

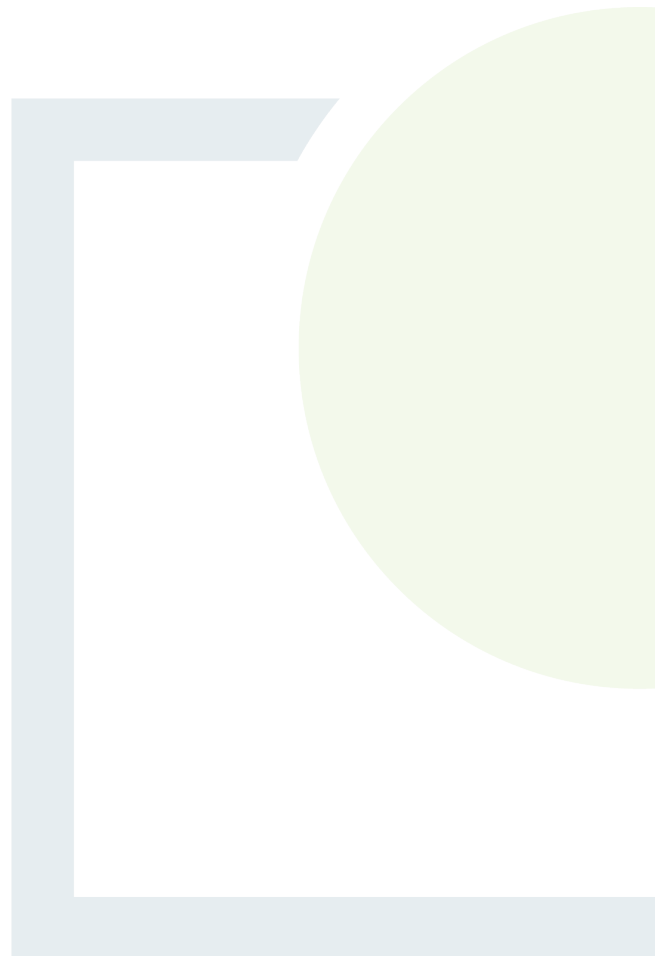


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CONSULTANTS IN ENGINEERING,
ENVIRONMENTAL SCIENCE & PLANNING

APPENDIX 16.2

Ballinagree Wind Farm
Impact on ILS Flight
Inspection (Report)





FLIGHT CALIBRATION SERVICES LTD

BALLINAGREE WIND FARM IMPACT ON ILS FLIGHT INSPECTION

Prepared For:	Fehily Timoney and Company
Author:	John Wilson
Reviewed by:	David Bartlett
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BALLINAGREE WIND FARM

Impact on ILS Flight Inspection

TABLE OF CONTENTS

1	Introduction.....	4
2	Details of Proposed Wind Farm	4
3	ILS Information	9
3.1	ILS Site Information	9
3.2	ILS Coverage Information	9
4	ICAO ILS Flight Inspection Recommendations	13
5	FCSL Flight Inspection Procedures.....	13
6	Impact Assessment	15
6.1	ILS Centreline Approach Flight Profile	15
6.2	ILS Part Orbit Flight Profile	15
7	Conclusions	17

ABBREVIATIONS

AIP	Aeronautical Information Publication
AMSL	Above Mean Sea Level
DME	Distance Measuring Equipment
FCSL	Flight Calibration Services Ltd
FIP	Flight Inspection Procedure
GP	Glide Path
GPS	Global Positioning System
ha	hectare
IAA	Irish Aviation Authority
ICAO	International Civil Aviation Organization
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
ING	Irish National Grid
LOC	Localiser
NM	Nautical Miles
WGS	World Geodetic System

1 INTRODUCTION

Ballinagree Wind Farm is a proposed renewable energy project located in County Cork in an area near Carrigagulla, approximately 20 NM north west of Cork Airport.

The Irish Aviation Authority (IAA) has requested that an assessment be performed to establish any adverse effect the proposed wind farm may have on flight inspection procedures and profiles associated with commissioning and calibrating the Cork Airport Runway 16 Instrument Landing System (ILS).

This report provides an assessment of the impact of terrain and obstacles on ILS flight inspection procedures. All references to turbine positions relate to Design Iteration 1 of the proposed project and are located within a fixed site boundary.

2 DETAILS OF PROPOSED WIND FARM

This study assesses Design Iteration 1 of the proposed Ballinagree Wind Farm and the proposed 100m meteorological mast (planning reference: 20/5342). Design Iteration 1 of the proposed Ballinagree Wind Farm comprises 19 wind turbines and associated infrastructure including turbine foundations, access tracks, an electricity substation, control building and meteorological mast located in an area of approximately 1000 ha as shown in Figure 2.1 below. Figure 2.2 below shows the location of the wind farm and proposed 100 m meteorological mast in relation to Cork Airport.

The proposed wind turbine and meteorological mast coordinates are shown in Table 2.1 below.

The maximum height of the proposed wind turbines (to blade tip) is 185 m (607 ft) above ground level. Ground height at the highest turbine (T14) is assumed to be 470 m (1542 ft) AMSL (see Figure 2.1 below).

