

12. Aviation Safeguarding

12.1 Introduction

- 12.1.1 The chapter takes into account the guidance contained within Civil Aviation Publication (CAP) 764 (2016) and identifies and assesses the potential effects that the Proposed Development may have on aviation communications, navigation and surveillance (CNS) infrastructure in the vicinity of the Development Site, and if required, the mitigation measures to be implemented to prevent, reduce or offset any potential adverse effects.
- 12.1.2 Wind turbines have the potential to affect aviation and the possible effects of wind turbines on aviation operations are well understood. There are two main scenarios in this instance that may lead to objection from aviation stakeholders:
- wind turbines can present a physical obstruction at, or close to, an aerodrome or other aviation activities such as military and civil low flying operations; and
 - impacts on aviation CNS systems and the provision of a radar-based Air Traffic Service (ATS). Wind turbine derived radar clutter (unwanted radar returns) appearing on radar displays can affect the air traffic controller's ability to differentiate between aircraft and those radar returns resulting from the detection of wind turbines. Furthermore, the appearance of multiple false targets in close proximity can generate false aircraft tracks and seduce those returns from real aircraft away from the true aircraft position.
- 12.1.3 The main concern is any potential effect on the safety of aviation and, if unmitigated, that these effects persist for the operational lifetime of the wind farm and/or the CNS infrastructure.
- 12.1.4 The assessment considers whether the Proposed Development is likely to have any significant effect on the following:
- civil aviation interests, including "En Route" facilities managed and operated by NATS (formerly known as National Air Traffic Services), airports, licensed and unlicensed aerodromes, light aircraft landing strips, microlight sites, parachute and gliding sites; and
 - military facilities including Ministry of Defence (MOD) Airfields and military Air Traffic Control (ATC) facilities, Air Defence Radars, Danger Areas and Ranges and low flying operations.

12.2 Legislation, Planning Policy and Guidance

- 12.2.1 All national and development plan policies and other considerations of relevance to the Proposed Development are outlined in the Planning Statement.
- 12.2.2 Of specific relevance to the technical assessments provided in this chapter, the Scottish National Planning Framework (NPF4, 2023) notes that considerations in the determination of

applications for energy infrastructure developments are likely to include “*impacts on aviation and defence interests....*” (Policy 11, paragraph e.(iv)).

12.2.3 The Scottish Government’s advice regarding onshore wind turbines includes guidance regarding potential impacts on aviation safeguarding and the need for civil and military aviation stakeholders to be consulted regarding proposed wind energy developments.

12.2.4 This assessment takes into account the additional aviation consultation, regulatory, safeguarding and operational requirements as laid down in a number of publications and regulations including:

- Civil Aviation Publication (CAP) 670 Air Traffic Services Safety Requirements;
- CAP 393 The Air Navigation Order 2016 and Regulation;
- CAP 168 Licensing of Aerodromes;
- CAP 670 ATS Safety Requirements;
- CAP 774 UK Flight Information Services;
- CAP 738 Safeguarding of Aerodromes;
- CAP 793 Safe Operating Practices at Unlicensed Aerodromes;
- CAP 493 Manual of Air Traffic Services Part 1;
- CAP 1096 Guidance to Crane Users on aviation lighting and notification;
- Military Aviation Authority Traffic Management (3000 series) Regulatory Articles;
- Military Aviation Authority Regulatory Article 2330 (Low Flying);
- UK Military Aeronautical Information Publication (MIL AIP);
- UK Aeronautical Information Publications (AIP); and,
- NATS 1:250,000 and 1:500,000 VFR Charts.

12.3 Consultation

12.3.1 WFAS completed a desk top study and radar modelling assessment on an initial proposal (Scoping Layout) for 23 wind turbines at a blade tip height of 220.0 m above ground level (agl) and have since repeated that assessment and modelling to reflect the submitted layout.

