



Chapter 12: Aviation, Radar and Defence

Mid Hill Wind Farm

Invenergy Development UK Ltd

Prepared by:

WPAC

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Basis of Report

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Acronyms and Abbreviations

ADSB	Automatic Dependent Surveillance Broadcast
AGL	Above Ground Level (Height)
ANO	Air Navigation Order
AMSL	Above Mean Sea Level (Elevation)
APDO	Approved Procedure Design Organisation
ATC	Air Traffic Control
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication (Refers to Specific Documents)
CNS	Communications, Navigation and Surveillance
DIO	Defence Infrastructure Organisation
EWG	Eskdalemuir Working Group
HAL	Highlands and Islands Airports Ltd
HNTA	Helicopter Night Training Area
IFP	Instrument Flight Procedure
IR	Infra-Red
Kts	Knots: a measure of airspeed (10 kts = 12mph = 19 kph)
LED	Light Emitting Diode
MOD	Ministry of Defence
NATS	National Air Traffic Services Ltd
NERL	NATS En Route Ltd
Nm	Nautical Mile
NVD	Night Vision Devices - Aircraft Mounted
NVG	Night Vision Goggles - Operator Worn
Rad Alt	An altimeter that uses radar to accurately measure height above ground
PSR	Primary Surveillance Radar
QFE	Setting on Altimeter that gives Height above Airfield or datum
RoAR	Rules of the Air Regulations
Rule 5	The Low Flying Rule – part of RoAR
Rule 28	VFR Rules Outside Controlled Airspace – part of the RoAR
SIL	Seismic Impact Limit
SSR	Secondary Surveillance Radar
VFR	Visual Flight Rules (Flight without ATC on a see-and-be-seen basis)
VMC	Visual Meteorological Conditions (Weather suitable for VFR flight)
WPAC	Wind Power Aviation Consultants



12.0 Aviation, Radar and Defence

12.1 Introduction

- 12.1.1.1 This chapter of the EIA Report presents the findings of the assessment of effects of the Proposed Development in relation to aviation, radar and defence issues. The assessment considers potential effects on the aviation and air defence activities of the Ministry of Defence (MOD) as safeguarded by the Defence Infrastructure Organisation (DIO). It also considers the possible effects of wind turbines upon the National Air Traffic Services En Route Ltd (NERL) communications, navigation and surveillance (CNS) systems which consist of a network of primary and secondary radars and navigation facilities around the country. The chapter also considers the possible effects on airport radars and other aviation stakeholder interests. Finally, the impact of the Proposed Development on the Eskdalemuir Seismic Array and presents potential mitigation options.
- 12.1.1.2 As well as examining the technical impact of wind turbines on Air Traffic Control (ATC) facilities, it is also necessary to consider the physical safeguarding of ATC operations to determine whether the Proposed Development will breach obstacle clearance criteria.
- 12.1.1.3 This assessment should be read in conjunction with the following technical appendices set out in **Volume 4** of the EIA Report:
- **Technical Appendix 12.1: Aviation Lighting and Mitigation,**
 - **Technical Appendix 12.2: Xi Engineering Mid Hill Wind Farm, Eskdalemuir Seismic Array Considerations Seismic Budget, SIL Analysis & Queue Scenarios.**
 - **Technical Appendix 12.3: Mid Hill Mitigation and Curtailment Report**
- 12.1.1.4 Wind turbines have the potential to affect civil and military aviation. This chapter presents the methodology used to undertake the aviation safeguarding assessment, lists the aviation references used and describes the aviation baseline condition, consultation requirements, identified potential impacts, and mitigations to be applied, if required.
- 12.1.1.5 The Aviation Chapter has been written by Cdr John Taylor RN (Ret) of Wind Power Aviation Consultants Ltd (WPAC). John has over 35 years of experience as an Air Traffic Controller, Fighter Controller and Aviation Regulator and was head of Air Traffic Control for the Royal Navy. His responsibilities included responding to wind farm consultations on and offshore. Since 2008, WPAC has provided advice on the interaction between wind turbines and aviation, including assessing over 3,000 wind turbine proposals and has given evidence at over 20 Public Inquiries and appeals in England and Scotland. John has also advised a number of Local Authorities on aviation related issues. WPAC has expertise in a number of areas including radar propagation and modelling, general aviation operations, turbine induced turbulence, aviation lighting and low flying operations.
- ### 12.1.2 Legislation, Policy and Guidance
- 12.1.2.1 There are a number of aviation publications relevant to the interaction of wind turbines and aviation containing guidance and legislation which cover the complete spectrum of aviation activity in the UK, as listed below:



