Technical Appendix 14.5: Aviation Report

Windburn Wind Farm

Windburn Wind Farm Limited

2 Walker Street, Edinburgh, Scotland, EH3 7LA

Aviation Review

Windburn Windfarm

Report

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Executive Summary

This report critically evaluates the NATS Technical and Operational Assessment (TOPA) concerning the Windburn Wind Farm, focusing on its justification for radar mitigation requirements. The assessment reveals significant shortcomings in how NATS determines the need for mitigation, highlighting an over-reliance on worst-case technical scenarios without sufficient operational evidence.

A key issue identified is the lack of a comprehensive review of actual air traffic patterns, radar system performance, and environmental conditions that could influence radar interference. Instead, the TOPA appears to assume that any technical impact automatically translates into an operational impact, without demonstrating a tangible risk to air traffic management.

Additionally, the financial implications for the project developer, with regards to implementing radar mitigation, are unclear and potentially unjustified. Recent planning decisions and public inquiry outcomes emphasize that mitigation should only be mandated when an operational impact is proven, with fair and transparent cost-sharing mechanisms in place.

The report concludes that the NATS TOPA does not provide a sufficient basis for requiring radar mitigation at Windburn. Moving forward, a more evidence-based and equitable approach is necessary to balance the interests of both the aviation and renewable energy industries.

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Overview

1. Wind2 Limited is progressing a proposed development known as the Windburn Wind Farm.
2. The proposed development consists of 13 wind turbines with a maximum tip height of 149.9m above ground level located in the Ochil Hills in the Central Belt of Scotland.
3. During the pre-application phase, a submission was made to NATS Safeguarding for a Technical and Operational Assessment (TOPA). This was progressed and reported on in NATS TOPA reference SG35103, dated April 2023, and assessed 15 turbine locations. The developer has subsequently reduced the number of turbines to 13 with minor siting changes.
4. Straten Consulting has been contacted to review the TOPA and provide comment on the basis that the operational impact is not demonstrated, and mitigation costs are disproportionate. This report sets out the review through the application of UK CAA policy and guidelines together with practical experience, in Air Traffic Control, on aspects related to operational impact.
5. This review will consider the regulatory environment and then cross reference that to the TOPA conducted by NATS. The intent of the review is to provide an evidence-based approach to determine the validity of the TOPA.

Review

Regulatory Environment

6. In reviewing the proposed development site and the NATS TOPA, it is important to understand the UK's position with regards to the aviation and renewables industry. Additionally, the future of aviation, specifically with regards to future technologies and airspace modernisation, is included for review.
7. The UK Government recognises the national interests and legitimate interests of both the wind energy and aviation industries[1]. The expectation, at national level, is for the aviation industry to '*engage positively*' in the process of developing solutions to potential conflicts of interest.
8. Additionally, the 2023 release of the Scottish Government's Onshore Wind Sector Deal whereupon consultees were encouraged to facilitate targets through a transparent, fair and equitable processes, and reduced costs, is relevant. Since the release, there has been no change in the NATS TOPA or mitigation process.
9. CAP764 is the primary document covering the UK CAA's position on wind turbines, the document, CAA Policy and Guidelines for Wind Turbines, originally released in 2006 is now in its sixth edition (2016). This CAP has undergone a review in 2024, and the seventh edition is expected soon.
10. The UK embarked on a Future Airspace Strategy (FAS) in 2011, which was later replaced with the Airspace Modernisation Strategy (AMS). The future strategy was borne from the DfT's 'The Future of Air Transport' White Paper in 2003 and subsequent progress report in 2006.
11. It is accepted that technical impacts need to consider the existing systems and solutions in the aviation environment. However, the future aviation strategy of aviation stakeholders must consider the future landscape of the wind energy industry and plan accordingly in the interests of the national economy.
12. An important aspect of the AMS is its alignment with both regional and international requirements. The UK is a member State of the International Civil Aviation Organisation (ICAO) and is in fact a founding member at the Chicago Convention. ICAO, as a body of the United Nations, sets out a series of Standards (mandatory requirements) and Recommended Practices (not mandatory but highly advisable) to ensure international air travel has a uniform set of practices to ensure safety. Given the aviation industry's impeccable safety record, this system appears to be working well.

[1] CAP764, Foreword, fifth paragraph, page 8.

13. The DfT and CAA set out the strategy of modernising the UK airspace through the ICAO GANP[2] and is available in various documents accessible through the CAA website. Core to this review is CAP2547: A Guide to the Airspace Modernisation Strategy and CAP1711: Airspace Modernisation Strategy 2023-2040 Part 1: Strategic Objectives and Enablers.
14. In summary, the regulatory environment has set out requirements and guidance to which, in many instances, the aviation industry is not demonstrating efforts to comply with.
15. Given the viewpoint of the UK Government to the renewable and aviation industries, it would be expected that the aviation industry would contribute to costs on an equitable basis. The DfT's paper was released 22 years and CAP764 19 years ago.

NATS TOPA SG35103

16. NATS conducted a Technical and Operational Assessment in April 2023 on the proposed development. The TOPA considered 15 wind turbines with a tip height of 149.9m, which was the subject of the scoping request made to the Energy Consents Unit.
17. The TOPA identified four NERL radar sites (GDF, Lowther Hill, Perwinnes and Tiree), of these only the Lowther Hill site is identified as impacted.
18. The Kincardine Radar site is also notified as an impact but not included in the list of four systems.
19. The results accord with Straten Consulting radar line of site analysis[3]. Figure 1 provides a coverage diagram of both radars at 150m. Yellow depicts the Kincardine coverage with Lowther Hill in green.