The proposed meteorological mast is a 100 m high guyed lattice mast structure as shown in Figure 2.3 below.



Figure 2.1 - Design Iteration 1 of the Proposed Ballinagree Wind Farm Site Layout

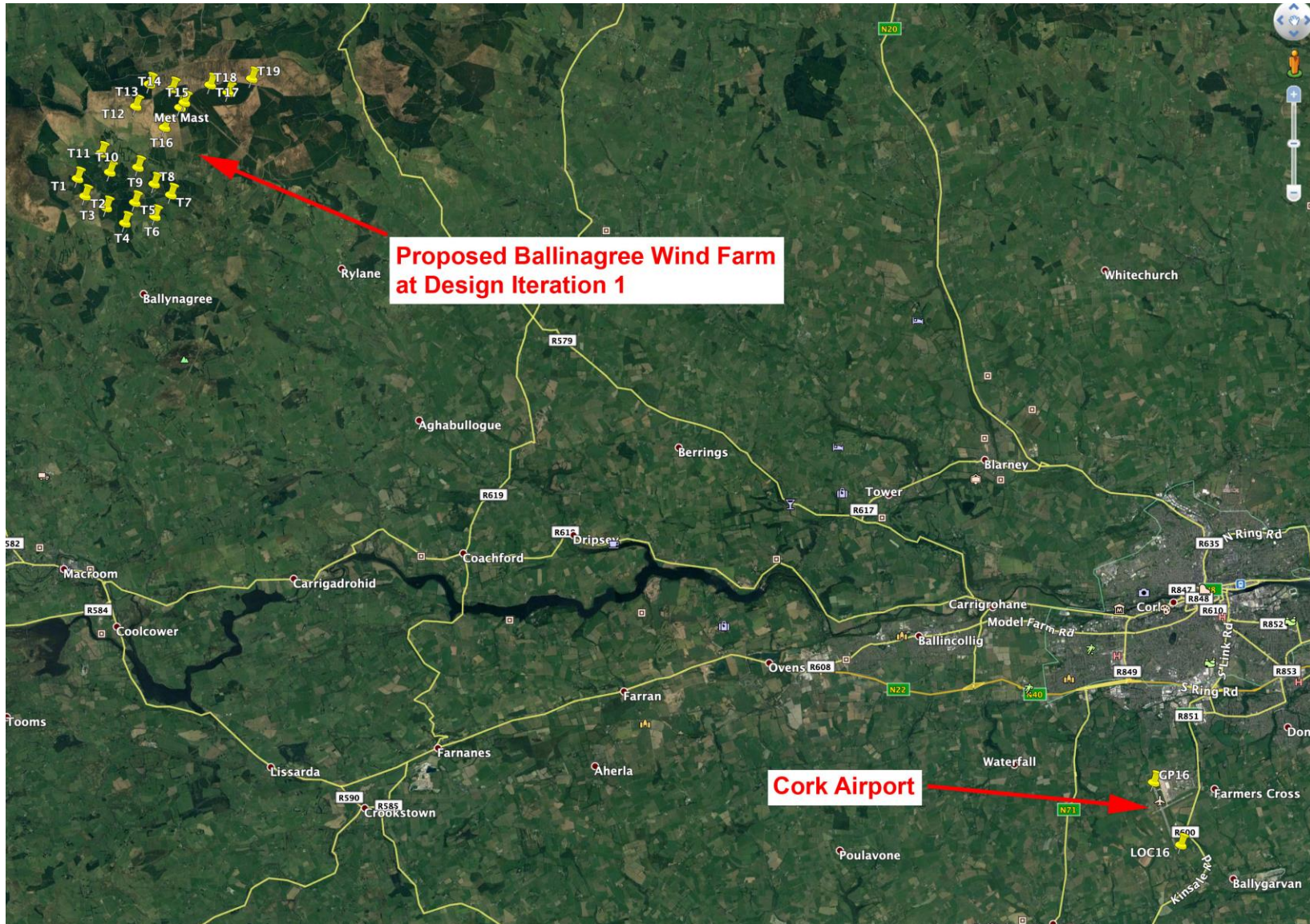


Figure 2.2 – Location of Proposed Ballinagree Wind Farm and Cork Airport

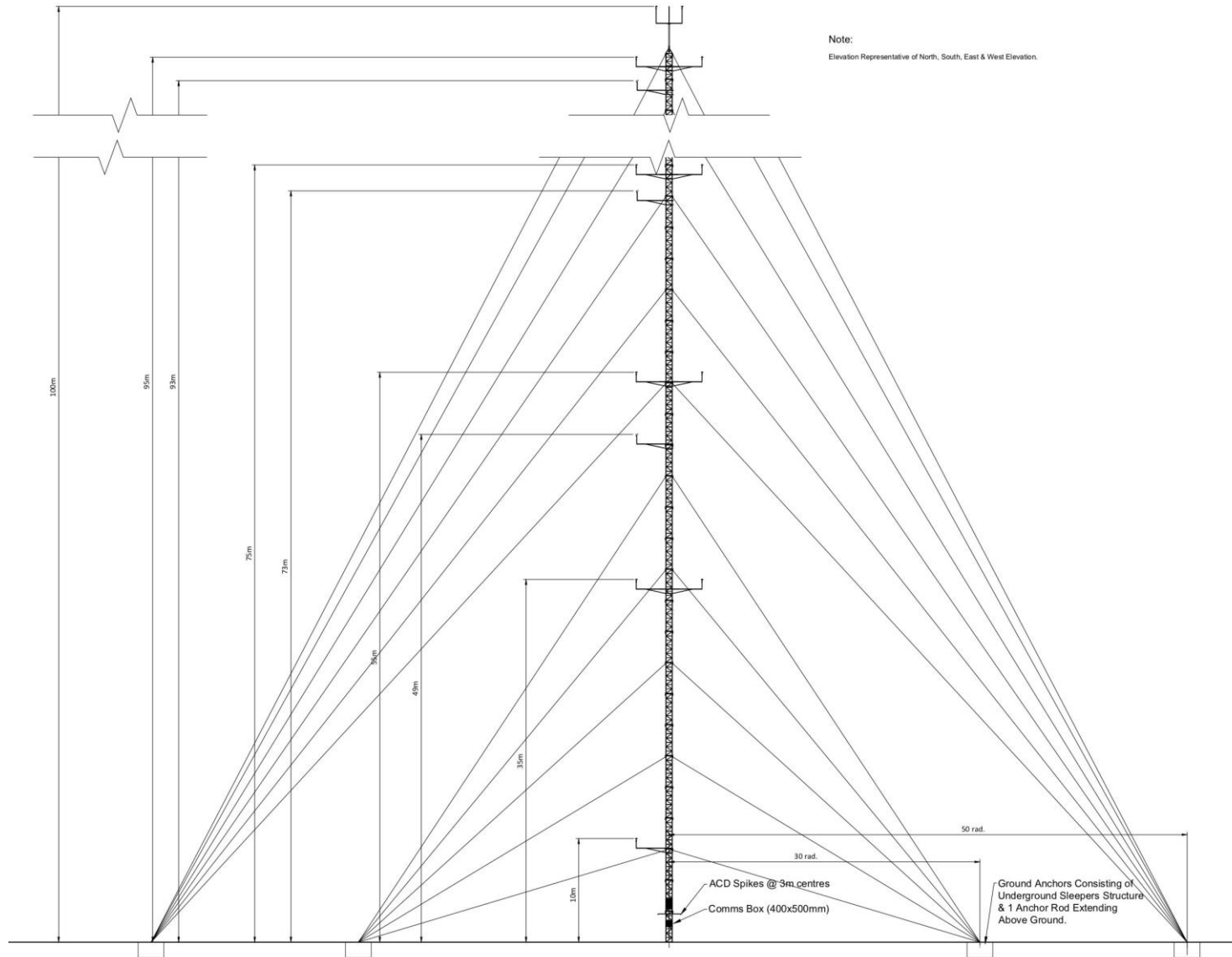


Figure 2.3 – Proposed Meteorological Mast

Turbine	ING Coordinates		WGS-84 Coordinates	
	Easting	Northing	Latitude	Longitude
T1	134560	83979	52.00432125	-8.95376701
T2	134770	83470	51.99977121	-8.95061192
T3	135412	83118	51.99668259	-8.94119723
T4	135931	82677	51.99277912	-8.93355798
T5	136227	83273	51.99816993	-8.92935941
T6	136796	82867	51.99458595	-8.92099941
T7	137247	83503	52.00035338	-8.91454946
T8	136763	83822	52.00316556	-8.92165615
T9	136300	84307	52.00747169	-8.92848876
T10	135490	84164	52.00609287	-8.94025850
T11	135266	84711	52.01097409	-8.94362390
T12	136314	86034	52.02298620	-8.92860600
T13	136723	86670	52.02874924	-8.92276497
T14	137399	86519	52.02746882	-8.91288747
T15	137604	85986	52.02270142	-8.90980332
T16	137114	85436	52.01770279	-8.91684098
T17	138475	86642	52.02869475	-8.89723180
T18	138997	86415	52.02671219	-8.88958532
T19	139673	86823	52.03045320	-8.87980778
Met Mast	137738	086127	52.023983761	-8.907876756

Table 2.1 - Proposed Ballinagree Wind Farm Turbine Coordinates at Design Iteration 1 and Proposed Meteorological Mast Coordinates

3 ILS INFORMATION

3.1 ILS Site Information

The Runway 16 ILS provides radionavigation information to aircraft in the initial and final approach phases of flight towards Runway 16 within 25 NM of Cork Airport. The ILS ground installation comprises:

- Localiser equipment (providing lateral guidance to the runway centreline) located on the extended runway centreline approximately 190 m from the stop end of Runway 16.
- Glide Path equipment (providing vertical guidance to a 3.0° glide path) located approximately 130 m offset from runway centreline and backset 300 m from Runway 16 threshold.
- Distance Measuring Equipment (DME) transponder (providing distance to runway threshold information). The DME antenna is mounted on the Glide Path mast.

ILS Localiser, Glide Path and DME antenna coordinates are shown in the extract from AIP Ireland shown in Figure 3.1 below.