12.3.2 The key issues which arose during the 2024 Scoping Opinion and subsequent consultation with stakeholders on the submitted Proposed Development are provided in **Table 12.1**.

Table 12.1 Consultee Responses

Consultee	Summary of Key Issues
NATS	NATS responded to the original layout, number of turbines and higher tip height in Sept 2024 stating that had no safeguarding objection to the proposal.
MOD	Defence Infrastructure Organisation (DIO) responded to the original layout highlighting their concerns with the Proposed Development. The

Consultee	Summary of Key Issues
	principal safeguarding concerns of the MOD were in relation to the turbines representing a physical obstruction to aircraft, especially as the Proposed Development would lie, partially, within the Tactical Training Area (TTA 14T). To address the impact up on low flying given the location and scale of the development, the MOD stated that they would require that Planning Conditions are added to any consent issued ensuring that the development is fitted with aviation safety lighting and that sufficient data is submitted to ensure that structures can be accurately charted to allow deconfliction. The MOD have been provided with the submitted Aviation Lighting Impact and Mitigation Assessment (Appendix 12.1) and have stated that their low flying Subject Matter Experts are content that all of the turbines will be lit with infra-red aviation warning lights (email 03/10/2025). In relation to the met mast for the Proposed Development they have also stated that, if acceptable, the mast will require both lighting and charting and will be subject to Planning Conditions to ensure that MOD requirements are met.
Highlands and Island Airports Ltd (HIAL)	HIAL responded to the original layout and tip height in September 2024 stating that they required that an Aviation Impact Feasibility Study be undertaken to assess the Optical Line of Sight between the two radars at Inverness (Primary Surveillance Radar (PSR) and TERMA) and the Proposed Development. This was confirmed in consultation with HIAL in Oct 2024 and with an undertaking that HIAL would be informed of changes to the turbine positions for the submitted layout and with a radar Line of Sight Assessment (LoS) for the Proposed Development positions. That assessment was forwarded to HIAL in July 2025, and consultation is ongoing with HIAL as to the extent of any envisaged effects on airport operations with a view to determining if mitigation will be required. HIAL have, subsequently, been requested to provide details of any wind turbine mitigation capability within the Thales radar in use at Inverness Airport (email 13/10/2025).

- 12.3.3 This chapter presents a summary of the results of a revised desk-based assessment which was undertaken to identify any potential impacts to aviation stakeholders in the area of the Development Site which may be created by the layout revisions reflected within the submitted Proposed Development. It provides an objective assessment of the effects and any necessary mitigation measures if they are required.
- 12.3.4 In order to confirm which aviation radar stakeholders could be scoped out of the assessment as detailed in **paragraph 12.4.8** and **Table 12.2**, radar performance and propagation modelling has been undertaken to determine the theoretical detection of wind turbines by the region's radar infrastructure at the blade tip heights of the Proposed Development.

12.4 Approach and Methodology

Study Area

12.4.1 Taken collectively the reference and guidance sources establish that:

- Officially safeguarded aerodromes and aerodromes with a surveillance radar facility need to be consulted if the proposed wind turbines are within 30 km;
- Within airspace coincidental with any published Instrument Flight Procedure (IFP) to take into account the aerodrome's requirement to protect its IFPs;
- Consultation with the operators of officially safeguarded technical sites is required if the proposed wind turbines are within 10 km;
- Further assessment and/or consultation will be required if turbines are planned within:
 - 17 km of a licensed aerodrome within a runway of 1100 m or more;
 - 5 km of a licensed aerodrome with a runway of less than 1100 m;
 - 4 km of an unlicensed aerodrome with a runway of more than 800 m; and/or
 - 3 km of an unlicensed aerodrome with a runway of less than 800 m.

12.4.2 CAP 764 goes on to state 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. As well as examining the technical impact of wind turbines on ATC facilities, it is also necessary to consider the physical safeguarding of ATC operations using the criteria laid down in CAP 168 to determine whether a proposed development will breach obstacle clearance criteria.