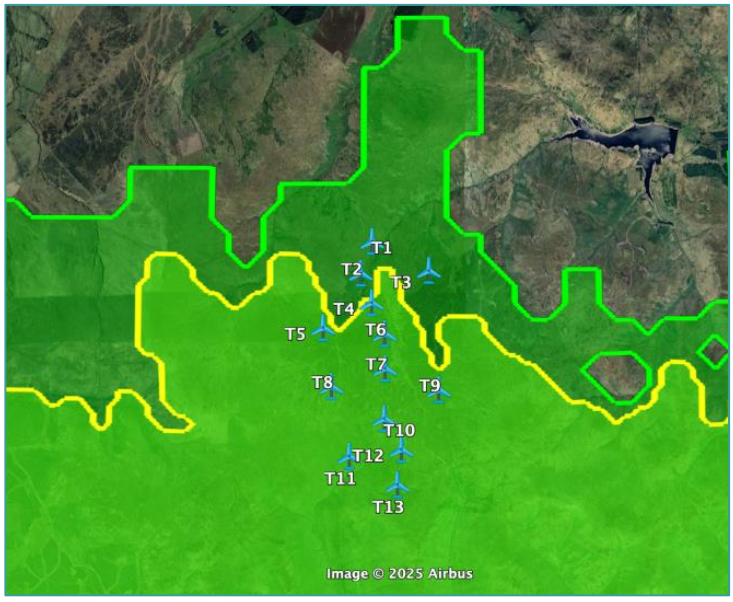

FIGURE 1: LINE OF SIGHT COVERAGE AT 150M FOR LOWTHER HILL (GREEN) AND KINCARDINE (YELLOW)

[2] ICAO Global Air Navigation Plan (GANP).
[3] Software analysis undertaken using SPx Radar Coverage Tool Pro. Shuttle Radar Topography Mission (SRTM) terrain data is used to calculate the radar visibility with data resolution of approximately 30m and includes DTED data files as the source of terrain data.

20. The review confirms there is a technical impact to both Radar sites as a result of the proposed development being within line of sight at a tip height of 149.9m above ground level (agl).
21. Two technical concerns are noted in the NATS TOPA, the first being the generation of false plots and the second a reduction in the probability of detection, for real aircraft. The terminology used to describe the technical impact is '*likely'* and '*anticipated'*. The use of language indicates that only a line-of-sight analysis was undertaken with no further assessment to determine probability of detection.
22. Section 4.1.3., of the TOPA, states that where a technical impact is identified, users of the Radar are consulted to determine if there is an operational impact. The supporting table identifies that Prestwick Centre ATC provides a comment stating '*Unacceptable*'. It is assumed the '*Unacceptable*' statement refers to a direct operational impact. However, the *Conclusion* does not specify the operational impact is unacceptable.
23. The TOPA Conclusion determines that the proposed development has been deemed unacceptable as a result of an anticipated technical impact. The conclusion makes no mention on the operational impact. This does raise a concern that the technical impact is the driving motivation for a costly mitigation. The basis for mitigation should be a demonstrated operational impact.

Technical Analysis

24. Straten Consulting has reviewed the site from both a technical and operational perspective to understand the nature of the unacceptable impact of the NATS TOPA.
25. This analysis will consider both the technical and operational impact. It is acknowledged that there is a limited operational knowledge, of the author, in this area.
26. The technical analysis must always be considered 'worst-case', i.e., the radar is operating at full capacity, the climatic conditions provide no impact and vegetation, and other ground obstacles are not considered. A 'worst-case' assessment only captures terrain data with resolution of approximately 30m thereby limiting accuracy.
27. In terms of radar performance, it must also be acknowledged that climatic and environmental factors impact the actual radar coverage and will be less than that undertaken by a desktop study.
28. In analysing the technical performance, a view of the turbine layout, as seen by the radar angle must be considered. In this case, the Windburn turbines present a narrow perspective to both radars thus resulting in many turbines falling within the shadow of the development. As a result, less than the proposed 13 turbines will be visible to the radar.

29. Figure 2 provides a view of the layout in reference to the two radars. The yellow line represents the direction from Lowther Hill, the green line Kincardine. The turbine layout is in a north-south line with both radars to the south.

30. Figure 3 presents an elevation profile from Lowther Hill (to the extreme right-hand side of the profile). Turbine 7 (T7) is located in the centre of the site, on the higher ground of the upland plateau, with T1 through to T6 located on the northern slopes of the plateau as the ground elevation decreases to the north. T1 is located approximately 94m lower than T7 with turbines T7 to T13 creating a shield of the northern turbines. There may be an argument that the nature of wave propagation may result in shielded turbines to be visible; however, it would be expected that there is sufficient evidence provided by NATS to demonstrate this effect in the existing environment.