3.2 ILS Coverage Information

International Standards and Recommended Practices (SARPS) for ILS are published by the International Civil Aviation Organization (ICAO). ICAO Annex 10 Chapter 3.1 defines ILS Localiser and Glide Path lateral coverage sectors as described below.

3.2.1 Localiser Coverage

The Localiser coverage sector shall extend from the centre of the localiser antenna system to distances of:

- 46.3 km (25 NM) within plus or minus 10 degrees from the front course line;
- 31.5 km (17 NM) between 10 degrees and 35 degrees from the front course line;
- 18.5 km (10 NM) outside of plus or minus 35 degrees from the front course line if coverage is provided.

Figure 3.2 below shows ILS Localiser lateral coverage sector as defined in ICAO Annex 10.

Figure 3.3 below shows the Runway 16 ILS Localiser lateral coverage sector in relation to the proposed Ballinagree Wind Farm.

3.2.2 Glide Path Coverage

The Glide Path equipment shall provide signals sufficient to allow satisfactory operation of a typical aircraft installation in sectors of 8 degrees in azimuth on each side of the centre line of the ILS glide path, to a distance of at least 18.5 km (10 NM).

Figure 3.4 below shows ILS Glide Path coverage as defined in ICAO Annex 10.

Figure 3.5 below shows the Runway 16 ILS Glide Path lateral coverage sector in relation to the proposed Ballinagree Wind Farm.

3.2.3 DME Coverage

The DME equipment shall provide aircraft with distance to threshold information throughout the Localiser coverage sector as defined in 3.2.1 above.

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EICK AD 2.19 RADIO NAVIGATION AND LANDING AIDS							
Type of aid, MAG VAR, Type of supported OP (for VOR/ ILS/MLS/ GNSS/SBAS and GBAS, give declination)	ID	Frequency	Hours of operation	Position of transmitting antenna coordinates	Elevation of DME transmitting antenna or SBAS: ellipsoid height of LTP/ FTP	Service Volume Radius from the GBAS Reference Point	Remarks
1	2	3	4	5	6	7	8
DVOR/DME 4°W (2018)	CRK	114.6MHz	H24	515026.19N 0082939.37W	500ft		Designated Operational Coverage 80 NM
ILS LOC RWY 16 CAT II 4° W (2018)	ICS	109.9 MHz	H24	514950.47N 0082905.47W			Coverage is restricted to 35° either side of course line. Signals received outside the coverage sector including back beam radiation should be ignored. Use at 3000 feet AMSL restricted to 18NM, due low signal coverage. LLZ Flags may be observed below 3000ft AMSL outside 10NM range from threshold.
ILS GP RWY 16		333.8 MHz	H24	515050.04N 0082947.93W			GP Angle 3.0° RDH 57ft Perturbations might be observed between 3NM and touchdown. Flight calibration reported perturbations to be well within tolerances.
ILS DME RWY 16	ICS	CH36X	H24	515050.04N 0082947.93W	530ft *		The DME Zero range is indicated at THR RWY 16 * Data whose quality is not assured

