Appendix 1B

Stakeholder Consultation and Responses

MWP

Reen Point, Blennerville, Tralee,
Co. Kerry, V92 X2TK, Ireland

e: tralee@mwp.ie
t: +353 (0)66 712 3404
w: mwp.ie

Ref: PB/22156.
14th December 2021.

xxxxxx
xxxxxx

Re: Proposed Ballycar Wind Farm
Subject: EIA Consultation

Dear Sir/Madam,

Malachy Walsh and Partners (MWP) has been commissioned by Ballycar Green Energy to undertake an Environmental Impact Assessment (EIA) and prepare a subsequent Environmental Impact Assessment Report (EIAR) relating to plans for the proposed development of a wind farm on lands at and near Ballycar in Co. Clare. Preliminary details of the proposed project are attached.

I am consulting with you on this proposal as it may be of interest to you (or your organisation). While there will be the opportunity to make comments and/or a submission on the proposed development as part of the planning process, if there is any key issue which you consider should be addressed in the EIA/EIAR we would welcome your input at your earliest convenience.

Should you require additional information or wish to further discuss the development proposal please contact me via email at peter.barry@mwp.ie or by post at Malachy Walsh and Partners, Reen Point, Blennerville, Tralee, Co. Kerry.

Yours sincerely,

_____
Peter Barry.....
for MWP

ENGINEERING AND ENVIRONMENTAL CONSULTANTS

Organisation	Response/Feedback Received
An Taisce	No
Arts Council of Ireland	No
Bat Conservation Ireland	No
Bird Watch Ireland	No
Clare County Council Conservation Officer	No
Clare County Council Environmental Department	No
Clare County Council Heritage Department	No
Clare County Council Planning Department	Yes
Clare County Council Roads and Transportation Department	Yes
Clare County Council Tourism Development Department	Yes
Department of Culture, Heritage, and the Gaeltacht	No
Department of Agriculture, Food and the Marine	Yes
Department of Business, Enterprise and Innovation	No
Department of Commuincations, Climate Action and the Environment	No
Department of Housing, Planning and Local Government	Yes
Failte Ireland	No
Friends of the Earth	No
Friends of the Irish Environment	No
Geological Survey of Ireland (GSI)	No
Health Service Executive (HSE)	No
Heritage Council	No
Inland Fisheries Ireland (IFI)	Yes
Institute of Geologists of Ireland (IGI)	No
Irish Aviation Authority (IAA)	Yes
Irish Farmers Association (IFA)	No
Irish Landscape Institute	No
Irish Sports Council	No
Irish Wildlife Trust (IWT)	No
Limerick County Council Environmental Department	No
Limerick County Council Heritage Department	No
Limerick County Council Planning Department	No

Organisation	Response/Feedback Received
Limerick County Council Roads and Transportation Department	No
National Monuments Service (NMS)	No
National Parks and Wildlife DAU	Yes
Office of Public Works (OPW)	No
Rapture Survey of Ireland BWI	No
Shannon Airport Authority DAC	No
Southern Regional Assembly	No
Sustainable Energy Authority of Ireland (SEAI)	No
Tipperary County Council Environmental Department	No
Tipperary County Council Heritage Department	No
Tipperary County Council Planning Department	No
Tipperary County Council Road Department	No
Transport Infrastructure Ireland (TII)	Yes
Visit East Clare	No
Waterways Ireland	No

Seirbhís Aerloingseoireachta na hÉireann
ag trádáil mar **AirNav na hÉireann**
Foirgneamh na hAmanna
11–12 Sráid D'Olier
Baile Átha Cliath 2, D02 T449,
Éire

The Irish Air Navigation Service
trading as **AirNav Ireland**
The Times Building
11–12 D'Olier Street
Dublin 2, D02 T449,
Ireland

T: +353 1 6031505
www.airnav.ie

Mr. David McDonnell
Director - GreenSource
Station Road, Adare, Co. Limerick, V940Y50, Ireland

Re. Proposed Windfarm Ballycar, Co.Clare/AirNav Ireland Letter of Support

Dear David and to Whom it may concern,

For the purposes of the planning application process in reference to the above and in my capacity as AirNav Ireland (Air Navigation Service Provider (ANSP) Manager Airspace and Navigation, I wish to acknowledge the supporting documentation received, including:

- Mitigation Options Study, Ballycar Windfarm, AI Bridges Ltd, completed by Cyrrus
- Thales Technical Reports

I also acknowledge the proactive engagement with the ANSP and Shannon Airport Authority by the Developer Team.

There are three areas of concern for the ANSP regarding this proposal:

1. *Instrument Flight Procedures serving Shannon Airport:* I can confirm that there is no impact on these procedures in relation to the proposed development.
2. *Navigation Aids at Shannon Airport, managed by AirNav Ireland:* I can confirm that there is no impact on these procedures in relation to the proposed development.
3. *Surveillance (Radar) Systems managed by AirNav Ireland:* This is our main are of concern as the proposed development, being at the same elevation as our Woodcock Hill Surveillance Radar, at c.2nm from the most westerly turbine proposed in this development, will have an impact on this radar service.

Based on the interactions with you and your Consultants, I'm satisfied that there is adequate time to consider how to mitigate issues related to the Woodcock Hill Radar site that at this point do not present a reason for us to object to the proposed development going to Planning application stage.

The main issue for us in not necessarily the effect on lower altitude aircraft operations, although these will need to be mitigated, but more so the potential impacts on aircraft at higher flight levels, served by the Woodcock Hill Radar.

Noting the comparator developments supplied through our ongoing correspondence, ***I support this application in principle, on behalf of AirNav Ireland***, subject to our ongoing interaction withy you and your consultants in developing appropriate mitigations for the potential surveillance impacts, as outlined above. I also note the willingness of the developer to bear costs associated with these mitigations.

Seirbhís Aerloingseoireachta na hÉireann
ag trádáil mar **AirNav na hÉireann**
Foirgneamh na hAmanna
11–12 Sráid D'Olier
Baile Átha Cliath 2, D02 T449,
Éire

The Irish Air Navigation Service
trading as **AirNav Ireland**
The Times Building
11–12 D'Olier Street
Dublin 2, D02 T449,
Ireland

T: +353 1 6031505
www.airnav.ie

I may be contacted for any queries or clarifications required as follows:

Email: cathal.maccriostail@iaa.ie

Mobile: +353 86 0527130

Yours Sincerely,

_____
Cathal Mac Criostail
AirNav Manager Airspace & Navigation

20th December 2023
cc. Paul Hennessy, Shannon Airport Authority
AirNav Ireland Corporate Affairs, Planning

From: Gareth Ruane <GRuane@clarecoco.ie>
Sent: Wednesday 22 December 2021 17:03
To: Peter Barry
Subject: Ballycar Windfarm [Filed 07 Jan 2022 11:03]
Attachments: Ballycar Windfarm.docx; Ballycannon West Habitat Data.pdf

Follow Up Flag: Follow up
Flag Status: Flagged

Peter,
I refer to your submission regarding this windfarm.
Attached are some brief comments with respect to same.
Hope this is of assistance.

Regards,

Garreth Ruane
Senior Executive Planner
Planning and Economic Development
Clare County Council, Áras Contae an Chláir, New Road, Ennis, Co. Clare, V95 DXP2
T: 065 6846227 | **E:** gruane@clarecoco.ie | **W:** www.clarecoco.ie

COMHAIRLE CONTAE AN CHLÁIR
CLARE COUNTY COUNCIL

Proposed Ballycar Wind Farm

The Environmental Impact Statement for the project must contain the information specified in Paragraph 1 of Schedule 6 of the Planning and Development Regulations 2001, as amended and the additional information specified in Paragraph 2 of Schedule 6 by way of explanation or amplification of the information referred to in paragraph 1. The Planning Authority advises that the following information is considered in the preparation of the EIAR:

- The proposed windfarm is partially within the Lower River Shannon catchment and partially within the Shannon Estuary North catchment. As such the EIAR should take into consideration the potential for impacts on water quality in the wider catchment;

- All stages of the development should be considered in compiling information regarding the interactions of the development with surface water and groundwater. Impacts on downstream receptors shall be identified;

- With respect to the proximity to sensitive receptors the EIAR should take into account existing dwellings and permitted dwellings that may not as yet be constructed;

- Should the presence of peat be confirmed on the site, a peat stability assessment and landslide susceptibility modelling are recommended. The model should show areas at risk of landslide based on peat depth, slope, altitude, aspect and curvature.

- The landslide susceptibility modelling in the peat stability assessment should feed into an assessment of the risk of major accidents and disasters. The EIAR must include the expected effects from the vulnerability of the project to risks of major accidents and/or disasters that are relevant to the project.

- The overall site is dominated by conifer plantation (WD4) and dry humid acid grassland (GS3). However there are pockets of scrub (WS1), wet heath (HH3), wet Willow-Alder-Ash woodland (WN6), wet grassland (GS4), dense bracken (HD1) and dry calcareous and neutral grassland (GS1) throughout the site. Of particular note:
  - There is an area of identified high ecological value in southern portion of the site. Target Note ID No. TN1 relates and is attached for reference.

The EIAR must fully assess the impact of the proposal on habitats within and surrounding the site.

- Acoustics and Vibration should be considered in relation to noise and vibration arising from the proposed development. Noise should be assessed in the context of site preparation, ongoing operation and any restoration required. Baseline readings at all noise-sensitive locations (e.g. houses, schools etc) should be obtained. In-combination noise levels should also be considered, having regard to existing developments in the vicinity.

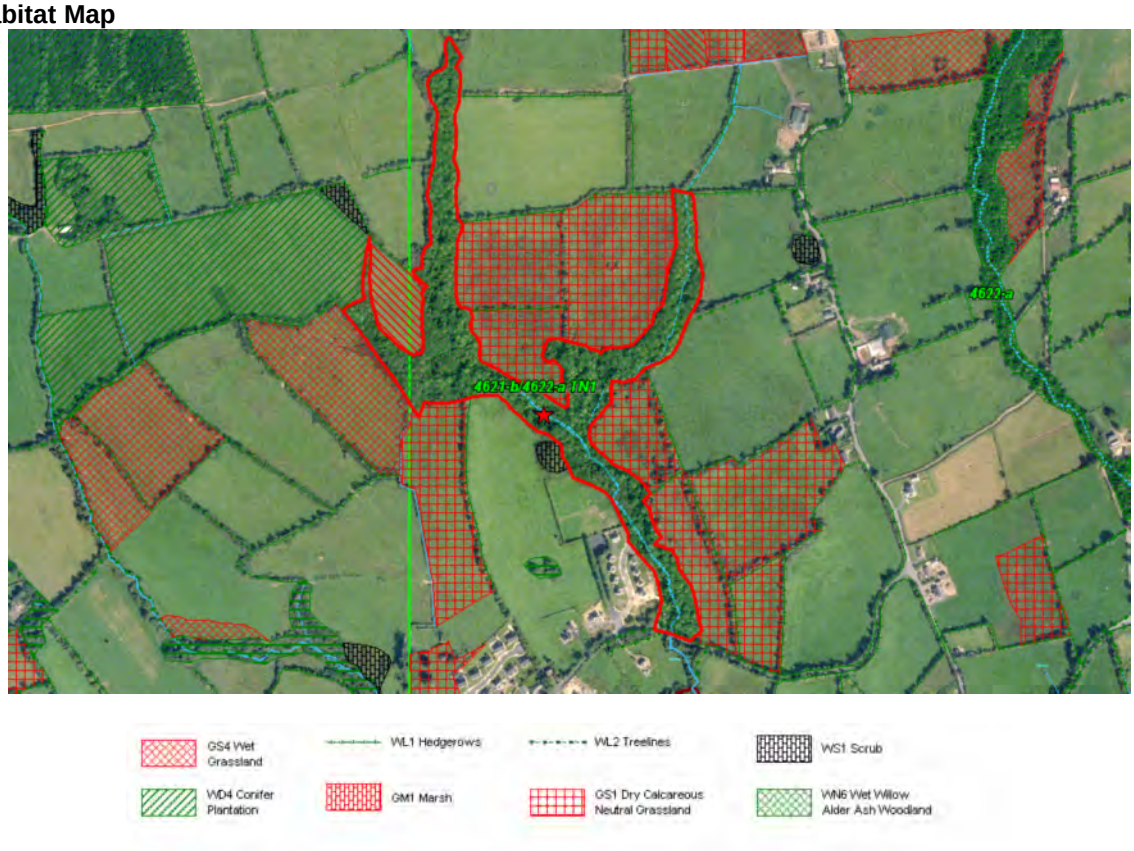
- In combination effects of the proposal should also be considered including those of the quarry to the north of the site.

- The visual impact of the windfarm must be assessed, with particular emphasis on views towards the site from nearby settlements and main transport routes in the vicinity. Views from Limerick city and sensitive sites (eg St Johns Castle) should also be assessed and considered.

- The provisions of the Clare County Development Plan 2017-2023 and associated Wind Energy Strategy should be considered. Note that the Planning Authority have prepared a new Draft County Development Plan and we are currently in the public consultation period for same - https://countydevelopmentplanreview.clarecoco.ie/stage2-draft/display/

TARGET NOTES			
Survey Title: South East Clare Habitat Mapping			**Survey date:** 18/09/08
Surveyor: Jean Hamilton			**County name:** Clare
1:2,500 Sheet no: 4621-b/4622-a	**Townland:** Cappateemore		**Grid Ref:** 155962, 162155
Target note no.: TN1		**Area:** 10.6ha	
Ecological Importance: This area is considered to be of **High** Ecological value in a local context			
Habitat code WN6	This woodland comprises mostly of Ash (*Fraxinus* excelsior) with some Willows (*Salix* spp.), Blackthorn (*Prunella vulgaris*) and Hawthorn (*Crataegus monogyna*) and is classified Wet Willow Alder Ash Woodland WN6. Ground flora of comprises Remote Sedge (*Carex remota*), rushes (*Juncus*), mosses, Ivy (*Hedera helix*), Bramble (*Rubus fruticosus*), Bracken (*Pteridium aquilinum*), Marsh Thistle (*Cirsium palustre*), Creeping Buttercup (*Ranunculus repens*), Wood-sorrel (*Oxalis acetosella*) and Harts-tongue Fern (*Phyllitis* (*Asplenium*) *scolopendrium*). There is a small stream flowing through the woodland.		

Habitat Map



Photographic Record

Plate 1: Showing Willows, Ash and ground flora.

Plate 2: Ground flora and small stream flowing in woodland

Plate 3: Dense bramble scrub at edge of woodland

From: Peter Barry
Sent: Tuesday 25 January 2022 11:22
To: Valerie Heffernan
Subject: 22156 - FW: Ballycar Windfarm - Roads & Transportation

Can you add to the file please

From: Anne O'Sullivan <AnOSullivan@clarecoco.ie>
Sent: Tuesday 25 January 2022 11:08
To: Peter Barry <Peter.Barry@mwp.ie>
Cc: Tom Mellett <tmellett@clarecoco.ie>
Subject: Ballycar Windfarm - Roads & Transportation

Thank you for forwarding your proposals to the Roads and Transportation Section at this stage of your project. There are a number of issues in any wind farm development that are of a concern to the Roads & Transportation Section and full and early engagement with this section is vital.

Issues that would be of concern to this section are as follows:

1. Agreement of construction haul routes with the Local Authority – including timing and scale of transports to and from the site. Assessment of junctions for turning movements along these routes would be required. Enabling works may be required.
2. Protection of the existing road network. Pre and post construction surveys on the pavement (PSCI) along the haul routes would be required. Enabling works may be required to facilitate the proposed loads.
3. Protection of structures on haul routes. Pre and post construction surveys on culverts along the haul routes. Enabling works may be required to facilitate the proposed loads.
4. The management of surface water during and post construction on the site and its impact on the adjacent drainage systems. Surface water drainage proposals for the site would be required and must incorporate the type of ground conditions on site.
5. The impact of the grid connection route on the road network must be appraised by the developer and discussed the Local Authority in the early stages of the development of this project.
6. Full engagement with the Local Authorities Abnormal Load Permitting system. All abnormal loads travelling to and form the site must be permitted.

Should you wish to discuss any further matters with me or my colleagues in Roads I will be happy to do so.
I have forwarded your correspondence to my colleagues in the Environment section as they may wish to have an input.

Yours Sincerely,
Anne O'Sullivan

Anne O'Sullivan, CEng MIEI MCIHT
Senior Executive Engineer
Roads & Transportation

Clare County Council, Áras Contae an Chláir, New Road, Ennis, Co. Clare, V95 DXP2
T: 065 6846319 | **E:** anosullivan@clarecoco.ie | **W:** www.clarecoco.ie

COMHAIRLE CONTAE AN CHLÁIR
CLARE COUNTY COUNCIL

Designated Public Official under the Regulation of Lobbying Act.
Oifigeach Ainmnithe de réir Acht un Brústocaireacht a Rialáil.

From: Peter Barry
Sent: Monday 24 January 2022 16:00
To: Valerie Heffernan
Subject: FW: Proposed Ballycar Wind Farm - letter & attachments dated 14th December, 2021.

fyi

From: Sile Cahill <SCahill@clarecoco.ie>
Sent: Monday 24 January 2022 15:59
To: Peter Barry <Peter.Barry@mwp.ie>
Subject: RE: Proposed Ballycar Wind Farm - letter & attachments dated 14th December, 2021.

A Chara,

I wish to acknowledge receipt of your letter and attachments dated 14th December, 2021 regarding the proposed Ballycar Wind Farm.

The contents have been noted.

Mise le meas,

On behalf of Deirdre O'Shea, Head of Tourism (Acting)

Síle Cahill
Clerical Officer
Tourism Department
Rural Development Directorate
Clare County Council, Áras Contae an Chláir, New Road, Ennis, Co. Clare, V95 DXP2
T: 065 6846283 | **E:** scahill@clarecoco.ie | **W:** www.clarecoco.ie

COMHAIRLE CONTAE AN CHLÁIR
CLARE COUNTY COUNCIL

visit CLARE | Blueways Ireland | Ireland's Hidden HEARTLANDS | WILD ATLANTIC WAY

23rd December 2021

MWP,

Reen Point,

Blennerville,

Tralee,

Kerry,

V92 X2TK.

Re: E.I.A.R. Scoping Request for the proposed Ballycar Green Energy Windfarm near Ballycar Co. Clare

Dear Sir/Madam,

The following are the comments from this Division in relation to the proposed development:

If the proposed development will involve the felling or removal of any trees, the developer must obtain a Felling License from this Department before trees are felled or removed. A Felling Licence application form can be obtained from **Felling Section, Department of Agriculture, Food and the Marine, Johnstown Castle Estate, Co. Wexford**. Email: felling.forestservice@agriculture.gov.ie or Web gov.ie - Tree Felling Licences (www.gov.ie)

A Felling Licence granted by the Minister for Agriculture, Food and the Marine provides authority under the Forestry Act 2014 to fell or otherwise remove a tree or trees and/or to thin a forest for silvicultural reasons. The Act prescribes the functions of the Minister and details the requirements, rights and obligations in relation to felling licences. The principal set of regulations giving further effect to the Forestry Act 2014 are the Forestry Regulations 2017 (S.I. No. 191 of 2017).

The developer should take note of the contents of **Felling and Reforestation Policy** document which provide a consolidated source of information on the legal and regulatory framework relating to tree felling; gov.ie - Tree Felling Licences (www.gov.ie) As this development is within forest lands, particular attention should be paid to deforestation, turbulence felling and the requirement to afforest alternative lands.

In order to ensure regulated forestry operations in Ireland accord with the principles of sustainable forest management (SFM), as well fulfilling the requirements of other relevant environmental protection laws, the Department (acting through its Forest Service division) must undertake particular consultations, and give certain matters full consideration during the assessment of individual Felling Licence applications. This includes consultation with

relevant bodies, the application of various protocols and procedures (e.g. Forest Service Appropriate Assessment Procedure), and the requirement for applicants on occasion to provide further information (e.g. a Natura Impact Statement).

Consequently, when the Forest Service is considering an application to fell trees, the following applies:

1. The interaction of these proposed works with the environment locally and more widely, in addition to potential direct and indirect impacts on designated sites and water, is assessed. Consultation with relevant environmental and planning authorities may be required where specific sensitivities arise (e.g. local authorities, National Parks & Wildlife Service, Inland Fisheries Ireland, and the National Monuments Service);

2. Where a tree Felling Licence application is received, the Department will publish a notice of the application before making a decision on the matter. The notice shall state that any person may make a submission to the Department within 30 days from the date of the notice. The notices are published online at: gov.ie - Felling Licence Applications (www.gov.ie)

3. Third parties that make a submission or observation will be informed of the decision to grant or refuse the licence, and on request, details of the conditions attached to the licence, the main reasons and considerations on which the decision to grant or refuse the licence was based, and where conditions are attached to any licence, the reasons for the conditions. Both third parties and applicants will be also informed of their right to appeal any decision within 14 days to the Forestry Appeals Committee. Felling Licence decision are published online at: gov.ie - Felling Licence Decisions (www.gov.ie)

It is important to note that when applying to **a Local Authority**, or **An Bord Pleanàla**, for planning permission where developments are:

a) subject to an EIA procedure (including screening in the case of a sub-threshold development) and any resulting requirement to produce an EIAR; and/or

b) subject to an Appropriate Assessment procedure (including screening) and any resulting requirement to a Natura Impact Statement (NIS); and

c) the proposed development in its construction or operational phases, or any works ancillary thereto, would directly or indirectly involve the felling and replanting of trees, deforestation for the purposes of conversion to another type of land use, or replacement of broadleaf high forest by conifer species,

1. that there is a requirement inter alia under the EIA Directive for an overall assessment of the effects of the project or the alteration thereof on the environment to be undertaken, including the direct and indirect environmental impact of the project;

   and

2. pursuant to Article 2(3) of the EIA Directive, the Department of Agriculture, Food and the Marine strongly recommends that, notwithstanding the fact that a parallel consent in the form of felling licence may also have to be applied for, any EIAR and/or NIS produced in connection with the application for planning permission to the Local Planning Authority or An Bord Pleanàla, should include an assessment of the impact of and measures, as appropriate, to prevent, mitigate or compensate for any significant adverse effects direct or indirect identified on the environment arising from such felling and replanting of trees, deforestation for the purposes of conversion to another type of land use, or replacement of broadleaf high forest by conifer species.

