);
- CAA, Safeguarding of Aerodromes (CAP 738);
- CAA, Implementation and Safeguarding of Instrument Flight Procedures (IFPs) in the UK (CAP 785B);
- CAA Policy Statement: Lighting of Onshore Wind Turbine Generators in the United Kingdom with a maximum blade tip height at or in excess of 150m Above Ground Level (June 2017); and
- The Ministry of Defence (MoD) (Eskdalemuir Seismic Recording Station) Technical Site Direction 2005.

Method of Assessment

13.9.5. The following study areas have been applied to identify aviation assets with the potential to be affected by the Proposed Development:

- 130 km radius for air traffic control and air defence primary surveillance radars (PSRs);
- 60 km radius for instrument flight procedures at licensed or certificated aerodromes;
- 30 km radius for licensed and certificated aerodromes and Meteorological Office radars;
- 20 km radius for aeronautical radio navigation aids and secondary surveillance radars;
- 15 km radius for unlicensed aerodromes and launching sites; and
- 50 km radius for the Eskdalemuir seismic monitoring array.

13.9.6. For PSRs within the study area, line of sight to the maximum blade tip height of the Proposed Development has been modelled. For PSRs found to have line of sight to the turbines, an operational impact assessment has been carried out taking account of the airspace structure and classification, the types of air traffic or other services being provided by the operator of the radar and the types and volumes of air traffic using the airspace.

13.9.7. Potential effects on military low flying have been assessed by considering the location and height of the Proposed Development relative to existing terrain and other constraints on the routes flown by low flying aircraft through the area.

13.9.8. Significance criteria for assessment of impacts on aviation, unlike those for environmental effects, are not based on the sensitivity of the receptor. Further, while magnitude of impact can be determined in some circumstances, it typically does not provide a standardised metric on which to measure the significance of any effects. In this context, the significance of effects on aviation has been determined in this chapter by application of professional judgement, underpinned by consideration of the magnitude of impact (where measurable), the regulations and procedures in place for ensuring that aviation infrastructure meets required performance standards, the safeguarding policies and practices in use by specific aviation stakeholders, and the consultation responses from those stakeholders.

13.9.9. Residual adverse effects of the Proposed Development on aviation are described as either nil, negligible, minor, moderate or major. Nil, negligible or minor impacts are categorised as not significant. Moderate or major effects are categorised as significant. The definitions of these criteria are shown in Table 13.9 below.

Table 13.9: Significance criteria

Significance of Effect	Description
Major	Regular, frequent or permanent effects which require changes to existing operational and/or technical practice in order to mitigate adequately, or which are not capable of being mitigated adequately.
Moderate	Periodic effects experienced which may require alterations to existing operational practice.
Minor	Occasional effects experienced which do not require any alteration of existing operational and technical practice.
Negligible	Normally no measurable change from baseline conditions; occasional, fleeting or very short term effects experienced which do not require any alteration of existing operational and technical practice.
Nil	No measurable change from baseline conditions

Consultation

13.9.10. The MoD, Edinburgh Airport, Glasgow Airport, Glasgow Prestwick Airport and NATS En Route plc (NERL) were consulted on the Scoping Report. Their responses are shown in Table 13.10.

Table 13.10 Aviation consultations

Consultee	Scoping response	Comment/response
MoD	The wind turbines proposed would be visible to air defence radar systems, specifically those sited at Remote Radar Head Brizlee Wood…This would reduce the Royal Air Forces' ability to detect and deter aircraft in United Kingdom sovereign airspace, thereby preventing it from effectively performing its primary function of Air Defence of the United Kingdom.	Effects on the Brizlee Wood radar are addressed in section 13.14.18 of this chapter.
MoD	The development site identified is in the vicinity of a remote site used by the RAF Spadeadam Electronic Warfare Tactics facility, the introduction of wind turbines may cause unacceptable interference to the operation of threat radar systems.	Effects on the Charterhall threat radar site are addressed in section 13.14.20 of this chapter.
MoD	The development falls within a part of the UK Military Low Flying System designated Low Flying Area 14 (LFA 14), an area within which fixed wing aircraft may operate as low as 250 feet or 76.2 metres agl to conduct flight training. The addition of turbines in this location has the potential to introduce a physical obstruction to low flying aircraft operating in the area.	Effects on military low flying are addressed in section 13.14.23 of this chapter.
NATS	The Proposed Development has been examined from a technical safeguarding aspect and does not conflict with our safeguarding criteria. Accordingly, NATS (En Route) Public Limited Company ("NERL") has no safeguarding objection to the proposal.	No further action required
Edinburgh Airport	The location of this development falls out with our Aerodrome Safeguarding zone for Edinburgh Airport therefore we have no objection/comment.	No further action required
Glasgow Airport	This proposal is located outwith the consultation area for Glasgow Airport. As such we have no comment to make and need not be consulted further.	No further action required
Glasgow Prestwick Airport	The Proposed Development lies outwith the Airport's safeguarding area and as such GPA have no comment to make on the scoping consultation and would have no aviation grounds to object to this proposal should it come to a full Section 36 Planning Application.	No further action required

Baseline

13.9.11. The airspace over the Proposed Development Site is Class G (uncontrolled) from ground level up to Flight Level (FL) 195 (approximately 19,500 ft above sea level). Above FL195 is Class C controlled airspace under the control of the NATS Prestwick Centre.

