



PAGERPOWER

Instrument Flight Procedure Assessment

Prepared for:

**SSE Renewables Developments
(UK) Ltd**

Tangy IV Wind Farm

February, 2018



ADMINISTRATION PAGE

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Issue	Date	Detail of Changes
1	February, 2018	Initial issue

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EXECUTIVE SUMMARY

Report Purpose

This report has assessed the potential impacts of the proposed Tangy IV Wind Farm on missed approach procedure for aircraft approaching runway 11 at Campbeltown Aerodrome. Aircraft flying this procedure would pass to the south of the Development.

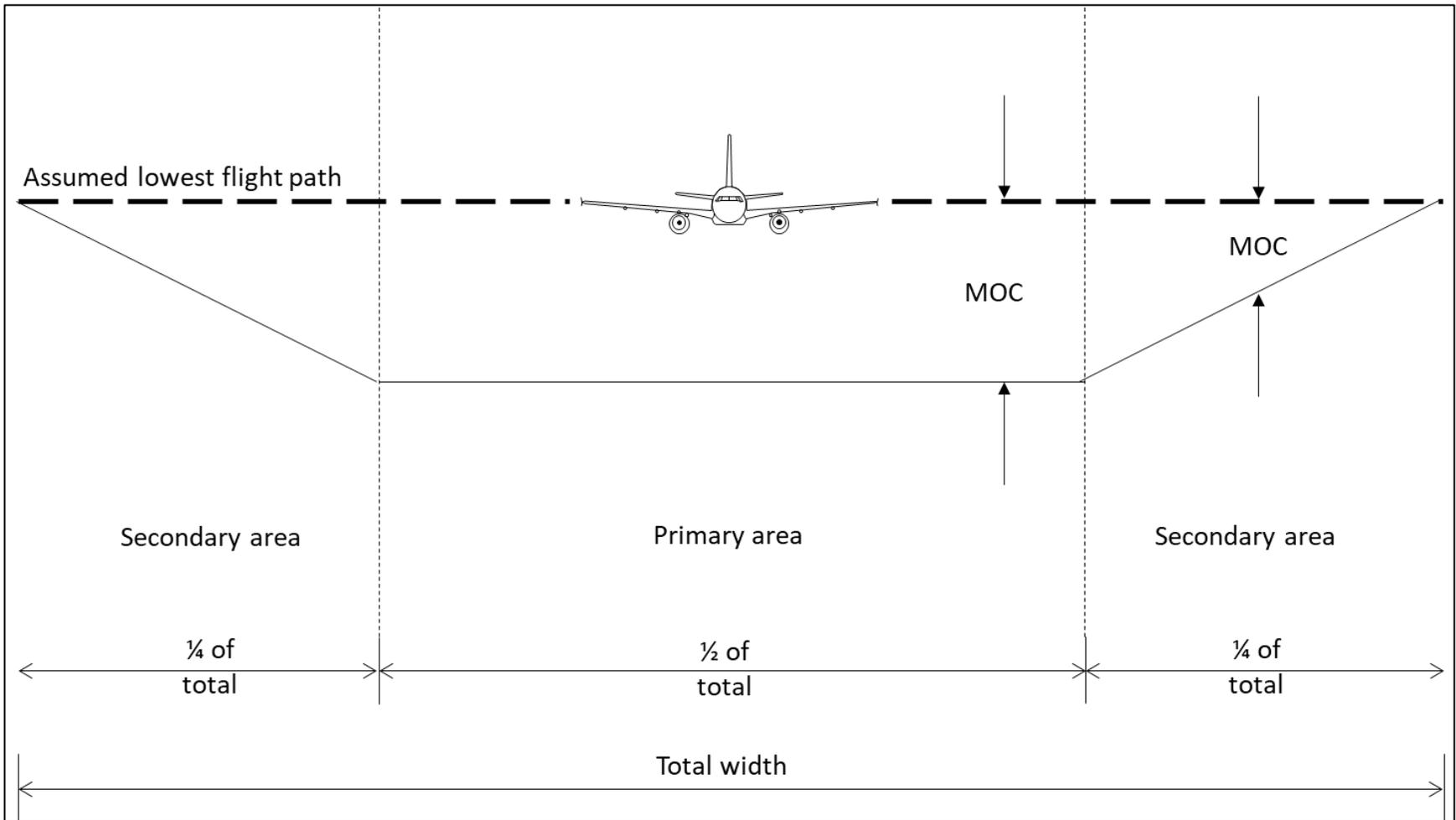
The safeguarding process for this procedure has been assessed in accordance with the guidance set out in the International Civil Aviation Organisation (ICAO) Doc 8168 Procedures for Air Navigation Services (PANS-OPS). The procedures set out in this document are the international standard used in many countries around the world.