Yours sincerely,

Tara Hendley

Tara Hendley
Felling Section
Department of Agriculture, Food and the Marine
Johnstown Castle
Co Wexford

From: Diarmuid Buttimer (Housing) <Diarmuid.Buttimer@housing.gov.ie>
Sent: Thursday 27 January 2022 16:16
To: Valerie Heffernan; Peter Barry
Subject: G Pre00307/2021 - EIA Consultation - Proposed Ballycar Wind Farm
Attachments: G Pre00307-2021 MWP - 22156.pdf

A Chara,

Please find attached Heritage Related recommendations for the above mentioned pre-planning application.

Regards
Diarmuid

Diarmuid Buttimer
Executive Officer

An Roinn Tithíochta, Rialtais Áitiúil agus Oidhreachta
Department of Housing, Local Government and Heritage
Aonad na nIarratas ar Fhorbairt
Development Applications Unit
Oifigí an Rialtais
Government Offices
Bóthar an Bhaile Nua, Loch Garman, Contae Loch Garman, Y35 AP90
Newtown Road, Wexford, County Wexford, Y35 AP90

—

Diarmuid.Buttimer@housing.gov.ie
Manager.DAU@housing.gov.ie

An Roinn Tithíochta,
Rialtais Áitiúil agus Oidhreachta
Department of Housing,
Local Government and Heritage

Your Ref: **PB/22156**
Our Ref: **G Pre00307/2021** (Please quote in all related correspondence)

27 January 2022

Malachy Walsh & Partners
Engineering & Environmental Consultants
Reen Point
Blennerville,
Tralee
Co. Kerry
V92 X2TK

Via email: Valerie.Heffernan@mwp.ie : Peter.Barry@mwp.ie

Proposed Pre Planning Development: Malachy Walsh and Partners (MWP) for Ballycar Green Energy: undertake an Environmental Impact Assessment (EIA) and prepare a subsequent Environmental Impact Assessment Report (EIAR) relating to plans for the proposed development of a wind farm on lands at and near Ballycar in Co. Clare. Preliminary details of the proposed project are attached: Ballycar in Co. Clare

A chara

I refer to correspondence received in connection with the above. Outlined below are heritage-related observations/recommendations co-ordinated by the Development Applications Unit under the stated headings.

Archaeology

The information provided was not sufficiently detailed to allow for a full assessment of the archaeological implications of this proposal, however the National Monuments Service (NMS) of the Department wishes to advise that as part of EIA requirements your client is obliged to retain the services of a Consultant Archaeologist to carry out the Archaeological Impact Assessment (AIA) as part of the overall Cultural Heritage Impact Assessment of the proposed development, which should be integrated into the finalised EIAR. In this regard the Department awaits the results of the Cultural Heritage Impact Assessment (CHIA) and full EIAR for the scheme before commenting further.

Further to the above, and by way of general archaeological advice, please note that, whilst the proposed development site (PDS) may or may not contain within it known or subsurface Recorded Monuments and/or Archaeological sites that may require assessment as part of the overall CHA, the PDS itself is located within a wider area of known archaeological

settlement and activity (NMS initial review of the Record of Monuments and Places, www.archaeology.ie and cartographic sources). All of these Recorded Monuments, both within and outside the PDS, are subject to statutory protection in the Record of Monuments and Places, established under section 12 of the National Monuments Act 1930-2014. Therefore the CHIA should include an assessment of the possible effects of the proposal on the wider archaeological landscape. It is of importance that the study area for the CHIA should be of sufficient size and extent to support this.

The Department advises that the CHIA should incorporate a robust desk-study supported by a comprehensive field inspection as well as a visual impact assessment (to assist in identifying any possible impacts to the setting of sites or monuments).

In this respect it should be noted that in addition to site-specific vulnerabilities to impact on setting many monument types–for example prehistoric monuments such as Standing Stone Alignments, Standing Stone Rows, Single Standing Stones, as well as some megalithic tombs—are often considered to represent a wide area of associated archaeological settlement and activity. As a result, the bunding/stockpiling of materials, intrusion into viewsheds may have a negative visual impact on such monuments and may diminish or interrupt alignment views and alter key aspects of their original function and layout. The Visual Impact Assessment should:

- Set out the key characteristics of the monument(s) and its surroundings that contribute to its setting and the degree to which this setting is integral to the significance and appreciation of the monument.
- Assess the effects of the development—both positive and negative—on these key characteristics. The development should be considered in terms of its location and siting relative to the monument as well as its form, appearance and permanence.
- Be supported by appropriate illustrations of the monument, its setting and the development.

The Department further advises that the following are also carried out as part of the overall CHIA to ensure a comprehensive assessment of the proposed development:

- The desk-study and field inspection regime should inform:
    - Targeted non-intrusive advance geophysical survey or prospection (such as Ground Penetrating Radar Surveys)
    - Targeted advance archaeological test excavation
- Any and all intrusive advance investigations (such as, but not limited to, ground investigations for soils/geology/hydrogeology) carried out as part of the EIA or design process should be subject to a programme of archaeological monitoring by a suitably qualified archaeologist

The results of these investigations should inform the EIA process and be incorporated within the EIA Report. The Department is happy to provide further advice and clarification as and if required in relation to the preparation of suitably comprehensive assessments as outlined above, with particular regard to the scope and locations for any advance non-intrusive prospection or advance test excavation that would be appropriate to inform the assessment of this proposed scheme.

Nature Conservation

As an initial response to your consultation, you are advised to consult the 'Planning' section of the NPWS website - https://www.npws.ie/development-consultations - as this contains text/advice on consulting NPWS in relation to 'development applications', data and information sources, and the basic elements of environmental assessments that may be required.

These observations are intended to assist you in relation to identifying potential impacts on European sites, other nature conservation sites, and biodiversity and environmental protection in general, in the context of the current proposal. Data collected and surveys carried out in connection with this proposed development may raise other issues that have not been considered here. The observations are not exhaustive and are made without prejudice to any recommendation that may be made by this Department in the future.

Guidance on EIAR

You are advised to consult the European Commission's (2017) 'Environmental Impact Assessment: Guidance on the preparation of the Environmental Impact Assessment Report (Directive 2011/92/EU as amended by 2014/52/EU)'. Any surveys and assessments should be based on a full details of the overall project, noting all lands that will be required. For a detailed list of potential considerations, see the 'Review checklist', and specifically 'Section 1 – Description of the project', in this guidance. Note also that if compensatory afforestation is required on other lands, the likely significant effects of that integral element of the development should be assessed in the main project EIAR.

In addition to guidance listed in Appendix 1, the following should be taken into account in planning and designing a windfarm and in completing the assessments. Please note the 2020 updates of the Guidance documents:

- *Guidance document on wind energy developments and EU nature legislation* (European Commission, **2020**)
- *Draft Revised Wind Energy Development Guidelines* (DoHLGH, **2020**), particularly the requirements in relation to assessing ground conditions/geology (section 5.3
- *Landslides in Ireland* (GSI, 2006)[1].

[1] Creighton, R. (ed.). 2006. *Landslides in Ireland: A Report of the Irish Landslide Working Group*. Geological Survey of Ireland, Dublin.

In considering a windfarm in this area, the Clare Wind Energy Strategy and its associated appropriate assessment and SEA Environmental Report should be checked for any mitigation that applies in this type of situation, given the proximity and potential for negative effects of this proposal on protected sites of national and international importance for nature conservation.

Project planning and design

It should be remembered that a key element of EIA is the avoidance or reduction of negative effects on the environment. EIA is an iterative process and the information gathered through assessments or surveys should be used to guide the planning and design of the windfarm so that sensitive ecological or hydrological areas are avoided, and negative impacts are minimised insofar as is possible. The size, layout and design of the proposed development should be informed by a constraints-type study and the compilation of an environmental constraints map that identifies and avoids, insofar as is possible and using appropriate separation distances, all nature conservation sites, other sensitive ecological and hydrological features, deep or intact peat deposits, and areas of wet and/or active bog, pool systems and flushes.

The National Biodiversity Action Plan 2017- 2021 aims to conserve and restore Ireland's biodiversity. A key objectives of the plan is to achieve; no net contribution to biodiversity loss arising from development projects occurring within the lifetime of the plan. Accordingly, the EIAR should outline how this project will avoid a net loss of biodiversity and include relevant mitigation and or compensatory measures where necessary.

Project components

In general, the EIAR should include sufficient project details so that the full nature and extent of the likely significant effects are clear and assessed fully in relation to, among other things, road design and construction methodology; site drainage details, including settlement ponds; temporary and permanent storage or disposal areas for peat and other materials or wastes arising; extraction sites/borrow pits; and any modifications to roads, bridges or culverts along the entire length of haul routes. Volumes of surplus material arising and of fill required should be calculated. Due consideration should also be given to the grid connection.

The EIAR should give specific consideration to the mobilisation of silt and changes to the stability of soil. The proposed windfarm has the potential for significant changes in patterns of surface water flow and may desiccate underlying soils allowing pathways to open up resulting in subsurface water losses. It should be noted that in 2020 a number of major upland peatland (blanket bog) landslides occurred across Ireland, most notably on Shass Mountain near Drumkeeran in County Leitrim[2] and Meenbog, near Ballybofey in County Donegal. If a Peat Stability Risk Assessment is required it must be considered in light of these occurrences with consideration of climate change predictions (e.g. rainfall level) in the hazard rating and should thoroughly assess risk with regard to change in weather patterns due to climate change such as more frequent and intense storms and rainfall events,

[2] https://www.npws.ie/news/shass-mountain-peat-landslide-report-published

increased likelihood and magnitude of river flooding, prolonged periods of dry conditions which may increase the likelihood of unstable peat.

There are concerns regarding any potential loss and/or degradation of blanket bog, heath, cutover bog or other peatland habitats (including any potential nardus grassland, molinia meadow etc habitats) arising from the overall wind farm project (both regarding the wind farm site itself and the grid connection works), such habitats could also include potential Annex I habitat under the EU Habitats Directive for which the Department has reporting obligations under Article 17 of the Directive to the European Commission on details of losses and degradation. Effects on peatland habitats from the wind farm project on these habitats could arise from the following project works and details

- location of Wind Turbines, Foundations and Hardstand areas.
- location of On-site access roads.
- On-site interconnecting electrical cabling location.
- Substation location on the wind farm site.
- Construction compound location.
- Meteorological mast location.
- Location of Borrow Pits and spoil management areas.
- Turbine component haulage route
- Replacement land location for felled forestry
- Grid connection and underground cable route

Potential negative effects on peatland habitats could arise through direct excavation of peatland habitat, drainage effects on adjacent/nearby peatland habitat, habitat fragmentation, exposure of underlying peat, increased risk of erosion, opening up of areas of the habitats to new or increased exploitation or disturbance through the provision of new and upgraded roads, peat slippage, landscaping, side casting, drain installation, excavate storage, sediment disposal etc.

Only currently proposed turbine locations are supplied (i.e. not access routes, infrastructure locations etc.) but it is noted that in terms of the current turbine layout that the most north westerly located turbine (in terms of the overall turbine layout) appears to be proposed in a general area of peatland habitat with potential effects on peatland habitat, this location should be considered as part of the iterative process. No access routes or infrastructure etc. detail is provided but the main area of peatland habitat (roughly dividing the most westerly five turbines from the more easterly seven and with no turbines currently proposed within it) should be protected and taken account of in terms of avoiding negative effects from access routes, borrow pits, grid route, substation, mast, storage areas etc.

Detailed consideration should be given to the potential amount of peat / soil excavated, stored, and disposed/recovered. A detailed plan for the safe storage, disposal and rehabilitation of excavated or disturbed peat /soil would form part of the EIAR. The spreading

or recovery of excavated peat/soil on areas of intact bog, wet and revegetated areas of cutover bog or other habitats or vegetation of ecological value is unlikely to be acceptable. Excavated or exposed peat / soil should not pose any threat to surface waters and water quality.

A detailed site drainage map will be required and should show all existing watercourses, drainage ditches, flushes, lakes or ponds; new drainage ditches; all outfall points to watercourses or lakes; and all settlement ponds. The EIAR must demonstrate that the proposed development will not pose any threat to surface waters and associated species. Any impact on water table levels or groundwater flows may impact on wetland sites some distance away. The EIAR should assess cumulative impacts with other plans or projects, if applicable. Where negative impacts are identified suitable mitigation measures should be detailed as appropriate.

The associated impacts of quarrying or extraction should be included among the considerations at the earliest stages of project planning and design, and should be assessed fully in the EIAR. Reinstatement or restoration plans will be required for any quarries or borrow pits on-site and should be included in the EIAR. As with any other part of the development, all borrow pits (existing or proposed) to be used in construction should be included within the application area for the proposed development.

Any tree felling of forested sites should be included as an intrinsic element of the overall development, the impacts and implications of which should be assessed fully in the EIAR. The extent of tree felling should be mapped, and the future use and management of all cleared areas should be specified. The impacts of tree felling on wildlife, habitats and surface waters (e.g. water quality) should be assessed fully, including the risk of Phosphate mobilisation from peat soils as a result of tree clearance and ground disturbance.

Tree felling is licensed and regulated by the Forest Service; any additional requirements in respect of this element of the proposed development, including any obligations to replant on other lands, should be made known at the planning application stage, and assessed as part of the EIAR as appropriate. If restoration of planted areas is proposed as mitigation or compensation for negative ecological effects, the EIAR should include a detailed plan to show the location, nature and area of habitat to be reinstated, and provide details of how such areas will be reinstated, managed and improved for habitats and/or species, together with proposals for monitoring and reporting. This plan should be prepared by a suitably qualified ecologist in consultation with other experts as appropriate.

The likely impacts of grid connection, particularly for birds, sensitive habitats and surface waters, should be given due consideration at the EIA stage.

Any improvement or reinforcement works required for access and transport anywhere along the proposed haul route(s) should be included in the EIAR and subjected to ecological impact assessment with the inclusion of mitigation measures, as appropriate.

Any losses of biodiversity habitat associated with this proposed development (including access roads and cabling etc.) such as woodland, scrub, hedgerows and other habitats should be mitigated for. In addition, Annex 1 habitats which occur outside the Natura 2000

network are important in terms of biodiversity conservation. The presence of any Annex I habitats outside the network should be given due consideration as part of the consideration of biodiversity matters generally for the proposed development. The loss of Annex 1 habitats outside SACs should be avoided.

You are advised that no disturbing or damaging site or ground investigations, or testing, should take place in an ecological site in advance of the main project consent without due consideration of the need for planning permission (for exempted development where there are restrictions on exemptions), or another consent.

Impacts of lighting on-site should also be assessed noting that lighting of turbines and masts can increase collision risk[3].

Ecological Data and Surveys

The Department also highlights that along with the standard NPWS data requests which is recommended, other sources of habitat and species information beyond those already identified include (but are not be limited to): the National Biodiversity Data Centre (www.biodiversityireland.ie), Inland Fisheries Ireland (www.fisheriesireland.ie), Birdwatch Ireland (www.birdwatchireland.ie), Irish Raptor Study Group, Golden Eagle Trust and Bat Conservation Ireland (www.batconservationlreland.org). Some guidance and reference documents are provided in the Appendix to this letter.

It is expected by this Department that best practice will be adhered to with regard to survey methodology and if necessary non Irish methodology adapted for the Irish situation, noting specific gaps in relation to species and age of the data outlined in some guidance documents. The EIAR should cover the whole project, including construction, operation and, if applicable, restoration or decommissioning phases. Alternatives examined should also be included in the EIAR. Inland Fisheries Ireland should be consulted with regard to fish species, if applicable. For information on Geological and Geomorphological sites, the Geological Survey of Ireland, should be consulted.

Where ex-situ impacts are possible, survey work may be required, outside of the development sites. Such surveys should be carried out by suitably qualified persons at an appropriate time of the year, depending on the species being surveyed for. The EIAR should include the results of the surveys and detail the survey methodology and timing of such surveys including consistency in terms of timed vantage point surveys.

Ornithology

Surveys for all species should cover bird usage and facilitate assessment of potential collision risk, habitat loss, barrier effect and displacement for these species and should be based around the daily and seasonal activity patterns of the species being surveyed. Survey work should cover year-round site use and should cover a minimum of two years to allow for

[3] Douse, A (2020) "The Effect of Aviation Obstruction Lighting on Birds at Wind Turbines, Communication Towers and Other Structures", NatureScot Information Note. Version1.1

an accurate determination of site usage. Specific Target species for this site include Annex I (Birds Directive) species such as Hen Harrier, Merlin and Peregrine Falcon (quarry presence noted), and red listed Birds of Conservation Concern (BoCCI) such as kestrel, snipe, woodcock and potential red grouse. Hinterland surveys therefore should include breeding raptor surveys, including roost watches, surveys for nocturnal species and other species-specific surveys as appropriate. Potential significant effects on the aforementioned target species requiring assessment include collision effects, displacement effects, barrier effects, direct and indirect habitat loss and degradation, in combination effects, cumulative impact effects etc.

Vantage point surveys should be done in a manner that ensures sufficient data is collected to allow an assessment of the importance of all the flight paths into, out of and between sites and assess migratory movements. Consequently, the Department recommends that a visibility analysis of topography and vegetation is used in the selection of vantage points for ornithological surveys. Technological solutions should also be considered in conjunction with VPs surveys to ensure sufficient data is compiled for assessment.

Results for species need to be referenced back to the overall populations and their dynamics as, in some cases even a small risk to a population of a species could be considered significant.

When completing impact assessment for birds, assessment and monitoring results from nearby windfarms must be considered. Cumulative impact on birds from all windfarms in the area needs to be assessed and the data from surrounding sites needs to be considered in the assessment.

Bats

Bat roosts may be present in trees, buildings and bridges. Bat species are protected under the Wildlife Act, 1976 to 2018, and are subject to a regime of strict protection pursuant to the requirements of the Habitats Directive (92/43/EEC) as transposed in Irish law in Regulation 51 of the European Communities (Birds and Natural Habitats) Regulations, 2011 (as amended). Therefore, damage/disturbance to any such roosts must be avoided in the first instance. While the Minister may grant a derogation licence under Regulation 54 of the European Communities (Birds and Natural Habitats) Regulations 2011-2015, a licence can only be granted once a number of strict criteria have been met (see Regulation 54). An assessment of the impact of the proposed wind farm on bat species should be carried out noting recent guidance available, "*Bat and Onshore Wind Turbines: Survey, Assessment and Mitigation, 2019"* published jointly by Scottish Natural Heritage and Bat Conservation Trust and other stakeholders. Any proposed bat friendly lighting should be proven to be effective and follow up-to-date guidance.

Windfarms can have significant effects on bats with regard to 1) Collision mortality, barotrauma and other injuries (Operational Phase Impact), 2) Loss or damage to commuting and foraging habitat, 3) lighting issues. Regarding points 1 and 2 it is noted that in terms of the current turbine layout that some of the East centrally located turbines (in terms of the

overall turbine layout) appear to be proposed on or immediately adjacent to existing hedgerows and this should be assessed and considered as part of the iterative process.

Watercourses and wetlands

Wetlands are important areas for biodiversity and ground and surface water quality should be protected during construction and operation of the proposed development. The EIAR should include a detailed assessment of the hydrological impacts on wetlands from the proposed development. Any watercourse or wetland which may be impacted on should be surveyed for the presence of protected species and species listed on Annexes II and IV of the Habitats Directive. For example, these species could include Otter (*Lutra lutra*) which are protected under the Wildlife Acts and listed on Annex II and IV of the Habitats Directive, Salmon (*Salmo salar*), Lamprey (three species in Ireland) listed on Annex II of the Habitats Directive, Freshwater Pearl Mussel (*Margaritifera* species) and White-clawed Crayfish (*Austropotamobius pallipes*) which are both protected under the Wildlife Act and listed on Annex II of the Habitats Directive, Frogs (*Rana temporaria*) and Newts (*Trituris vulgaris*) protected under the Wildlife Acts and Kingfishers (*Alcedo atthis*) protected under the Wildlife Acts and listed on Annex I of the Birds Directive (Council Directive 79/409 EEC).

Further to potential impacts on the species listed above, for example, one of the main threats identified in the threat response plan for otter is habitat destruction (see https://www.npws.ie/sites/default/files/publications/pdf/2009_Otter_TRP.pdf). A 10m riparian buffer on both banks of a waterway is considered to comprise part of the otter habitat. Therefore any proposed development should be located at least 10m away from a waterway and should consider movements between waterways and waterbodies by otters.

Flood plains

Flood plains, if present, should be identified in the EIAR and left undeveloped to allow for the protection of these valuable habitats and provide areas for flood water retention (green infrastructure). If applicable, the EIAR should take account of the guidelines for Planning Authorities entitled "*The Planning System and Flood Risk Management*" published by the Department of the Environment, Heritage and Local Government In November 2009.

Hedgerows, Scrub and related habitats

Hedgerows and scrub should be maintained where possible, as they form wildlife corridors and provide areas for birds to nest in. Hedgerows provide a habitat for woodland flora, roosting places for bats and Badger setts may also be present. The EIAR should provide an estimate of the length/area of any hedgerow/scrub that will be removed. Where it is proposed that trees or hedgerows will be removed there should be suitable planting of native species in mitigation incorporated into the EIAR. Hedgerows, trees, scrub and uncultivated vegetation (including semi-natural habitats) should not be removed during the nesting season (i.e. March 1st to August 31st), noting the protection afforded under the Wildlife Act 1976-2018.

Marsh Fritillary

Marsh fritillary surveys should be carried out as per standard Marsh Fritillary Larval Web Survey methodology.

