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WIND BUSINESS SUPPORT

HOY

Marine Radar Impact Assessment

A report for

ITPENERGISED
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COMMERCIAL-IN-CONFIDENCE

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INTRODUCTION

This section considers the potential for the proposed Hoy 6 turbine development, to cause significant impacts on the Sandy Hills and Hill of Midlands Marine radars.

The potential impacts of any wind turbine on marine radar are:

- False detections (turbine detections)
- Ghost targets (fake targets in the wrong place caused by reflections)
- Side-lobe detections (turbine detections shown at the right range but in the wrong place/azimuth)
- Shadowing (Loss of Pd* behind the turbines)
- Receiver saturation (reduced Pd in the area of the turbines)

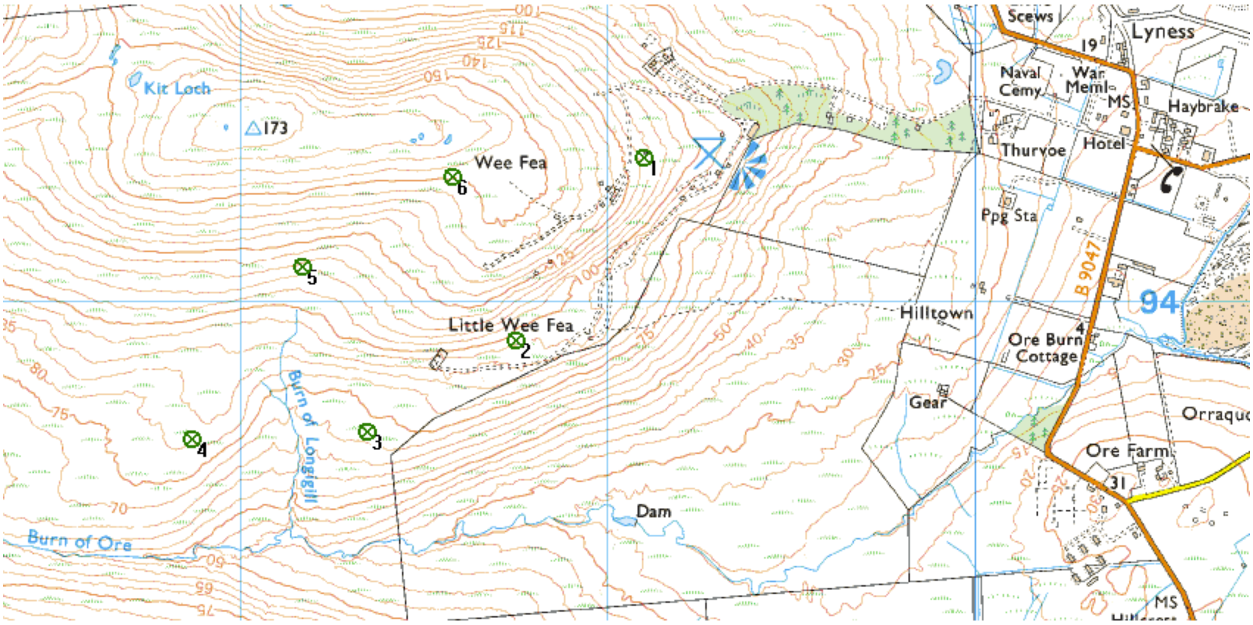
* Pd = Probability of detection

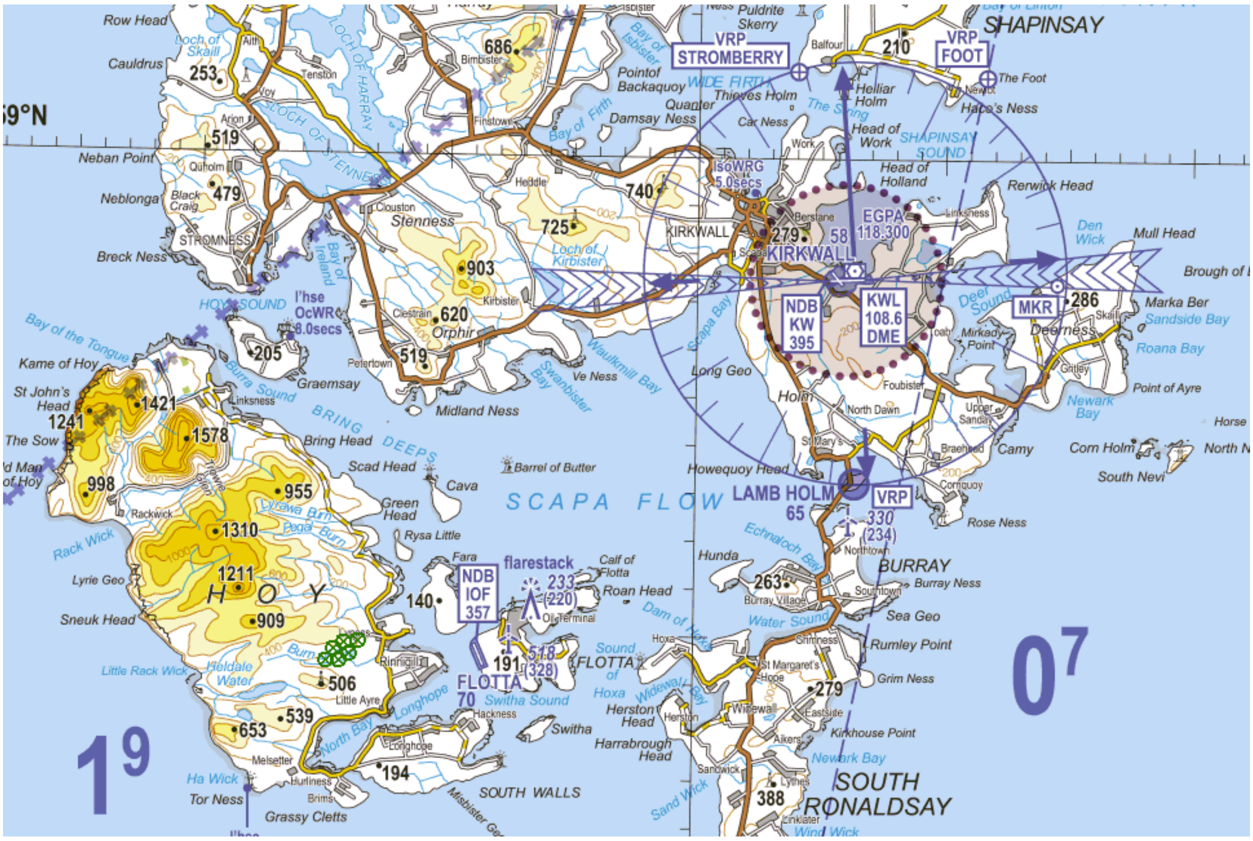
These potential effects are analysed in turn below for the specific circumstances of the radars of concern and the proposed Hoy development.

SITE DETAILS

Hub height 81.9m, rotor diameter 136m, tip height 149.9m. Turbine capacity 4.65MW,Enercon E136. Note that the turbine specification is not final and these dimensions are used for the purpose of the study only.

ID	Eastings	Northings	100km Grid	Base elevation (m AOD)
T1	329095	994396	ND 29095 94396	116
T2	328746	993900	ND 28746 93900	96
T3	328341	993650	ND 28341 93650	70
T4	327865	993632	ND 27865 93632	79
T5	328167	994098	ND 28167 94098	112
T6	328576	994345	ND 28576 94345	149





RADAR VISIBILITY

The table below provides a good <u>initial indication</u> of the visibility of the proposed development to the radars potentially affected. The results are derived from a radar Line of Sight (LoS) assessment.

Turbine ID	Radar ID	Turbine tip height	Turbine base height	Radar to turbine	LOS visibility	**LOS max tip height**
		m agl	m AOD	km	m	**m**
3	Sandy Hill	149.9	70	17	147	**3**
3	Hill of Midland	149.9	70	11.9	58	**92**

Turbine 3 is the turbine with the lowest elevation and hence the least visible. The results above indicate that all of the turbines are highly visible to both the Sandy Hills and Hill of Midland marine radar.

NOTES ON THE LINE OF SIGHT ASSESSMENT

Refraction arising from atmospheric variations is estimated by using a standard 4/3rds earth curvature radius model. This is the basis for determining the radar Line of Sight (***LoS***).

