PAGERPOWER

# Aviation and Radar Risk Assessment

Prepared for:

**SSE Renewables Developments (UK) Ltd**

Tangy IV Wind Farm

January, 2018

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# ADMINISTRATION PAGE

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# EXECUTIVE SUMMARY

## Report Purpose

This report has assessed the potential impacts of the proposed Tangy IV Wind Farm on aviation and radar operations. The Development is to be located at the same site as the existing Tangy I and II wind developments. Consent has been granted for sixteen additional turbines with a height of 125 metres above ground level. This report has assessed the effect of increasing the proposed height to 149.9 metres above ground level.

## Findings

Navigation Aids

- The Development is 6.23 km from a Non-Directional Beacon, a navigation aid for pilots, at Campbeltown Aerodrome.
- There is a DVOR (a navigation aid) located 7.18 km from the nearest turbine within the Development. No published procedures at Campbeltown Aerodrome are reliant on the DVOR.
- The Development is 7.18 km from a Distance Measuring Equipment (DME) located to the east of the aerodrome. This is within the NATS safeguarding range, however concerns are unlikely in practice.
- No significant change in impact on navigation aids is predicted due to the proposed turbine height increase.

Aerodrome Physical Safeguarding (Collision Risk)

- The Development would breach the Outer Horizontal Surface (OHS) at Campbeltown Aerodrome. The existing Tangy I and II turbines and the elevated terrain at the site area, both already breach the OHS at the aerodrome.
- The extent of the surface breach will be greater for the new turbines than for the existing ones and the consented ones.

Procedures at Campbeltown Aerodrome

- No increase in minimum sector altitudes would be required as a result of the Development.
- The missed approach procedure for aircraft approaching runway 11 is to continue east while climbing to 2,000 feet above mean sea level, then head north, then west over the Development location to join the hold to the west of the aerodrome.
- This procedure means that aircraft pass within 500 metres horizontally of the existing, consented and proposed turbine locations. The vertical clearance between the aircraft, as per the written procedure, and the turbine tips is:
    - Between 1,135 and 1,270 feet for the existing turbines.
    - Between 870 and 1,086 feet for the consented turbines.
    - Between 788 feet and 1,004 feet for the proposed turbines.
- A typical vertical clearance requirement is 984 feet. This clearance is maintained by the existing developments, but not by the consented or proposed developments.
- It is possible that the proposed tip height increase, from 125 metres to 149.9 metres (above ground), would be of greater concern with regard to this missed approach procedure.

Other considerations

- No significant impacts are predicted on radar installations.
- No concerns are predicted with regard to military low flying.

## Next Steps

- Recommended next steps are:
    - Further assessment of potential infringement of the missed approach procedure at Campbeltown Aerodrome.
    - External assessment, via the CAA and HIAL, of the missed approach procedure at Campbeltown Aerodrome.
    - Further engagement with HIAL.

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# ABOUT PAGER POWER

Pager Power is a dedicated consultancy company based in Suffolk, UK. The company has undertaken projects in 43 countries within Europe, Africa, America, Asia and Australia.

The company comprises a team of experts to provide technical expertise and guidance on a range of planning issues for large and small developments.

Pager Power was established in 1997. Initially the company focus was on modelling the impact of wind turbines on radar systems. Over the years, the company has expanded into numerous fields including:

- Renewable energy projects.
- Building developments.
- Aviation and telecommunication systems.

Pager Power prides itself on providing comprehensive, understandable and accurate assessments of complex issues in line with national and international standards. This is underpinned by its custom software, longstanding relationships with stakeholders and active role in conferences and research efforts around the world.

Pager Power's assessments withstand legal scrutiny and the company can provide support for a project at any stage.

# 1 INTRODUCTION

## 1.1 Report Purpose

Pager Power has been retained to assess the possible impact of a proposed wind farm called 'Tangy IV', hereafter referred to as 'the Development', on aviation and radar. This report contains the following:

- Development details.
- Identification of relevant:
  - Radar (military/civil and on airfield/En Route).
  - Licenced aerodromes.
  - Navigation aids.
  - Military Low Flying.
- Technical assessment.
- Conclusions and next steps.