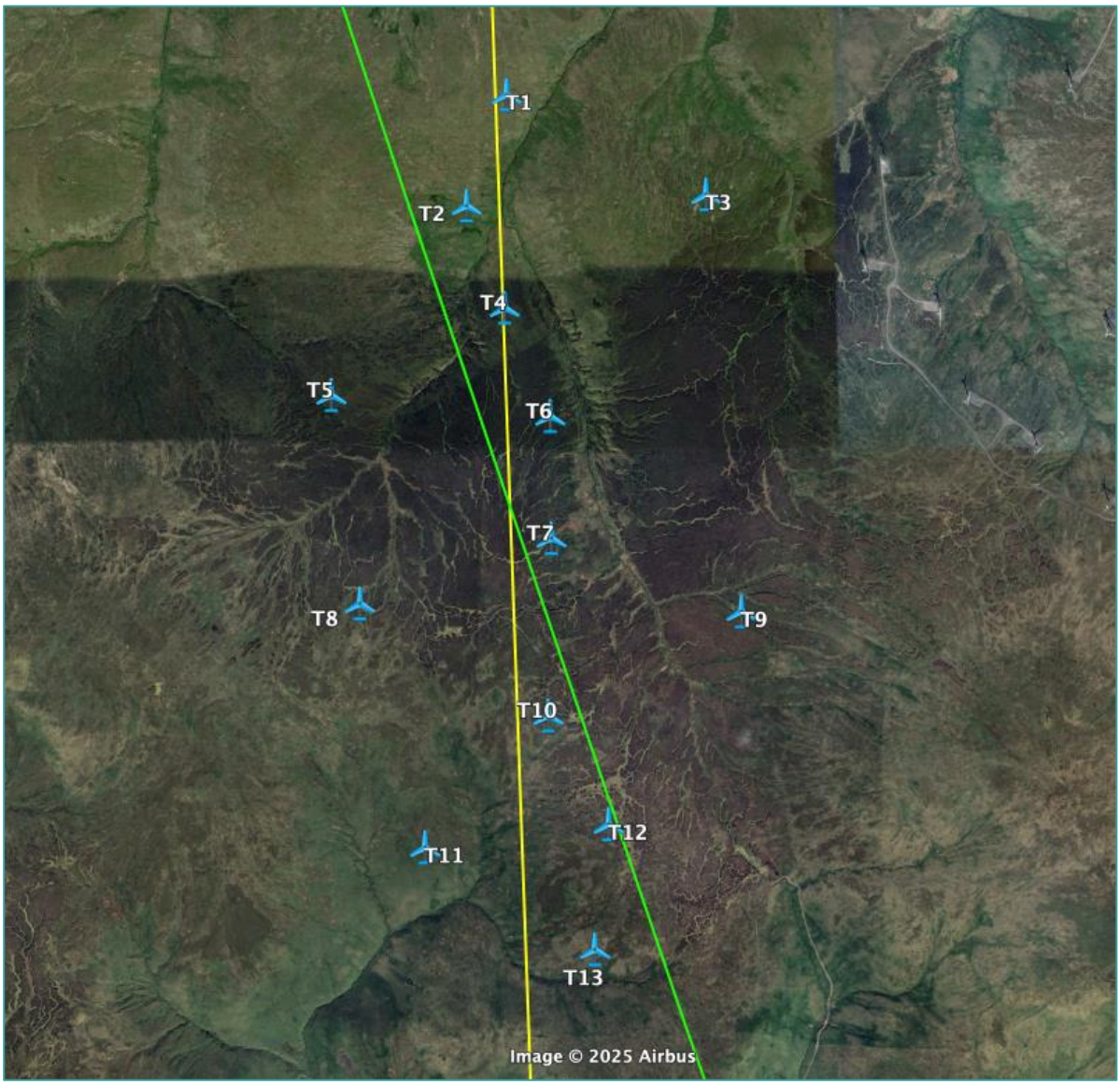

FIGURE 2: TURBINE LAYOUT RELATIVE TO RADAR POSITIONS - LOWTHER HILL (YELLOW LINE), KINCARDINE (GREEN LINE)

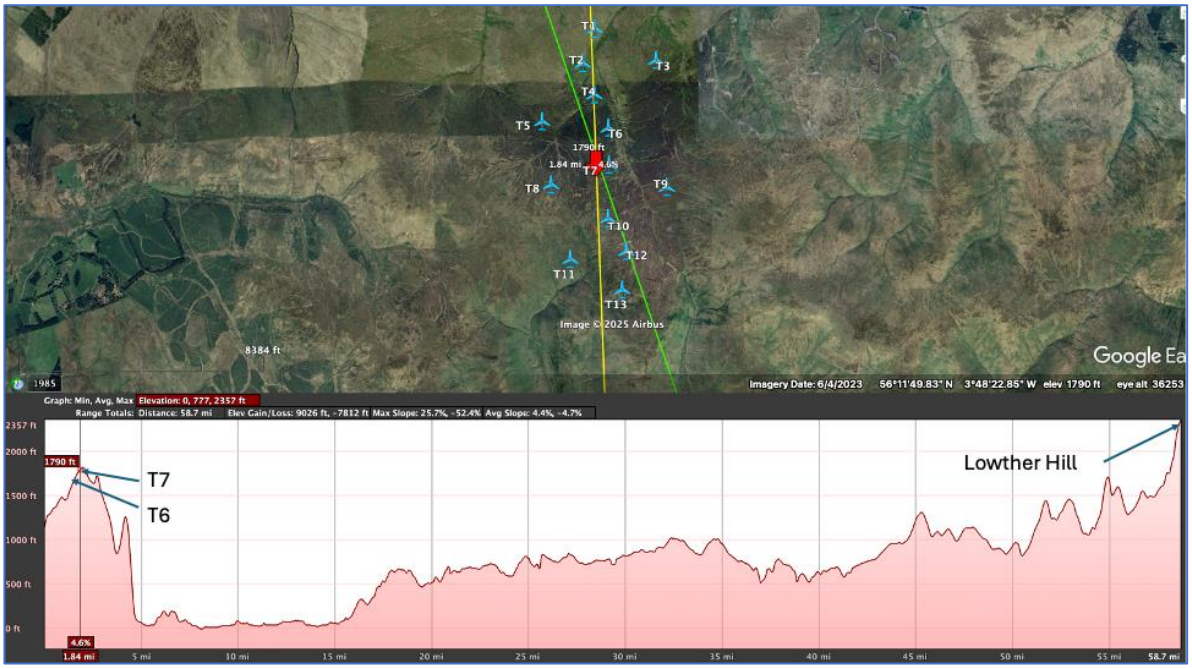

FIGURE 3: ELEVATION PROFILE FROM LOWTHER HILL TO PROPOSED DEVELOPMENT

31. The purpose of the above technical analysis is to demonstrate that the NATS TOPA does not adequately assess the full environment, considering system limitations, to determine technical impact.
32. The NATS TOPA concludes that based on a technical impact alone, an objection is in place. The analysis is insufficient to justify costly radar mitigation.
33. The more important point is that NATS have concluded an objection based on a technical impact alone. While an operational impact is stated, it should form the primary basis of an objection. Mitigation should be based on an operational impact, not a technical impact. Although a radar may have full coverage, a volume of airspace not used operationally should not require mitigation.
34. Concern is also raised at the inclusion of an impact to the Kincardine radar. This asset was purchased by SPR for the Whitelee Wind Farm and understood to be managed by NATS on behalf of SPR.
35. Any mitigation to the Kincardine radar should be at NATS own expense on the basis its purpose is to mitigate a specific windfarm. If NATS are using the radar to provide coverage in other areas, then new developers should not have to pay for a resource gifted from the renewables industry. This would result in mitigation required on existing mitigation. It would be more appropriate for NATS to use Kincardine proactively in supporting the renewables industry with no commercial benefit.