12.4.3 The maximum study area has, therefore, been informed by the operational ranges of all of the civil airport radars that have the capability of surveilling the airspace at the wind farm location.

Scope of Assessment

Ministry of Defence

12.4.4 It is necessary to take into account the aviation and air defence activities of the MOD. The issues that will be assessed include the likely significant effects of the Proposed Development on:

- MOD Airfields, both radar and non-radar equipped;
- MOD remote ATC radars;
- MOD Air Defence Radars (ADR);
- MOD Meteorological Radars;
- Military Aviation Authority Aerodrome Design and Safeguarding; and
- Military Low Flying.

- 12.4.5 The maximum study area has, therefore, been informed by the operational ranges of all of the military ATC and ADR radars that have the capability of surveilling the airspace at the wind farm location.

NATS Facilities

- 12.4.6 It is necessary to take into account the possible effects of wind turbines upon NATS radar systems, a network of primary and secondary radars and navigation facilities around the country.
- 12.4.7 The maximum study area has, therefore, been informed by the operational ranges of all of the NATS radars that have the capability of surveilling the airspace at the wind farm location. Taken collectively with civil airport radars and military ATC and ADR radars, the radar types and ranges have determined the maximum study area.

Methodology

Radar Modelling and Analysis Information

- 12.4.8 The Line of Sight (LoS) analysis is a limited and theoretical desk-based study. In reality there are variable levels of signal diffraction and attenuation within a given radar environment that can influence the probability of a turbine being detected by a particular radar. The analysis is designed to give an indication of the likelihood of the turbine being detected, such that the operational significance of the wind farm relative to nearby aviation stakeholders can be assessed.
- 12.4.9 The receptors selected as relevant to the assessment of effects, including radar were based upon an initial desktop screening exercise and reflect the relevant guidance and regulation. Each receptor has been considered and scoped in or out on the basis of effect–receptor pathway, professional knowledge, data confidence and the temporal and spatial scales involved. The line of sight conclusions are based on theoretical modelling results, otherwise there are no limitations within the completion of the assessment.
- 12.4.10 Radar modelling has been undertaken using the “Rview” system which utilises a comprehensive systems database incorporating the safeguarding criteria for a wide range of radar and radio navigation systems. Rview models terrain using the latest Ordnance Survey (OS) Terrain 50 digital terrain model, which has a post spacing of 50 metres 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. If needed, Rview is also capable of modelling a range of atmospheric refractive conditions. Rview models the trajectory of radar signals at different elevations enabling 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.

12.4.11 A number of consultees and receptors were scoped out from the consultation and final assessment of effects process for a variety of reasons:

- The system/stakeholder is located outside of the standard consultation distances stated in CAP 764 (2016),
- Conclusions of radar line of sight analysis indicate that assessed radar systems would not detect the Proposed Development turbines;
- Receptors have been scoped out as a result of their response to consultation.

12.4.12 Those receptors which were scoped out from further assessment and those taken forward for consideration are provided in **Table 12.2**.

12.4.13 There is a mandated procedure for the dissemination of information relating to vertical obstacles and the subsequent inclusion of those on aviation charts. The consideration of charting such obstacles, as highlighted in the MOD response, is scoped out of the assessment.

Table 12.2 Screening Potential Receptors to Take Forward to Assessment

Receptor	Assessment	Scoped into impact assessment
NATS Alanshill radar	Radar LoS analysis has concluded that Allanshill PSR would not be capable of detecting the turbines due to the intervening terrain.	No
NATS Perwinnes radar	Radar LoS analysis has concluded that Perwinnes PSR would not be capable of detecting the turbines due to the intervening terrain. Additionally, NATS stated in Scoping consultation that they had no safeguarding objection.	No
RAF Buchan ADR & RAF Benbecula ADR	Radar LoS results indicate that the Buchan and Benbecula Air Defence Radars (ADR) will not be capable of detecting the Proposed Development. DIO have not indicated any impact to the ADR network.	No
RAF Lossiemouth PSR (67km)	The Radar LoS results show RAF Lossiemouth PSR will be capable of detecting two of the turbines (five and six). However, DIO did not indicate any impact to RAF Lossiemouth operations within its response to scoping.	No