Figure 3.1 - AIP Ireland

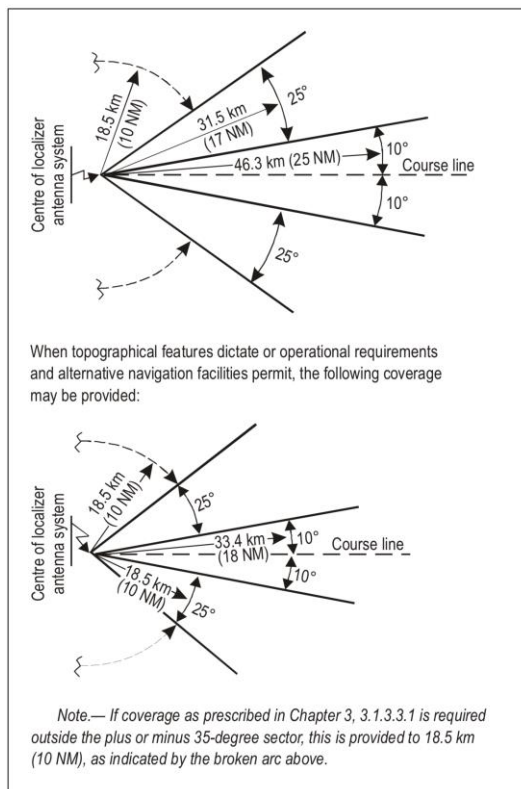


Figure 3.2 - ILS Localiser Lateral Coverage Sector

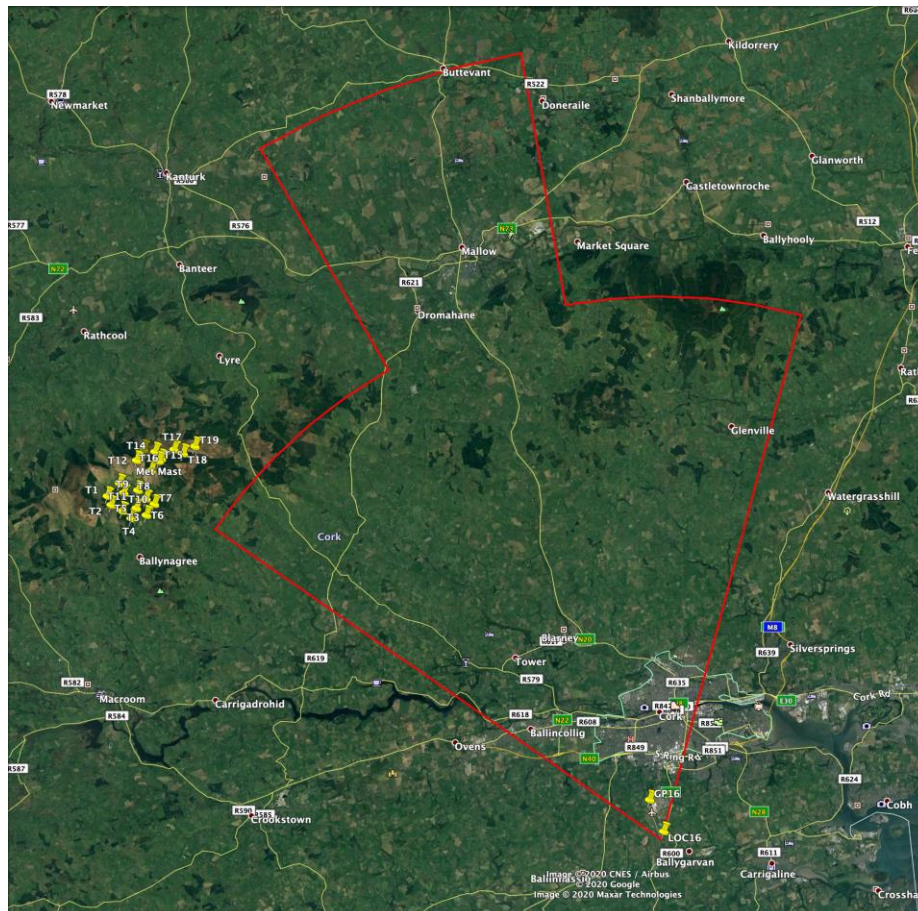


Figure 3.3 - Runway 16 ILS Localiser Lateral Coverage Sector

4 ICAO ILS FLIGHT INSPECTION RECOMMENDATIONS

International Standards and Recommended Practices (SARPS) for ILS are published by the International Civil Aviation Organization (ICAO). Guidance material on factory, ground and flight testing of ILS installations is published in ICAO Doc 8071 Volume I. The purpose of ICAO Doc 8071 Volume I is to provide general guidance on the extent of testing and inspection normally carried out to ensure that radio navigation systems meet the SARPS published by ICAO.

To verify guidance signal accuracy within the ILS coverage volume, ICAO Doc 8071 recommends that a normal centreline approach should be flown, using the glide path, where available. For a Category II and III Localisers, the aircraft should cross the threshold at approximately the normal design height of the glide path and continue downward to normal touchdown point.

To verify that the ILS Localiser and Glide Path guidance signals provide the correct information to the user throughout the area of operational use, coverage checks should be performed. At periodic inspections, it is necessary to check coverage only at 31.5 km (17 NM) and 35 degrees either side of the course, unless use is made of the localiser outside of this area. Arc (part orbit) profiles may be flown at distances closer than this, provided an arc profile is flown at the same distance and altitude during the commissioning inspection to establish reference values.

5 FCSL FLIGHT INSPECTION PROCEDURES

FCSL have developed company procedures for commissioning and routine flight inspection of ILS Localiser and Glide Path facilities. Customer flight inspection requirements are initially captured on a Client Facility Data Sheet (Form 101). Form 101 records the technical details of the navigation aid to be flight checked and the specified interval between flight checks.

In the case of the Runway 16 ILS, the ILS is flight checked in accordance with FCSL Flight Inspection Procedure (FIP) FIP 23 (ILS Flight Inspections GPS Southern Ireland).

FIP 23 specifies that approach and part orbit profiles are flown as defined in FCSL Form 102 (Flight Profile Chart). Figures 5.1 and 5.2 below show the flight profiles to be flown during ILS flight inspection.

The start points, heights and distances for each flight profile are decided by the FCSL Flight Inspector in conjunction with the pilots to ensure correct and sufficient data is recorded while taking into account local terrain and obstacle clearance requirements.

FCSL FIP 23 states that flight inspection pilots will not fly within 1000 ft of the ground in IMC (unless on centreline and edge approaches) and commissioning flights should be carried out in sight of the surface at all times. FIP 23 also states that pilots will determine suitable minima to ensure that they will always be further than 500 ft from any object (except the last 2 miles of an approach with runway in sight).