Operational Analysis

36. An operational analysis is undertaken to understand the operational impact. FlightRadar24® (FR24) has been used (in fast time) to understand the level of traffic in the area. This data is an extract of

ADS-B, it is acknowledged that this represents only those aircraft that carry the appropriate transponder.

37. Aircraft without transponders are not visible and therefore cannot be considered. To counteract this, it is considered that a majority of aircraft, within the UK, are fitted with a transponder as discussed below.
38. Research undertaken by the Light Aircraft Association in 2014 and revised in 2015 indicated that 70.9% fixed-wing aircraft in the weight category 750kg to 5700kg are fitted with transponders (electric conspicuity). Since this research was undertaken, the UK Government has provided a 50% rebate scheme to encourage light aircraft pilots to fit their aircraft with transponders. According to the CAA, the positive response resulted in the rebate period being extending for a considerable length of time. It is expected that the percentage of aircraft fitted with some form of electronic conspicuity (EC) should exceed 90% by now.
39. The ANO requires aircraft at weight exceeding 5700kg or with a capable airspeed of greater than 250 knots being required to carry ADS-B; this is published in the AIP under GEN 5.3.1.3 and copied below for ease of reference (Figure 4).

5.3.1.3 A SUMMARY OF THE SURVEILLANCE EQUIPAGE REQUIREMENTS IS GIVEN BELOW:

Sub - para	Applicability	Requirements
	SSR Transponder Equipment for Aircraft Operating Under IFR	
(a)	All fixed-wing aeroplanes operating under IFR having a MTOM in excess of 5700 KG **or** having a maximum cruising true airspeed capability in excess of 250 KT with an individual certificate of airworthiness first issued on or after 7 June 1995.	Mode S Enhanced Surveillance, ADS-B version 2 and Mode S Enhanced Surveillance
(b)	Other aircraft operating in accordance with instrument flight rules within UK airspace.	Mode S Elementary Surveillance
	SSR Transponder Equipment for Aircraft Operating Under VFR	
(c)	All aircraft operating under VFR within United Kingdom controlled airspace of Classification B and C.	Mode S Elementary Surveillance
(d)	All aircraft operating under VFR within United Kingdom airspace at and above FL 100.	Mode S Elementary Surveillance
(e)	All aircraft operating under VFR within United Kingdom airspace notified as a 'Transponder Mandatory Zone'. *Note: Applies to Airspace Classes D, E, F and G as appropriate.*	Mode S Elementary Surveillance
(f)	All aircraft operating under VFR flying for the purpose of Public Transport.	Mode S Elementary Surveillance

FIGURE 4: UK AIP EXTRACT GEN 5.3.1.3

40. In the first instance, the airspace structure in and around the proposed development was viewed to understand the environment and resultant impact to operations.
41. The proposed development falls below the Scottish TMA-7. This is Class E airspace from a lower altitude of 4000ft to an upper altitude of 7000ft. Immediately above this airspace is Scottish TMA-3 from a lower altitude of 6000ft extending up to Flight Level (FL) 195. The upper en-route airspace structure sits above the Scottish TMA from FL195 and above.
42. The Scottish TMA and en-route airspace is managed from Prestwick Centre.
43. The nearest Air Traffic Service (ATS) route is P600, with a published lower altitude of 7000ft extending to FL255.
44. The proposed development is within 5nm of ATS route P600 as demonstrated in Figure 5. The white circles represent 5nm circles from each outer turbine with the cyan line depicting P600.