Findings

- The Minimum Obstacle Clearance (MOC) that must be maintained beneath an aircraft flying missed approach is defined as shown in the figure on the following page.
- At the Development location, the MOC is 50 metres. This means the tip of the turbines would have to be at least 50 metres below the aircraft if they were located within the 'primary area' beneath the flight path.
- The aircraft altitude specified within the procedure is 2,000 feet (609.6 m) above mean sea level. All proposed turbine tips within the Development are more than 50 metres below this altitude. If the turbines were 149.9 metres above ground level, the most elevated turbine tip within the development would be 1,211 feet (369.2 m) above mean sea level. This is a clearance of 240 metres, which is more than four times the required clearance.

Recommendation

- This report should be made available to HIAL.
- It is likely that external assessment from the CAA in conjunction with HIAL will be required to confirm the safeguarding criteria for Instrument Flight Procedures are maintained. It is recommended that this external assessment is initiated.



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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 the Missed Approach Procedure for aircraft approaching Runway 11 at Campbeltown Airport.

1.2 Previous Analysis

An aviation and radar risk assessment¹ identified the missed approach procedure for aircraft approaching runway 11 at Campbeltown Aerodrome as a potential concern.

Aircraft following this missed approach path will pass within 500 metres of the Development.

Figure 1 below² shows the missed approach procedure for aircraft approaching Runway 11 at Campbeltown Aerodrome.



Figure 1 Missed approach procedure (chart)

Figure 2 on the following page³ shows this path overlaid onto imagery of the Development location.

¹ Pager Power, 2018,

² Source: NATS AIP accessed January 2018

³ ©2018 Getmapping plc, Terrametrics, DigitalGlobe, Google

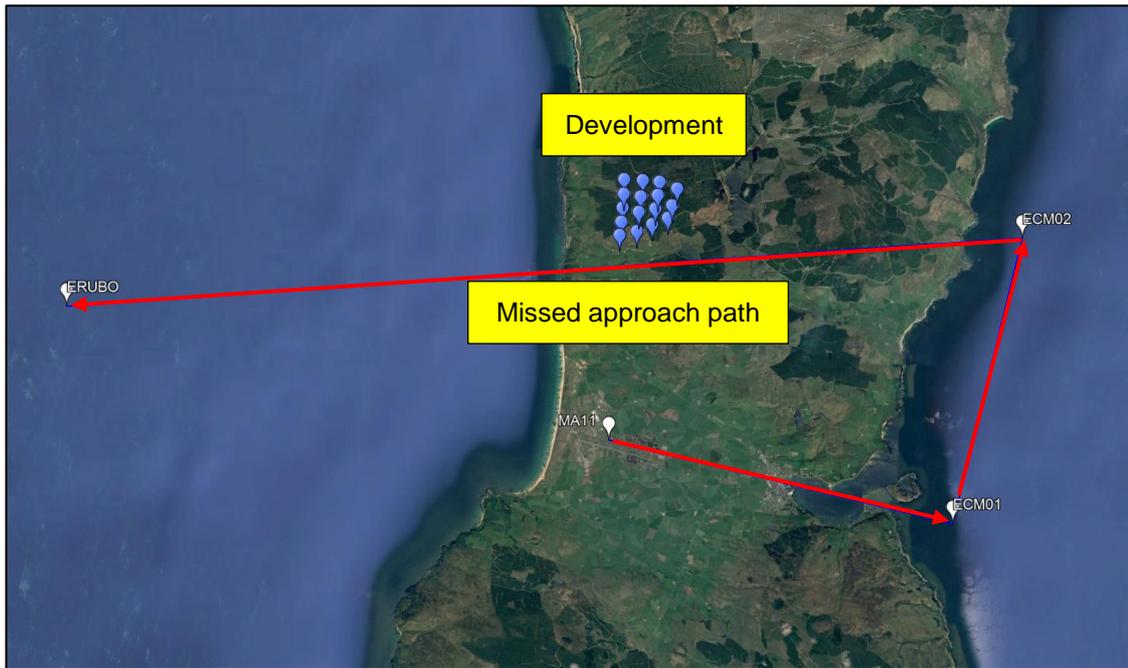


Figure 2 Missed approach procedure (aerial)

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 3 below shows the Development location (provided to Pager Power by the Developer).