- Civil Aviation Authority (2020). Safeguarding of Aerodromes, Version 3, CAP738 CAA;
- Civil Aviation Authority (2010). Safe Operating Practices at Unlicensed Aerodromes, Ed 1, CAP 793 CAA;
- Civil Aviation Authority (2016) Policy and Guidance on Wind Turbines Version 6, CAP764 CAA;
- Civil Aviation Authority (2017). CAA Policy Statement: Lighting of Onshore Wind Turbine Generators in the United Kingdom with a maximum blade tip height at or in excess of 150 m Above Ground Level CAA;
- Civil Aviation Authority (2023). Manual of Air Traffic Services, Part 1, Ed 11.0, CAP 493 CAA;
- Civil Aviation Authority (2021). UK Flight Information Services, Ed 4, CAP 774 CAA;
- Civil Aviation Authority (2019). ATS Safety Requirements, Version 3, CAP 670 CAA;
- Civil Aviation Authority (2022). Licensing of Aerodromes, Version 12, CAP 168 CAA;
- Civil Aviation Authority (2020). Parachuting, Ed 5, CAP660 CAA;
- Civil Aviation Authority (2022). Implementation of Safeguarding of Instrument Flight Procedures (IFPs) in the UK, Ed 2, Version 2, CAP 785B CAA;
- Civil Aviation Authority (2021) 'Guidance to crane users on aviation lighting and notification' CAP 1096 CAA: and
- Ministry of Defence (MoD) (2022). Military Aviation Authority Regulatory Article 2330 (Low Flying).

12.1.2.2 The above noted publications have also been considered in the aviation lighting assessment.

12.1.3 Consultation and Engagement

12.1.3.1 A scoping exercise was undertaken in August 2024 to establish the scope of the EIA including the methodology and approach to the aviation, radar and defence assessment to be followed. The Scoping Report¹ records the findings of the scoping exercise and details the technical guidance, standards, best practice and criteria being applied in the assessment to identify and evaluate the likely significant effects of the Proposed Development on landscape and visual aspects. A Scoping Opinion¹ was adopted by the Scottish Ministers on 27 November 2024. Further consultation relevant to the aviation assessment was undertaken with the relevant aviation consultees including NATS and the MOD based upon the final turbine layout for the Proposed Development.

12.1.3.2 Consultation to inform this chapter, including a summary of comments raised in the formal Scoping Opinion, and other pre-application engagement, are summarised in **Table 12-1** alongside a summary of how the Applicant's assessment responded to this feedback.

¹ The EIA Scoping Report and Scoping Opinion can be accessed on the ECU website: <https://www.energyconsents.scot/ApplicationDetails.aspx?cr=ECU00005192&T=9>



12.1.3.3 **Technical Appendix 4.1: Scoping & Post-Scoping Consultation** provides a summary of how topics raised in the Scoping Opinion by the Scottish Ministers and consultees have been addressed in the EIA Report, including where the scope of the EIA has been modified.