## 1.2 Context

The Development is to be located at the same location as the existing Tangy I and Tangy II wind farms. Combined, there are currently 22 turbines with tip heights of 75 metres above ground level at the site (15 within Tangy I and a further 7 within Tangy II).

Tangy IV, which comprises 16 turbines, is likely to replace the existing wind developments. The new wind turbine heights are 149.9 metres, which is taller than the existing turbines.

# 2 DEVELOPMENT DETAILS

## 2.1 Tangy IV

The Development will comprise 16 turbines with a tip height of up to 149 metres above ground level and a rotor diameter of up to 130 metres. Figure 1 below shows the Development location (provided to Pager Power by the Developer).

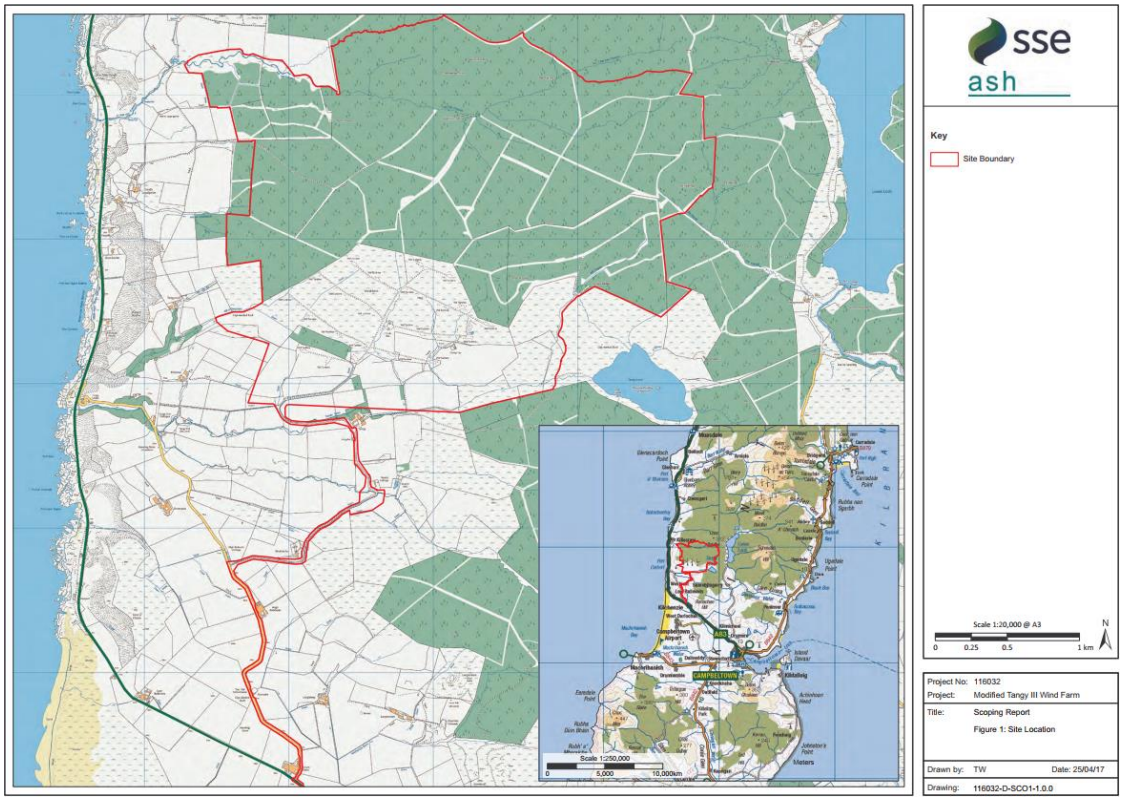


Figure 1 *Development location*

The layout that has been assessed within this report is shown in Table 1 below.