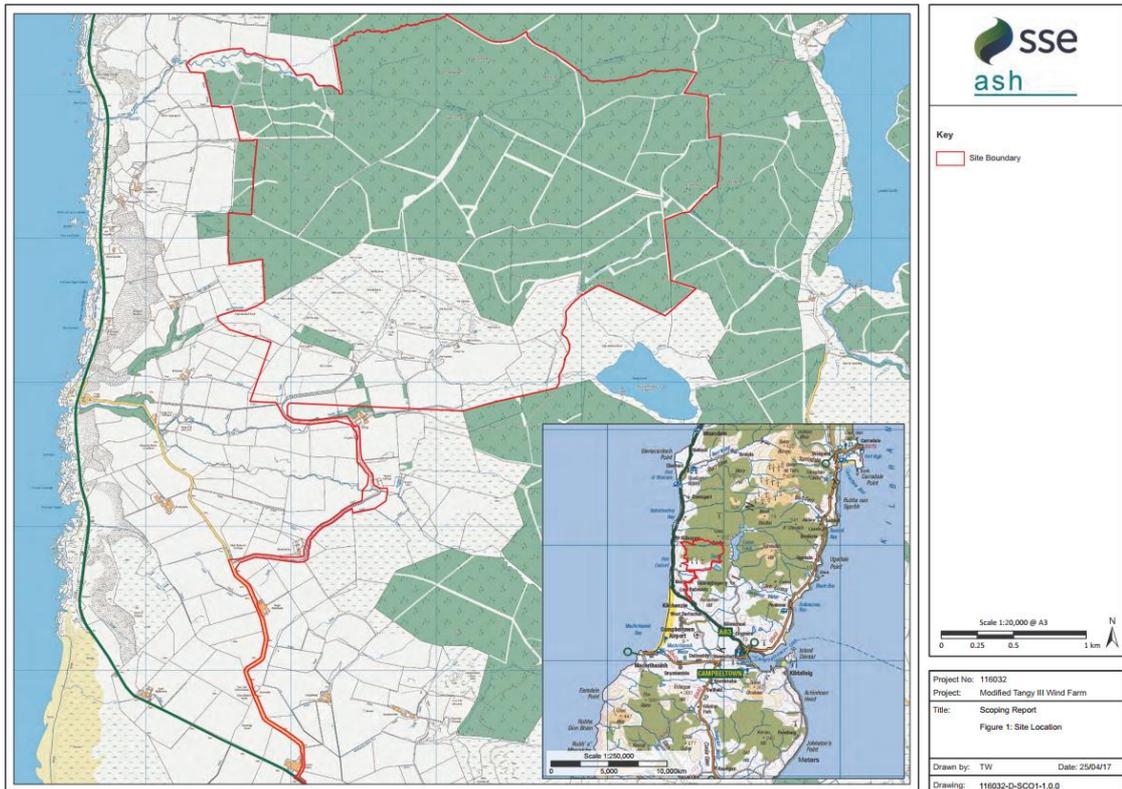


Figure 3 Development location

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 LITERATURE REVIEW

3.1 Relevant Documents

The sections below summarise the publications that are relevant with regard to safeguarding Instrument Flight Procedures in the United Kingdom.

3.2 PANS-OPS

The International Civil Aviation Organisation (ICAO) provides a publication called Doc 8168 Procedures for Air Navigation Services (PANS-OPS).

The procedures set out in this document are the international standard used in many countries around the world.

PANS-OPS provides extensive detail regarding the safeguarding of missed approach procedures against obstacles.

The potential impact on the missed approach procedure has been assessed in accordance with PANS-OPS, further details are set out in Section 4.

3.3 CAP 764 – Policy and Guidelines on Wind Turbines

The UK Civil Aviation Authority (CAA) produces a document called Civil Aviation Publication (CAP) 764 titled *Policy and Guidelines on Wind Turbines*. Version 6 is current at the time of writing.

There are references to missed approaches within the document, however these are mostly general without specific measures for safeguarding a missed approach procedure against wind turbines.

3.4 CAP 168 – Licensing of Aerodromes

The CAA produces CAP 168 titled *Licensing of Aerodromes*. Version 10 is current at the time of writing.

There are references to missed approaches within the document, however it does not set out explicit obstacle clearance parameters that are relevant for the Development.

4 PANS-OPS

4.1 Key Sections and Findings from PANS-OPS

The key sections that have informed this assessment are summarised in Table 2 below. The assessment has been undertaken in accordance with Edition 5 dated 2006.

Section Number	Section Name	Key Extract	Relevance	Remarks
1.2.1	Areas	<i>Each segment has an associated area ... subdivided into primary and secondary areas... When secondary areas are permitted, the outer half of each side of the area ... is designated as secondary area. See Figure I-2-1-1.</i>	This sets out the general form of the safeguarding zone for obstacles beneath an aircraft.	The figure referred to in the document has been reproduced on reference (see Figure 4 of this report or the executive summary).
6.1.2	<i>Phases of missed approach segment</i>	<i>c) final phase – extends to the point at which a new approach, holding or return to en-route flight is initiated.</i>	The turbines are potential obstructions in the final phase of a missed approach.	-
6.1.3	<i>Types of missed approach</i>	<i>There are two types of missed approach: a) Straight missed approach (includes turns less than or equal to 15 degrees); and b) turning missed approach.</i>	The procedure in question is a turning missed approach.	-
6.4.5.3	<i>Obstacle clearance for turns at a designated altitude</i>	<i>Obstacle elevation/height in the turn area shall be less than: TNA/H + d₀ tan Z – MOC ... MOC is 50 m ... reducing linearly to zero at the outer edge of the secondary areas</i>	This describes how to calculate minimal obstacle clearance for a turning missed approach, such as the one being assessed for Campbelltown Aerodrome.	In this equation: TNA/H is the altitude/height of the aircraft at the turn. d ₀ is measured from the obstacle to the turn initiation. Tan Z is the tangent of the angle of the missed approach surface with the horizontal plane.