Table 12-1: Consultation Summary Table

Consultee	Summary of Response	How comments have been addressed in this chapter
Scoping Report 2024		
MOD DIO	MOD responded to the 42 turbine proposal listing four concerns, Eskdalemuir Seismic Array, RAF Spadeadam Deadwater Fell ATC radar, Spadeadam Threat Radar and Physical Obstruction.	Eskdalemuir is a non-aviation issue discussed later in this chapter. RAF Spadeadam Deadwater Fell radar - the MOD have been reconsulted in relation to the new reduced scheme and radar modelling is reported later in this chapter. Threat Radar – the effect of the 13 turbine layout on threat radar is assessed in this chapter Physical Obstruction – this issue is addressed in Technical Appendix 12.1: Aviation Lighting and Mitigation.
NATS En Route Ltd (NERL)	NATS Safeguarding responded to the 42 turbine proposal objecting to the proposal on the grounds of unacceptable effects on the Lowther Hill Radar	Radar modelling of the 13 turbine layout has been undertaken and reported later in this chapter.
Borthwickwater Valley Landscape Conservation Group	When addressing the Eskdalemuir Array the EIA should fully take account of the headroom budget and, in the event that it is identified that there is no further room within the headroom budget, the Application should be immediately cancelled or withdrawn, to avoid unnecessary distress to the local residents.	Consideration of the Eskdalemuir Seismic Array is set out Section 12.4 and mitigation is identified in Section 12.5 .
Pre-Application Engagement		
MOD DIO	The MOD have been re-consulted in relation to the 13 turbine layout.	Radar modelling has been undertaken and reported in this chapter. All of the turbines will be visible to the Deadwater Fell radar. The MOD have yet to respond to the 13 turbine layout.
NERL	NERL have been re-consulted in relation to the 13 turbine layout.	Radar modelling of the new layout is reported later in this chapter



12.2 Assessment Approach, Methodology and Significance Criteria

12.2.1 Scope of Assessment

12.2.1.1 The assessment of effects of the proposed turbines is based upon the guidance outlined in CAP 764. Consultation criteria for aviation stakeholders are defined in Chapter 4 of CAP764. The following distances inform the size of the study area and have been adopted in undertaking this assessment which comprise:

- airfield with a surveillance radar – 30 km;
- non radar licensed aerodrome with a runway of more than 1,100 metres – 17 km;
- non radar licensed aerodrome with a runway of less than 1,100 metres – 5 km;
- licensed aerodromes where the turbines would lie within airspace coincidental with any published Instrument Flight Procedure (IFP);
- unlicensed aerodromes with runways of more than 800 metres – 4 km;
- unlicensed aerodromes with runways of less than 800 metres – 3 km;
- gliding sites – 10 km; and
- other aviation activity such as parachute sites and microlight sites within 3 km – in such instances developers are referred to appropriate organisations.

12.2.1.2 CAP 764 further states that these distances are for guidance purposes only and do not represent ranges beyond which all wind turbine developments will be approved, or within which they will always be objected to. These ranges are intended as a prompt for further discussion between developers and aviation stakeholders; which are reported upon in this chapter. For example, Glasgow Prestwick Airport have stated a requirement to be consulted in relation to wind farms out to the maximum range of their radars and Instrument Flight Procedures.

12.2.1.3 The assessment is desk based, drawing largely from published guidance and data.

12.2.1.4 It is necessary to take into account the aviation and air defence activities of the Ministry of Defence (MOD) as safeguarded by the Defence Infrastructure Organisation (DIO).

12.2.1.5 It is also necessary to take into account the possible effects of wind turbines upon the National Air Traffic Services En Route Ltd (NERL) communications, navigation and surveillance (CNS) systems – a network of primary and secondary radars and navigation facilities around the country.

12.2.1.6 In addition to examining the technical impact of wind turbines on Air Traffic Control (ATC) facilities, it is also necessary to consider the physical safeguarding of ATC operations, using the criteria laid down in CAP 168 Licensing of Aerodromes, to determine whether a proposed development will breach obstacle clearance criteria. In this case, there are no physical safeguarding issues associated with the Proposed Development.



12.2.2 Assessment Methodology

Radar Modelling Methodology

- 12.2.2.1 The radar calculation results referred to in this chapter were produced using specialist propagation prediction software (RView Version 5). Developed over a number of years by WPAC it has been designed and refined specifically for the task. RView is used to identify potential aviation effects of the Proposed Development. The results are then used as a basis for consultation and liaison with relevant aviation bodies, as detailed below. RView models terrain using the Ordnance Survey (OS) Terrain 50 digital terrain model, which has a post spacing of 50 m and has a root mean square (RMS) error of 4 m. The results are verified using the Shuttle Radar Topography Mission (SRTM) dataset, a separate smoothed digital terrain model with data spacing of 3 arc seconds. By using two separate and independently generated digital terrain models, anomalies are identified and consistent results assured. Rview models the refractive effects of the atmosphere on radio waves and the First Fresnel Zone. A feature of RView is that as well as performing calculations in the manner believed to be most appropriate, it also allows comparison with results from simpler models. For example, RView can perform calculations using the true Earth Radius at the midpoint between the radar and the wind turbine or the simplified 4/3 Earth Radius model. If needed, Rview is also capable of modelling a range of atmospheric refractive conditions. RView models the trajectory of radar signals at different elevations allowing modelling of both volume surveillance and pencil beam radars as well as the effects of angular sterilisation as applied, for example, in Met Office radars.