| Turbine | Easting | Northing | Turbine | Easting | Northing |
|---|---|---|---|---|---|
| 01 | 167315 | 628150 | 09 | 168130 | 629820 |
| 02 | 167860 | 628240 | 10 | 168650 | 629740 |
| 03 | 167392 | 628558 | 11 | 169185 | 629495 |
| 04 | 168349 | 628427 | 12 | 169000 | 628979 |
| 05 | 168850 | 628597 | 13 | 168475 | 628908 |
| 06 | 167456 | 628996 | 14 | 167951 | 628835 |
| 07 | 167517 | 629424 | 15 | 168040 | 629307 |
| 08 | 167555 | 629887 | 16 | 168573 | 629327 |

Table 1 *Assessed layout*

# 3 TECHNICAL BACKGROUND

## 3.1 Potential Radar Impacts

Wind turbines can affect radar by reflecting or obstructing the emitted radar signal. The most commonly affected radar types are set out in Table 2 below.

| Radar Type | Short Description | Potential Turbine Impacts | Wind Farm Safeguarding Criteria |
|---|---|---|---|
| Primary Surveillance Radar (PSR) | This is a non-cooperative radar system, designed to detect moving targets (aircraft) by emitting a radar signal and receiving an echo. The time delay between emitting the signal and receiving the echo, combined with the bearing of the rotating radar antenna, allow the range and bearing of the target to be determined.<br>In the UK, such radar are used by military and civil operators, both for En-Route purposes and for operations at specific airports. | Reflections of the radar signal by wind turbines could lead to wind developments falsely being displayed as targets (aircraft) on an air traffic controller's screen.<br>Other concerns such as obstruction of the radar signal and overloading receivers can be raised but are unlikely to be technically or operationally significant. | Civil En-Route PSR installations are safeguarded by NATS in the UK, out to distances of over 100 km in some cases.<br>Civil on-aerodrome PSR installations are typically safeguarded within 30 km, however there is no formal cut-off distance.<br>Military PSR installations are typically safeguarded to their maximum instrumented range. |
| Secondary Surveillance Radar (SSR) | This is a cooperative radar system, designed to send and receive information via an aircraft's transponder.<br>In the UK, such radar are used by military and civil operators, both for En-Route purposes and for operations at specific airports. | Reflection of the signal from the radar or the aircraft transponder can affect the accuracy of the range and bearing information displayed on the radar operator's screen.<br>Other concerns such as obstruction of the radar signal can be raised. | Civil and military SSR installations in the UK are typically safeguarded to ranges of 10-30 kilometres. |

| Radar Type | Short Description | Potential Turbine Impacts | Wind Farm Safeguarding Criteria |
|---|---|---|---|
| Meteorological Radar | Meteorological radar are used to monitor and predict precipitation / rainfall. | Reflection of the radar signal can affect the apparent precipitation levels displayed on the radar screen.<br>Obstruction of the radar beam can be a concern, particularly if the turbine(s) are above the horizontal relative to the centre of the radar. | Meteorological radar installations are rarely safeguarded beyond 20 km. |
| Precision Approach Radar (PAR) | An on-airfield radar designed to guide aircraft to the touchdown point very accurately. The radar is directed towards the end of the runway that is being used, and does not rotate.<br>In the UK such radar are used exclusively by the military. | Reflections of the radar signal by wind turbines can affect the radar's accuracy and performance. | Safeguarding is typically within a defined 'cone' emanating from runways that have an available PAR approach. Beyond approximately 20 nautical miles, concerns are highly unlikely. |

Table 2 *Commonly affected radar types*

## 3.2 Navigation Aids

Navigation aids are ground-based installations that emit and/or receive radio signals in order to help aircraft navigate more accurately. Some commonly affected navigation aids are shown in Table 3 below.