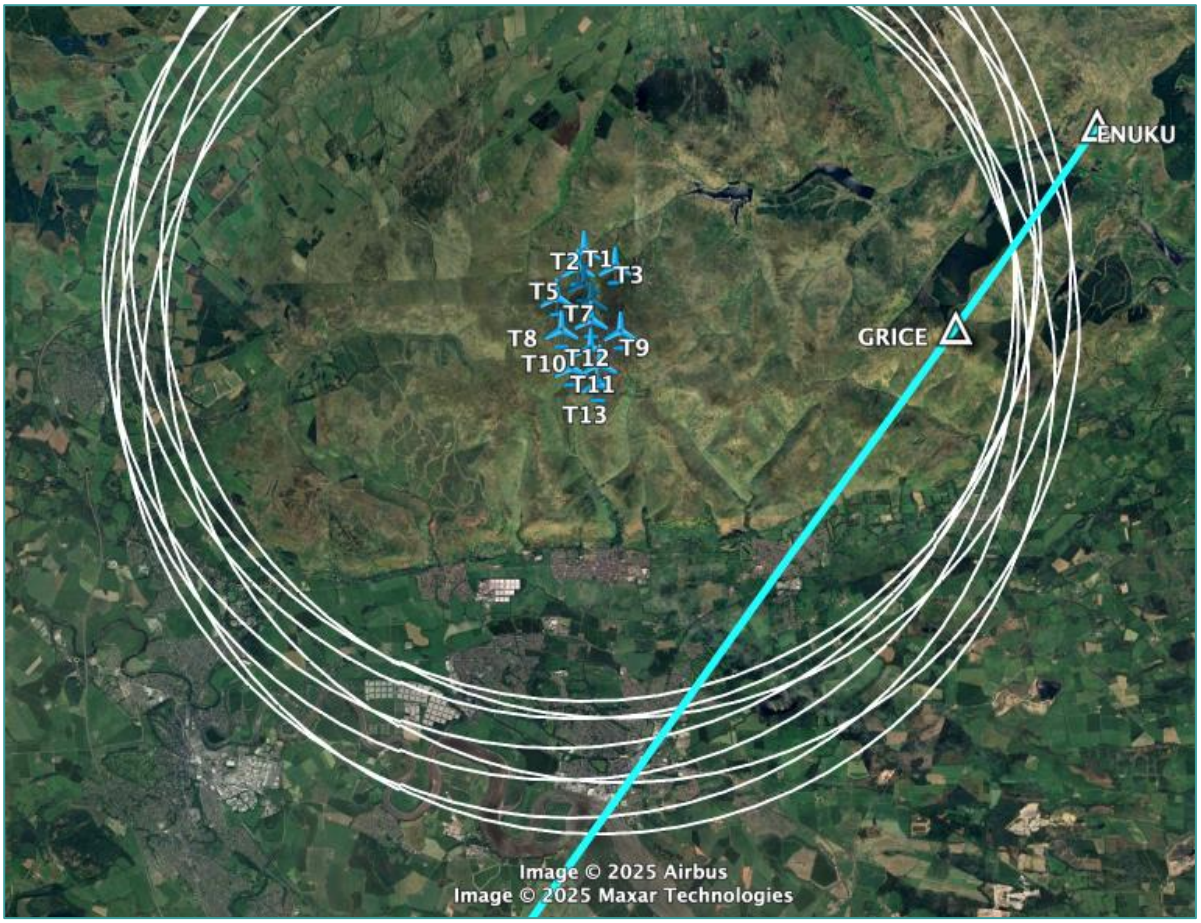

FIGURE 5: ATS ROUTE P600 PASSING WITHIN 5NM OF THE PROPOSED DEVELOPMENT

45. A further analysis was undertaken to determine the frequency of flights using P600 to understand the operational impact. The purpose of determining the operational impact must inform the need and type of mitigation required.
46. The accompanying diagrams (Figure 6 to Figure 7) provide an overview of traffic over a 24-hour period commencing from 0600 from 17th to 18th March 2025.
47. Figure 6 represents data extracted from Flight Radar 24®(FR24) and presented in Google Earth. The white circles represent 5nm circles for each turbine of the outer turbines. The colour differences are representative of each flight's altitude with green being the lowest and red the highest. The purpose is to define the area of concern in terms of operational impact based on the required radar separation.

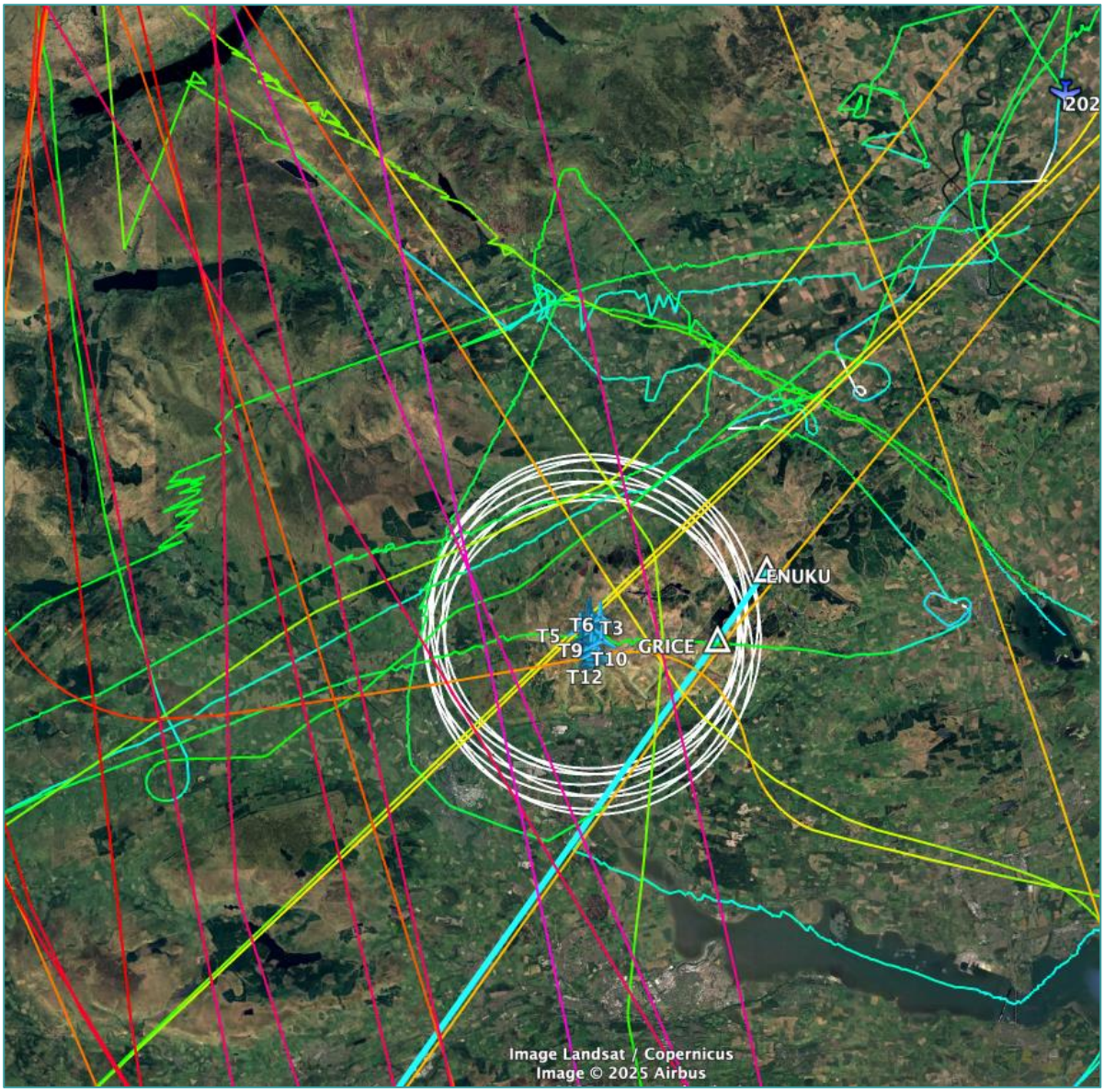

FIGURE 6: REPRESENTITIVE FLIGHTS OVER AN 18-HOUR PERIOD

48. Of note, only one aircraft, within a 24-hour period, appears to be flying along ATS Route P600.
49. Figure 7 represents a zoomed in picture of Figure 6, a total of 13 flights are identified during a 24-hour period.
50. The busiest single period did not have more than 1 aircraft within 5nm of the proposed development at any given time.