Alien invasive species

The EIAR should also address the issue of invasive alien plant and animal species such as *Rhododendron ponticuum* and Japanese Knotweed, and detail the methods required to ensure they are not accidentally introduced or spread during survey and or construction. Information on alien Invasive species In Ireland can be found at http://invasives.biodiversityireland.ie/ and at http://invasivespeciesireland.com/

Impact assessment

The impact of the proposed development on the flora/ fauna and habitats present should be assessed with particular regard to:

Natura 2000 sites, i.e.:

- Special Areas of Conservation (SAC) designated under the EC Habitats Directive (Council Directive 92/43/EEC)
- and Special Protection Areas (SPA) designated under the EC Birds Directive (Council Directive 2009/147 EC),

Other designated sites, or sites proposed for designation such as,

- Natural Heritage Areas;
- proposed Natural Heritage Areas;
- Nature Reserves;
- Refuges for Fauna or Flora designated under the Wildlife Acts 1976 to 2018;
- species protected under the Wildlife Acts including protected flora;

'Protected species and natural habitats', as defined in the Environmental Liability Directive (2004/35/EC) and European Communities (Environmental Liability) Regulations, 2008 including

- Birds Directive - Annex I species and other regularly occurring migratory species, and their habitats (wherever they occur);
- Habitats Directive - Annex I habitats, Annex II species and their habitats;
- Annex IV species and their breeding sites and resting places (wherever they occur);
- important bird areas such as those identified by Birdlife International, features of the landscape which are of major importance for wild flora and fauna, such as those with

a "stepping stone" and ecological corridors function, as referenced in Article 10 of the Habitats Directive;

- other habitats of ecological value in a national to local context (such as those identified as locally important biodiversity areas within Local Biodiversity Action Plans and County Development Plans);
- Red data book species;
- and biodiversity in general.

Construction Management Plans and Mitigation

Complete project details including Construction Management Plans (CMPs) need to be provided in order to allow an adequate EIAR and appropriate assessment to be undertaken. CMPS should contain sufficient detail to avoid any post construction doubt with regard to the implementation of mitigation measures, timings and roles and responsibilities for same. Any mitigation needs to be included in detail and if being relied upon to reach conclusions must be proved to be achievable and likely to be effective in any given scenario it is needed. Proof of effectiveness will be required with examples of where similar techniques have been employed previously.

Applicants need to be able to demonstrate that CMPs and other such plans are adequate, all mitigation is included and effective and supported by scientific information and analysis and that they are feasible within the physical constraints of the site. The positions, locations and sizes of construction infrastructure and mitigation such as settlement ponds, disposal sites and construction compounds may significantly affect European and other designated sites, habitats and species in their own right and could have an effect for example on, drainage, water quality, habitat loss, and disturbance. If these are undetermined at time of the assessment all potential effects of the development on the site are not being considered.

Construction work should not be allowed to impact on water quality and measures should be detailed in the EIAR to prevent sediment and/or fuel runoff from getting into watercourses which could adversely impact on aquatic species.

Inland Fisheries Ireland (IFI) should be consulted with regard to impacts on fish species and the applicant may find it useful to consult their publication entitled "Planning for watercourses in the urban environment" (2020) which can be downloaded from their web site.

If applicants are not in a position to state the exact location and details of cable routes at the time of application, then they need to consider the range of options (overhead and underground) that may be used within their assessment. Should the exact height and rotor diameter of the turbines not be known at EIAR stage then the assessment of impacts must be applicable to a variety of turbine heights and rotor diameters which could be used. This should be made clear in the EIAR.

Guidance on the Appropriate Assessment (AA):

The development site occurs approximately 5km from the River Shannon and River Fergus Estuaries SPA 004077 and approximately 1km upstream of the Lower River Shannon SAC 2165. Numerous tributary streams of the sites occur, arise and flow through the proposed windfarm and therefore water quality effects and issues must be assessed and addressed. Any Peatland habitat works would be a potential significant effect for example. In addition any potential barrier, disturbance, flight path and collision risks for the SPA bird species must be assessed and addressed also. In order to carry out the Appropriate Assessment screening, and/or prepare a Natura Impact Statement (NIS), information about the relevant European sites including their conservation objectives will need to be collected.

Screening for appropriate assessment should focus on the likely significant effects of the proposed development and related activities on European sites noting that impacts to sites via air and water may occur over large distances using the source-pathway-receptor model. Details of designated sites and species and conservation objectives can be found on http://www.npws.ie/ .

Site-specific, as opposed to generic, conservation objectives are now available for many sites. Each conservation objective for a qualifying interest (QI) habitat or species is defined by a list of attributes and targets and is often supported by further documentation. Where these are not available for a site, an examination of the attributes that are used to define site-specific conservation objectives for the same QIs in other sites can be usefully used to ensure the full ecological implications of a proposal for a site's conservation objective and its integrity are assessed. It is advised, as per the notes and guidelines in the site-specific conservation objectives that any reports quoting conservation objectives should give the version number and date, so that it can be ensured and established that the most up-to-date versions including map boundaries[4] are used in the preparation of Natura Impact Statements and in undertaking appropriate assessments.

In addition, the Article 12 and 17 reports under the Birds and Habitats Directives should be referenced https://www.npws.ie/publications. The Departmental guidance document on Appropriate Assessment is available on the NPWS website at https://www.npws.ie/development-consultations and in EU Commission guidance entitled:

- "*Wind energy developments and Natura 2000*"[5]
- "*Assessment of plans and projects significantly affecting Natura 2000 sites. Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC*"[6];

[4] https://www.npws.ie/maps-and-data/designated-site-data
[5] https://ec.europa.eu/environment/nature/natura2000/management/docs/Wind_farms.pdf
[6] http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/natura_2000_assess_en.pdf

- 2018 Commission notice "*Managing Natura 2000 sites The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC*"[7] (updated June 2020)

More recent CJEU and Irish case law has clarified some issues and should also be consulted.

The NIS should present a robust and reasoned scientific assessment and analysis of the implications of the proposals for the relevant conservation objectives of relevant European sites. Best scientific knowledge in the field should be applied to the understanding of the likely effects, and to the assessment and analysis of the implications of the proposals for the conservation objectives and integrity of the sites. When carried out by the competent authority, the appropriate assessment cannot have lacunae and must contain complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the project on European sites. General advice on the preparation, content and scope of an NIS is included in Appendix A.

Cumulative and ex situ impacts

A rule of thumb often used is to include all European sites within a distance of 15km. It should be noted however that this will not always be appropriate. In some instances where there are hydrological connections a whole river catchment or a groundwater aquifer may need to be included. Similarly where bird flight paths are involved the impact may be on an SPA more than 15 kilometres away.

Other relevant Local Authorities should be consulted to determine if there are any projects or plans which, in combination with this proposed development, could impact on any European sites.

Cumulative impact from all windfarms in the area needs to be assessed and the data from surrounding sites needs to be considered in the assessment of impacts. Post construction monitoring results and data from nearby windfarms should be considered and their associated EIARs.

Post construction monitoring

This Department recognises the importance of pre and post construction monitoring, such as recommended in Drewitt et al. (2006), and Bat Conservation Ireland (2012). The applicant should not use any proposed post construction monitoring as mitigation to supplement inadequate information in the assessment. Please refer to Circular Letter PD 2/07 and NPWS 1/07 on this issue. This can be downloaded from the Department's website https://www.npws.ie/development-consultations .

7 https://ec.europa.eu/environment/nature/natura2000/management/docs/art6/EN_art_6_guide_jun_2019.pdf

The EIAR process should identify any pre and post construction monitoring which should be carried out. The post construction motoring should include bird and bat strikes/fatalities including the impact on any such results of the removal of carcasses by scavengers. Monitoring results should be made available to the competent authority and copied to this Department. An appropriate plan of action needs to be agreed at planning stage with the Planning Authority if the results in future show a significant mortality of birds and/or bat species. It is important to note that unless post decision consultation with NPWS is specifically stated as a condition of planning, NPWS has no post consent role. However, regional staff are available for liaison regarding any associated licencing requirements and or new information arising for specific species of concern.

Licenses

Where there are impacts on protected species and their habitats, resting or breeding places, licenses may be required under the Wildlife Act 1976-2018 or derogations under the EC (Birds and Natural Habitats) Regulations 2011, as amended.

In particular, bats as outlined earlier and otters, are subject to a regime of strict protection pursuant to the requirements of the Habitats Directive (92/43/EEC) as transposed in Irish law in Regulation 51 of the European Communities (Birds and Natural Habitats) Regulations, 2011 (as amended). A copy of Circular Letter NPWS 2/07 entitled "*Guidance on Compliance with Regulation 23 of the Habitats Regulations 1997 – strict protection of certain species/applications for derogation licences*" can be found on the Departmental web site at www.npws.ie/sites/default/files/general/circular-npws-02-07.pdf. It should be noted that the Regulations of 1997 have since been superseded by the European Communities (Birds and Natural Habitats) Regulations 2011, as amended. Part 6 of those Regulations is now the relevant section dealing with the protection of flora and fauna. Reference to Regulation 23 in the circular letter should be taken to mean Regulation 51 in the current Regulations.

In addition, the EIAR should take account of species protected under sections 21, 22 and 23 of the Wildlife Acts if there are any impacts on other protected species or their resting or breeding places, such as on protected plants, badger setts or birds' nests. And will also need to be cognisant of article 5 (d) of the Birds Directive. For that reason uncultivated vegetation, including hedges and trees, should not be removed during the nesting season (i.e. March 1st to August 31st).

In order to apply for any such licenses or derogations as mentioned above the results of a survey should be submitted to the National Parks and Wildlife Service of this Department. Such surveys are to be carried out by appropriately qualified person/s at an appropriate time of the year. Details of survey methodology should be provided. Should this survey work take place well before construction commences, it is recommended that an additional ecological survey of the development site should take place immediately prior to construction to ensure no significant change in the findings of the baseline ecological survey has occurred. As outlined already, if there has been any significant change mitigation, this may require amendment and where a licence has expired, there will be a need for new licence applications for the protected species.

Appendix 1

Notes on the preparation and content of an NIS

The term 'NIS' is defined in legislation[8]. In general, an NIS, if required, should present the data, information and analysis necessary to reach a definitive determination as to 1) the implications of the plan or project, alone or in combination with other plans and projects, for a European site in view of its conservation objectives, and 2) whether there will be adverse effects on the integrity of a European site. The NIS should be underpinned by best scientific knowledge and objective information, as required in the case of screening for appropriate assessment, and by the precautionary principle.

Based on the Department's experience of reviewing such reports, the following advice is offered in relation to the preparation and content of an NIS:

1. An NIS is a scientific assessment that presents relevant evidence, data and analysis, and focuses on the implications of the plan or project, on its own and in combination with other plans and projects, for the conservation objectives of the relevant European site(s), taking the full scope of these objectives, whether generic or site specific, into account;
2. Examination of the potential effects of the plan or project must be undertaken to identify what European sites, and which of their qualifying interests (SAC), special conservation interests (SPA) or conservation objectives, are potentially at risk. In combination effects must also be taken into account. This is required to determine a 'zone of influence' or 'zone of impact' for the project, if such a concept is used. The 15km distance in existing guidance is an indicative figure only and its application and validity should be examined and justified in each specific case on an ecological or other basis;
3. The scientific basis on which sites and their conservation objectives are included or excluded from assessment and analysis should be presented and justified;
4. The full area or extent of the likely effects of the plan or project should be determined and quantified. Where temporary damage and disturbance will occur, predicted timelines for recovery should be presented;
5. The relevant environmental baseline and trends in European sites should be taken into account, bearing in mind changes and in combination effects which have occurred since site designation;
6. An NIS should be informed by any necessary surveys of habitats and species at the appropriate time(s) of year to identify, describe, evaluate and map their presence within the receiving environment. In all relevant cases, the scientific basis and

[8] The term, 'NIS', is defined in the European Communities (Birds and Natural Habitats) Regulations, 2011, and Part XAB, Section 177T of the Planning and Development Act, 2000 as amended

justifications for categorising or not categorising habitats as Annex I habitats, or priority types, should be presented;

7. An NIS should be informed by any necessary hydrological, hydrogeological or geotechnical investigations to assess impacts on habitat structure and function;
8. Where mitigation measures are required, full details should be included in the project description and drawings, with method statements provided, where necessary. It must be demonstrated that mitigation measures will be delivered in full, and at the appropriate time, at all post-consent stages, and that they will be effective in any specific location or set of conditions. The necessary analysis should be presented to demonstrate how the mitigation measures will avoid or remove the risks of adverse effects on the integrity of European sites that have been identified in an NIS so that the final analysis is undertaken in the context of the predicted residual effects;
9. An NIS should contain, or clearly cross-reference, all the scientific data and analysis on which the assessment is based, and should contain clear and precise findings and conclusions as to the implications of the project, on its own and in combination with other plans and projects, for the conservation objectives and integrity of the relevant European site(s).

The above observations/recommendations are based on the papers submitted to this Department on a pre-planning basis and are made without prejudice to any observations that the Minister may make in the context of any consultation arising on foot of any development application referred to the Minister, by the planning authority/ies, in the role as statutory consultee under the Planning and Development Act, 2000, as amended.

You are requested to send further communications to the Development Applications Unit (DAU) at **manager.dau@housing.gov.ie**.

Is mise le meas**,**

Diarmuid Buttimer
Development Applications Unit
Administration

From: Paul Hennessy <paul.hennessy@shannonairport.ie>
Sent: Monday 20 December 2021 18:34
To: Peter Barry
Subject: Proposed Ballycar Wind Farm - EIA Consultation [Filed 07 Jan 2022 09:26]

Importance: High

Hi Peter,

Your documentation relating to the above has been forwarded for my attention.

We have a statutory "safeguarding" role in respect of the aerodrome and developments such as wind farms and solar PV developments are often referred for review.

Key points of interest from our and the perspective:

- Obstacle Limitational Surfaces (OLS) assessment required to be carried out by us as the Airport Authority
- Effects on NAVAIDS/Radar – IAA ANSP to assess
- Effects on Instrument Flight Procedures (IFP's) – IAA ANSP to assess

Depending on the outcome of the above, the developer may be required to undertake a full aeronautical study on the proposal at their own cost.

Should the proposal be approved the following issues will require attention:

- Pre-notification to the IAA and aerodrome (30 days in advance) of the intention to use mobile cranage in the erection of the turbines
- The developer must apply the following standard: *Chapter Q (Visual Aids for Denoting Obstacles)* of the Certification Specifications contained within the *EASA Easy Access Rules for Aerodromes CS ADR-DSN.Q.851 Marking and Lighting of wind turbines* (Regulation (EU) No. 139/2014) for wind turbine projects.

If you require any further clarifications, please don't hesitate to contact me.

Brgds,

Paul

Paul Hennessy
Safety Compliance & Environment Manager

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Shannon Airport,
Co. Clare, Ireland.
V14 EEO6

From: Paul Hennessy <paul.hennessy@shannonairport.ie>
Sent: Friday 7 January 2022 12:29
To: Peter Barry
Subject: RE: [External] RE: Proposed Ballycar Wind Farm - EIA Consultation

No problem Peter,

Please keep us in the loop as necessary.

Many Thanks,

Paul

Paul Hennessy
Safety Compliance & Environment Manager

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shannon AIRPORT
PART OF shannon GROUP

From: Peter Barry <Peter.Barry@mwp.ie>
Sent: 07 January 2022 12:03
To: Paul Hennessy <paul.hennessy@shannonairport.ie>
Cc: Valerie Heffernan <Valerie.Heffernan@mwp.ie>
Subject: [External] RE: Proposed Ballycar Wind Farm - EIA Consultation

the sender's email address and know the content is safe. If for any reason you are suspicious, please contact the IT department on 061-712444.

Thanks Paul,

I also received a response from the IAA which included yourself as a contact, see attached. It outlines the information you need to carry out the assessment below. We will get that across to you in the next few days. There is still some tweaking of the layout.

If there is anything else you need just let me know.

From: Paul Hennessy <paul.hennessy@shannonairport.ie>
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Depending on the outcome of the above, the developer may be required to undertake a full aeronautical study on the proposal at their own cost.

Should the proposal be approved the following issues will require attention:

- Pre-notification to the IAA and aerodrome (30 days in advance) of the intention to use mobile cranage in the erection of the turbines
- The developer must apply the following standard: *Chapter Q (Visual Aids for Denoting Obstacles)* of the Certification Specifications contained within the *EASA Easy Access Rules for Aerodromes CS ADR-DSN.Q.851 Marking and Lighting of wind turbines* (Regulation (EU) No. 139/2014) for wind turbine projects.

If you require any further clarifications, please don't hesitate to contact me.

Brgds,

Paul

Paul Hennessy
Safety Compliance & Environment Manager

T +353 (0) 61 712471
M +353 (0) 87 2382453
E paul.hennessy@shannonairport.ie

W shannonairport.ie

Shannon Airport,
Co. Clare, Ireland.
V14 EEO6

Shannon Airport Authority DAC. Registered office: Shannon Airport, County Clare, Registered Number: 391054 Ireland, V14 EE06 CGA Údarás Aerfort na Sionainne. Oifig Chláraithe: Aerfort na Sionainne, Contae an Chláir, Uimhir Chláraithe: 391054 Eire, V14 EE06 DISCLAIMER: The information contained in this email and in any attachment(s) is confidential and may contain legally privileged material. It is intended solely for the attention and use of the intended Recipient(s). If you are not the intended recipient(s) of this email any review, retransmission, disclosure, dissemination or any action taken or omitted to be taken in reliance on it or its attachment(s) is prohibited and may be unlawful. If you believe that you have received this email in error, please contact the sender and remove the email from your computer system. Unless expressly stated, this email is not intended to create any contractual relationship. If this email is not sent in the course of the senders employment or fulfilment of his/her duties to Shannon Airport Authority, Shannon Airport Authority accepts no liability whatsoever for the content of this message or any attachment(s). Please refer any queries to infosec@shannonairport.ie SÉANADH: Is eolas faoi rún gach eolas atá sa ríomhphost seo agus in aon cheangaltán/cheangaltáin a bheadh leis agus d'fhéadfadh ábhar a bheadh faoi phribhléid dlí a bheith mar chuid de. Is don té chuig a seoltar an ríomhphost atá an ríomhphost seo beartaithe agus d'úsáid an té sin amháin. Tá cosc ar dhuine ar bith seachas an té chuig a raibh sé beartaithe, an ríomhphost seo a athbhreithniú, a athsheoladh, a scaipeadh nó aon úsáid eile a bhaint as, nó gníomh a ghlacadh bunaithe air nó ar an gceangaltán/na ceangaltáin agus d'fhéadfadh sin a bheith in aghaidh an dlí. Más dóigh leat go bhfuair tú an ríomhphost seo trí earráid, déan teagmháil le do thoil leis an té a sheol é agus scrios an ríomhphost de do chóras ríomhaireachta. Mura bhfuil sé ráite go sonrach, ní ionann an ríomhphost seo agus aon ghaol conarthach. Mura seoltar an ríomhphost seo mar chuid d'fhostaíocht an tseoltóra nó dá chuid dualgas i leith Údarás Aerfort na Sionainne, ní ghlacann Údarás Aerfort na Sionainne aon fhreagracht maidir le hábhar na teachtaireachta ná aon cheangaltán/cheangaltáin. Seol fiosruithe ar bith chuig infosec@shannonairport.ie

From: O'LEARY Geraldine <Geraldine.O'LEARY@IAA.ie>
Sent: Wednesday 5 January 2022 14:04
To: Peter Barry
Subject: Proposed Ballycar Wind Farm [Filed 07 Jan 2022 11:03]

Follow Up Flag: Follow up
Flag Status: Completed

"Dear Mr. Barry,

Thank you for your letter and scoping report and request for comments in relation to a proposed wind farm on lands at and near Ballycar, Co. Clare.

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Mr. Paul Hennessy Safety Compliance and Environment Manager Shannon Airport Authority DAC t: +353-61-712471 m: +87-2382453 e: paul.hennessy@shannonairport.ie	Mr. Cathal Mac Criostail Airspace & Navigation Manager Údarás Eitlíochta na hÉireann / Irish Aviation Authority The Times Building, 11-12 D'Olier Street, Dublin 2, D02 T449, Ireland cathal.maccriostail@iaa.ie +353 (0)1 6031173 +353 (0)86 0527130	Mr. Jonathan Byrne Operations Manager STBU/CTBU Air Traffic Control Irish Aviation Authority jonathan.byrne@iaa.ie +353 61 703704 +353 87 9375486

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Yours sincerely

Deirdre Forrest
Corporate Affairs

From: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Sent: Thursday 13 January 2022 13:41
To: Peter Barry
Cc: Paul Hennessy; BYRNE Jonathan; Valerie Heffernan; DOYLE Fergal; ARTHURS Fergal; OLOUGHLIN Charlie; SYMMANS Terry
Subject: 220112 Proposed Ballycar Wind Farm
Attachments: Turbine Layout 2022-01-06 Issued to IAA.xls

Importance: High

Dear Peter,

Happy New Year and many thanks for the data supplied in the attached file.

There are a number of surfaces that the IAA Air Navigation Service Provider (ANSP) are responsible for safeguarding around Shannon Airport, including Navigation Aids, Surveillance Radar and Instrument Flight Procedures (IFPs).

In regard to the IFP surfaces, I am responsible for safeguarding here and we have a safeguarding grid to guide as to whether there is a potential impact on the IFP surfaces, generated by new obstacles, such as the proposed (12) wind turbines.

Below is a depiction of this safeguarding grid with a pin at Ballycar:

The values each grid cell represent an Above Mean Sea Level (AMSL: Site elevation + Height of obstacle) elevation value, above which, an IFP impact assessment will be required. In the case of

the Ballycar area and taking the highest turbine height supplied, 254m added to an approximate site elevation of 240m, gives an AMSL elevation of in excess of 400m, which is above the safeguarding values in this area.

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This is not the only wind turbine proposal for this area and to be completely upfront, nearly all are creating issues for the surfaces referenced.

If you could supply confirmation of the AMSL elevations of the turbines and give co-ordinates in WGS 84 format (Latitude and Longitude), this would be appreciated and will allow me to give greater clarity on requirements for the ANSP and indeed SAA. If I have picked up on information incorrectly, please do correct me.