Receptor	Assessment	Scoped into impact assessment
Unlicensed airstrips	No non-radar equipped licensed aerodromes within 17 km. no known unlicensed aerodromes within consultation distance. The closest facility of interest is the private airstrip at Knockbain, 23 km to the south.	No
Met radars	No Met Office radars within consultation / safeguarding distance of 20 km	No
Inverness Airport Physical Safeguarding	In their Scoping Response HIAL did not request any assessment of their flight procedures;	No
Inverness Airport radars	Although outwith the 30km mandatory consultation zone Inverness airport has requested an Aviation Impact Feasibility Study be undertaken to assess the Optical Line of Sight between the two radars located at Inverness.	Yes
UK Low Flying System	DIO have stated that aviation lighting meeting their specification is required to address impacts on low flying. There were no additional physical obstruction concerns raised. DIO have already confirmed they are satisfied with the proposed lighting scheme.	No
Civil lighting Requirement	There is a legal requirement for all structures at or above 150 m agl to have appropriate lighting.	Yes
Military lighting Requirement	The DIO have confirmed requirement for IR lighting on all turbines and met mast.	Yes

12.5 Potential Significant Effects

Significance Criteria

- 12.5.1 In order to assess the effect that wind farms have on aviation operations it is necessary to undertake an assessment of the potential technical effects on CNS systems and to then determine if the technical effect would lead to a significant effect on operations or flight safety. The fact that a wind farm might affect the performance of a radar system for example, does not always lead to the conclusion that there will be a significant effect. The guidance laid down in CAP 764 encourages a dialogue between the developer and aviation stakeholders to agree what effect if any there will be on operations and then to agree mitigation if that is feasible.
- 12.5.2 To determine the potential effects of the Proposed Development on aviation operations, the sensitivity of a receptor was considered in relation to the magnitude of effect. Significance criteria for aviation impacts are typically difficult to establish; there is no standard definition,

and they are not strictly based on the sensitivity of the receptor or magnitude of effect but on whether the industry regulations for technical safeguarding, safe obstacle avoidance or radar separation (from radar clutter) can be maintained in the presence of wind turbines. Any anticipated impact upon aviation stakeholders which results in restricted operations will be considered to be of significance, but it is down to the affected stakeholder as to whether any effect is significant on their operations or not.

- 12.5.3 In this sense aviation does not conform to normal EIA significance assessment techniques or criterion.

Construction

- 12.5.4 The fact that any tall object can represent a vertical obstacle to flight and, potentially, pose a flight safety risk is self-evident.
- 12.5.5 During construction, and prior to testing/commissioning, the wind turbine blades will not be rotating; there will be no prospect of any turbines, either assembled or being assembled, being detected by any radar and presented on to controllers' radar display screens on any radar. There will be no radar impacts during the construction phase.
- 12.5.6 Depending on their position in relation to airports/airfields the magnitude of the effect of turbines as a vertical obstruction to aircraft can be significant when assessed against the flight profiles of civil and military aircraft in the area. To facilitate safe flight, day or night, there are regulations governing the procedures that must be followed to ensure the timely dissemination of information regarding the construction of anemometer masts and wind turbines. Information regarding any such construction must be passed to the Defence Geographical Centre (DGC) and the General Aviation Awareness Council (GAAC) in advance of the commencement of turbine construction and then be updated regarding location, height and lighting type. Information will then be promulgated within the civil UK Integrated Aeronautical Information Package (UK IAIP), the main resource for information for all of the UK airspace, as well as the Military Aeronautical Information Publications. Furthermore, the notification on the use of cranes is to be made to the CAA in advance of the commencement of any crane erection begins detailing position, height, lighting etc.
- 12.5.7 With mitigation by informing the aviation community of the ongoing work, and the subsequent charting of the turbines, the effect during construction will be **negligible** and **not significant** in the context of the EIA Regulations. There will be no residual effect.