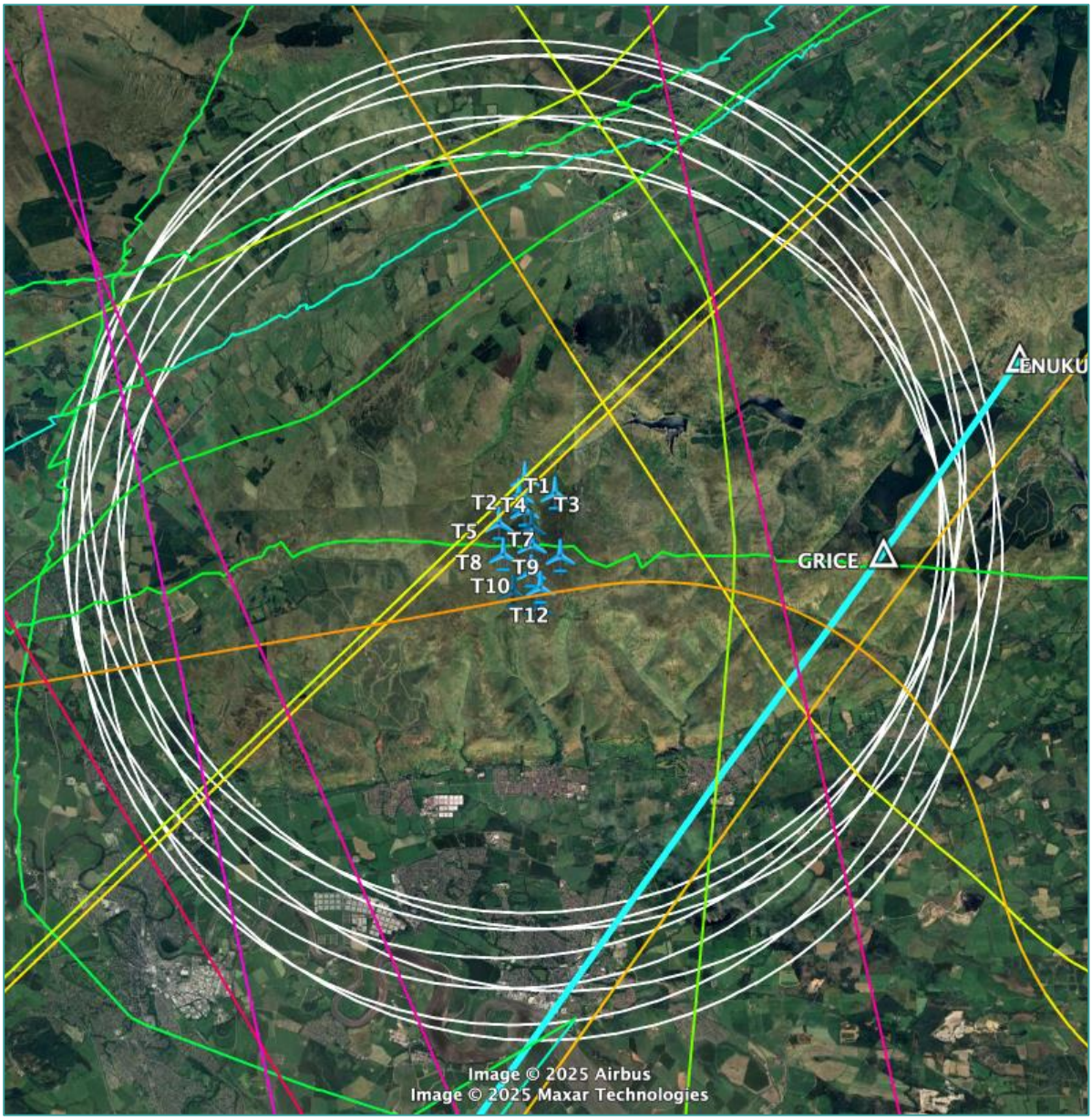

FIGURE 7: ZOOMED IN DIAGRAM OF FIGURE 6

51. Two aircraft were observed below 6000ft appearing to fly cross-country flights. A review of the weather for the day indicated overcast conditions but with good visibility of >6 miles[4] below the cloud.
52. The general traffic pattern is predominantly traffic arriving and departing Edinburgh from and to the south.
53. Given the limited flights north of Edinburgh, these are primarily two flights departing Edinburgh plus an arrival, two flight for Aberdeen, one flight for Sumburgh and one for Stornoway.

[4] Source: https://mesonet.agron.iastate.edu/sites/obhistory.php?station=EGPH&network=GB__ASOS&metar=0&madis=0&year=2025&month=3&day=17&sortdir=asc.

54. The remaining flights consist of high-level en-route traffic with two GA flights with one flight transiting the area twice.
55. In summary, 13 flights over a 24-hour period indicates a very quiet portion of airspace. Even considering the flights in close proximity, the review concludes the airspace is not very active.
56. Further examination of the wind was reviewed on the basis that the position of the blades in relation to the radar site will determine whether clutter will be generated. A turbine with blades perpendicular to the radar is unlikely to generate clutter, i.e., the turbine is facing the Radar. Blade rotation in line with the radar signal is likely to generate radar clutter as a result of Doppler Shift, i.e., the blades are travelling towards or away from the Radar. Figure 8 provides a simple view of the impact.