Kind regards,

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www.iaa.ie
Do you *really* need to print this?

From: Peter Barry <Peter.Barry@mwp.ie>
Sent: Thursday 13 January 2022 10:35
To: O'LEARY Geraldine <Geraldine.O'LEARY@IAA.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>
Subject: RE: Proposed Ballycar Wind Farm

Hi Geraldine,

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If you need any more information, please let me know.

I would appreciate if you would acknowledge receipt of this email.

Peter Barry
BSc MSc CEnv

Principal Environmental Scientist

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t +353 (0)66 7123404 w www.mwp.ie

Reen Point, Blennerville,
Tralee, Co. Kerry, V92 X2TK, Ireland

MWP

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Sent: Wednesday 5 January 2022 14:04
To: Peter Barry <Peter.Barry@mwp.ie>
Subject: Proposed Ballycar Wind Farm [Filed 07 Jan 2022 11:03]

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Yours sincerely

Deirdre Forrest
Corporate Affairs

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==========
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Turbine	Hub Height	Rotor Diameter	X	Y	Height (m)	
T1	90	68	554496	664315	233	
T2	90	68	554632	663833	205	
T3	90	68	554860	664132	223	
T4	90	68	554984	663637	195	
T5	90	68	555455	663745	238	
T6	90	68	555791	664097	254	
T7	90	68	555910	663609	191	
T8	90	68	555486	663236	161	
T9	90	68	555092	663181	166	
T10	83	68	556023	663086	115	Reduced Hub Height
T11	90	68	555635	662799	106	
T12	90	68	555937	662535	77	

Turbine V136

From: Peter Barry
Sent: Thursday 13 January 2022 10:35
To: O'LEARY Geraldine
Cc: Paul Hennessy; MACCRIOSTAIL Cathal; jonathan.byrne@iaa.ie; Valerie Heffernan
Subject: RE: Proposed Ballycar Wind Farm
Attachments: Turbine Layout 2022-01-06 Issued to IAA.xls

Hi Geraldine,

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I would appreciate if you would acknowledge receipt of this email.

Peter Barry
BSc MSc CEnv

Principal Environmental Scientist

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t +353 (0)66 7123404 w www.mwp.ie

Reen Point, Blennerville,
Tralee, Co. Kerry, V92 X2TK, Ireland

MWP

From: O'LEARY Geraldine <Geraldine.O'LEARY@IAA.ie>
Sent: Wednesday 5 January 2022 14:04
To: Peter Barry <Peter.Barry@mwp.ie>
Subject: Proposed Ballycar Wind Farm [Filed 07 Jan 2022 11:03]

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Yours sincerely

Deirdre Forrest
Corporate Affairs

From: Peter Barry
Sent: Wednesday 12 January 2022 14:13
To: Jane Gilleran
Cc: Valerie Heffernan
Subject: RE: EIA Consult Ballycar Wind Farm

Thanks Jane

From: Jane Gilleran <Jane.Gilleran@fisheriesireland.ie>
Sent: Wednesday 12 January 2022 14:08
To: Peter Barry <Peter.Barry@mwp.ie>
Subject: EIA Consult Ballycar Wind Farm

Dear Peter,

Thank you for your consult request we received on December 17th.

I aim to have a response to you by early next week.

Regards

Jane

Jane Gilleran
Fisheries Environmental Officer
Inland Fisheries Ireland - Limerick

Iascach Intíre Éireann
Inland Fisheries Ireland

Tel (061) 300238
Email jane.gilleran@fisheriesireland.ie
Web www.fisheriesireland.ie

Ashbourne Business Park. Dock Rd. Limerick. V94 NPE0

Valerie Heffernan

From: Peter Barry
Sent: Friday 14 January 2022 12:34
To: O'LEARY Geraldine
Cc: Valerie Heffernan
Subject: RE: Proposed Ballycar Wind Farm

Thanks Geraldine

From: O'LEARY Geraldine <Geraldine.O'LEARY@IAA.ie>
Sent: Friday 14 January 2022 12:33
To: Peter Barry <Peter.Barry@mwp.ie>
Subject: RE: Proposed Ballycar Wind Farm

Hi Peter,

I wish to acknowledge receipt of your email with further information in regard to the Proposed Ballycar Wind Farm and confirm that it has been forwarded to the relevant departments.

Kind Regards,

Geraldine O'Leary

From: Peter Barry <Peter.Barry@mwp.ie>
Sent: Thursday 13 January 2022 10:35
To: O'LEARY Geraldine <Geraldine.O'LEARY@IAA.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>
Subject: RE: Proposed Ballycar Wind Farm

Hi Geraldine,

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If you need any more information, please let me know.

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Subject: Proposed Ballycar Wind Farm [Filed 07 Jan 2022 11:03]

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Deirdre Forrest
Corporate Affairs

From: Peter Barry
Sent: Thursday 13 January 2022 15:16
To: MACCRIOSTAIL Cathal
Cc: Paul Hennessy; BYRNE Jonathan; Valerie Heffernan; DOYLE Fergal; ARTHURS Fergal; OLOUGHLIN Charlie; SYMMANS Terry
Subject: RE: 220112 Proposed Ballycar Wind Farm [Filed 13 Jan 2022 15:16]
Attachments: Turbine Layout 2022-01-06_IAA.xls

Hi Cathal,

Attached table with Lat/ Long coordinates included. Also, to clarify the column *rotor diameter* was labelled wrong in the earlier table I emailed, it should have been labelled *blade length*, rotor diameter is then double. Corrected table attached with AMSL as requested.

We are happy to discuss findings once you have had a chance to carry out your internal studies. We are still in the design and assessment stage.

Let me know if I can do anything else.

Peter

From: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Sent: Thursday 13 January 2022 13:41
To: Peter Barry <Peter.Barry@mwp.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>
Subject: 220112 Proposed Ballycar Wind Farm
Importance: High

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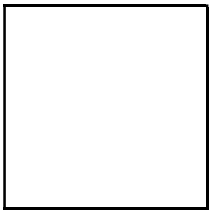
Corporate Affairs



Turbine	Hub Height	Blade Length	Rotor Diameter	Tip Height (Height of Obstacle)	X	Y	Lat	Long	Site Elevation (m)	AMSL: Site elevation + Height of obstacle
T1	90	68	136	158	554496	664315	52.72801172	-8.673676284	233	391
T2	90	68	136	158	554632	663833	52.72369128	-8.671596429	205	363
T3	90	68	136	158	554860	664132	52.72639754	-8.668262604	223	381
T4	90	68	136	158	554984	663637	52.72195917	-8.6663592	195	353
T5	90	68	136	158	555455	663745	52.72296877	-8.659402265	238	396
T6	90	68	136	158	555791	664097	52.72615984	-8.654476153	254	412
T7	90	68	136	158	555910	663609	52.72178375	-8.652649104	191	349
T8	90	68	136	158	555486	663236	52.71839679	-8.658874461	161	319
T9	90	68	136	158	555092	663181	52.71786995	-8.664698317	166	324
T10	83	68	136	151	556023	663086	52.71709259	-8.650906544	115	266
T11	90	68	136	158	555635	662799	52.71448158	-8.656610217	106	264
T12	90	68	136	158	555937	662535	52.71213359	-8.652105498	77	235

Turbine V136

From: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Sent: Monday 14 February 2022 17:44
To: Peter Barry
Cc: Paul Hennessy; BYRNE Jonathan; Valerie Heffernan; DOYLE Fergal; ARTHURS Fergal; OLOUGHLIN Charlie; SYMMANS Terry; Planning
Subject: 220214 Proposed Ballycar Wind Farm ANSP Update
Attachments: Turbine Layout 2022-01-06_IAA.xls; 20140909-impact-wind-turbines-sur-sensors-guid-v1.2 (1).pdf

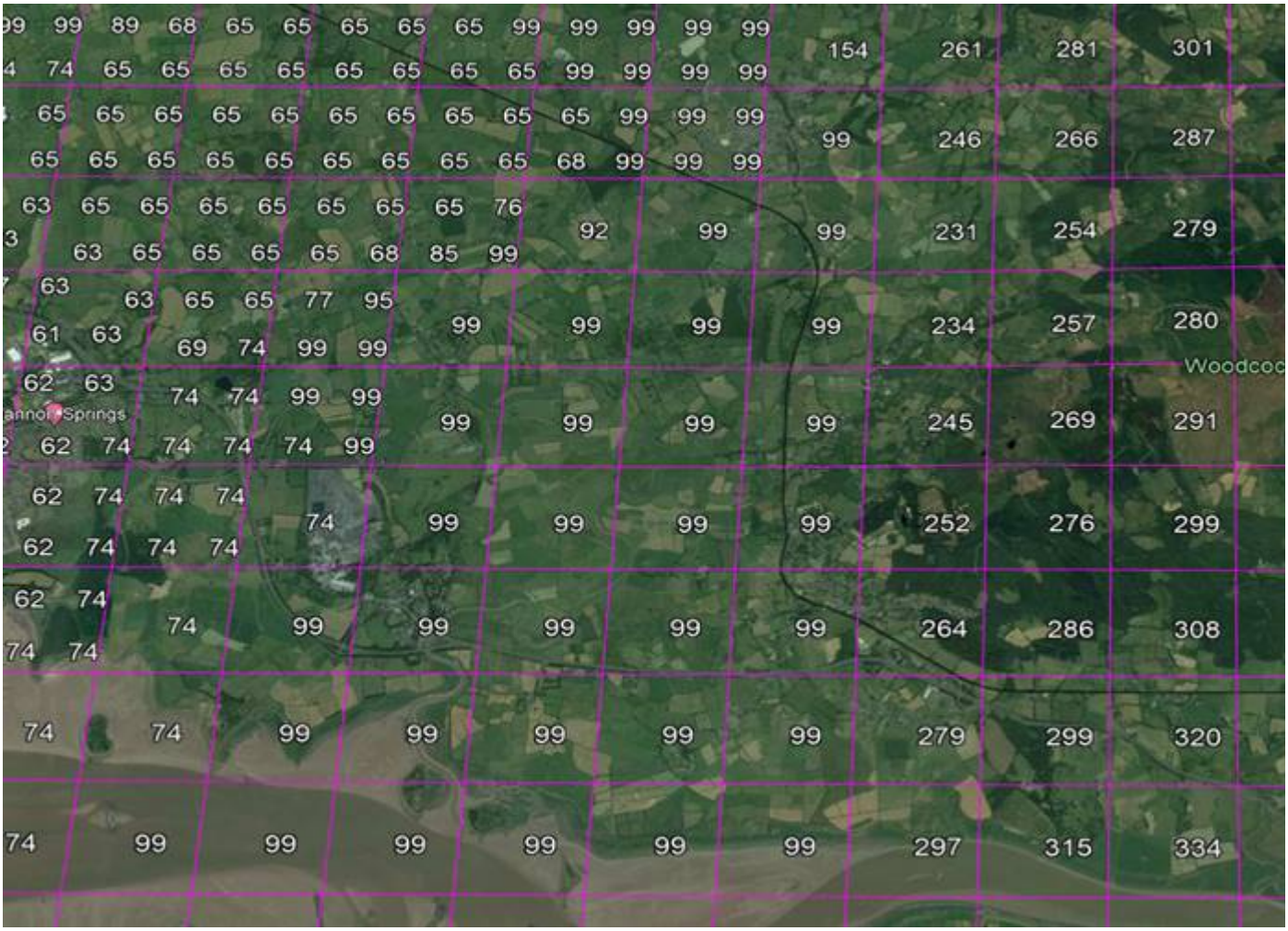
Importance: High

Dear Peter,

Many thanks for the email and the attached detailed outline of the proposed Turbine co-ordinates and AMSL elevations. Thanks also for the phone-call by way of reminder on this.

As I outlined there are three areas of concern for us the IAA Air Navigation Service Provider:

1. **Instrument Flight Procedures (IFPs) surfaces:** Below is a Google Earth outline of the turbines with our IFP safeguarding girds overlayed:



As you can see the guide (IFP) elevation which does not affect the IFPs, is exceeded for many of the proposed turbines. This does not mean that this is not acceptable. It does however require an IF assessment to be carried out by a certified IFP designer to assess possible impacts. When you're ready to engage on this I can advise on which companies are certified for this work. The result should confirm no impact, or recommend mitigations, e.g. lowering of some turbines elevations possibly

2. **Navigation Aids:** The nearest turbine proposed is c. 16.5 km from Shannon Airport and as such should be outside area of concern for our ground-based navigation aids. This may need to be confirmed by the company who carry out flight checking if these systems. Fergal Arthurs and Fergal Doyle, Could you review and provide an opinion please?
3. **Surveillance:** The turbines as proposed are close to our surveillance systems at Woodcock Hill and will need to be considered for an effect on these systems. Attached is some guidance material and I'll refer this element to my colleague Charlie O'Loughlin for a view on this.

If you are proceeding to planning application, could you advise all copied please and we can assess where we are at that point?

I hope this all makes sense.

Kind regards,

Cathal
Cathal Mac Criostail
Údarás Eitlíochta na hÉireann / Irish Aviation Authority
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Do you *really* need to print this?

From: Peter Barry <Peter.Barry@mwp.ie>
Sent: Thursday 13 January 2022 15:16
To: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>
Subject: RE: 220112 Proposed Ballycar Wind Farm

Hi Cathal,

Attached table with Lat/ Long coordinates included. Also, to clarify the column *rotor diameter* was labelled wrong in the earlier table I emailed, it should have been labelled *blade length*, rotor diameter is then double. Corrected table attached with AMSL as requested.

We are happy to discuss findings once you have had a chance to carry out your internal studies. We are still in the design and assessment stage.

Let me know if I can do anything else.

Peter

From: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Sent: Thursday 13 January 2022 13:41
To: Peter Barry <Peter.Barry@mwp.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>
Subject: 220112 Proposed Ballycar Wind Farm
Importance: High

Dear Peter,

Happy New Year and many thanks for the data supplied in the attached file.

There are a number of surfaces that the IAA Air Navigation Service Provider (ANSP) are responsible for safeguarding around Shannon Airport, including Navigation Aids, Surveillance Radar and Instrument Flight Procedures (IFPs).

In regard to the IFP surfaces, I am responsible for safeguarding here and we have a safeguarding grid to guide as to whether there is a potential impact on the IFP surfaces, generated by new obstacles, such as the proposed (12) wind turbines.

Below is a depiction of this safeguarding grid with a pin at Ballycar:

The values each grid cell represent an Above Mean Sea Level (AMSL: Site elevation + Height of obstacle) elevation value, above which, an IFP impact assessment will be required. In the case of the Ballycar area and taking the highest turbine height supplied, 254m added to an approximate site elevation of 240m, gives an AMSL elevation of in excess of 400m, which is above the safeguarding values in this area.

Separately, the heights proposed will likely impact the Surveillance Radar at Woodcock Hill and navigation aids for approaches to Shannon Airport. I've copied colleagues from the ANSP in these areas, for information.

This is not the only wind turbine proposal for this area and to be completely upfront, nearly all are creating issues for the surfaces referenced.

If you could supply confirmation of the AMSL elevations of the turbines and give co-ordinates in WGS 84 format (Latitude and Longitude), this would be appreciated and will allow me to give greater clarity on requirements for the ANSP and indeed SAA. If I have picked up on information incorrectly, please do correct me.

Kind regards,

Cathal
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From: Peter Barry <Peter.Barry@mwp.ie>
Sent: Thursday 13 January 2022 10:35
To: O'LEARY Geraldine <Geraldine.O'LEARY@IAA.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>
Subject: RE: Proposed Ballycar Wind Farm

Hi Geraldine,

Please find attached the turbine coordinates, hub height, rotor diameter and ground elevation as requested (email thread below).

If you need any more information, please let me know.

I would appreciate if you would acknowledge receipt of this email.

Peter Barry
BSc MSc CEnv

Principal Environmental Scientist

e peter.barry@mwp.ie m +353 86 4474440
t +353 (0)66 7123404 w www.mwp.ie

Reen Point, Blennerville,
Tralee, Co. Kerry, V92 X2TK, Ireland

MWP

From: O'LEARY Geraldine <Geraldine.O'LEARY@IAA.ie>
Sent: Wednesday 5 January 2022 14:04
To: Peter Barry <Peter.Barry@mwp.ie>
Subject: Proposed Ballycar Wind Farm [Filed 07 Jan 2022 11:03]

"Dear Mr. Barry,

Thank you for your letter and scoping report and request for comments in relation to a proposed wind farm on lands at and near Ballycar, Co. Clare.

As the blade tip height proposed is not included, nor specific turbine positions and the ground elevation of each site is not provided, Safety Regulation Division - Aerodromes cannot make any specific comments at this time.

The development appears to be approximately 16km East of Shannon Airport, as such, the applicant should engage with Shannon Airport Authority and the IAA's Air Navigation Service Provider (ANSP) as a matter of urgency to undertake a preliminary screening assessment to confirm that the proposed wind farm and the associated cranes that would be utilised during its construction would have no impact on instrument flight procedures, communication and navigation aids or flight checking at Shannon Airport. Contact details are as below:

Aerodrome Operator – Shannon Airport:	**IAA-ANSP:**	**Shannon Tower Business Unit**
Mr. Paul Hennessy Safety Compliance and Environment Manager Shannon Airport Authority DAC t: +353-61-712471 m: +87-2382453 e: paul.hennessy@shannonairport.ie	Mr. Cathal Mac Criostail Airspace & Navigation Manager Údarás Eitlíochta na hÉireann / Irish Aviation Authority The Times Building, 11-12 D'Olier Street, Dublin 2, D02 T449, Ireland cathal.maccriostail@iaa.ie +353 (0)1 6031173 +353 (0)86 0527130	Mr. Jonathan Byrne Operations Manager STBU/CTBU Air Traffic Control Irish Aviation Authority jonathan.byrne@iaa.ie +353 61 703704 +353 87 9375486

Subject to any study noting a potential impact on the safety of operations at Shannon Airport, during the formal planning process, the Safety Regulation Division – Aerodromes would likely make the following general observation:

In the event of planning consent being granted, the applicant should be conditioned to contact the Irish Aviation Authority to: (1) agree an aeronautical obstacle warning light scheme for the wind farm development, (2) provide as-constructed coordinates in WGS84 format together with ground and tip height elevations at each wind turbine location and (3) notify the Authority of intention to commence crane operations with at least 30 days prior notification of their erection.

Yours sincerely

Deirdre Forrest
Corporate Affairs

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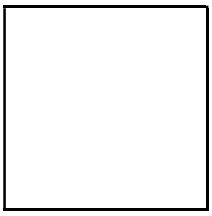

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EUROCONTROL

EUROCONTROL Guidelines

How to Assess the Potential Impact of Wind Turbines Surveillance Sensors

Edition: 1.2
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EUROPEAN ORGANISATION
FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL Guidelines for Assessing the Potential Impact of Wind Turbines on Surveillance Sensors

DOCUMENT IDENTIFIER : EUROCONTROL-GUID-0130

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Abstract

This document provides guidelines for Air Navigation Service Providers (ANSP), and also wind energy developers, on how to assess whether or not wind turbines could impact upon the provision of surveillance services currently provided and identifies some possible means of mitigation.
This document aims at maintaining the necessary levels of safety and efficiency of surveillance related Air Traffic Services whilst supporting to the maximum extent possible the development of wind energy.
The proposed process defines different geographical zones, based on simple criteria, for each type of sensors (radar only for the time being). For each of these zones different conditions are defined to ensure that the impact of the wind turbine is tolerable. In the “safeguarding” zone, the closest area to the sensor, wind turbines are not allowed to be built. In the second zone, wind turbines can be built provided that a specific impact assessment analysis demonstrates that the impact can be tolerated. In the third zone, wind turbine can be built on the basis of the results of a simple and generic impact assessment analysis that is further described in this document. In the last zone, the impact is acceptable or even non-existent.

Keywords

Wind	Turbine	Surveillance	Sensor
Radar	SSR	PSR	Mode S
Engineering	Operational	ADS-B	WAM
MLAT	ANSP		

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DOCUMENT APPROVAL

The following table identifies all management authorities who have successively approved the present issue of this document.

AUTHORITY	NAME AND SIGNATURE	DATE
Editor:	Andrew DESMOND-KENNEDY Secretary of the Surveillance Steering Group	25/09/2014
Editor:	Michel BORELY	25/09/2014
Head of Surveillance and Code Coordination Unit (and Chairman of the Surveillance Steering Group)	Robert STEWART	2/10/2014
Head of Standardisation Unit	Peter GREEN	2/10/2014
Director Pan-European Single Sky	Luc TYTGAT	6/10/14
Director General	Frank BRENNER	10/10/14

DOCUMENT CHANGE RECORD

The following table records the complete history of the successive editions of the present document.

EDITION NUMBER	EDITION DATE	REASON FOR CHANGE	PAGES AFFECTED
1.0	17/05/2010	First released issue	All
1.1	09/06/2010	Correction of equation 30	67
1.2	20/02/2014	Section 1.9 removal of link from section title Section 2.10 added Section 3.2 CFAR text elaborated Section 4.3.1 modified Section 4.4.12 added Section 4.6.1 modified Table 3 in 4.6.2 modified Annex C correction to footnote references	16 21 23 33 and 34 38 39 41 56

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EXECUTIVE SUMMARY

Many countries have set ambitious renewable energy targets for the year 2020. Meeting these targets requires a considerable deployment of renewable electricity generating capacity such as wind turbines. Wind turbines can have a detrimental impact on the functioning of Air Traffic Control (ATC) surveillance.

This document provides an approach based on an early and constructive dialogue promoting reciprocal transparency between Air Navigation Service Providers (ANSP) and wind energy developers to maintain the necessary levels of safety and efficiency of surveillance Air Traffic Services whilst supporting the development of wind energy.

The document provides three elements:

- A framework process further, supported by
- A methodology to assess whether or not wind turbine could impact on the provision of surveillance services
- A (non-exhaustive) list of possible measures to be applied to the air traffic control system or wind farm to mitigate that impact.