13.9.12. Primary surveillance radars with the potential to detect turbines in the Proposed Development Site are as follows:

- National Air Traffic Services (NATS) En Route Great Dun Fell (120 km south of the Proposed Development);
- NATS En Route Lowther Hill (93 km south west of the Proposed Development);
- NATS En Route/Scottish Power Kincardine (87 km north west of the Proposed Development);
- Leuchars Diversion Aerodrome (72 km north north west of the Proposed Development);
- Edinburgh Airport (61 km north west of the Proposed Development);
- MoD Brizlee Wood air defence radar (56 km south east of the Proposed Development);
- Royal Air Force (RAF) Spadeadam Deadwater Fell (56 km south south west of the Proposed Development); and
- a mobile threat emitter radar deployment site, associated with the RAF Spadeadam Electronic Warfare Tactics Range (EWTR), at Charterhall airfield (7 km south south east of the Proposed Development).

13.9.13. Radar line of sight assessment has established that the radars at Great Dun Fell, Lowther Hill, Kincardine, Leuchars, Edinburgh and Deadwater Fell are not capable of detecting turbines up to 200 m at the Proposed Development Site due to intervening terrain.

13.9.14. There are no instrument flight procedures, licensed or certificated aerodromes, Meteorological Office radars, aeronautical radio navigation aids or secondary surveillance radars within the study area.

13.9.15. The nearest unlicensed airfield is Charterhall, a 600 m light aircraft airstrip located 7 km south south east of the Proposed Development Site. The CAA (CAP 764) recommended consultation zone for wind farms around airfields of Charterhall's size is a 3 km radius.

13.9.16. The closest turbine in the Proposed Development Site will be 65.7 km from the centre of the Eskdalemuir seismic array. This is substantially beyond the 50 km consultation zone specified in the MoD (Eskdalemuir Seismic Recording Station) Technical Site Direction 2005.

13.9.17. The Proposed Development Site is in a zone classified by the MoD as a "regular military low flying area where mitigation may be necessary to resolve concerns". However, the Proposed Development is not within a specialist low flying area such as a Tactical Training Area.

Assessment of Potential Effects

13.9.18. Radar line of sight modelling has confirmed that the Brizlee Wood air defence radar will have line of sight to all six turbines in the Proposed Development. This may result in unwanted returns on the radar display and/or reduction in the radar's ability to detect and track real aircraft targets in the airspace over the Proposed Development. The significance of this effect is assessed as **moderate** and therefore **significant**.

13.9.19. The deployment location for threat emitter equipment at Charterhall airfield has been subject to variation over time. At some locations used, the line of sight to the turbines in the Proposed Development would be constrained by buildings on the north side of the airfield. Using worst case analysis, all six turbines will be within line of sight of threat emitter equipment deployed at Charterhall airfield. The MoD has stated that this can result in threat emitter equipment losing

target lock on aircraft that it is tracking, resulting in a loss of threat realism and training value for the aircrew.

13.9.20. An analysis of the potential impact of the Proposed Development on the Charterhall remote threat radar site has been conducted by Aviatica. The study assessed:

- the radar line of sight from threat emitter equipment to the Lees Hill wind turbines;
- MoD responses to other wind turbine developments in the vicinity of Charterhall;
- other examples of threat emitter sites with wind turbines within line of sight; and
- trials evidence on the effects of wind turbines on threat emitter equipment.

13.9.21. The study concluded that:

- the MoD did not object to 13 previous wind turbine applications within line of sight of the Charterhall threat radar site;
- previous UK government planning decisions have concluded that wind farms do not have an unacceptable impact on threat radar systems;
- seven other threat radar sites with line of sight to 14 different wind farms have continued to provide effective electronic warfare training; and
- trials evidence indicates that wind farms located in areas where ground clutter already occurs do not generate significant additional adverse effects on threat emitter equipment.

13.9.22. The study was submitted to the MoD for comment in October 2022. A response is awaited. In view of the conclusions of the Aviatica report the significance of the potential effects of the Proposed Development on threat emitter equipment deployed at Charterhall airfield is assessed as **minor** and therefore **not significant**.

13.9.23. The Proposed Development is not located in an area where the flight paths of low flying aircraft are constrained by terrain or other features requiring horizontal or vertical avoidance. The significance of any effects on military low flying is assessed as **minor** and therefore **not significant**.