Assessing Significance

- 12.2.2.2 There is no agreed or mandated definition of significance when assessing development proposals for wind farms in relation to aviation. Whilst technical effects on communications, navigation and surveillance (CNS) systems are simple to identify and evaluate, operational and flight safety effects can be subjective and are often challenged by third parties. It is sufficient in this context to identify any technical effects and then, taking into account the statements in CAP 764 regarding the status of aviation stakeholders, in general to accept the judgement of those stakeholders in assessing the significance of the effects. For example CAP 764 states:

“Where an ANSP determines that it is likely that a planned wind turbine development would result in any of the above effects on their CNS infrastructure, this may not, in itself, be sufficient reason to justify grounds for rejection of the planning application. The ANSP must determine whether the effect on the CNS infrastructure has a negative impact on the provision of the ATS. The developer should pay for an assessment of appropriate mitigating actions that could be taken by the ANSP and/or wind energy developer to deal with the negative impact. The position of an ANSP at inquiry would be significantly degraded if they had not considered all potentially appropriate mitigations.”

- 12.2.2.3 Therefore, it is not considered to be appropriate for the Applicant to make an assessment of the significance of an effect in relation to aviation interests. Also, it is often the case that different Air Navigation Service Providers (ANSP) take a different view of the same scenario and may disagree with the assessment findings; this can require further post submission consultation, to confirm the findings of the assessment and/or agree to the need for and extent of mitigation. Therefore, this assessment does not make a judgement of significance but is



focussed on identifying potential impacts and agreeing mitigation with aviation stakeholders as required.

12.3 Baseline Conditions

12.3.1 Current Baseline

- 12.3.1.1 The Proposed Development is located in an area that is very remote from any significant aviation facilities; over 70 km to the south of Edinburgh Airport, 100 km to the east of Glasgow Prestwick Airport and 70 km to the north-west of Newcastle Airport. It is located within Class G unregulated airspace which extends upwards to Flight Level (FL) 115 (approximately 11,500ft) above which is Class A Controlled Airspace designated as the Borders Control Area (CTA) used to funnel aircraft into the Scottish Terminal Area (TMA) to the north.
- 12.3.1.2 In military terms the Proposed Development is over 11 km to the north of the RAF Spadeadam Danger Area designated D510A&B and 23 km to the north-west of the range control radar at Deadwater Fell.

12.4 Assessment of Effects

12.4.1 Construction

- 12.4.1.1 There are no technical effects on aviation interests during construction. The only aviation issues are those associated with the operation of large cranes which will be the subject of standard conditions for crane operations as laid down in CAA CAP1096 'Guidance to crane users on aviation lighting and notification'.

12.4.2 Operation

- 12.4.2.1 The turbine layout of the Proposed Development has changed significantly since Scoping and now consists of 13 turbines as compared with the 42 turbines considered and responded to by aviation stakeholders through scoping. Initial consultation was completed for a much larger development, and it is, therefore, essential to reassess what the effect of the Proposed Development will be on aviation and defence. The following section assesses the effect on both radar and non-radar facilities, in accordance with the guidance in CAP 764.

12.4.3 Radar Equipped CAA Licensed Aerodromes

- 12.4.3.1 None of the turbines in the Proposed Development are within or even close to consultation distance for any licensed aerodromes. Radar modelling also confirms that none of the radars at Glasgow Prestwick Airport, Edinburgh Airport or Newcastle Airport will be affected.

12.4.4 Non-Radar Equipped CAA Licensed Aerodromes

- 12.4.4.1 None within or even close to consultation distance.

12.4.5 Unlicensed Aerodromes, Gliding and Micro-light Sites

- 12.4.5.1 None within or even close to consultation distance.