Diffraction effects are not included, generated by the interaction of the radio waves with the terrain. Diffraction can have a very significant effect on the detectability of a turbine. It is taken into account in the assessments conducted by most aviation stakeholders including the NATS and the MoD. For this reason the LoS figures above should generally only be used as an initial indication of detectability with more detailed assessments required to gain a more robust result in many cases. Exceptions to this are where turbines are either very clearly visible or very clearly undetectable because of substantial terrain screening. Whether or not a radar displays any detected objects also depends upon the settings and processing of the radar.

MARINE RADAR IMPACTS

TURBINE DETECTIONS

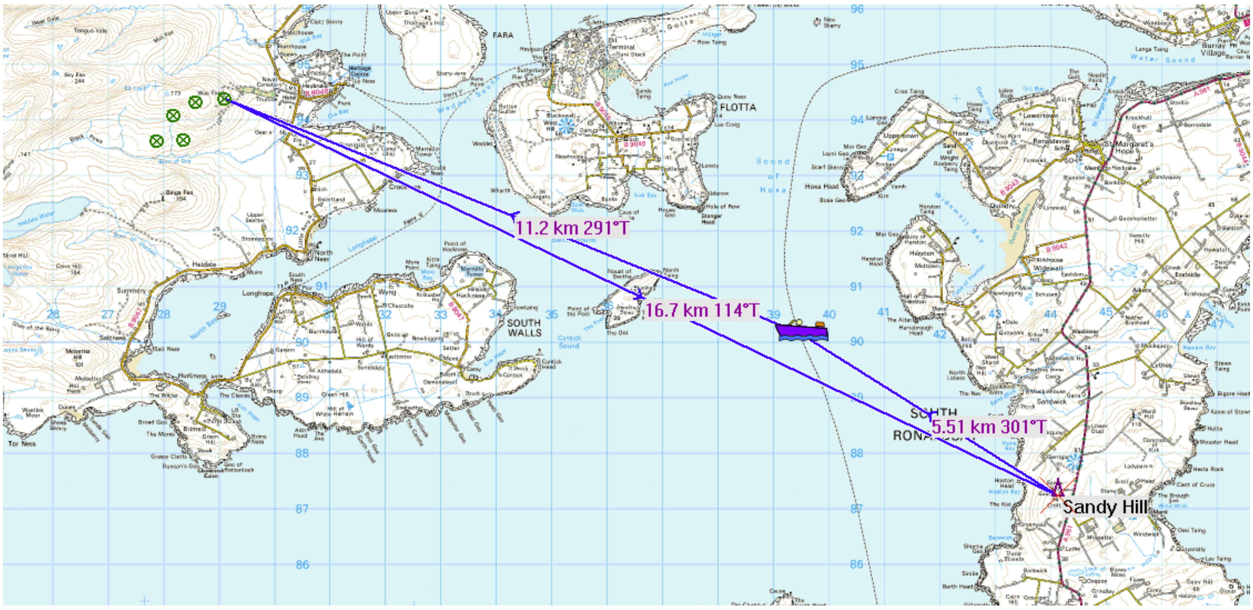
The direct detection of the turbines should not be of concern as it will be marked on the navigational maps as on land. The turbine returns can therefore be readily ignored without compromise to vessel navigation.