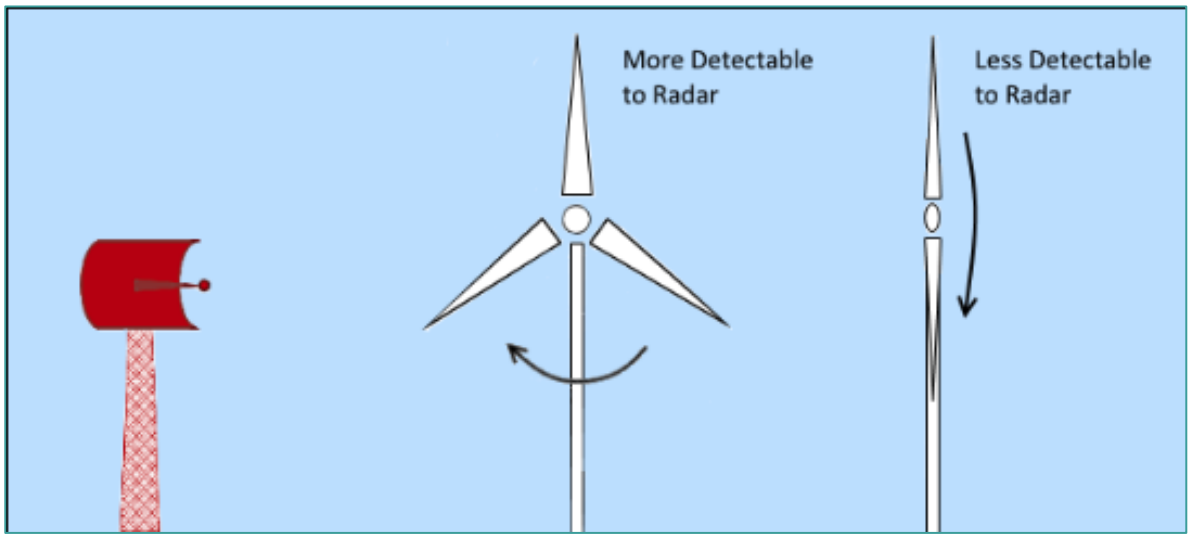

FIGURE 8: PRESENTATION OF TURBINE TO THE RADAR[5]

57. The predominant wind, in this region is from the west-south-west meaning there it is very unlikely that the turbines will create clutter.
58. Wind data (Figure 9) is supported from Edinburgh, this has been correlated with 51-year historical wind data. Figure 10 provides an overlay of the wind rose over the site.

[5] Obtained from PagerPower at https://www.pagerpower.com/news/how-it-works-cyrrus-smartener-wind-farm-radar-mitigation/ on 17 January 2025.