Operation

- 12.5.8 Other than RAF Lossiemouth, against which there is no objection based on radar, the only radar equipped licensed aerodrome within consultation distance is the civil Inverness Airport, owned and operated by HIAL. Located approximately 36 km to the south-east, it is a medium intensity regional airport equipped with a Thales Star 2000- radar with an effective range of

approximately 65 nautical miles (nm). The radar system is not currently capable of fully mitigating the effect of wind turbines on radar performance or on the probability of detection of aircraft.

- 12.5.9 As a wind turbine mitigation radar the airport also operates an additional TERMA radar as an in-fill to mitigate the impacts of other existing wind farm developments in the area.
- 12.5.10 The radar line of sight results for the radars are at **Table 12.3** and **Table 12.4**. For the turbines not to be visible to the radar, and therefore not to have any technical effect on the radar system, the LoS values have to be greater than the turbine tip height; if the LoS value is less than the tip height the turbines will be detectable by the radar in question.

Table 12.3 Radar line of sight values to Inverness Airport PSR (Thales Star)

Turbine No.	Tip height	Inverness PSR Distance (km)	Inverness PSR Radar LoS (m agl)
1	200	37.616	189.9
2	200	38.174	182.4
3	200	39.1	217.6
4	200	39.631	223.0
5	200	40.219	228.6
6	200	40.782	253.2
7	180	40.316	246.2
8	200	39.316	229.9
9	200	38.676	175.5
10	200	37.853	179.7
11	180	37.362	143.9
12	180	37.114	126.8
13	180	36.832	139.9

- 12.5.11 As can be seen in **Table 12.3** seven of the turbines would be detectable by the PSR

Table 12.4 Radar line of sight values to Inverness Airport TERMA radar

Turbine No.	Tip height	Inverness TERMA Distance (km)	Inverness TERMA Radar LoS (m agl)
1	200	37.9	202.1
2	200	38.463	162.1

Turbine No.	Tip height	Inverness TERMA Distance (km)	Inverness TERMA Radar LoS (m agl)
3	200	39.392	180.7
4	200	39.924	177.2
5	200	40.515	171.8
6	200	41.093	111.6
7	180	40.625	116.1
8	200	39.621	125.2
9	200	38.97	125.6
10	200	38.149	127.3
11	180	37.659	89.6
12	180	37.396	139.1
13	180	37.122	115.4

12.5.12 As shown in **Table 12.4** only one turbine would be expected to be screened from the TERMA radar.

12.5.13 Our understanding of the TERMA system would suggest it would be a suitable mitigation, if mitigation is required for the potential impacts on operations at Inverness Airport. Consultation will continue with HIAL as to the extent of any effects on Inverness Airport operations and any requirement for mitigation.

Decommissioning

12.5.14 During decommissioning the wind turbine blades will not be rotating; there will be no prospect of any turbines, either assembled or being assembled, of being detected by any radar and presented on to controllers' radar display screens on any radar. There will be no radar impacts during the decommissioning phase.

12.5.15 Decommissioning operations including the use of cranes will be notified in accordance with the requirements outlined in **paragraph 12.5.6**. The effects of decommissioning will be **negligible** and **not significant** in the context of the EIA Regulations. There will be no residual effect.

Aviation Lighting

12.5.16 In accordance with civil aviation requirements, appropriate lighting of wind turbines at or above 150 m agl is regulated and approved by the CAA.