The proposed process includes an assessment methodology that defines different geographical zones, based on simple criteria, for each type of sensor (radar only for the time being). For each of these zones different conditions are defined to ensure that the impact of the wind turbine is manageable from an operational point of view. In summary these are as follows, in the “safeguarding” zone, the closest area to the sensor, wind turbines are very likely to cause harmful interferences. In the second zone, wind turbines could be built provided that a specific impact assessment analysis demonstrates that the impact can be managed. In the third zone, wind turbines could be built on the basis of the results of a simple and generic impact assessment analysis that is further described in this document. In the last zone, from a surveillance perspective, wind turbines could be built without any constraints.

The process also foresees wind energy developers and Air Navigation Service Providers mutually assessing possible mitigation options.

The document was written by a group of civil and military surveillance experts from the ECAC countries. The procedures described are a consolidation of practical experiences supplemented by the results of third-party studies.

It is recognised that the state of knowledge and the state of technology is continuously evolving. Therefore it is desirable to keep the document updated by modifying the approach when appropriate and adding new mitigation options when available.

The application of the procedures outlined in this document is not mandatory.

EUROCONTROL makes no warranty for the information contained in this document, nor does it assume any liability for its completeness or usefulness. Any decision taken on the basis of the information is at the sole responsibility of the user.

It is noted that only ATC surveillance related aspects are covered in this document. The readers are advised to ensure that all parties that may be impacted by such deployments are adequately consulted.

1. Introduction

1.1 Background

Air Navigation Service Providers (ANSP), throughout Europe, are legally responsible for the safe and expeditious movement of aircraft operating within their designated airspace. To undertake this responsibility, each has a comprehensive infrastructure of surveillance sensors (including radars), communication systems and navigational aids.

All these ground systems have an interface with the aircraft through a Radio Frequency (RF) link. Any structure that is located between a ground-based surveillance system and an aircraft has the potential to disturb the RF link between the ground system and the aircraft.

A large number of wind turbines are being deployed within the ECAC countries in order to support the strategy of increasing the share of renewable energy (e.g. 20% by 2020 for EU states).

Both communities of stakeholders have set ambitious development objectives for the next years, and it is therefore essential to ensure that each community achieves its objectives without detrimental impact on the other's.

Recommendations such as European Guidance Material on Managing Building Restricted Areas [RD 3] have been published for protecting an ANSP's Air Traffic Management infrastructure against static structures like buildings, telecommunication masts, etc. However wind turbines are not static structures (blades are turning, blade orientation is changing, nacelle is rotating), the recommendations defined for static structures are not applicable to wind turbines.

In responses to concerns regarding interference between surveillance sensors and wind turbines, the EUROCONTROL Surveillance Team established, at the end of 2005, a Wind Turbine Task Force and gave it the responsibility to develop a recommended methodology that could be used to assess the potential impact of structures such as wind turbines on Surveillance Systems and to provide suggestions for possible mitigation options.

This methodology and the framework process, in which it is embedded, are described in this document. They aim at maintaining the necessary levels of safety and efficiency of surveillance related Air Traffic Services whilst supporting to the maximum extent possible the installation of wind turbines.

1.2 EUROCONTROL Guidelines

EUROCONTROL guidelines, as defined in EUROCONTROL Regulatory and Advisory Framework (ERAF) [RD 5], are advisory materials and contain:

"Any information or provisions for physical characteristic, configuration, material, performance, personnel or procedure, the use of which is recognised as contributing to the establishment and operation of safe and efficient systems and services related to ATM in the EUROCONTROL Member States."

Therefore, the application of EUROCONTROL guidelines document is not mandatory.

In addition, it is stated in [RD 6] that:

"EUROCONTROL Guidelines may be used, inter alia, to support implementation and operation of ATM systems and services, and to:

- *complement EUROCONTROL Rules and Specifications;*
- *complement ICAO Recommended Practices and Procedures;*
- *complement EC legislation;*
- *indicate harmonisation targets for ATM Procedures;*
- *encourage the application of best practice;*
- *provide detailed procedural information."*

1.3 Objective of this document

The objective of this document is to provide a concise and transparent reference guide for both ANSPs and Wind Energy developers when assessing the impact of wind turbines on ATC surveillance systems.

This reference guide relies on a framework process including an assessment methodology and mitigation options. The assessment methodology is based on establishing when ATC services based on surveillance information could be affected beyond manageable level by the construction of a proposed wind turbine development.

For radar, the key performance characteristics are defined in the EUROCONTROL Standard Document for Radar Surveillance in En-route Airspace and Major Terminal Areas [RD 1]. They are used throughout this document when assessing radar performance.

For the time being the assessment methodology is limited to mono-static ATC radar surveillance sensor (Primary Surveillance Radar – PSR, Secondary Surveillance Radar – SSR); it is the intention to extend it to other technologies like Wide Area Multilateration (WAM), Automatic Dependent Surveillance Broadcast (ADS-B) and Multi-Static Primary Surveillance Radar (MSPSR) if relevant.

Initial studies showed that these technologies, which currently have different levels of maturity[1], are likely to be less susceptible to wind turbines than radars. Therefore, they could be implemented as possible mitigations in certain cases, provided that their deployment has been fully validated in the ATC context. Other currently available mitigations are described in section 4.6.

Wind turbines can also have detrimental impacts upon other aspects of air transport. Such aspects include, but are not limited to, performance reduction of ATM infrastructure (Communication, Navigation), constraints on procedure design, airspace planning and design, minimum safe altitudes, climb rates of aircraft, descent rates of aircraft, procedures to ensure that wind turbine locations are correctly represented on maps and in terrain avoidance tools, procedures to ensure that they are appropriately lit etc.

These aspects have to be addressed in accordance with the relevant documents. In particular, the European guidance material on managing Building Restricted Areas (BRA) (ICAO doc 015 [RD 3]) provides some specific recommendations in its Appendix 4 regarding wind turbine assessment for navigation facilities.

The relationships between these guidelines and ICAO doc 015 [RD 3] are further described in section 1.9 below.

[1] It should be noted that MSPSR maturity is currently at a research status.

1.4 Designing the Assessment Methodology

When producing this methodology the objective was to document a mechanism that was simple in its application and transparent in its structure.

Secondary Surveillance Radars (SSRs) are classified as a cooperative surveillance technique – equipment on board the aircraft receives an interrogation from the ground station and cooperates by replying with a signal broadcast of its own. The need to interface with the transponder carried by the aircraft means that, whilst various technologies can be employed (classical sliding window SSR, Monopulse SSR and Mode S SSR), Secondary Surveillance Radars are well standardised. This high degree of consistency between co-operative surveillance systems allows the prediction of a single range beyond which it is believed that wind turbines would have only a manageable impact upon the performance of an SSR system. Up to that range the deployment of wind turbines would only be permitted if a comprehensive study demonstrates that no detrimental impact will arise.

Primary Surveillance Radars differ in that the aircraft is non-cooperative and the only 'interface' is the electro-magnetic energy reflected from the body of the aircraft. In this sense the technique is classified as non-cooperative. The disparate nature of non-cooperative surveillance systems, such as Primary Surveillance Radar (PSR), requires a more complex approach tailored to the specific technology employed and the environment in which it is operated.

Whilst the basic physics behind non-cooperative target detection are common it can be said that no two designs of Primary Surveillance Radars achieve the same end goal by following the same approach. The following, non exhaustive, list highlights some of the considerations that should be taken into account to carry out a full, detailed and analytical assessment into whether a technical interference would result from the placement of a wind turbine in the proximity of a PSR:

- Antenna Design – ATC PSR systems normally use an antenna with a complex Cosec2 beam pattern, typically with two beams (one Tx/Rx and one Rx only) – each beam with a different pre-set elevation angle. Each antenna has different characteristics, from the electrical elevation, through to gain and Integrated Cancellation Ratio and such parameters impact upon how much of a wind farm would be 'illuminated' by the radar and how much of the return would be passed to the subsequent receiver stage. The horn arrangement may support linear or circular polarized transmission or be switchable between the two. Phased array antennas present a different approach.
- The turning gear rotating the antenna is not an immediate consideration except for the fact that many can apply mechanical tilts to the antenna pattern to optimise either low level detection or minimise ground clutter returns.
- The receiver stages of the PSR would normally permit the application of one or more Sensitivity Time Control (STC) laws to reduce the impact of ground clutter. The STC is normally integrated with multiple beam switch points (switching between the signals received from either the high or low antenna beam).
- The transmitted signal can differ significantly depending upon the technology employed – either a magnetron, a solid state system or a travelling wave tube etc. The choice of driver influences the waveform, the number and characteristics of the pulses, the frequency band, the utilisation of frequency diversity schemes etc. The frequency band selected can also impact upon the susceptibility of the system to anomalous propagation effects.
- The signal processing techniques and capabilities differ – sub-clutter visibility and ground clutter rejection capabilities vary and the rejection capabilities differ significantly between different types of sensor, types of signal processing, such as MTI or Moving Target Detection (MTD) and the system parameter settings established during site optimization and flight trials.

- Plot extraction techniques are often employed to facilitate further processing and to reduce the bandwidth of the data signal to be transmitted from a remote PSR to an ATC control centre. The resulting data reduction also removes the possibility of an ATC to review the 'raw video' of the radar and this can impact upon the ability of a controller to monitor flights over areas where wind farms are deployed.
- Some PSRs are equipped with mono-radar track processing capabilities and these could be used to suppress radar returns from over wind farms. Unfortunately this can also often result in suppressing the returns from valid targets as well – the performance of any mono-radar tracker will therefore also need to be taken into account when conducting an assessment of whether wind farms will impact upon the performance of such systems.
- The geographic environment plays a great part in defining radar coverage. Considerations such as radar horizon would obviously drive requirements for tower heights. Proximity to the sea or large areas of flat or marshy land can result in beam ducting whilst the shape of mountains and whether they are sparsely or heavily covered in either snow or vegetation can also increase or decrease the radar returns. The nature of the aircraft to be detected and the airspace in which they fly will also determine design and deployment considerations.

The authors of the document have taken key characteristics into account to produce a simplified approach to be used when conducting an initial assessment of whether wind turbines deployed in the proximity of a PSR would result in performance degradation for the latter.

Whilst this initial assessment may err on the side of caution from the radar operators perspective, the authors also fully support the wind farm applicant in their right to conduct their own detailed assessment and to this end have provided some guidelines for how to perform such an assessment – these guidelines can be found in the supporting annex of this document.

Surveillance providers will be able to assist in the detailed assessment by providing key radar characteristics to be used in the detailed assessment performed by the applicant but, depending upon the PSR, additional support may also need to be sought from the manufacturer of the system.

To summarise, the approach adopted within the methodology is for an initial safeguarding region in the vicinity immediately surrounding the surveillance sensor within which all planning applications would be objected. Beyond this restrictive zone lie regions where progressively reducing levels of proof are required. The approach is common for both the cooperative and non-cooperative surveillance techniques covered within this document.

1.5 Application of the assessment methodology

The methodology is based upon the following zone arrangements:

- Zone 1: Safeguarding Zone (PSR and SSR):

  An initial restrictive or safeguarding region that surrounds the surveillance sensor. No developments shall be agreed to within this area.

- Zone 2: Detailed Assessment Zone (PSR and SSR):

  Following the safeguarded region is an area where surveillance data providers would oppose planning applications unless they were supported by a detailed technical and operational assessment provided by the applicant and the results of which are found to be acceptable to the surveillance provider.

  The detailed technical assessment shall be based upon the approach detailed in paragraph 4.4.

- Zone 3: Simple Assessment Zone (PSR only):

  Beyond the detailed assessment zone is a region within which a simple assessment of PSR performance, as detailed in section 4.3, should be sufficient to enable the surveillance data provider to assess the application.

- Zone 4: Accepted Zone (PSR and SSR):

  Beyond the simple assessment zone are areas within which no assessments are required and within which Surveillance Service providers would not raise objections to wind farms on the basis of an impact to surveillance services.

It is important to note that the zones are based upon a combination of range from the sensor and radar line of sight and therefore are not necessarily annular bands.

If necessary ANSPs and wind energy developers should discuss and agree mitigation options (see paragraphs 2.6 and 4.6) to overcome issues that have been identified in the course of the assessment.

1.6 Structure of the document

This document is structured in 5 chapters and 5 annexes:

- Chapter 1, this chapter provides an introduction to the document describing its background, its objective, its approach, its structure and its use.
- Chapter 2 describes the process flow when assessing the impact of wind turbines on surveillance sensors.
- Chapter 3 defines the required input information needed to undertake the previously defined process.
- Chapter 4 specifies for radar sensors the different zones, the simple impact assessment process, and the issues to be addressed, as a minimum, in the frame of the detailed assessment process. It also contains a table identifying possible mitigation options.
- Chapter 5 provides the lists of referenced documents and the definition of acronyms.
- Annexes A to C justify and describe the different equations that are used in the different assessments described in chapter 4.
- Annex D provides the justification for the selection of the zone 2 range defined for SSR.
- Annex E proposes a wind energy project description pro-forma.

1.7 Use of this document

This document is intended to be read and used by:

- Civil and military Air Navigation Service Provider (ANSP)
- Surveillance data provider
- National Supervisory Authority (NSA)
- Civil and military aviation authority
- Wind energy developer

EUROCONTROL makes no warranty for the information contained in this document, nor does it assume any liability for its completeness or usefulness. Any decision taken on the basis of the information is at the sole responsibility of the user.

1.8 Conventions

The following drafting conventions are used in this document:

- **"Shall"** – indicates a statement of specification, the compliance with which is mandatory to achieve the implementation of these EUROCONTROL Guidelines.
- **"Should"** – indicates a recommendation or best practice, which may or may not be applied.
- **"May"** – indicates an optional element.

1.9 Relationship with ICAO Doc 015

The aim of this document is to supplement ICAO doc 015 [RD 3]. In particular with respect to § 6.4 where it is stated that: "*For surveillance and communication facilities it is recommended that wind turbine(s) should be assessed at all times even outside the BRA for omni-directional facilities.*"

2. Impact assessment process

Figure 1 describes the generic process to be followed by ANSP and the wind energy developers when assessing the impact of a wind turbine project on surveillance infrastructure. This diagram has deliberately been kept at a high level to be compatible with formal and informal requests.

Wind energy developers are invited to initiate this process on the basis of these guidelines as soon as possible in the preparation phase of their project. At the earliest stages of the project, when there is more room for adaptation, it is anticipated that cost effective mitigation options (see section 4.6 for some possible mitigations) could be agreed; whereas at later stages, viable mitigation options could be more difficult to define and to agree on.

In order to facilitate this dialogue, it is recommended that ATM stakeholders (e.g. ANSP, NSA) publish a single point of contact (e.g. a generic email address) through whom initial contact can be established.

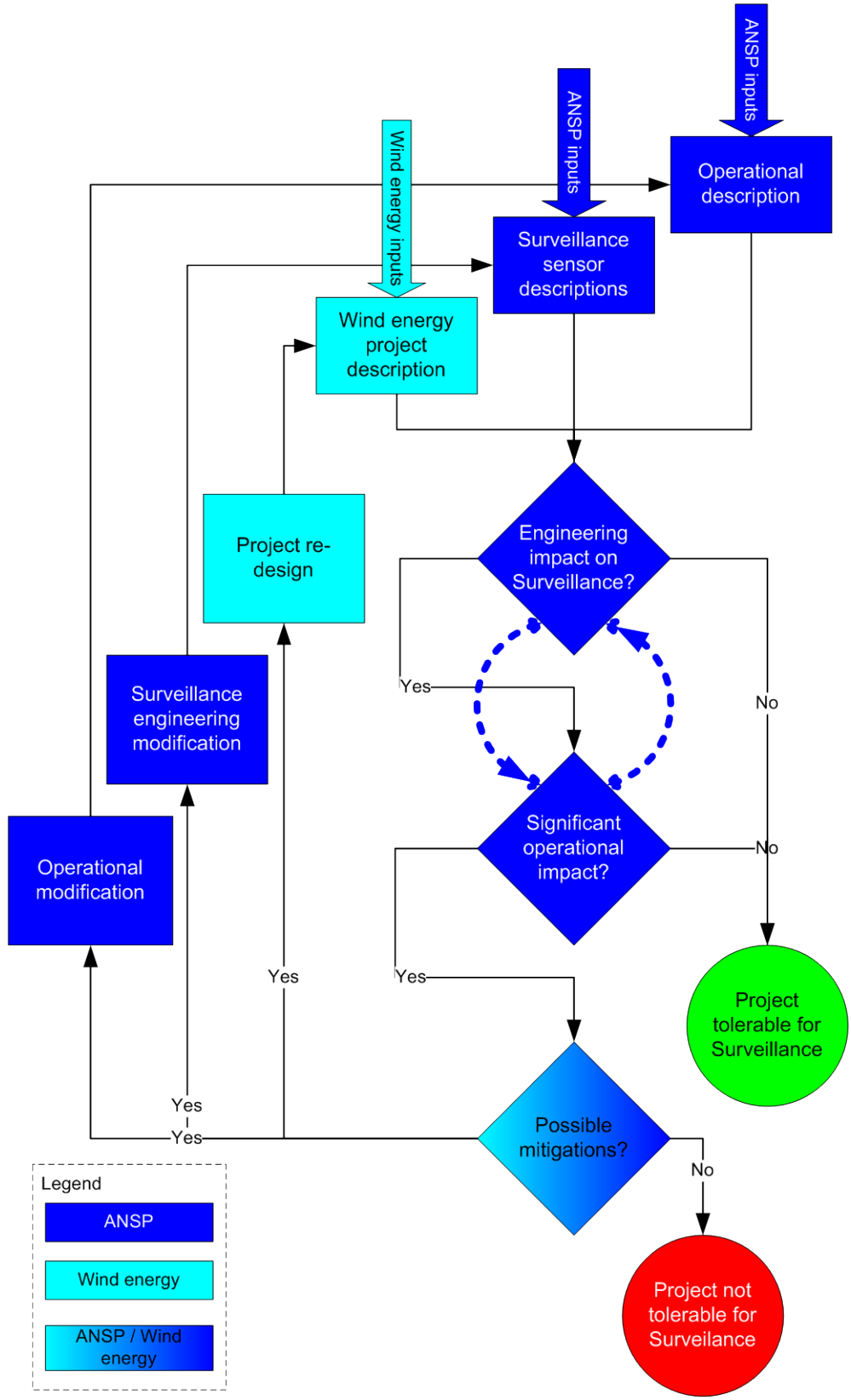

Figure 1: Impact Assessment Process

On Figure 1 the activities have been allocated on the basis of a formal request. In theory any activity can be undertaken by anybody provided that they have all the required pieces of information and the relevant knowledge.

2.1 Wind energy project description

This is a wind energy developer activity; it consists of collecting all the relevant wind energy project information to perform an impact assessment on the proposed development.

The information to be provided is described further in Section 3.1.

This project description shall be provided with any formal request to get a formal advice from the ANSP. It is to be noted that this process only addresses the impact on surveillance infrastructure, whereas the project may have other impacts that the ANSP have to assess. It is also to be noted that formal requests will be governed by state policy and as such will have to respect a number of national rules.

This project description may also be provided through an informal request at the earliest possible stage to avoid any further nugatory works. This is typically an informal approach to gauge reaction to a new development which is still at the exploratory stage of design. This should be encouraged, as early changes to a development proposal, prior to formal submittal to the planning authorities, are much easier to introduce to meet the needs of the ANSP.

By whatever route notification is received, it is important that as much of the relevant information is included as possible. At a pre-planning stage precise details of turbine locations and dimensions are often not fixed therefore any results based on this incomplete information must obviously be caveated such that relevant decision making authorities treat them with caution. Any change in the design proposal will require a re-assessment.

2.2 Surveillance sensor description

This is an ANSP activity; it consists of collecting all the relevant surveillance sensor information to perform an impact assessment on the proposed development.

In case the sensor is associated to a Far-Field Monitor (FFM), information related to that FFM is also needed.

The information to be provided is described further in Section 3.2.

This surveillance sensor description shall, subject to appropriate security and confidentiality considerations, be made available on request for preliminary analysis or site selection to wind energy developer.

2.3 Operational description

This is an ANSP activity; it consists of collecting all the relevant operational information (e.g. aeronautical navigation routes) to perform an impact assessment on the proposed development.

The information to be provided is described further in Section 3.3.

This operational description may, subject to appropriate security and confidentiality considerations, be made available on request for preliminary analysis or site selection to wind energy developer.

This operational description shall, subject to appropriate security and confidentiality considerations, be made available in response to a formal request attributable to a specific planning application

2.4 Engineering impact on surveillance

This is an ANSP activity, which consists of assessing the potential performance impacts that the submitted wind energy project could have on individual surveillance sensors operated by the ANSP, to derive the impact it may create at the output of the surveillance system and to consider possible mitigation mechanisms that could be introduced.

The assessment is described further for each type of radar in Chapter 4.

Although it is recognised that in most cases the sensor outputs will not be provided directly to the Air Traffic Controllers, but will go through further processing stages like Surveillance Data Processing systems; there are still some cases where the sensor output is used operationally (in normal or in fall-back mode). Therefore the maximum effort should be undertaken to minimise the impact of wind turbines at the earliest stages of the surveillance chain i.e. at the surveillance sensor level.

The application of specific features at surveillance data processing level is considered as a possible mitigation. Further mitigation possibilities may also be considered – a range of these are identified in section 4.6.

At this stage, the methodology encourages an ANSP engineering department to initiate discussions with the operational staff (as shown with the curved arrows on Figure 1) to assess the potential technical and operational impacts of the wind energy project in order to identify realistic mitigation measures that, in general, have both engineering and operational implementation aspects.

2.5 Operational impact on surveillance

This is an ANSP activity, which consists of assessing the impacts that the submitted wind energy project could have on the ANSP operations based on surveillance services and/or on the surveillance data service the ANSP is providing to other users.

This activity is described further for each type of radar in Chapter 4.

It is to be remembered that an ANSP is held legally accountable for the safe provision of service at all times.