Cumulative Effects

13.9.24. Assessment of the cumulative effects of the Proposed Development on the MoD Brizlee Wood air defence radar has taken account of other operational and consented wind farms within 20km radius of the Proposed Development Site that are also within line of sight of the Brizlee Wood radar. This includes the following developments:

- Black Hill;
- Fallago Rig;
- Crystal Rig 1, 2, 3 and 4;
- Aikengall, AIkengall 2 and Aikengall 2A.

13.9.25. With the exception of Black Hill, which was consented in 2001, before the MoD began requiring mitigation of wind farm effects on air defence radar, all of these developments have been consented on the basis of an approved Air Defence Mitigation Scheme, consisting of the application of a Non-Auto Initiation Zone (NAIZ) in the TPS-77 radar's coverage over the wind farm. It is understood that a NAIZ has also been applied retrospectively over the Black Hill wind farm. The effects of the existing and consented wind farms in the area have, therefore, been mitigated to a level acceptable to the MoD. The MoD has been content to apply successive NAIZs over wind farms in relatively close proximity to each other in this part of the Scottish Borders. There is no indication from the history of MoD assessments that the cumulative effects of the existing mitigated wind farms with the Proposed Development without mitigation would have a significance greater than that of the stand-alone Proposed Development, i.e. **moderate** and therefore **significant**.

13.9.26. The MoD has given 'no objection' responses to 13 previous applications for wind turbines that would have been within line of sight of threat emitter equipment deployed to Charterhall airfield. These applications, if all had been consented, would have resulted in the erection of 67 turbines within line of sight of threat emitter equipment at Charterhall. However only 16 have been built. On the assumption that the MoD was content for up to 67 turbines to operate within line of sight of Charterhall, the Proposed Development, which would increase the number of radar-visible turbines from 16 to 22, is assessed as having a cumulative effect of **minor** significance i.e. **not significant**.

13.9.27. The only other wind farm within 10 km of the Proposed Development is Black Hill. The cumulative effects of the Proposed Development with Black Hill would not significantly constrain the flight paths of low flying aircraft. The significance of the cumulative effects of the Proposed Development on military low flying is therefore assessed as **minor** and therefore **not significant**.

Mitigation and Residual Effects

13.9.28. The Applicant will commission a radar mitigation feasibility assessment from Serco, who manage air defence radars on behalf of the MoD. This will determine whether the standard mitigation technique for the effects of onshore wind farms on air defence radars, a NAIZ over the wind farm area, will be feasible. If confirmed, this will be submitted to the MoD for approval. The approved mitigation will then be the subject of a condition on the planning consent. Following implementation of the mitigation the residual effects on the Brizlee Wood will be **minor** and therefore **not significant**.

13.9.29. No significant effects on threat emitter equipment at Charterhall are predicted. Therefore, no mitigation is required and the residual effects will be **minor** and therefore **not significant**.

13.9.30. Any effects on military low flying will be mitigated by provision of details to the MoD prior to construction to ensure that the development is marked on aeronautical charts, and by provision of lighting on the turbines. The residual effects on low flying military aircraft will be **negligible** and therefore **not significant**.

13.9.31. Since the turbines in the Proposed Development will be 150m or more above ground level they are subject to the mandatory lighting requirements of Article 222 of the ANO. An application has been made to the CAA for approval of a lighting scheme in which three of the six turbines would be fitted with 2000 candela lights on the nacelle, with no lights on the turbine towers. This was approved by the CAA in December 2023 (see Technical Appendix 13.3, Volume 4).

Conclusions

13.9.32. The Proposed Development will have a moderate (significant) effect on the Brizlee Wood air defence radar. Following implementation of the standard means of mitigation (NAIZ) on the radar, the residual effect will be reduced to minor and therefore not significant.

13.9.33. The Proposed Development will have no significant effects on MoD threat emitter equipment deployed to Charterhall airfield.

13.9.34. The Proposed Development will have no significant effects on military low flying.

13.9.35. There are no other effects on aviation. Overall, it is concluded that, after implementation of appropriate mitigation, the Proposed Development will have no significant effects on aviation.

13.10. Statement of Competence

13.10.1. The 'Other Considerations' section of this chapter has been prepared by Natural Power. As a company, Natural Power has provided independent, expert advice to the renewable energy industry for over 3,500 projects since 1995.

13.10.2. The company comprises a team of experts to provide unrivalled renewable energy expertise and services with experience at every phase of the project lifecycle. In addition, the company is accredited by the Institute of Environmental Management and Assessment (IEMA) as well as many staff being IEMA members and holding qualifications at various levels.

13.10.3. The company offers expertise in multiple fields including project management, planning permitting and environment and due diligence amongst others.

13.10.4. The aviation section of this chapter has been compiled by Aviatica, a specialist aviation consultancy with 27 years' experience of assessing the impacts of wind energy developments on aviation. This has included the preparation of more than 100 Environmental Impact Assessment (EIA) chapters for projects across the UK and assessment of more than 50 wind farm developments in the south of Scotland.