12.4.6 NATS En Route (NERL) Communications, Navigation and Surveillance (CNS) Systems

- 12.4.6.1 There are two radars with low level coverage in this location, Lowther Hill and Great Dun Fell. NATS were consulted about the original 42 turbine scheme and



objected based upon the potential effect of the turbines on the Lowther Hill radar. Radar modelling has been conducted in relation to the 13 turbine layout and the results are shown in **Table 12-2**. Where the radar line of sight figure exceeds 200 m, the turbines are screened from the radar by terrain and where the figure is less than 200 m, it shows that the turbines have the potential to be visible to the radar and create unwanted radar clutter or other obscuration effects.

Table 12-2: NATS Lowther Hill Radar Line of Sight Results

Turbine	Distance (km)	Radar line of sight (m AGL)
1	52.264	212.6
2	51.992	277.2
3	52.621	259
4	52.907	209.5
5	51.754	342.9
6	52.229	378.1
7	52.296	359.7
8	52.59	359.6
9	53.158	368.9
10	53.54	369.8
11	52.863	335.6
12	53.442	373.5
13	53.831	356.2

- 12.4.6.2 The results of the radar modelling show that all the turbines are screened by terrain from the Lowther Hill radar. NATS have been reconsulted to confirm the results but there should be no effect on the performance of the Lowther Hill radar and mitigation should not be required.
- 12.4.6.3 Radar modelling has also been undertaken against the Great Dun Fell radar with the results presented in **Table 12-3**. These results also confirm that the turbines will be screened by terrain and have no effect on the radar.
- 12.4.6.4 The Applicant has re-consulted with NATS to confirm the results and to confirm that mitigation will not now be required.

Table 12-3: NATS Great Dun Fell Radar Line of Sight Results

Turbine	Distance (km)	Radar line of sight (m AGL)
1	82.013	264.2
2	82.743	266.7
3	82.391	311.3
4	81.994	320.5
5	83.307	240.6
6	83.643	324.8
7	83.246	281.4
8	82.895	306.2



Turbine	Distance (km)	Radar line of sight (m AGL)
9	82.823	337.8
10	82.517	351.3
11	83.426	314.6
12	83.296	330.1
13	82.994	274.7

12.4.7 Ministry of Defence ATC radars

12.4.7.1 The closest military ATC radar is the Deadwater Fell Thales Star 2000NG used for range safety at RAF Spadeadam. Radar modelling has been undertaken with the results presented in **Table 12-4**.

Table 12-4: RAF Spadeadam / Deadwater Fell Radar Line of Sight Results

Turbine	Distance (km)	Radar line of sight (m AGL)
1	24.177	107.8
2	24.728	90.9
3	24.116	93
4	23.718	109.8
5	25.181	41.9
6	25.049	64.1
7	24.787	46.1
8	24.401	73.1
9	23.987	44
10	23.566	62.8
11	24.517	7.5
12	24.073	38.6
13	23.65	51.6

12.4.7.2 The results of the modelling show that every turbine will be visible to the radar and create a potential area of clutter and obscuration in this location. The MOD were consulted at scoping and listed the effect of the 42 turbine scheme as being unacceptable. They have been reconsulted in relation to the final 13 turbine scheme, however, if they maintain their objection, it will be necessary to consider a radar mitigation scheme.

12.4.7.3 It will not be possible to identify the specific mitigation to be used until the wind farm radar mitigation trials due to take place on an identical radar at RAF Lossiemouth have been undertaken. It is understood that these trials will not take place until 2026, however, there are a number of potential mitigation options that will be considered including use of the 'Windfarm Filter' already installed in the radar, blanking the clutter on the Deadwater Fell radar and infilling with the unaffected Berryhill radar also located at Spadeadam, or the installation of a new wind farm mitigation radar such as a Terma Scanter 4002. The Applicant will continue to engage with the MOD on this issue.

12.4.7.4 The MOD also listed the Great Dun Fell radar as being an issue of concern as RAF Spadeadam has access to data from this radar. As already shown in the



previous section, the finalised turbine layout will not be visible to the Great Dun Fell radar and NATS have not listed it as an issue of concern.