GHOST TARGETS

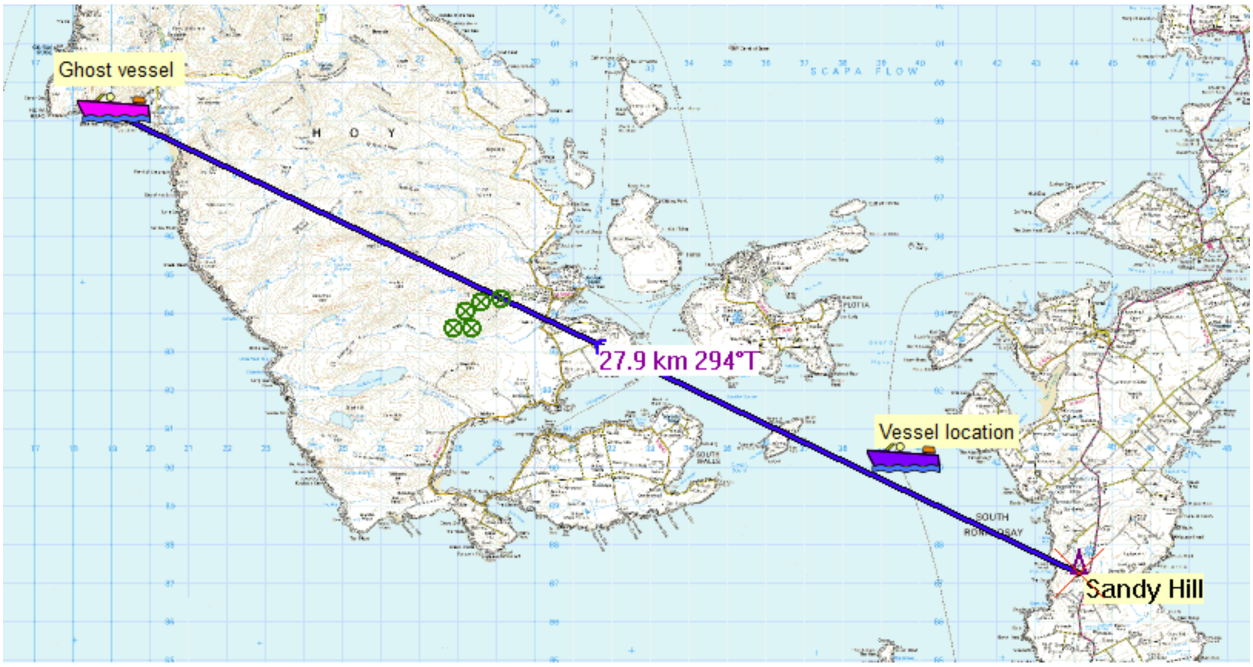
Ghost targets may be generated. This requires a strong reflection of a vessel from a turbine and hence will only occur when the turbine is in the correct orientation for the specific circumstances. In practice this will be infrequent for this reason, but cannot be eliminated as a possible impact.

Ghost targets are generated in addition to genuine targets, so a vessel will appear both at the correct location and at the ghost location.

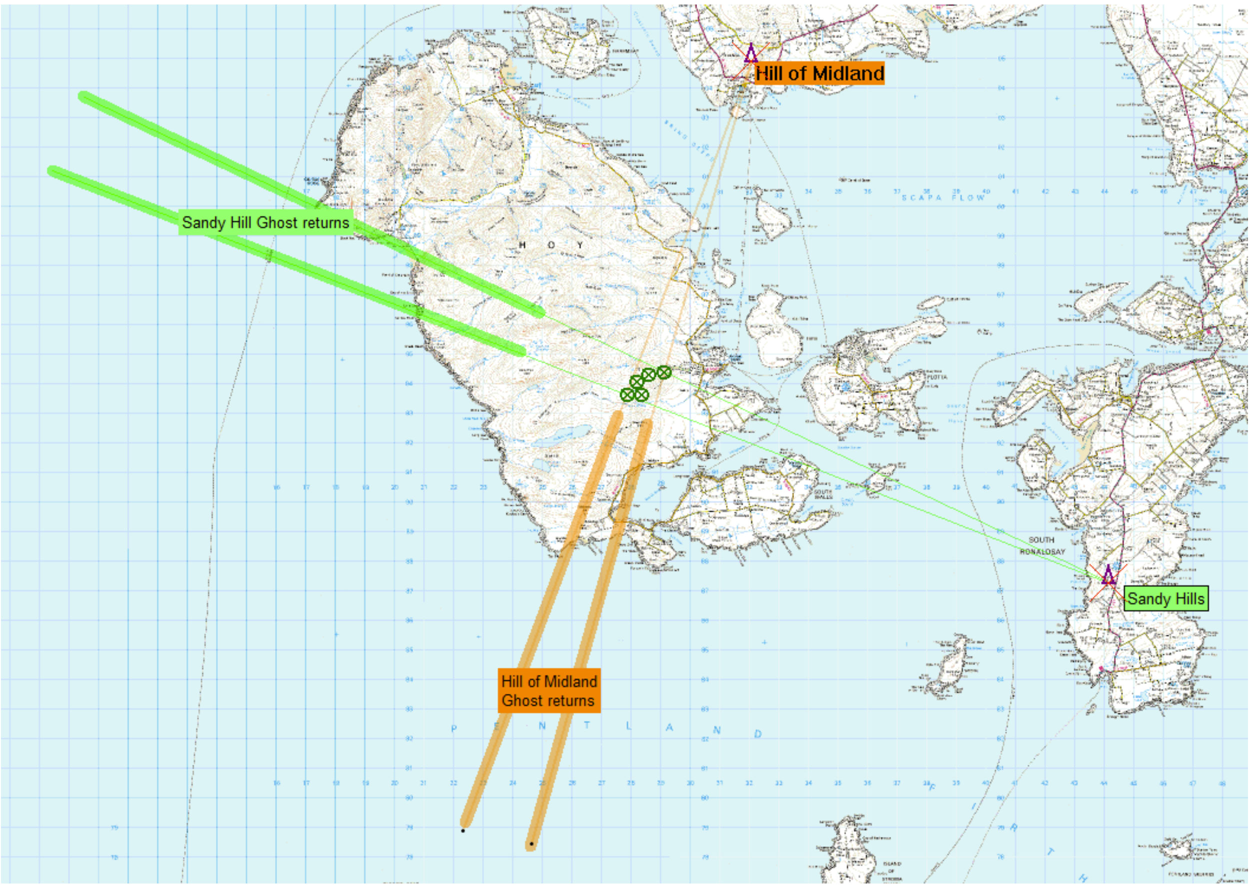
Ghost targets appear at the range of the wind farm + the distance between the wind farm and the target. They are always in the same direction as the wind farm, from which the reflections are generated, but at a greater range than the wind farm. This is illustrated in the diagrams below.