| Navigation Aid | Short Description | Potential Turbine Impacts | Wind Farm Safeguarding Criteria |
|---|---|---|---|
| VHF Omni-Range (VHF) | Ground station that emits a reference and variable radio signal that allows a pilot to determine the aircraft bearing relative to the beacon location. | Reflection or obstruction of the emitted signal can affect the accuracy of the information received by a pilot. | Typically safeguarded to approximately 10 km by NATS in the UK. |
| Distance Measuring Equipment (DME) | Ground station that emits a signal designed to help pilots accurately determine their distance from the beacon location. | Reflection or obstruction of the emitted signal can affect the accuracy of the information received by a pilot. | Typically safeguarded to approximately 10 km by NATS in the UK. |

| Navigation Aid | Short Description | Potential Turbine Impacts | Wind Farm Safeguarding Criteria |
|---|---|---|---|
| Air-Ground-Air Station | Ground station that facilitates voice communication, via radio, between operators on the ground and pilots of aircraft. | Reflection or obstruction of the emitted signal can affect the quality of the communications. | Typically safeguarded to approximately 10 km by NATS in the UK. |
| Instrument Landing System (ILS) | Runway approach aid that emits two radio signals that, in combination, give vertical and horizontal guidance to a pilot approaching a runway. | Reflection or obstruction of the emitted signal can affect the accuracy of the ILS data received by a pilot. | This can vary – it is most significant for developments that are in line with an airport's runway. |
| Non-Directional Beacon (NDB) | A ground station that emits a signal in all directions, containing information for station identification. | Reflection or obstruction of the signal could affect the quality of the signal reaching the aircraft. | This can vary. |

Table 3 *Commonly affected navigation aids*

## 3.3 Aerodromes

**Technical Considerations**

Licensed and military aerodromes are safeguarded against physical obstructions (collision risk) based on assessment of Obstacle Limitation Surfaces (OLSs).

The rules for defining each OLS are published by the Civil Aviation Authority (CAA) and the Military Aviation Authority (MAA) for licensed civil and military aerodromes respectively.

The dimensions of an OLS are determined by various technical parameters including runway length[1]. Proposed wind developments are assessed against OLSs to minimise collision risks.

**Operational Considerations**

The impacts of proposed wind developments on operations at nearby aerodromes must be assessed, particularly where technical impacts are predicted.

## 3.4 Military Low Flying

Military low flying can take place anywhere in the UK. The MOD publishes a map showing which areas are strategically of most concern with regard to wind turbine developments specifically.

[1] Formally based on declared distances for civil licensed aerodromes, in practice these are closely correlated to physical runway length in most cases.

# 4 ASSESSMENT

## 4.1 Methodology

Potentially affected aviation and radar installations have been identified. Technical assessment has been undertaken based on the issues set out in the previous section.

The aim of the assessment is to establish the effect of the height increase from 125 metres above ground level to 149.9 metres above ground level. The former has already been consented subject to conditions.

The presence of the Tangy I and Tangy II developments, located at the same site as the proposed turbines, has also been considered within the overall assessment.

## 4.2 Radar Impacts

The Development is unlikely to affect any radar installations. Specifically:

- On-airfield radar are unlikely to be affected due to the Development's distance from licensed and military aerodromes that are equipped with radar.
- The NATS Tiree En-Route radar is not predicted to have line of sight to the turbines. The NATS Lowther Hill En-Route radar is predicted to have marginal[2] line of sight to one of the sixteen turbines – this is unlikely to be significant in practice.
- Meteorological radar installations are unlikely to be affected due to the distance of the Development from any such radar.

## 4.3 Navigation Aids

The following navigation aids are the most significant with regard to the Development:

- NDB at Campbeltown Aerodrome.
- DVOR east of Campbeltown Aerodrome.
- DME east of Campbeltown Aerodrome.

Figure 2 on the following page[3] shows the relative locations of the navigation aids.