Table 2 PANS-OPS key sections

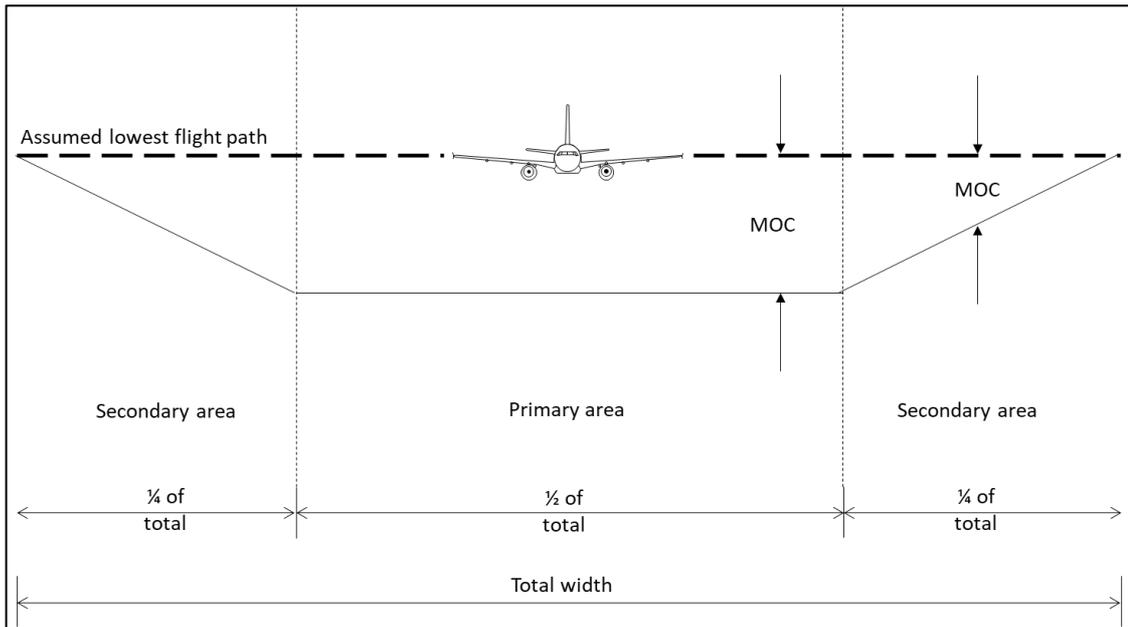


Figure 4 *Obstacle safeguarding – cross section*

5 ASSESSMENT

5.1 Vertical Clearance

The vertical clearance required⁴ for aircraft following the missed approach procedure nearest the Development is described by the equation⁵:

$$\text{TNA/H} + d_0 \tan Z - \text{MOC}$$

Where:

- TNA/H is the altitude/height of the aircraft when it turns.
 - In this case, the altitude is 2,000 feet above mean sea level as per the procedure.
- $d_0 \tan Z$ is the product of the distance between the aircraft and the turn initiation point and the tangent of the surface relative to the horizontal.
 - In this case, the aircraft is travelling horizontally as per the procedure so this argument of the equation is zero.
- MOC is the Minimum Obstacle Clearance required for a turning missed approach.
 - MOC is defined as 50 metres as per Section 6.4.5.3 of PANS-OPS.

5.2 Calculation

Any turbine blade tips that are more than 50 metres (164 feet) below the aircraft will not cause a safeguarding concern with regard to the missed approach.

Considering turbines with a tip height of 149.9 metres, the blade tip elevation across the Development 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 minimum vertical clearance above the turbine tips would be between 788 feet.

⁴ In the primary area – which is the most restrictive

⁵ See Table 2 in Section 4

6 CONCLUSIONS

6.1 Analysis Results

- At the Development location, the MOC is 50 metres – i.e. the tip of the turbines would have to be at least 50 metres below the aircraft if they were located within the 'primary area' beneath the flight path.
- All proposed turbine tips within the Development are more than 50 metres below this altitude. If the turbines were 149.9 metres above ground level, the most elevated turbine tip within the development would be 1,211 feet (369.2 m) above mean sea level. This is a clearance of 240 metres, which is more than four times the required clearance.

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