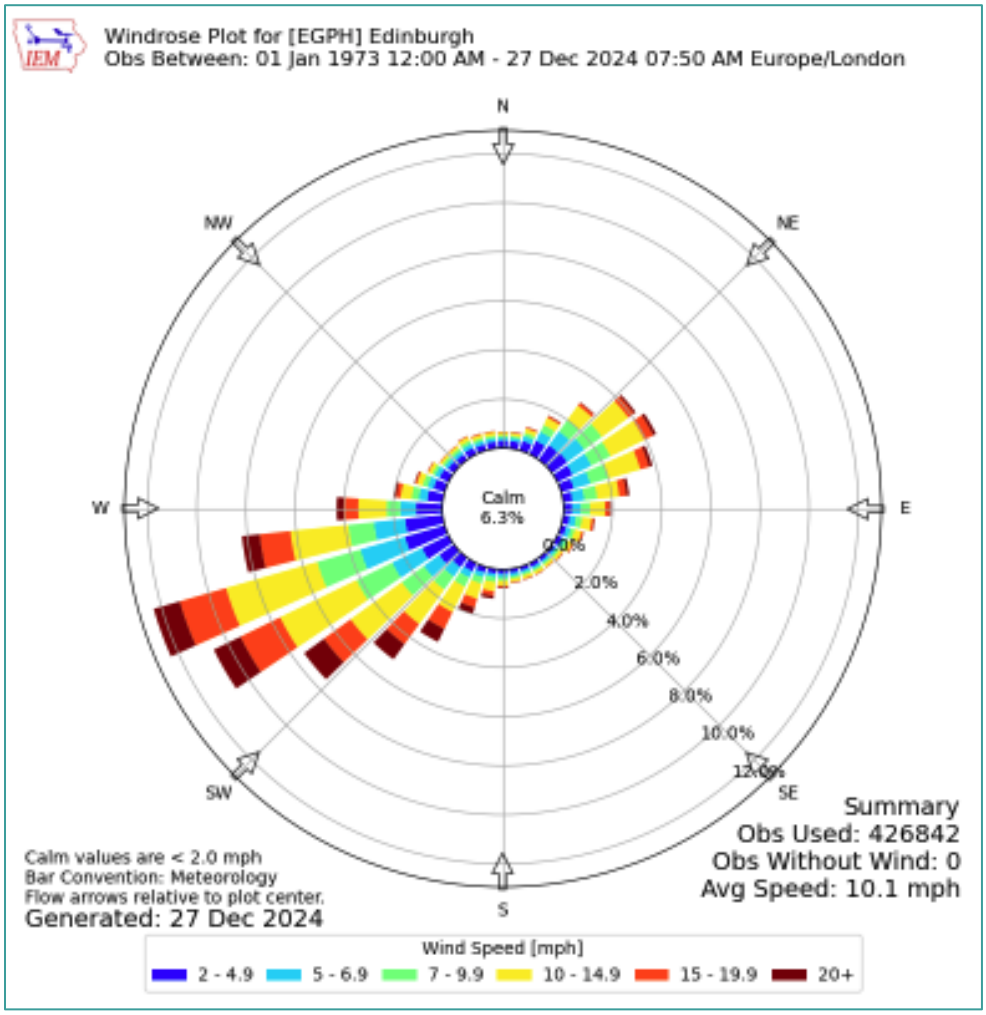

FIGURE 9: ON-SITE WIND ROSE DATA

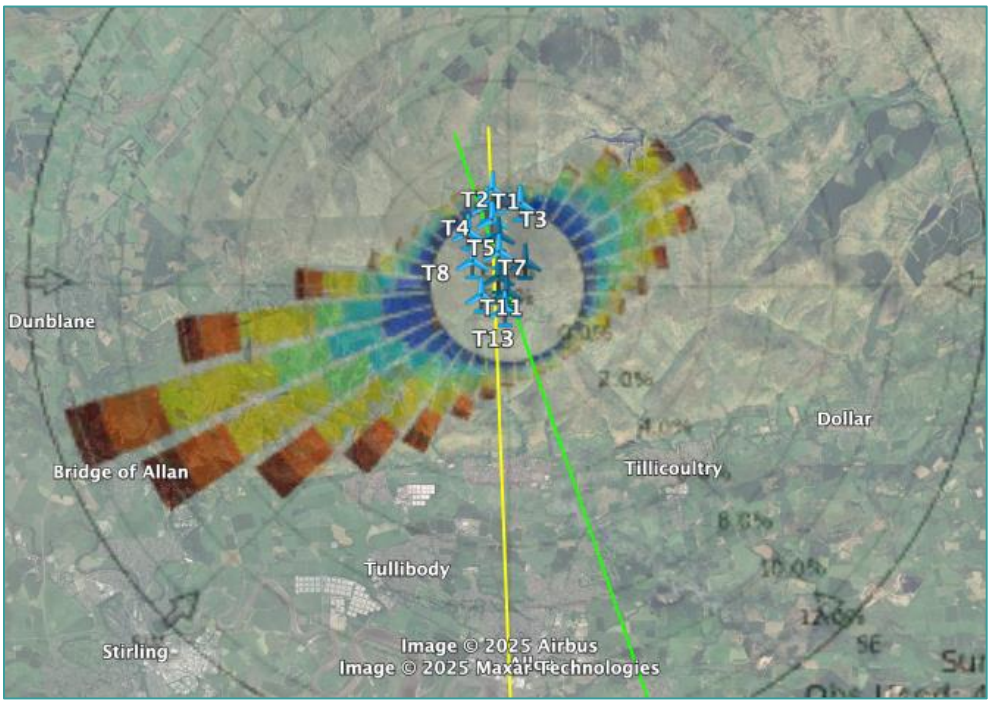

FIGURE 10: WIND ROSE OVERLAY ON GOOGLE EARTH WITH RADAR LINES DEPICTING DIRECTION

59. The wind rose was imported into Google Earth; Figure 10 provides an indication of the prevailing wind over the proposed development site. Both Radar sites at Lowther Hill and Kincardine are indicated. It is clear that both radars are highly unlikely to be impacted on a regular basis.
60. In addition, where the likelihood of clutter could be formed, existing technologies such as radar processing and application of radar trackers should automatically eliminate clutter.
61. Multi-Radar Tracking or use of the ARTAS surveillance data processing system, are designed to ensure that unnecessary clutter can be eliminated without risk of identifying flying aircraft.
62. Multi-Radar Tracking uses a mosaic system of identifying radar coverage of an area. If NERL use the Mosaic MRT methodology, then defining the mosaic in the area of the proposed development is a routine task that can be applied without undue cost implications.
63. It is understood NELR do use ARTAS, if this is the case, then the processing system should automatically eliminate unnecessary clutter.
64. In summary:
    - The NATS TOPA fails to adequately address a number of areas that would support a costly radar mitigation scheme.
    - The operational impact is not demonstrated.
    - The cost mechanism for mitigation is not consistent with the UK Government's position in relation to equal importance of the wind and aviation industries. The current system is one-sided to the sole benefit of aviation.
    - The process of mitigation does not align to mitigation for other aviation safeguarding matters. Impacts to IFPs and OLS follows a simple, 'user pays for the change' rather than the radar mitigation commercial terms.
    - The mitigation requirements by NATS have not considered recent public inquiry decisions for Sanquar II and Clauchrie and in fact contradicts all criteria below:
        - It is not appropriate to include an ongoing maintenance cost;
        - The charge per megawatt basis is not appropriate;
        - Costs should be demonstrable; and
        - There is no basis for ongoing compensatory costs.
    - A more recent planning decision by the North Ayrshire Council planning committee, dated 19 February 2025, for the South Hourant Farm demonstrates an appropriate planning condition on NATS for the Lowther Hill radar. The committee have a clear stated condition that the developer shall pay, "*such sums demonstrably and reasonably incurred by the Operator in optimising the Operator's 3D INDRA SISTEMAS, S.A primary surveillance radar located at Lowther Hill*…". This is a clear condition to NATS that any costs to meeting mitigation are transparent, proportionate and reasonable.
65. The developer should only pay for mitigation that is demonstrated to impact operations, and these costs should be transparent, reasonable and proportional.

66. The argument by NATS that these contracts have been accepted within industry for over 10 years does not demonstrate a willingness by NATS to be a proactive partner in addressing solutions on an equitable basis. NATS are demonstrating a 'dominant market' position, which given recent inquiry decisions, needs to be urgently addressed.

Conclusion

67. The review of the NATS Technical and Operational Assessment (TOPA) for the Windburn Wind Farm highlights several critical concerns regarding the validity of its conclusions and the justification for radar mitigation.
68. The analysis demonstrates that while a technical impact is identified, the operational impact—the primary basis for any mitigation requirement—is not sufficiently established.
69. The lack of comprehensive assessment regarding actual air traffic patterns, radar performance, and the prevailing environmental conditions suggests that the TOPA relies on a worst-case technical scenario rather than a balanced, evidence-based approach.
70. Furthermore, the financial burden imposed on the developer lacks transparency, fairness, and alignment with the UK Government's position on balancing the interests of the aviation and wind energy industries. The precedent set by recent public inquiries and planning decisions further reinforces the need for demonstrable, proportionate, and reasonable cost allocation.
71. Given these findings, the conclusion of the NATS TOPA should not serve as the sole justification for costly mitigation measures or as the basis of an objection from NATS to an application for Section 36 consent. Instead, mitigation should only be required where a direct operational impact is demonstrated, with clear and fair cost-sharing mechanisms in place.
72. A more collaborative and equitable approach is necessary to ensure that both the aviation and renewable energy sectors can coexist without undue financial or operational burdens on developers.