As stated in paragraph 2.4 above and although the engineering and operational impact assessment stages are shown as two different boxes on Figure 1, a strong cooperation between the operational and engineering departments of the ANSP is needed to ensure that all aspects have been analysed and that all possible mitigations have been identified.

2.6 Possible mitigations

This is a combined ANSP/wind energy developer activity, which consists of identifying potential modifications to the surveillance system **and/or** the operational environment **and/or** the wind energy project that could mitigate to a tolerable level the impact of the wind energy development project.

This activity should be based on a transparent, coordinated and balanced approach with the objective of finding a solution that can be agreed by all parties.

When assessing mitigation options the following criteria shall be taken into account:

- Air traffic safety is maintained
- Cost efficiency based on through life cost over an agreed time period

The detailed assessment required to judge the suitability of such mitigations is beyond the scope of these guidelines due to their site specific nature.

2.7 Project re-design

This is a wind energy developer activity, which consists of taking into account in his project the possible mitigations identified at the previous stage to make the project impacts tolerable.

2.8 Surveillance engineering modification

This is an ANSP activity, which consists of taking into account the possible mitigations identified at the previous stage and that are applicable to the surveillance system to make the project impacts tolerable.

It is desirable that any surveillance engineering modification should be carbon neutral and have no detrimental impact on the environment.

2.9 Operational modification

This is an ANSP activity, which consists of taking into account the possible mitigations proposed at the previous stage and that are applicable to the operational environment to make the project impacts tolerable.

It is desirable that any operational modification should be carbon neutral and have no detrimental impact on the environment (e.g. noise, longer routes, etc.).

2.10 Feedback to surveillance sensor manufaturers

The ANSP should feedback to the surveillance sensor manufacturer the observed impacts of wind turbines on the sensor behaviour so that the manufacturer can improve its sensor design to be less sensitive to wind turbines.

3. Input information

3.1 Wind energy project description

A simple way that an ANSP can ensure that planning authorities and developers understand what information is required prior to an assessment is by making available a pro forma which developers can complete and submit. The following list of requested information has been constructed based on the pro-forma used by different stakeholders and is further developed in ANNEX E where a practical pro-forma can be found. The different parts of a wind turbine are identified on Figure 2 below.

The following parameters are needed to perform the simple engineering assessment:

- Hub height (above ground level in m)
- Rotor diameter (m)
- Turbine locations (National Grid system and/or WGS84 including terrain height)

Additional parameters could be needed to perform the detailed engineering assessment, for example:

- Wind turbine model and manufacturer
- Number of blades
- Rotation speed (Rpm) nominal and maximum
- Tower design (tubular/lattice)
- Tower base diameter (m)
- Tower top diameter (m)
- Nacelle Dimensions (width x length x height in m)
- Rotor blade material including lightening conductor

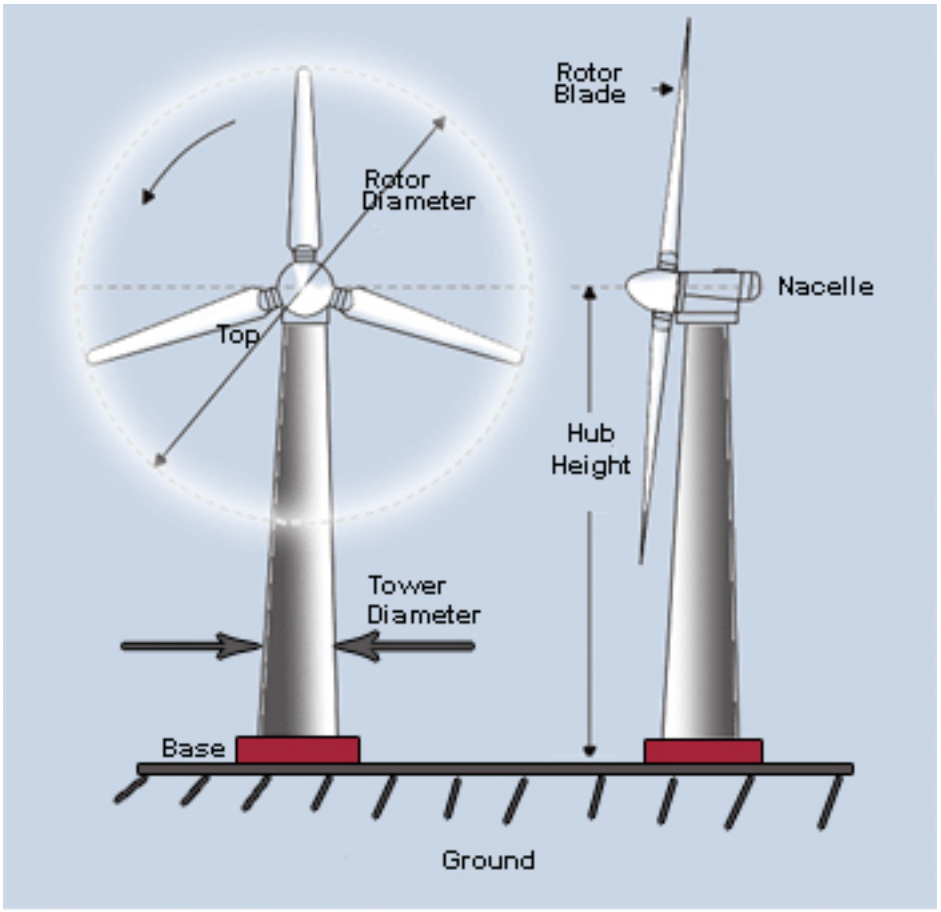

Figure 2: Wind turbine diagram

3.2 Surveillance sensor description

The list of information needed to undertake the simple engineering assessment is the following:

- Radar line of sight calculation method/tool
- Primary Surveillance Radar:
  - Antenna 3D position (WGS84 and/or national grid system and height above terrain)
  - Frequency range (in GHz)
  - Instrumented range (in NM)
  - Antenna horizontal beam-width at 3 dB (in °).
  - Information related to signal processing (such as CFAR), plot extractor (such as 'plot density filtering') and mono-radar tracker techniques required to undertake the assessment described in section 4.3.1. As it is recognized that radar operators do not always have such detailed knowledge on their systems, it is recommended that they request a list of potential impacts from their radar supplier.
  - Radar processing capacities (e.g. plots, tracks)
  - Overload prevention technique
- SSR:
  - Antenna 3D position (WGS84 and/or national grid system and height above terrain).
  - Antenna horizontal beam-width at 3 dB (in °) – 2.4° by default.

- SSR/PSR far-field monitor:
    - Position (WGS84 and/or national grid system)

In addition, further parameters could be needed to perform the detailed assessment, for example:

- Primary Surveillance Radar:
    - Antenna transmit vertical pattern.
    - Antenna receive vertical pattern.
    - Antenna tilt (in °).
    - Frequencies used (in GHz).
    - Anti-reflection processing capabilities (number of reflectors, number of reflections).
    - Transmitted power (in dBW).
    - Receiver, signal and data processing capabilities.
- SSR:
    - Type: classical sliding window, monopulse, Mode S.
    - Anti-reflection processing capabilities (number of reflectors, number of reflections).
    - Receiver, signal and data processing capabilities.
    - Overload prevention technique.

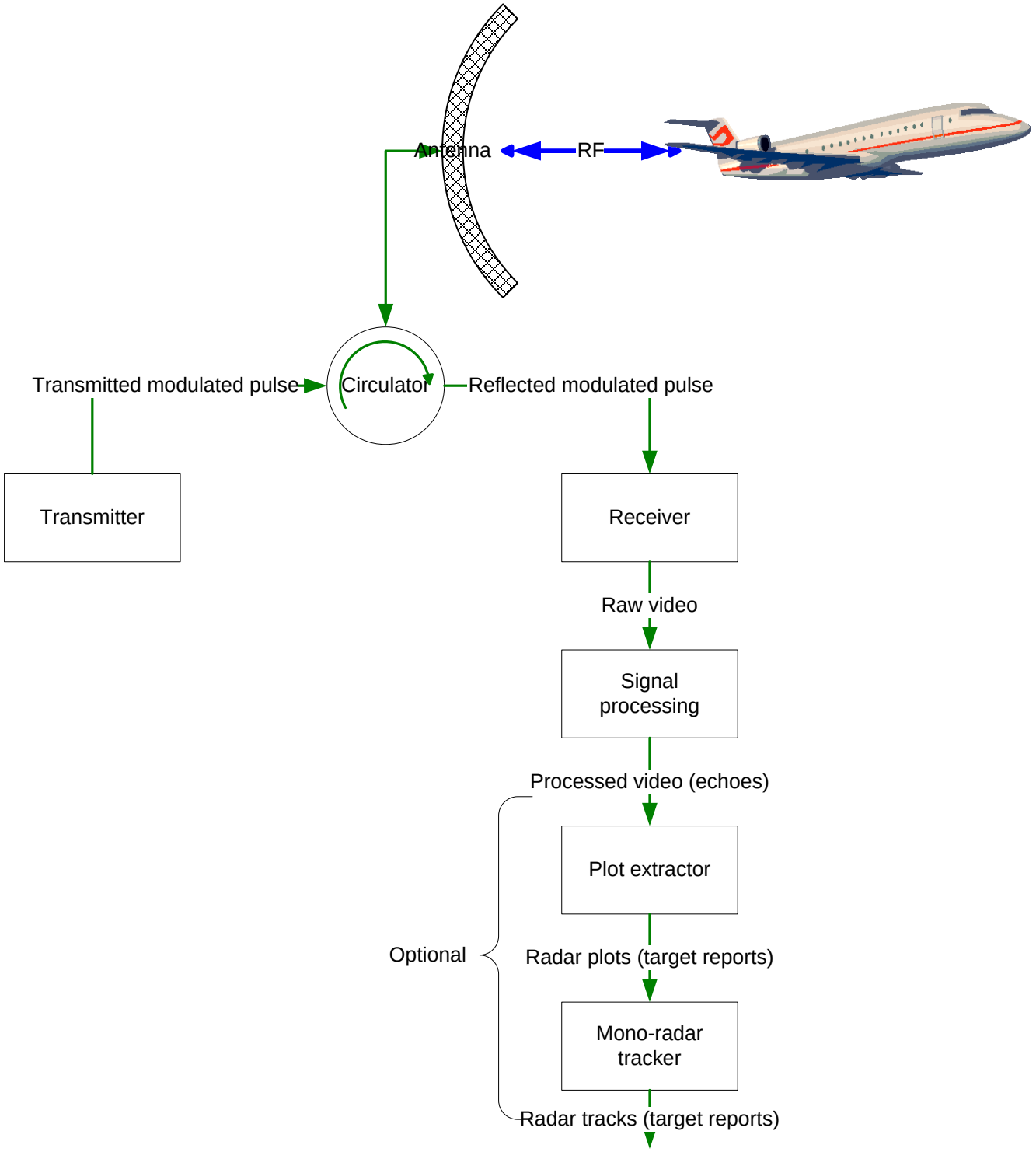

Figure 3: Primary Surveillance Radar diagram

The diagram above illustrates the main components of a modern primary surveillance radar system; the radar output may also be at processed video or at plot level. The radar output may be connected directly to a Controller Working Position or to a multi-sensor tracker for further processing.

The picture below (Figure 4) shows a primary radar antenna co-mounted with a secondary radar antenna (on top).

Figure 4: Primary and secondary co-mounted radar antennas

3.3 Operational description

The information needed to undertake the operational impact assessment is the 3D airspace volume, per ATC service[2] (e.g. 3 NM horizontal separation, parallel runway monitoring, vectoring), where surveillance information is required to support ATC operations.

[2] The different ATC services are described in Chapter 8 of [RD 4].

4. Radar impact assessment

Information on how such an assessment can be performed is contained within the following paragraphs. The assessment shall be conducted for each sensor that has at least one wind turbine within its range coverage.

4.1 Radar line of sight assessment

The first assessment that shall take place is to determine whether or not any part of the turbine will be within the line of sight of the radar (i.e. from the electrical centre of the radar antenna). If the turbines are located in a way that does not affect the surveillance sensor performance (e.g. the turbines are fully 'hidden' from the sensors by terrain or the turbines are located further away than the radar instrumented range), then consent for the development can be approved. However if a part of the wind turbine (e.g. a blade) can be in radar line of sight then there is potential for an impact upon the radar.

Tools are available to undertake this assessment. Each of them has some specific features and some limitations. The focus is put on the agreement to be reached between the ANSP and the wind energy developer to select a tool that is familiar to the ANSP and which is parameterised in accordance with the local conditions and/or the type of assessment (e.g. the accuracy of the digital terrain modelling may depend on the distance between the wind turbine and the radar and/or whether a simple or a detailed assessment is being conducted).

4.2 Top-level engineering assessment

In order to facilitate this process, different zones have been defined corresponding to different levels of engineering assessment. They are summarised in the tables below.

It should be noted that Zone 2 is not a No-Go area but indicates where further consideration needs to be applied compared to Zone 3. In any case wind turbines could be placed in zone 2 or zone 3 if no intolerable impact would result from their deployment.

4.2.1 Primary Surveillance Radar

Zone	Zone 1	Zone 2	Zone 3	Zone 4
Description	0 - 500 m	500 m - 15 km and in radar line of sight	Further than 15 km but within maximum instrumented range **and in** radar line of sight	Anywhere within maximum instrumented range but **not in** radar line of sight or outside the maximum instrumented range.
Assessment Requirements	**Safeguarding**	**Detailed assessment**	**Simple assessment**	**No assessment**

Table 1: PSR recommended ranges

The PSR safeguarding range where no wind turbine shall be built is derived from the recommendations provided in the ICAO EUR 015 document [RD 3] which is applicable for any obstacle (r: radius of the first cylinder on figures 2.1 and 2.2).

PSR radar designs vary considerably and the design choices made by PSR manufacturers influence the susceptibility of their radars to wind turbines (see paragraph 1.4 above). The figure for the PSR recommended limit between detailed and simple assessment is therefore derived from the best practices collected from the ECAC member states and it is also a figure recognised in the ICAO EUR 015 document [RD 3] (R: radius of the second cylinder on figures 2.1 and 2.2).

Therefore these figures are applicable to current wind turbine design, e.g. 3-blades, 30-200 m height, horizontal rotation axis. For other types of turbines, it is recommended to undertake the detailed assessment as long as the wind turbine is in radar line of sight.

When outside the radar line of sight of a PSR, the impact of the wind turbine (3-blades, 30-200 m height, and horizontal rotation axis) is considered to be tolerable.

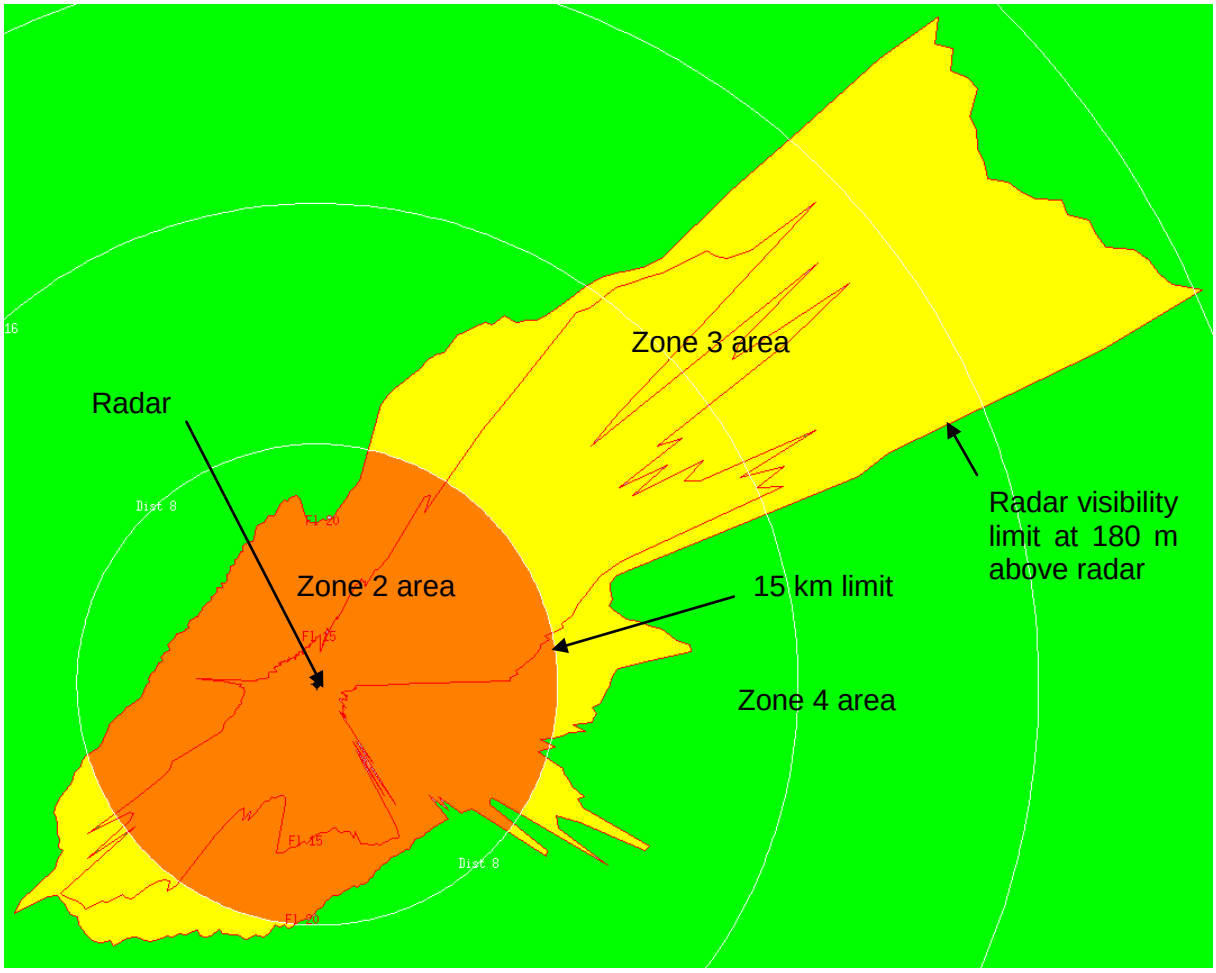

Figure 5: Example of zones at 180 m above a real radar

Figure 5 above shows that the different zones are not annular bands (unless in a theoretical no obstacle environment) and their shape depends on the terrain surrounding the radar. These zones have been calculated on the basis of a real radar and, for this example, at 180 m above the radar ground level.

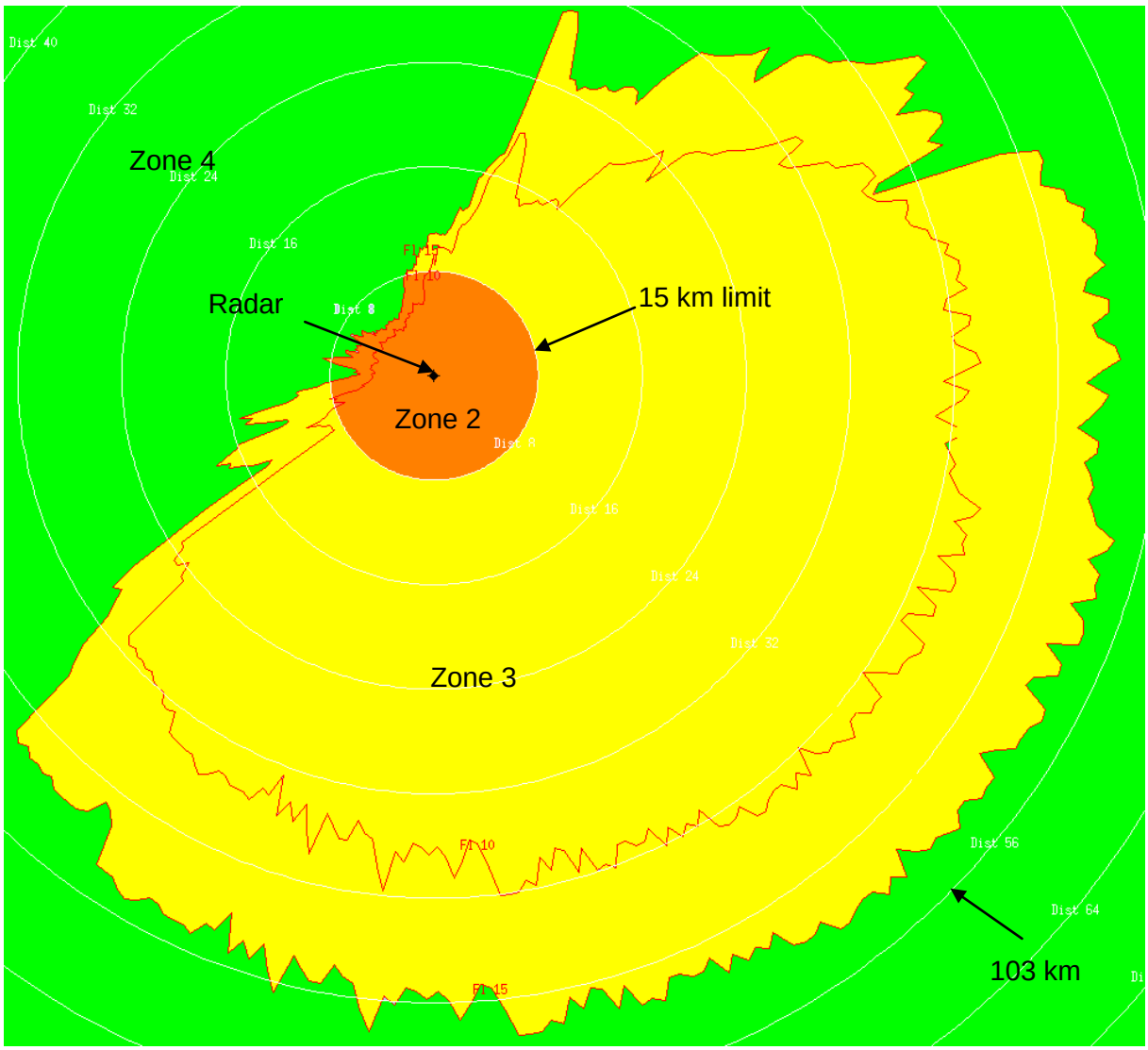

Figure 6: Example of zones at 320 m above a real radar

Figure 6 above shows another example of the different zones around a real radar at 320 m above the ground level at the radar site.