12.5.17 The United Kingdom Low Flying System (UKLFS) covers the open airspace of the whole UK below 2,000 ft agl. Low Flying by military aircraft is permitted within established low flying

areas which exclude large urban areas. The MOD has not raised any concerns regarding impacts on the UKLFS within its response to scoping other than as a physical obstruction. DIO have however requested specific aviation lighting to be fitted, in accordance with CAA regulations which is expected to mitigate any obstruction impact created by the Proposed Development. Additionally, there will be a requirement for the provision of MOD infra-red lighting in accordance with MOD lighting policy. An Aviation Lighting Impact and Mitigation Assessment has been commissioned and accompanies this chapter as **Appendix 12.1**. The lighting plan detailed in **Appendix 12.1** proposes visible lighting on five of the turbines and infra-red lighting on all 13 turbines. This has been submitted to and approved by both the CAA and the MOD. Both the MOD and CAA lighting and charting requirements will be secured by planning condition.

12.5.18 The potential visual impact of the aviation lighting on landscape receptors can be found in **Appendix 6.2**.

12.5.19 The MOD have stated that, as the Met Mast is outside the footprint of the lit wind farm, it will also need to be charted and lit with infra-red lighting as a separate entity. In order to secure the MOD requirements the aviation planning conditions should be stated to apply to both the turbines and the met mast.

12.6 Residual Effects

12.6.1 With the potential mitigations outlined there should be no residual aviation impacts.

12.6.2 Landscape and visual effects associated with aviation lighting are discussed in **Chapter 6 Landscape and Visual** and a full assessment can be found in **Appendix 6.2**.

12.7 Cumulative Effects

12.7.1 Cumulative aviation effects will occur where a number of wind farm developments all show on a specific radar and where the overall ability of the air traffic control service provider or MOD Air Defence System to maintain a surveillance and control service is likely to suffer additional operational and technical effects. If radar mitigation is required and implemented on the Inverness Airport PSR radar then there should be no technical cumulative effects.

12.8 Summary and Conclusion

12.8.1 In terms of radar impacts the Proposed Development has been assessed to have LoS to both of the Inverness radar systems. Consultation will be ongoing with HIAL considering the extent of the potential effects on operations and the possible requirement for additional mitigation.

12.8.2 Aviation lighting will be required and proposed lighting scheme is detailed in **Appendix 12.1** Aviation Lighting Impact and Mitigation Assessment, which has been approved by both the CAA and MOD (CAA letter (Windfarms/Creachan) dated 29 September 2025).

12.9 References

Scottish National Planning Framework (NPF4, 2023)

Civil Aviation Authority (2025) Civil Aviation Publication 493 Manual of Air Traffic Services, Ed. 12.0.

Civil Aviation Authority Civil Aviation Publication 393 The Air Navigation Order (2016) and Regulation, Version 6 (2021).

Civil Aviation Authority (2022) Civil Aviation Publication 168 Licensing of Aerodromes, Version 12.

Civil Aviation Authority (2019) Civil Aviation Publication 670 ATS Safety Requirements, Version 3.

Civil Aviation Publication 774 (2021) UK Flight Information Services, Ed. 4.

Civil Aviation Authority Civil Aviation Publication 738 (2020) Safeguarding of Aerodromes, Version 3.

Civil Aviation Authority Civil Aviation Publication 764 (2016) Policy and Guidance on Wind Turbines, Version 6.

Civil Aviation Authority (2010) Civil Aviation Publication 793 (2010), Safe Operating Practices at Unlicensed Aerodromes, Edition 1.

Civil Aviation Authority (2017) Policy Statement: Lighting of Onshore Wind Turbine Generators in the United Kingdom with a maximum blade tip height at or in excess of 150m Above Ground Level. Civil Aviation Authority (2017)

CAP 1096 Guidance to Crane Users on aviation lighting and notification (2021), Version 2.2.

Military Aviation Authority (Ministry of Defence) Regulatory Article 2330 (Low Flying).

Ministry of Defence UK Military Aeronautical Information Publication (MIL AIP).

National Air Traffic Services Ltd (2020a) UK Aeronautical Information Publications (AIP).

National Air Traffic Services Ltd (2019) CAA 1:250,000 VFR Charts.

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