[2] Predicted visibility of less than 2 metres at a range of more than 100 km.
[3] ©2018 Gettmapping plc, Terrametrics, DigitalGlobe, Google

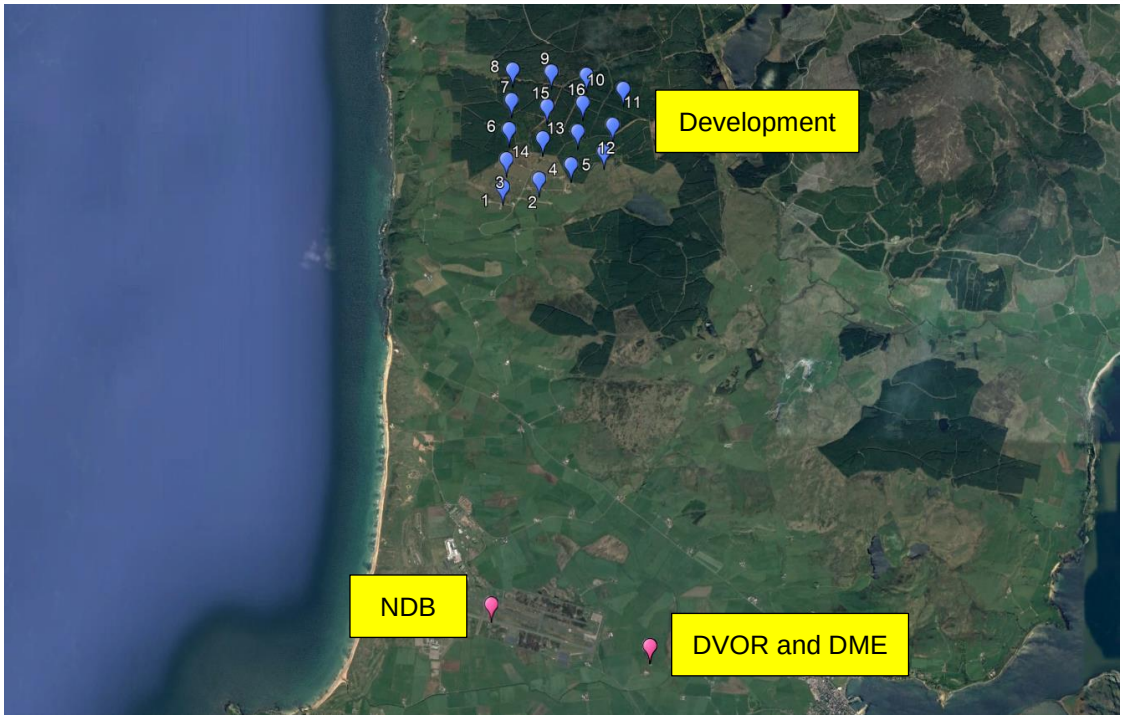


Figure 2 *Navigation aids*

**NDB Impact**

The NDB is located approximately 6.23 km from the nearest turbine. The beacon is located to the south of the Development.

The potential impact of the Development would be similar to the impact of the existing Tangy I and II developments.

The height increase, from 125 metres to 149.9 metres (above ground), is unlikely to make a material difference regarding impact on the NDB.

**DVOR Impact**

The DVOR is collocated with the DME to the east of Campbeltown Aerodrome.

It is understood that the DVOR was scheduled to be decommissioned by NATS as part of their work to refine their operations and that ownership was subsequently transferred to Campbeltown Aerodrome.

A review of the published procedures at the airport has been completed. No procedures that rely on the DVOR have been identified.

The height increase, from 125 metres to 149.9 metres (above ground), is unlikely to make a material difference regarding impact on the DVOR.

**DME Impact**

The DME is collocated with the DVOR to the east of Campbeltown Aerodrome. It is safeguarded by NATS. The NATS AIP states that:

*Due to terrain, coverage at low level is reduced in Sectors R123°-163°, R208°- 238° and R348°-083°*

The Development is located mostly within the sector 348-083 degrees, such that coverage in the direction of the Development is already compromised to some extent.

The height increase, from 125 metres to 149.9 metres (above ground), is unlikely to make a material difference regarding impact on the DME.

## 4.4 Aerodromes

The nearest licensed aerodrome is Campbeltown Aerodrome, which is operated and managed by Highlands and Islands Airport Limited (HIAL).

**Physical Safeguarding – Campbeltown Aerodrome**

All proposed turbines within the Development are located beneath the Outer Horizontal Surface (OHS). All turbines breach the surface – largely due to the elevated terrain at the site location which itself breaches the surface in parts.