4.2.2 Secondary Surveillance Radar (classical, monopulse and Mode S)

Zone	Zone 1	Zone 2	Zone 4
Description	0 - 500 m	500 m - 16 km but within maximum instrumented range **and in** radar line of sight	Further than 16 km **or not** in radar line of sight
Assessment Requirements	**Safeguarding**	**Detailed assessment**	**No assessment**

Table 2: SSR recommended ranges

The SSR safeguarding range where no wind turbine shall be built is derived from the recommendations provided in the ICAO EUR 015 document [RD 3] which is applicable for any obstacle (r: radius of the first cylinder on figures 2.1 and 2.2).

The figure for the recommended limit of SSR detailed assessment is further justified in □based on the SSR specifications provided in ICAO Annex 10 Volume IV [RD 2].

As the justifications developed in □are based on current wind turbine design, e.g. 3-blades, 30-200 m height, horizontal rotation axis. For other types of turbines, it is recommended to undertake the detailed assessment as long as the wind turbine is in radar line of sight.

It is to be noted that in the case of SSR there is no simple assessment zone.

When outside the radar line of sight of an SSR the impact of the wind turbine is considered to be tolerable.

When further than 16 km from an SSR the impact of a wind turbine (3-blades, 30-200 m height, and horizontal rotation axis) is considered to be tolerable.

4.2.3 Radar Far-Field Monitors (FFM)

In addition, irrespective of the zone in which the wind turbine falls, it is recommended to protect the radar far-field monitor as described below.

Wind turbines shall not be built in a sector of 2 times the radar antenna horizontal beam-width at 3dB, centred on the far-field monitor azimuth and limited up to the range of the far-field monitor (as illustrated on Figure 7 below). This is applicable to far-field monitors of primary or secondary surveillance radar.

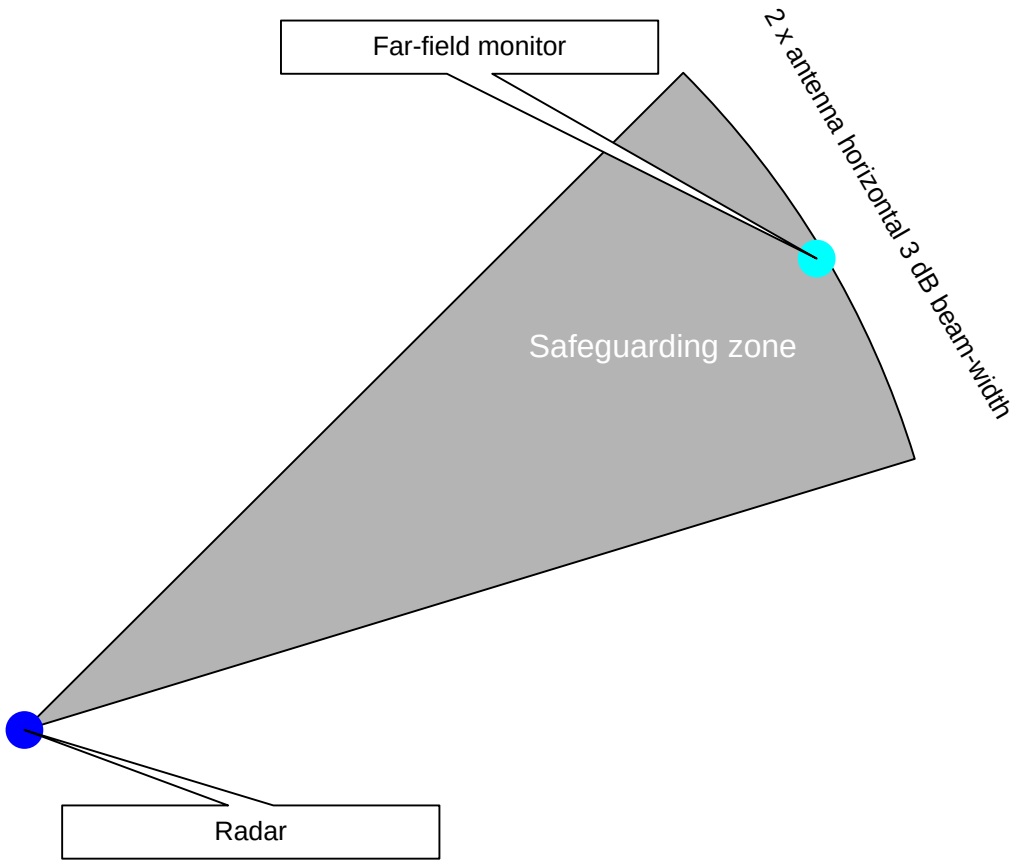

Figure 7: Recommended protection zone for far-field monitor

Possible mitigations are to move either the wind turbine or the far-field monitor.

4.2.4 Radar data sharing

In case the surveillance data provided by the impacted radar is shared, the radar data user should be informed of the wind turbine project. If applicable, the engineering assessment process shall take into account any radar data quality requirements imposed by the SLA (Service Level Agreement) associated to this radar data sharing.

4.2.5 Cumulative impact

As further detailed in the following sections, the impact of wind turbines on the operational service provided by a radar depends on the number of wind turbines located in the radar line of sight. Therefore it is strongly recommended that ANSP's keep an accurate tracking of all the approved wind energy projects. With this information they will be able to conduct the impact assessment of the new project in conjunction with the neighbouring approved projects that may already affect the performance of radars.

4.3 Simple engineering assessment for PSR

4.3.1 PSR Probability of detection

One of the key performance characteristic of a Primary Surveillance Radar, as defined in § 6.2.2.2 of the EUROCONTROL Standard Document for Radar Surveillance in En-route Airspace and Major Terminal Areas [RD 1], is the probability of detection.

When a wind turbine lies in the line of sight of the PSR, the probability of detection can be reduced in three ways:

- In a shadow region directly behind the turbine (region 1 on Figure 8).
- In a volume located above and around the wind turbine (region 2 on Figure 8).
- In a larger volume located above and around the wind turbine if the radar has signal processing, plot extractor or mono-radar tracker techniques which can be affected by wind turbines.

The first effect is caused by the attenuation due to the wind turbine being an obstacle for the electromagnetic field. The second effect is caused by the large amount of energy reflected back by the wind turbine, causing an increase in the radar's detection threshold (CFAR) in the range-azimuth cell where the wind turbine is located and also in some adjacent cells.

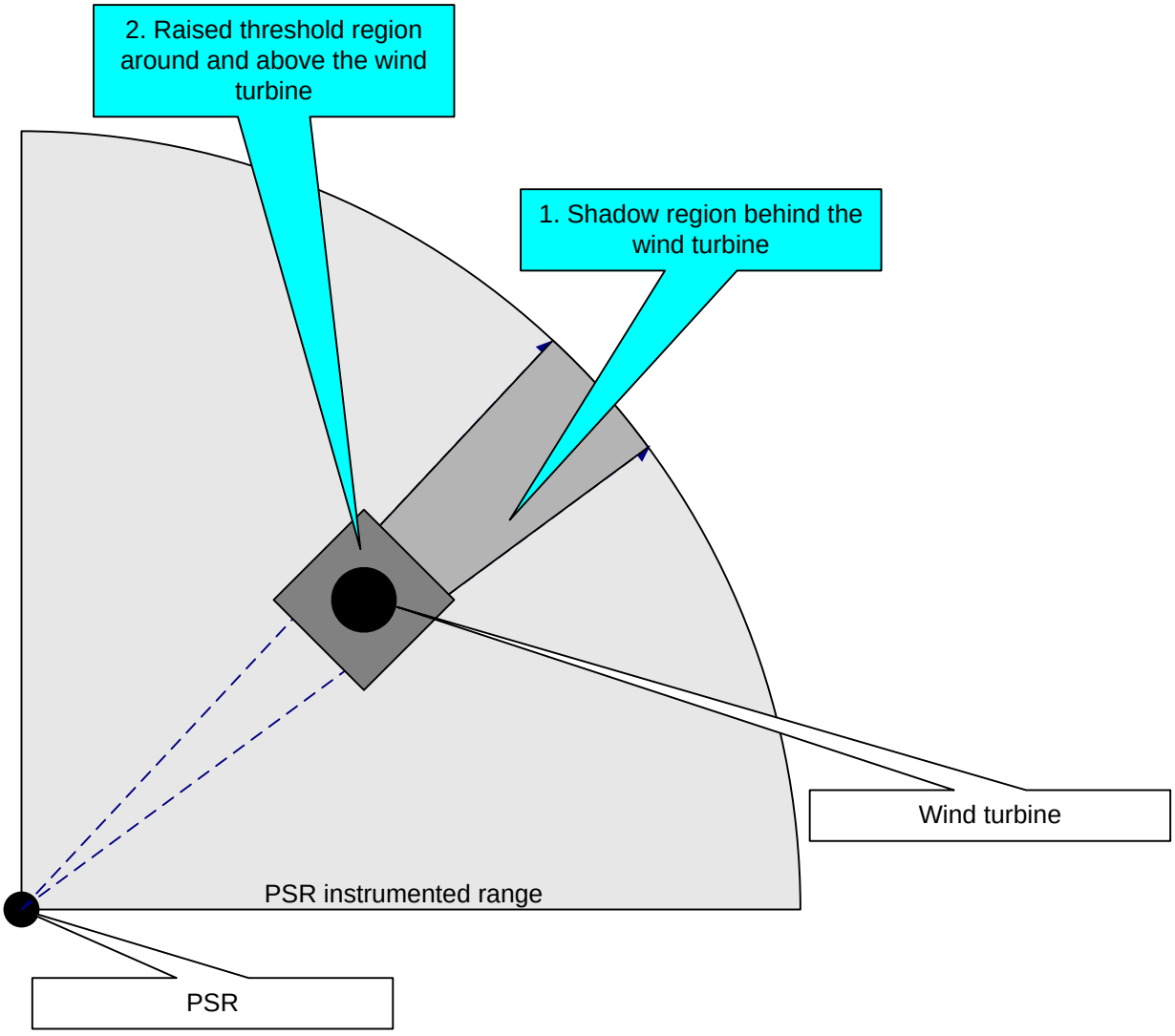

Figure 8: Shadow region behind a wind turbine and raised threshold region around and above a wind turbine

The cumulative impact of all mechanisms resulting in a reduced PSR probability of detection can be determined as:

1. Determine the areas with reduced detection for each wind turbine separately (cf. Figure 8)
   a. Dimensions of the shadow region (1) can be determined using Equation 4 in annex A.3 to calculate its width and Equation 1 annex A.2 to determine its height.
   b. The region (2) located directly above the wind turbine[3] is typically one to sixteen[4] clutter cells large, depending on the exact CFAR algorithm.
2. Enlarge the obtained zone to cover for losses due to plot extractor techniques such as 'plot density filtering'
3. If the obtained zone after step 1 and 2 is sufficiently large to cause track drops, enlarge the zone further to take track initialization into account

These calculations have to be repeated for each wind turbine of a wind farm and the global impact is the sum of the individual impacts. This may be achieved by overlaying the shadow zones from individual wind turbines to give an overall shadow representation.

4.3.2 PSR false target reports (due to echoes from wind turbines)

One of the key performance characteristic of a Primary Surveillance Radar, as defined in § 6.2.2.3 of the EUROCONTROL Standard Document for Radar Surveillance in En-route Airspace and Major Terminal Areas [RD 1], is the number of false target reports.

Due to their large radar cross section and moving parts turbines can be directly detected by a PSR and may generate false target reports.

If the highest point of the wind turbine (hub height + half the rotor diameter) is within the radar line-of-sight, it is assumed that the turbine will be detected by the PSR. This may manifest itself in the raw/processed video that may be presented to an ATCO, in plot reports, additionally they may be promoted to a mono or multi-sensor track due to their strength or when multiple plot reports correlate to form a track.

Further radar processing techniques (see Annex B.2) may provide protection against the generation of target reports corresponding to wind turbines.

These calculations have to be repeated for each wind turbine of a wind farm and the global impact is the sum of the individual impacts.

4.3.3 PSR processing overload

When PSR is including a plot extractor and/or a mono-radar tracker there will be a limitation in the number of inputs that it can process. If the number of PSR echoes, including those due to wind turbines, is too high, the plot processor may need to apply anti-overload techniques. Similarly, if the number of plots, including false plots due to wind turbines, is too high, the tracker may need to apply overload prevention techniques. Both may have an operational impact (e.g. reducing the operational capability of the radar).

It is to be noted that in this case the affected areas do not depend on where the wind turbines are located but on the internal design of the system (i.e. the applied overload prevention techniques).

It is assumed that the next stages of the surveillance chain (e.g. communication network and multi-sensor tracker) are compatible with the maximum PSR output capacity.

[3] The effect has been observed for wind turbines at any range from the radar. Placing the wind turbines further away from the radar is therefore not necessarily a solution to this problem.

[4] The column of airspace can extend out from the turbine position if smearing algorithms are used in clutter map generation.

4.4 Detailed engineering assessment for PSR and SSR

4.4.1 Generalities

When a wind turbine is located close to a radar (less than 15 km for a PSR, less than 16 km for an SSR) a detailed impact assessment shall be undertaken unless the potential impact of the wind turbine does not cause an operational issue (e.g. if the wind turbine is not located under an ANSP operational area). This detailed impact assessment shall, at least, address the topics identified in the following paragraphs.

Moreover, in case of a wind farm the detailed impact assessment shall be made for each individual wind turbine and globally for all the visible wind turbines of the wind farm as the global impact may not be equal to the sum of the individual impacts.

As a summary, the detailed engineering assessment is a complex and lengthy process; it requires identifying a large number of cases corresponding to different parameter values each of them corresponding to different external conditions (wind speed and direction, terrain configuration, etc.). Therefore it is recommended to avoid impacting operational areas or to remain within the simple assessment conditions in order to facilitate the impact assessment and the discussions between the ANSP and the wind energy developer.

At this stage, a more accurate assessment of the visibility of the wind turbines by the radars may be undertaken, to concentrate the detailed assessment efforts on the relevant issues.

The following paragraphs specify the requirements that shall be included, as a minimum, in the detailed engineering assessment statement of work.

4.4.2 PSR shadowing

The detailed assessment shall include:

- A calculation of the (two-way) attenuation caused by the wind turbines in three dimensions
- The impact in the three dimensions of this attenuation on the radar detection performance.

The detailed assessment shall address this topic in terms of impact on the PSR probability of detection.

4.4.3 PSR false target reports (due to echoes caused by wind turbines)

The detailed assessment should include:

- A calculation of the amount of energy reflected back to the radar by the wind turbine taking into account:
  - Different nacelle orientations,
  - Different blade orientations,
  - Different radar frequencies,
  - Different surface conditions (wet, moisture, etc), materials, etc are correctly incorporated in the study,
  - The different elements of the wind turbine located at different heights,
  - Appropriate terrain attenuation calculation based on the use of an agreed tool using appropriate parameters.
- The impact of this energy in terms of false target reports taking into account:
  - Radar receiver capability,
  - Radar signal processing capability,
  - Radar data processing capability

If some of the above aspects cannot be taken into account in a reliable way, it may be agreed by all parties to replace them by mutually agreed assumptions (e.g. worst case).

The detailed assessment shall address this topic and assess the region where these false target reports may appear and their density.

4.4.4 PSR false target reports (due to secondary or indirect reflections from the wind turbines)

In addition to the case reported above, another potential mechanism providing spurious false target reports is through reflection of true target echoes on wind turbines and through reflection of wind turbine echoes on aircraft.

Four different cases of reflections may happen; they are summarised below and are further described in ANNEX C.

True aircraft echoes reflected from the wind turbine: aircraft located in the vicinity of a wind turbine (for cases 1 and 2) or in the vicinity of the radar (only for case 2) will produce a genuine target report at their actual position and may produce a reflected target report in the azimuth of the wind turbine.

Wind turbine echoes reflected to the aircraft: aircraft located in the vicinity of a wind turbine or radar (both cases 3 and 4) will produce a genuine target report at their actual position and may produce a second, reflected target report in the azimuth of the aircraft.

The different cases (1, 2, 3 and 4) and examples of calculation based on simplified equations are provided in ANNEX C.

The detailed assessment of false target reports due to reflections shall include:

- A calculation of the aircraft locations where reflections can occur.
- A calculation of where the corresponding false target reports due to reflections will be located.

4.4.5 PSR range and azimuth errors

When there is a small path difference between the direct and reflected signals the received signal will be a combination of both, which can result in a range and/or bearing measurement error.

In the case where there is a large path difference the two can be separated, which can lead to a false target - as discussed in paragraph 4.4.4 (reflection case).

This effect may occur to targets located further away than the wind turbine and in the same azimuth region.

The detailed assessment shall address this topic and assess the region where these errors may occur and the impact on PSR position accuracy performance in this region.

4.4.6 PSR processing overload

When PSR is including a plot extractor and/or a mono-radar tracker there will be a limitation in the number of inputs that it can process. If the number of PSR echoes due to wind turbines (clutter and reflections) is too high, the plot processor may need to apply anti-overload techniques. Similarly, if the number of false plots due to wind turbines is too high, the tracker may need to apply overload prevention techniques. Both may have an operational impact (e.g. reducing the operational capability of the radar).

The detailed assessment shall address this topic.

It is to be noted that in this case the affected areas do not depend on where the wind turbines are located but on the internal design of the system (i.e. the applied overload prevention techniques).

It is assumed that the next stages of the surveillance chain (e.g. communication network and multi-sensor tracker) are compatible with the maximum PSR output capacity.

4.4.7 PSR raised thresholds

In addition to the generation of false target reports the amount of energy reflected back to the radar by the wind turbine (see paragraph 4.4.3 above) will have an impact on the radar CFAR.

The detailed assessment shall address this topic in terms of impact on the PSR probability of detection.

4.4.8 PSR receiver saturation

In certain cases, the amount of energy reflected back to the radar from the wind turbine (see paragraph 4.4.3 above) can be so large that it saturates the radar receiver.

The detailed assessment shall address this topic in terms of impact on the PSR probability of detection.

4.4.9 SSR Probability of detection and probability of Mode A and Mode C code detection

If a wind turbine is located close to an SSR, the detection of aircraft located close to the wind turbine and within the same azimuth may be impacted. The impact shall be calculated in the three dimensions independently for the uplink (aircraft located in the shadow region behind the wind turbine) and the downlink transmissions (SSR located in the shadow region behind the wind turbine). In the case of the downlink transmission, the aircraft position detection may not be affected whereas the Mode A or Mode C code detection may be affected.

The detailed assessment shall address this topic and shall predict the impact in the 3 dimensions on position detection and Mode A and C code detection performance.

4.4.10 SSR false target reports

Most SSR systems build up maps of static reflectors (e.g. tower, buildings) to reject reflected replies; but because wind turbines are not seen as static objects, this technique is not as efficient.

Therefore SSR false target reports may appear due to reflection on the wind turbine of the uplink signal, of the downlink signal and/or of both.

The detailed assessment shall address this topic and shall predict where the false target reports will be located.

4.4.11 SSR 2D position accuracy

SSR bearing errors may occur when there is a small path difference between the direct and reflected signals. In the case where there is a large path difference the two can be separated which can lead to a false target - as discussed in paragraph 4.4.10.

Effects can be seen in MSSR, Mode S and classical ‘sliding window’ SSR systems.

An MSSR or Mode S system calculates the bearing of an aircraft using the orientation of the EM wave as it reaches the antenna. Reflections of the transponder signal from nearby objects (such as wind turbines) will combine with the direct signal in such a way that the wave-front is distorted. This can lead to errors in the bearing calculation.

In sliding window systems, the reflected energy arriving back at the antenna will be dispersed in azimuth, such that it is no longer centred on the true target azimuth. This will ‘fool’ the algorithms used by many SSRs to determine azimuth, and an error will occur.

Under these conditions (small path difference) range measurement errors may also occur due to the combination of the direct and reflected signals and the measurement of the time of arrival of the SSR reply may be altered.

This effect may occur to targets located further away than the wind turbine and in the same azimuth region.

The detailed assessment shall address this topic and shall predict the impact in the 3 dimensions on the SSR position accuracy performance.

It is to be noted that in case of a Mode S radar a single reply is sufficient to generate a target report.

4.4.12 Other PSR detection losses

The detailed assessment should look at mechanisms resulting in PSR detection losses, such as plot density filtering, time needed to start a new track (track initialisation) in case of track loss in the mono-radar tracker, etc.

4.5 Operational assessment

4.5.1 Generalities

Once an adverse engineering impact has been predicted, the next phase will be to assess whether this effect will be operationally tolerable or not. The process can be made quicker if certain 'ground rules' can be established, or areas of known sensitivity are published in advance which precludes the need for engineers to approach ATC operational staff. Certain applications may have such dramatic effects that the need to enter a dialogue with ATC is nugatory. However, the majority of cases will normally involve discussions with ATC Operations representatives who are familiar with the airspace being affected and/or Human Factors specialists.

4.5.2 PSR Probability of detection

The operational assessment will be based on the location of the affected 3D zones with respect to the operational volume of airspace and the criticality of the PSR surveillance information in these zones.

4.5.3 PSR false target reports

The operational assessment will be based on the location of the false target reports due to the presence of the wind turbines with respect to the operational volume of airspace.

4.5.4 PSR 2D position accuracy

The operational assessment will be based on the location of the affected 2D zones with respect to the operational volume of airspace and the criticality of the PSR surveillance information in these zones.

4.5.5 PSR plot/track processing capacity

The operational assessment will be based on the location of the affected 2D zones with respect to the operational volume of airspace and the criticality of the PSR surveillance information in these zones.

4.5.6 SSR probability of detection

The operational assessment will be based on the location of the affected 3D zones with respect to the operational volume of airspace and the criticality of the SSR surveillance information in these zones.