12.4.8 Ministry of Defence Threat Radars

12.4.8.1 In their response to scoping, the MOD also listed as an issue of concern the effect of the Proposed Development on the performance of unspecified threat radar locations. Threat radars are training aids used to train aircrew flying through the range to operate in a hostile environment. The MOD maintain 20 such sites throughout the Borders region and regularly deploy different systems to different sites. In this case, radar modelling has identified that the Proposed Development is likely to be visible to just one such location, at Wigg Knowe. All the turbines will be in radar line of sight as shown in **Table 12-5** but that at a distance of approximately 16 km, will be beyond the range of a number of the surface to air threats being simulated and to the west of the radar site. It is unlikely that aircraft being illuminated would be approaching from this direction so that there would be either an extremely limited loss of training or none at all, however, this is an issue again subject to discussion with the MOD.

Table 12-5: RAF Spadeadam Wigg Knowe Threat Radar Location Radar Line of Sight Results

Turbine	Distance (km)	Radar line of sight (m AGL)
1	16.985	25.5
2	17.42	0
3	16.782	0
4	16.424	0
5	17.797	0
6	17.531	34.9
7	17.332	0.4
8	16.969	41.5
9	16.481	0
10	16.06	0
11	16.944	9.3
12	16.437	9.5
13	16.01	0

12.4.9 Ministry of Defence Physical Obstruction

12.4.9.1 The MOD requested that if the other issues can be overcome, they would require MOD and CAA standard aviation lighting. This is addressed in **Technical Appendix 12.1: Aviation Lighting and Mitigation**.

12.4.10 Eskdalemuir Seismological Recording Station

12.4.10.1 The final MOD objection from the Scoping Report is in relation to Eskdalemuir. It is the case that the Proposed Development is within the 50 km safeguarded zone within which a maximum 'noise budget' has been imposed by the MOD. In their response, the MOD stated that *'at this time there is no seismic noise capacity*



- available*'. The Applicant continues to engage on this issue which affects a number of other wind farm developments in the Scottish Borders.
- 12.4.10.2 Industry funded work is currently underway (coordinated through the Scottish Government's Eskdalemuir Working Group (EWG), which is closely aligned with the Onshore Wind Taskforce) to more accurately quantify and assess the impact of wind turbine ground vibration on the performance of the array, and to develop a Seismic Impact Limit (SIL) based on available seismic budget (the cumulative seismic noise limit all wind farms in the Eskdalemuir Consultation Zone cannot exceed), currently set at 0.336 nm.
- 12.4.10.3 This work is now reflected in the UK Government's Onshore Wind Strategy which has two commitments in relation to Eskdalemuir, under Action 30 and Action 31:
- *"We will work with MoD and Scottish Government to implement an enduring solution to both unlock onshore wind capacity around Eskdalemuir Seismic Array and uphold necessary safeguarding.*
 - *We will work with MoD and Scottish Government to identify and implement an appropriate route to enforce the updated approach to Eskdalemuir Seismic Array".*
- 12.4.10.4 The Proposed Development is located between 15.1 km and 17.2 km from the Eskdalemuir Seismic Array. This places the Site outside both the existing 10 km exclusion zone and the proposed 15 km no-build zone, meaning it remains eligible for development under current and emerging planning policy. However, its proximity to the array places it within the SIL consultation zone, where additional safeguarding requirements apply to limit seismic ground vibrations (see **Section 12.5**).
- 12.4.10.5 It is anticipated that the issue may therefore become the subject of a suitably worded planning condition.

12.4.11 Decommissioning

- 12.4.11.1 There are no technical effects on aviation interests during decommissioning. The only aviation issues are those associated with the operation of large cranes which will be the subject of standard conditions for crane operations as laid down in CAA CAP1096 'Guidance to crane users on aviation lighting and notification.'