This means that the existing Tangy I and II developments will breach the OHS. It also means the consented turbines at 125 metres would breach the OHS.

No other surfaces are affected.

**Operations – Campbeltown Aerodrome**

Figure 3 below[4] shows the missed approach procedure for aircraft approaching Runway 11 at Campbeltown Aerodrome.

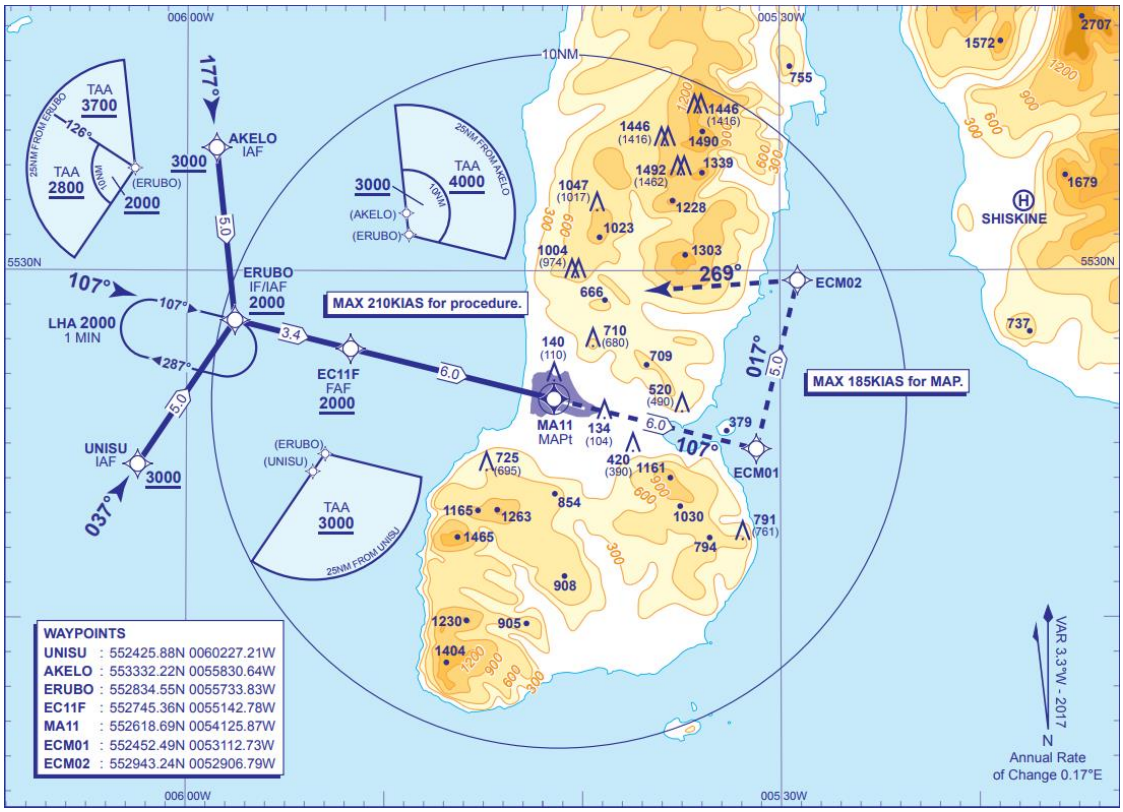


Figure 3 *Missed approach procedure (chart)*

Figure 4 on the following page[5] shows this path overlaid onto imagery of the Development location.