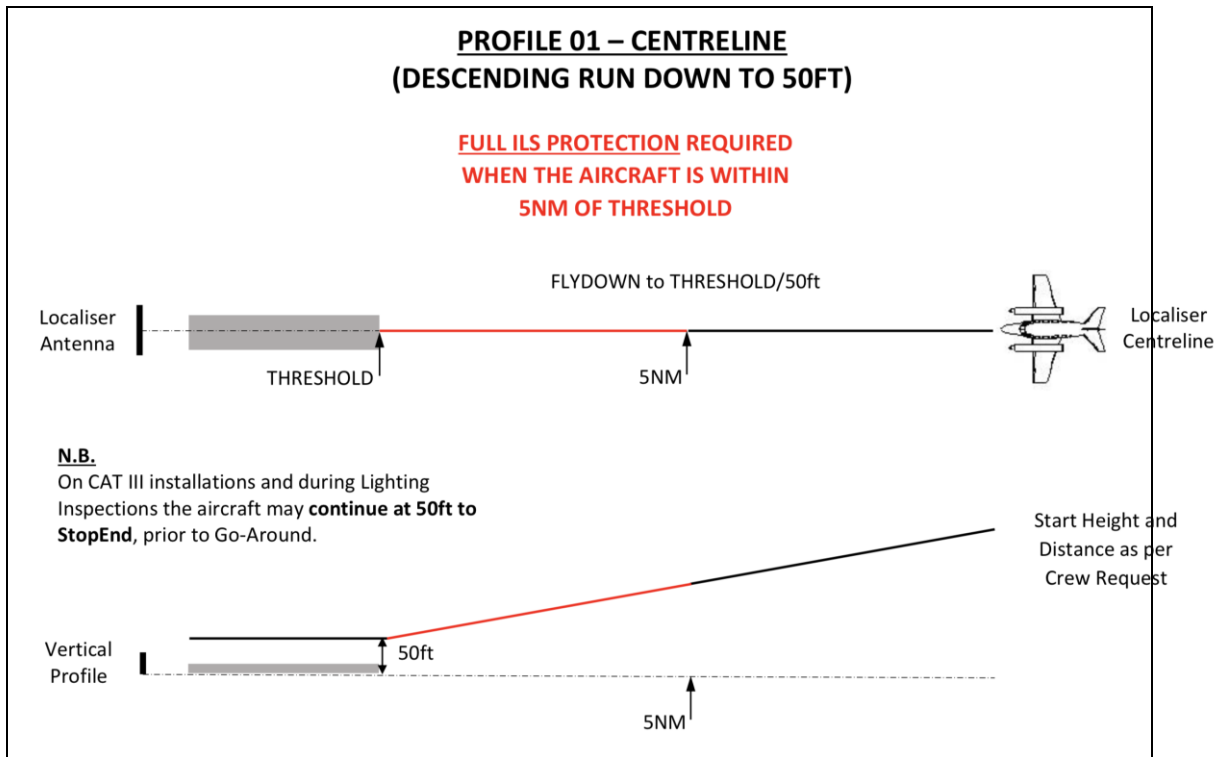


Figure 5.1 - Centreline Approach Flight Profile

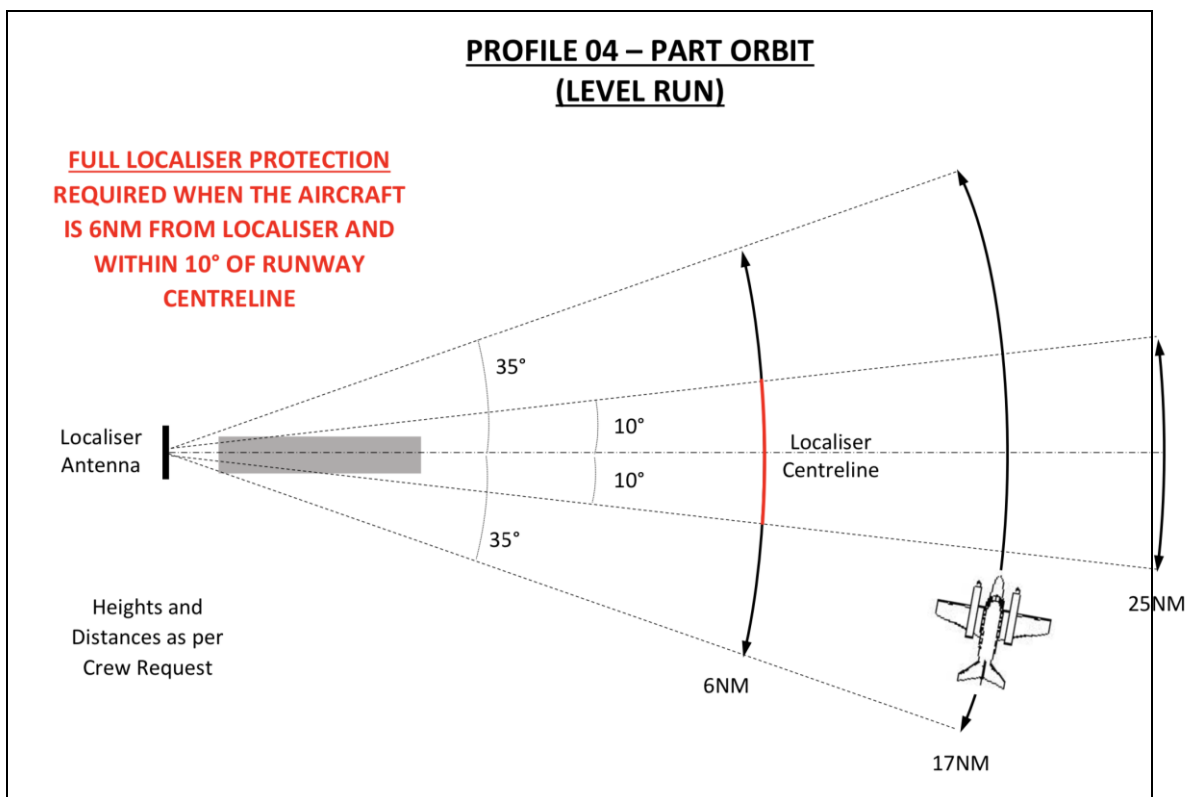


Figure 5.2 – Part Orbit Flight Profile

6 IMPACT ASSESSMENT

6.1 ILS Centreline Approach Flight Profile

For ILS centreline approach flight profiles, heights and distances are decided by the FCSL Flight Inspector in conjunction with the pilots to ensure correct and sufficient data is recorded while taking into account local terrain and obstacle clearance requirements.

For the seven most recent routine Runway 16 ILS flight inspections conducted by FCSL, centreline approaches were flown from a range of 25 NM.

For a centreline approach profile, the flight inspection aircraft will be at least 9.5 NM from the nearest wind turbine (T19) at a point on the extended runway centreline closest to the wind farm. This distance exceeds the minimum clearance required from any object, as defined in FIP 23.

6.2 ILS Part Orbit Flight Profile

For ILS part orbit flight profiles, heights and distances are decided by the FCSL Flight Inspector in conjunction with the pilots to ensure correct and sufficient data is recorded while taking into account local terrain and obstacle clearance requirements.

For the seven most recent routine Runway 16 ILS flight inspections conducted by FCSL, part orbits were flown at a range of 6 NM from the Localiser antenna and a height of 1500 ft AMSL.

The track of the 6 NM part orbit profile is shown in Figure 6.1 below. Figure 6.2 below shows the terrain elevation profile for the 17 NM part orbit.

6.2.1 Horizontal Obstacle Clearances

For a 6 NM part orbit flight profile, the flight inspection aircraft will be at least 12 NM from the nearest wind turbine at a point on the part orbit track closest to the wind farm site.