12.5 Additional Mitigation

12.5.1 Aviation Lighting

- 12.5.1.1 Wind turbines with a tip height in excess of 150 m are required to be illuminated with medium-intensity red aviation obstruction lights installed on the turbine hub in accordance with the Civil Aviation Authority Policy Statement: 'Lighting of Onshore Wind Turbine Generators in the United Kingdom with a maximum blade tip height at or in excess of 150 m Above Ground Level'. The Applicant provided a reduced lighting scheme (4 turbines (T1, T5, T6 and T13) to be lit at nacelles only) that fulfils the requirements for flight safety whilst minimising environmental (visual) effects and gained approval from the CAA for the design (see **Technical Appendix 12.1: Aviation Lighting Scheme** for details of the proposed mitigation).
- 12.5.1.2 This sets out the arrangement of the aviation lights, together with an assessment of the intensity of the visible lights at selected viewpoints assessed in the LVIA (see **Chapter 5: Landscape and Visual Impact Assessment**) and provides an



estimate of the percentage of time that the lights will be at full power and at 10% intensity based on historical Met Office records of visibility and cloudbase in the region. As noted above, each turbine will be fitted with MOD specification IR lighting to mitigate effects on military low flying. The implementation of the proposed lighting scheme (both visible and IR) will be subject to a suspensive planning condition to the consent if granted.

12.5.2 Eskdalemuir Mitigation

- 12.5.2.1 The UK Onshore Wind Taskforce has formally recommended that SIL frameworks be adopted to unlock constrained development potential in the Eskdalemuir region. Within the industry and EWG, 2.0 GW is the working SIL deployment scenario, forming the baseline for queue planning and turbine selection, although alternative scenarios (1 GW and 2.5 GW) are also under consideration.
- 12.5.2.2 This reflects broader industry consensus: turbine size and vibrational profile are critical factors in seismic compliance. As the Scottish Government and MOD endorse the use of before-and-after seismic monitoring, developers are now able to subtract background seismic noise from turbine measurements, a key policy shift that makes compliance more achievable for sites like the Proposed Development.
- 12.5.2.3 The Applicant has commissioned a study from Xi Engineering which examined a range of turbine sizes and power ratings (see **Technical Appendix 12.2: Xi Engineering Mid Hill Wind Farm, Eskdalemuir Seismic Array Considerations Seismic Budget, SIL Analysis & Queue Scenarios**). The study concluded that the Proposed Development's cumulative vibration contribution remains within the overall 0.336 nm MOD budget across all 2.0 GW and 2.5 GW SIL queue scenarios. However, due to the Proposed Development's proximity to the array, all turbine types/sizes considered in the study would require some form of technical mitigation/curtailment to meet the SIL thresholds in most scenarios — particularly at lower deployment capacities (e.g. 1.0 GW).
- 12.5.2.4 An additional report was also commissioned to examine potential mitigation options (see **Technical Appendix 12.3: Mid Hill Mitigation and Curtailment Report**). The potential mitigation options identified include:
- foundation Isolation;
 - tuned Mass Dampers; and
 - curtailment at certain wind speeds.
- 12.5.2.5 The mitigation solution(s) required would be based on further studies once the precise model of turbine has been procured.
- 12.5.2.6 Additionally, some wind farm developers are looking at other forms of mitigation for the array, such as boreholes to bury the monitoring equipment.

12.5.3 Conclusion

- 12.5.3.1 The aviation and radar assessment for the Mid Hill Wind Farm has identified three key areas of concern raised by the Ministry of Defence (MOD): visibility of turbines to the RAF Spadeadam radar, potential interference with one of the MOD's training threat radars, and the impact on the Eskdalemuir Seismic Array. The reduction in turbine numbers from 42 to 13 has significantly lowered the potential for interference, particularly with radar systems. Radar modelling confirms that the turbines are screened from key civil aviation radars, and no impacts are expected on licensed aerodromes or NATS radar systems.



- 12.5.3.2 While the RAF radar at Deadwater Fell will detect all turbines, technical mitigation options are available and will be explored further, especially following radar trials planned for 2026. The impact on the MOD's threat radar is expected to be minimal due to the location and distance of the turbines. Regarding Eskdalemuir, industry-led work is progressing to update vibration limits and improve compliance frameworks. The Proposed Development is expected to meet these requirements, although some technical adjustments may be necessary.
- 12.5.3.3 Overall, the remaining concerns are being actively addressed through consultation and technical studies. With appropriate mitigation and planning conditions, it is anticipated that the Proposed Development can proceed without significant adverse effects on aviation, radar or defence interests.

12.6 References

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