Ghost target generation path example



Ghost target location example



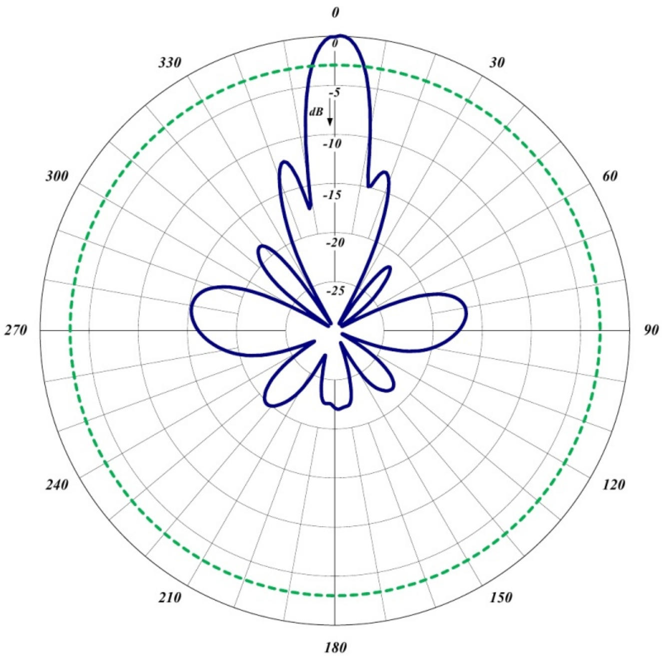
Map showing the zones in which ghost targets may be generated

Because any ghost targets will be generated behind the wind farm with respect to the source radar, it will be clear to the radar operators that the returns cannot be from vessels. This is because these areas are screened from the radars at sea level.

SIDE LOBE DETECTIONS

Side lobe detections are detections of the wind turbines when the antenna is not pointing at them. If they occur, they will be generated at the same range as the wind turbines but in a different direction. The potential for these detections depends upon the antenna pattern of the radar and hence how strongly it discriminates between detections in the main beam and in the side-lobes. The diagram here shows a simplified typical antenna pattern.