For a 17 NM part orbit flight profile, the flight inspection aircraft will be at least 1.9 NM from the nearest wind turbine at a point on the part orbit track closest to the wind farm site. This distance exceeds the minimum clearance required from any object, as defined in FIP 23.

6.2.1 Vertical Obstacle Clearances

In accordance with FCSL FIP 23, pilots must not fly within 1000 ft of the ground in IMC. The 17 NM part orbit flight must therefore be flown at a height of at least 1000 ft above the highest obstacle to be encountered.

Figure 6.1 shows that a flight inspection aircraft flying a 17 NM part orbit will pass overhead and close to the summit of Corran Mountain (1337 ft). The 17 NM part orbit must therefore be flown at a height of at least 2337 ft AMSL to remain at least 1000 ft clear of the summit of Corran Mountain.

Figure 6.1 shows that the track of a flight inspection aircraft flying a 17 NM part orbit will pass within 1.9 NM of the proposed Ballinagree Wind Farm site at a heading of approximately 305° from the ILS Localiser site.

The maximum height of the highest wind turbine can be estimated as:

Ground height + maximum turbine height = 457 m + 185 m = 642 m (2106 ft).

For an orbit height of 2337 ft AMSL, a flight inspection aircraft will therefore have a clearance of 231 ft above the highest wind turbine.

Although this vertical clearance is less than the minimum required in IMC, the track of the 17 NM part orbit will not pass directly overhead the proposed wind farm site, and an aircraft on this track will be at least 1.9 NM from the nearest wind turbine at a point on the part orbit track closest to the wind farm site.