[4] Source: NATS AIP accessed January 2018
[5] ©2018 Gettmapping plc, Terrametrics, DigitalGlobe, Google

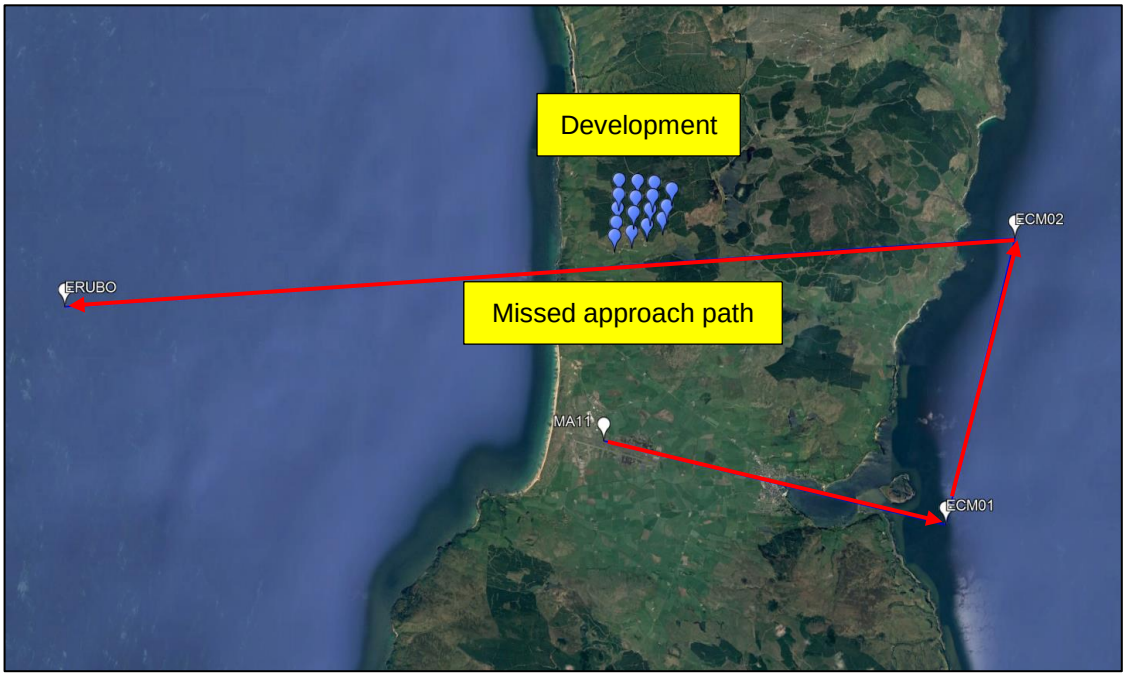


Figure 4 *Missed approach procedure (aerial)*

Aircraft following this missed approach path will pass within 500 metres of the Development. The turbine elevations will range from 996 feet to 1,212 feet above mean sea level.

Aircraft following this missed approach procedure would be at 2,000 feet or more above mean sea level, which means the vertical clearance above the turbine tips would be between 788 and 1,004 feet.

For the consented tip heights of 125 metres above ground level, the vertical clearance would be between 870 feet and 1,086 feet.

For the existing turbines, the vertical clearance is between 1,135 and 1,270 feet.

Typically, the required vertical clearance between an aircraft flying such a procedure and an obstacle would be 984 feet (300 metres).

The typical recommended clearance is maintained by the existing development. It is not maintained by the consented development even for a tip height of 125 metres above ground level.

It is possible that the proposed tip height increase, from 125 metres to 149.9 metres (above ground), would be of greater concern with regard to this missed approach procedure.

Further assessment of the procedure is recommended in order to ascertain whether safeguarding rules are breached by the Development.

## 4.5 Military Low Flying Impacts

The Development is located within an area that is low priority with regard to military low flying. The MOD has advised in May 2017 that it has no objections.

No impact on military low flying is predicted.

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# 5 OVERALL CONCLUSIONS

## 5.1 Analysis Results

The assessment has found that the change in impact due to the proposed turbine height increase is likely to be insignificant for:

- Radar installations.
- Military low flying.
- Navigation aids.

Potential concerns are possible for:

- Procedures at Campbeltown Aerodrome – specifically the missed approach procedure for aircraft approaching Runway 11.

## 5.2 Recommendation

It is recommended that further investigation of the potential impacts on instrument flight procedures at Campbeltown Aerodrome is undertaken. This can be progressed via:

- Further technical assessment.
- External assessment via HIAL and the CAA.
- Consultation with HIAL.


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