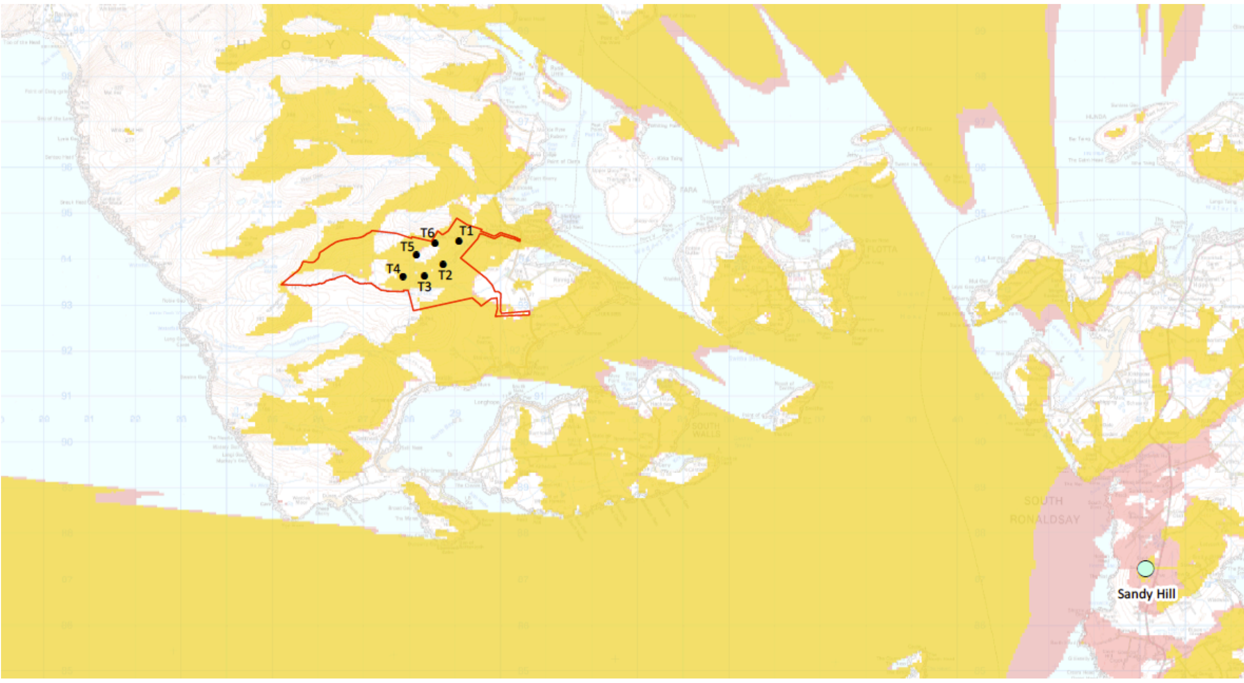
These detections will also only occur if/when the turbines are oriented to give a strong enough return, so it will depend upon wind direction. Side-lobe detections are likely to occur in consistent locations, corresponding to the largest side lobes (eg at 280 and 80 degrees in the example shown here)



Horizontal radiation pattern

SHADOWING

The shadowing effect is of little relevance here, because the Island of Hoy itself will cause greater shadows at the elevation of vessels behind the island (and wind farm) with respect to each of the radars. This is illustrated by the attached maps showing the zones of theoretical visibility; extracted below.



Map of Vessel visibility for the Sandy Hill radar

Map of Vessel visibility for the Hill of Midland radar

In each case the areas behind Hoy are already screened by land at vessel level, these areas shown as uncoloured on the maps.

RECEIVER LIMITING (SATURATION)

This effect is local to the turbines only, causing the detection threshold to rise to a level above that triggered by a smaller vessel. Because the turbines are 2km or more from sea areas where genuine targets need to be detected, this is not anticipated to have a significant effect.

EXPERIENCE

A number of studies have been conducted to investigate directly, the impacts of offshore wind turbines on marine radar, with offshore turbines having been considered as of greatest concern in the past.

Of these studies the one conducted in 2007 by Marine and Risk Consultants Limited on the Kentish Flats offshore wind farm, has been the most comprehensive.

Overall this study showed that whilst some impacts were present, experienced radar operators were readily able to discriminate between genuine returns and impacts. It was noted that Marine Radars are less complex than aviation radars and as a consequence they regularly suffer impacts and distortions in their normal operating environment, hence radar operators are routinely required to use discretion in interpreting the radar picture.

CONCLUSIONS

Of the potential impacts, only side lobe detections appear to represent any cause for concern, principally because other impacts will be able to be disregarded on the basis of their locations.

The experience to date has been that impacts are local and manageable, with competent radar operators both able and used to deciphering the radar picture containing some anomalies. It is likely that this will also be the case here.

Note that these conclusions are unlikely to be significantly altered for any commercial scale turbine, because of the high visibility of the site to the key radar.

REFERENCES

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