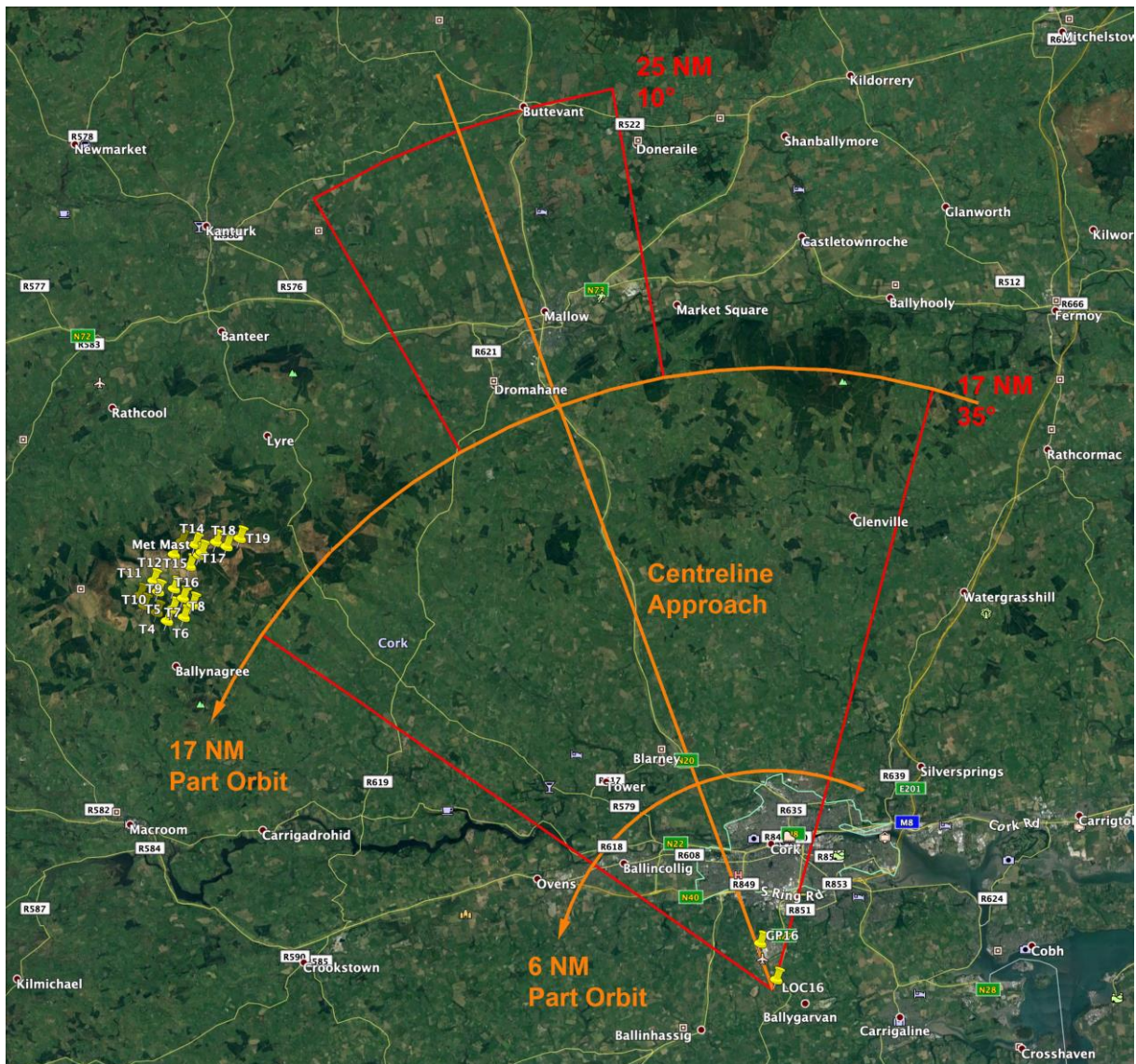


Figure 6.1 – ILS Centreline Approach and Part Orbit Tracks

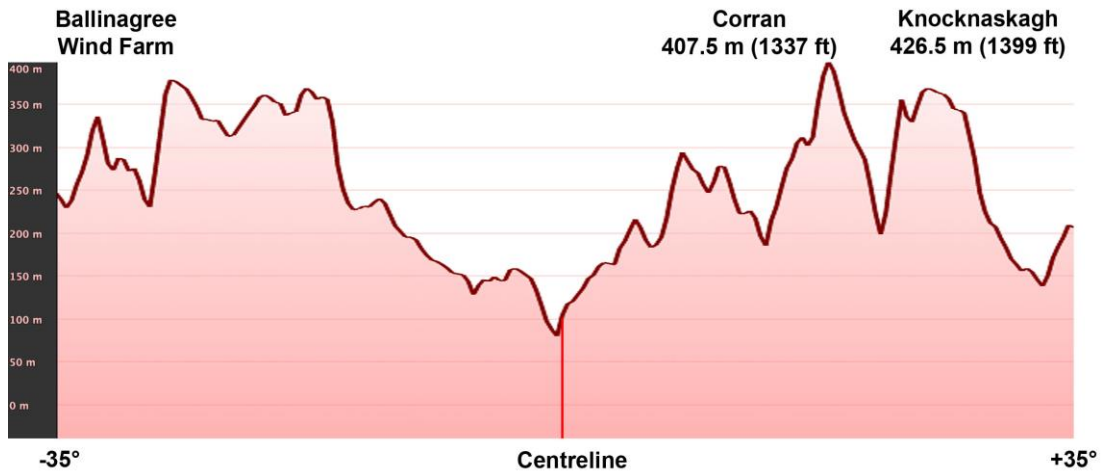


Figure 6.2 – 17 NM Part Orbit Terrain Elevation Profile

7 CONCLUSIONS

The assessment presented in Section 6 above has shown that a flight inspection aircraft flying centreline and part orbit flight profiles associated with the Cork Airport Runway 16 ILS will remain sufficiently clear of the proposed Ballinagree Wind Farm site.

The proposed Ballinagree Wind Farm and meteorological mast will therefore have no adverse effect on flight inspection procedures and profiles associated with the Runway 16 ILS.



FEHILY TIMONEY

CONSULTANTS IN ENGINEERING,
ENVIRONMENTAL SCIENCE & PLANNING

www.fehilytimoney.ie

CORK OFFICE

Core House
Pouladuff Road,
Cork, T12 D773,
Ireland
+353 21 496 4133

Dublin Office

J5 Plaza,
North Park Business Park,
North Road, Dublin 11, D11 PXT0,
Ireland
+353 1 658 3500

Carlow Office

Unit 6, Bagenalstown Industrial
Park, Royal Oak Road,
Muine Bheag,
Co. Carlow, R21 XW81,
Ireland
+353 59 972 3800