4.5.7 SSR false target reports

The operational assessment will be based on the location of the false target reports due to the presence of the wind turbines with respect to the operational volume of airspace.

4.5.8 SSR 2D position accuracy

The operational assessment will be based on the location of the affected 2D zones with respect to the operational volume of airspace.

4.6 Possible mitigations

4.6.1 Generalities

It may be possible that a certain amount of reduced performance is tolerable, either because it is in an area of minimal concern to the end user or sufficient operational procedures are in place to address any surveillance short fall.

Otherwise, in order to accommodate the wind turbine application, mitigation options may be investigated. The following options should be considered individually and/or in combination:

1. Wind energy developer mitigations: Can the wind turbine proposal be modified to eradicate or minimise the effects on ATC surveillance systems and operations?
2. ANSP technical mitigations: Can the sensor and/or surveillance system architecture be modified or configured to accommodate the wind energy project to within a level of tolerable degradation of service to ATC?
3. ANSP operational mitigations: Can ATC modify procedures to accommodate the expected reduction in surveillance quality?

An important consideration for choosing the mitigation options should be maintenance of ATC safety and cost-effectiveness, while at the same time taking into account that the global project (wind energy and associated mitigations) should result in an overall net reduction in carbon over an agreed time period.

It should also be noted that, when calculating the size of potential blanking zone (as means of mitigation see Table 3 below), the acquisition or re-acquisition time/distance of the traffic crossing or getting out of that zone is considered as part of the overall size of the blanked area, especially where traffic travelling at high speed is concerned. This may require the implementation of an in-fill sensor.

4.6.2 Mitigation option table

The table below lists different mitigation options that may be applied alone or in combination with others. The table provides for every mitigation option the issues that it can potentially solve.

Applicable to	Mitigation option	When mitigation could be applied							Consideration regarding the mitigation option
		Lack of PSR Pd	PSR false targets	PSR position accuracy i	Overload of PSR capacities	Lack of SSR Pd	SSR false targets	SSR position accuracy	
Non cooperative surveillance sensor	Blank PSR transmission in an azimuth sector		☑		☑				May need to be combined with in-fill PSR/MSPSR in blanked sector(s).
	Suppress PSR radar returns in range-azimuth sector		☑		☑				May need to be combined with in-fill PSR/MSPSR in blanked sector(s).
	Improve PSR anti wind turbine clutter capabilities		☑		☑				
	Strengthen primary track initiation conditions		☑						At mono-radar tracker or at multi-sensor tracker level.
	Adapt PSR overload prevention facilities				☑				
	Upgrade PSR processing capabilities				☑				
	Upgrade PSR output interface capabilities				☑				
	In-fill PSR (inc. 3D PSR)	☑	☑	☑					
	In-fill MSPSR	☑	☑	☑					Provided that MSPSR concept is validated.

Applicable to	Mitigation option	When mitigation could be applied							Consideration regarding the mitigation option
		Lack of PSR Pd	PSR false targets	PSR position accuracy i	Overload of PSR capacities	Lack of SSR Pd	SSR false targets	SSR position accuracy	
Cooperative surveillance system	Blank SSR transmission in an azimuth sector						☑	☑	May need to be combined with in-fill SSR/WAM/ADS-B in blanked sector(s)
	In-fill SSR					☑	☑	☑	
	In-fill WAM[5]					☑	☑	☑	
	In-fill ADS-B					☑	☑	☑	Provided that aircraft are ADS-B equipped
	Improve SSR anti-reflection capabilities						☑		At SSR level and/or at multi-sensor level
Operation	Move ATC route	☑	☑	☑		☑		☑	
	Change airspace classification or apply MTZ[6]	☑	☑	☑					Note that PSR may still be required to detect aircraft without a functioning SSR Transponder.
Wind turbine	Move wind turbines out of radar line of sight	☑	☑	☑	☑	☑	☑	☑	
	Move wind turbines out of critical areas	☑	☑	☑		☑	☑	☑	
	Change wind farm layout	☑							Affects Region 2 only, see § 4.3.1.
	Reduce number of wind turbines in radar line of sight				☑				
	Reduce wind turbine radar reflectivity		☑		☑		☑		If wind turbine is in radar line of sight of several radars, the mitigation is only applicable if they operate in the same frequency band.

Table 3: Mitigation options

[5] This version of the guidelines does not address the assessment of wind turbine impacts on WAM or ADS-B.
[6] Mandatory Transponder Zone: a portion of the airspace where all aircraft are required to be equipped with a transponder.

5. References and Acronyms

5.1 Referenced documents

[RD 1] EUROCONTROL Standard for Surveillance in En-route Airspace and Major Terminal Areas – SUR.ET1.ST01.1000-STD-01-01 dated March 1997 edition 1.0

[RD 2] ICAO Annex 10 Volume IV 4th edition July 2007

[RD 3] ICAO European Guidance Material on Managing Building Restricted Areas Second Edition 2009 ICAO EUR Doc 015

[RD 4] ICAO Procedures for Air Navigation Services Air Traffic Management (PANS ATM) Doc 4444 ATM/501 Fifteenth Edition 2007

[RD 5] EUROCONTROL Regulatory and Advisory Framework – Regulatory Provisions dated November 2005 Edition 3.0 ERAF/04-002/3.0

[RD 6] EUROCONTROL Regulatory and Advisory Framework – Advisory Material dated November 2005 Edition 3.0 ERAF/04-002/ADV/3.0

[RD 7] Fundamentals of Ground Radar for Air Traffic Control engineers and Technicians, Ronald Bouwman, Scitech Publishing, 2009

[RD 8] http://www.radartutorial.eu/10.processing/sp10.en.html

5.2 List of acronyms

Acronym	Definition
ADS-B	Automatic Dependent Surveillance - Broadcast
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATM	Air Traffic Management
BRA	Building Restricted Areas
CFAR	Constant False Alarm Rate (primary radar technique)
DTED	Digital Terrain Elevation Data
EC	European Commission
EM	Electro Magnetic
ERAF	EUROCONTROL Regulatory and Advisory Framework
FFM	Far-Field Monitor
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
MDS	Minimum Discernable Signal
MLAT	Multi LATeration
MSPSR	Multi Static Primary Surveillance Radar
MSSR	Monopulse Secondary Surveillance Radar
MTD	Moving Target Detector (primary radar technique)
MTI	Moving Target Indicator (primary radar technique equivalent to MTD)
MTZ	Mandatory Transponder Zone
NSA	National Supervisory Authority
PSR	Primary Surveillance Radar
RCS	Radar Cross Section
RF	Radio Frequency
Rx	Receiver
SES	Single European Sky

Acronym	Definition
SESAR	Single European Sky ATM Research
SLA	Service Level Agreement
SSR	Secondary Surveillance Radar
STC	Sensitivity Time Control (primary radar technique)
Tx	Transmitter
UNFCC	United Nations Framework Convention on Climate Change
WAM	Wide Area Multilateration
WGS84	World Geodetic System 1984

Table 4: Acronym list

ANNEX A PSR reduction of probability of detection – Assessment of Region 1 dimensions

A.1 Introduction

When a turbine lies directly between the transmitting and receiving antenna the strength of the signal reaching the receiver is lower than it would otherwise be. When the transmitter and/or receiver are part of the surveillance sensor under assessment the shape and severity of this 'shadow region' will determine the impact of the turbine on how the equipment can be used. In the case of the PSR it is considered that region 1 extends up to the PSR maximum range. The basic features of the shadow are:

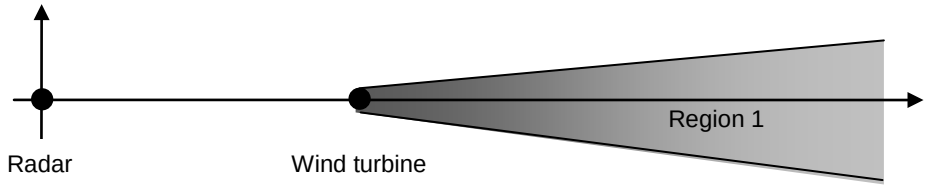

Figure 9: Top-view of wind turbine shadow

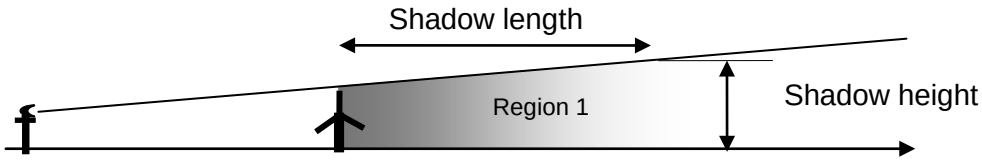

Figure 10: Side-view of wind turbine shadow

A.2 Shadow Height

The shadow height is calculated by simply considering the geometry of the wind turbine and the transmitter as shown on Figure 10 above, taking into account the maximum height of the turbine, the earth curvature (see Figure 11 below), the earth radius (R) and the fact that EM waves do not propagate in straight line above earth, therefore a factor k (typically 4/3) is applied to calculate the central angle.

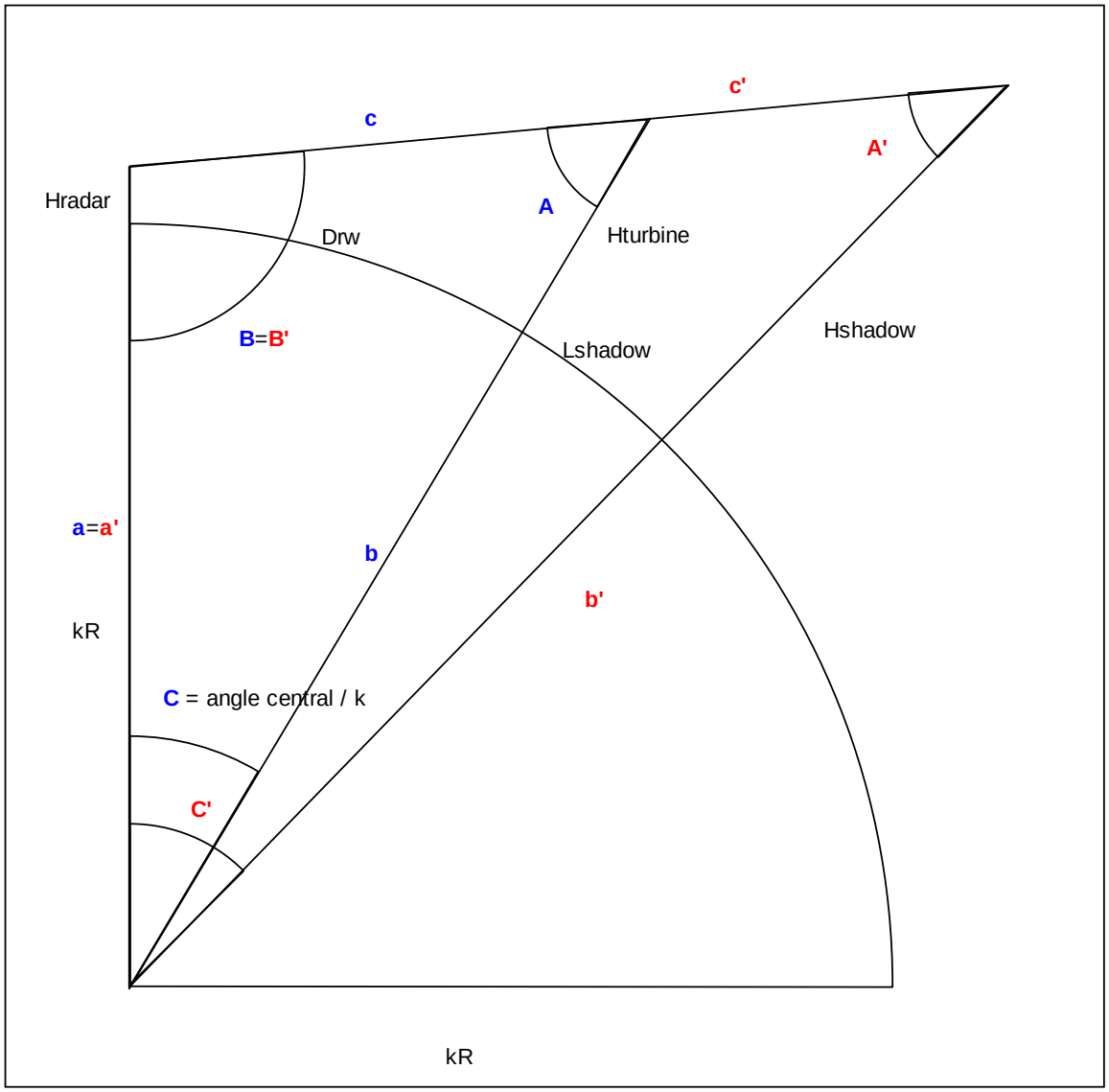

Figure 11: Principle of shadow height calculation

Taking into account that:

$$a = k.R + H_{radar}$$

$$b = k.R + H_{turbine}$$

$$c = \sqrt{a^2 + b^2 - 2.a.b.\cos(C)}$$

$$B = Arc\cos((a^2 - b^2 + c^2)/2.a.c)$$

$$C = D_{rw} / k.R$$

$$C' = \frac{D_{rw} + L_{shadow}}{R.k}$$

$$B' = B$$

$$A' = \pi - B' - C'$$

$$b' = a'.\sin(B')/\sin(A')$$

Where Drw is the distance between the radar and the wind turbine, R is the radius of the earth and Lshadow is the length of the shadow zone.

The height of the shadow zone can be calculated as follow:

$$H_{shadow} = b' - k.R \qquad \text{Equation 1}$$

The symbols used in this Annex have the following meanings

R	The radius of the earth (m) at the position of the radar
H_{radar}	Geodetic height of the radar (m)
$H_{turbine}$	Geodetic height of the wind turbine (m)
H_{shadow}	Geodetic height of the shadow of the wind turbine at shadow length (m)
L_{shadow}	Shadow length (m)
k	Factor (typically 4/3) to take into account that EM waves do not propagate in straight line above the earth.
D_{rw}	Distance radar to wind turbine (m)

A.3 Shadow Width

Figure 9 above shows a very simplistic representation of the shadow width, it is possible to calculate a more realistic estimate using the following argument. A typical cross-range section of the shadow effect is shown in the following Figure 12 where a reflection from a metallic object is assumed; hence the direct and reflected signals will be in anti-phase.

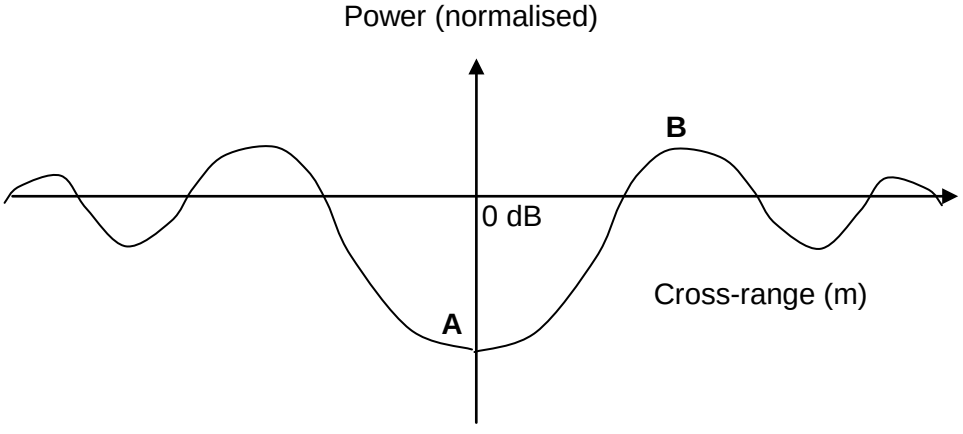

Figure 12: Diagram of a cross-section of a shadow

At point “A” the path difference is zero and so the signals combine de-constructively causing the deepest shadow; at point “B”, where path difference = λ/2, they combine constructively to give a maxima. Note that successive maxima are odd multiples of λ/2, where path difference = (2n+1)λ/2. The maxima get weaker because the interfering signal is weaker at larger angles off the forward-scatter direction.

A conservative estimate of shadow width is the locus of points formed by point B as a function of down-range; the geometry is as shown in Figure 13 below:

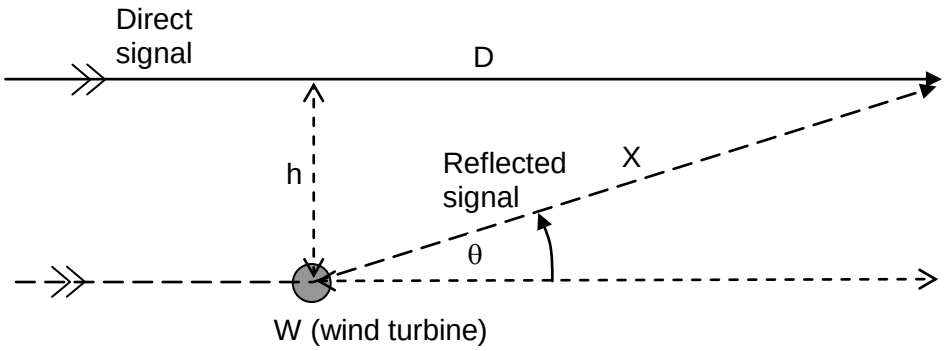

Figure 13: Path difference geometry for shadow width calculation

The path difference, Δ, between the direct and reflected signals at the receiver is given by:

$$\Delta = X - D = \sqrt{h^2 + D^2} - D \qquad \text{Equation 2}$$

and so the locus of points which define the width of the shadow at a distance D beyond the turbine is found by setting path difference = λ/2 and solving for the half-width, h:

$$\frac{\lambda}{2} = \sqrt{h^2 + D^2} - D \qquad \text{Equation 3}$$

$$h = \sqrt{\left(\lambda/2 + D\right)^2 - D^2} \qquad \text{Equation 4}$$

If λ is much smaller than D, which is the case here, Equation 4 can be simplified:

$$h = \sqrt{\lambda . D} \qquad \text{Equation 5}$$

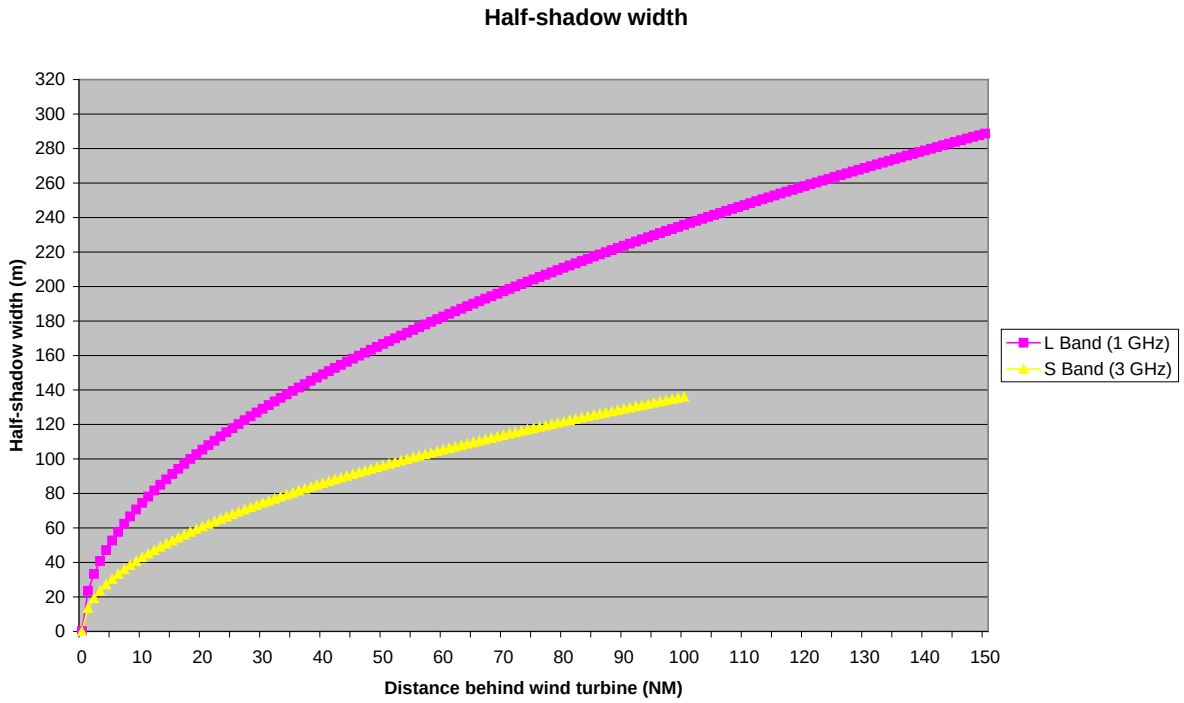

Figure 14: Half-shadow width as a function of D

ANNEX B PSR Equations (no reflection)

B.1 Basic Radar Equation

In normal PSR operation, the power reflected back from the wind turbine will be equal to:

$$P_{r\,ef} = \frac{\sigma.F^2.G_t.P_t.G_r.\lambda^2}{(4.\pi.)^3.D^4} \qquad \text{Equation 6}$$

where the symbols have the following meanings

P_{ref}	The power of the reflected signal arriving at the radar (W)
P_t	Transmitted power
G_t	Transmit antenna gain
G_r	Receive antenna gain
σ	The mono-static RCS of the wind turbine[7] (m^2)
F	Terrain induced attenuation factor between radar and wind turbine.
D	Distance radar to wind turbine (m)
λ	Signal wavelength (m)

B.2 Further Processing

Whilst at its most basic the remainder of the radar can be modelled as a simple threshold detector by comparing P_{ref}, above, to a defined threshold for the radar under test this is a huge simplification for a modern radar system.

Other than to state that where possible as much of the radars internal processing should be taken into account, it is not intended to go further within this document as data processing varies so widely from radar to radar and the relevant algorithms are often difficult to obtain or model. Some of the issues which may affect the probability of wind turbine detection include the following items:

Sliding window - Most systems determine detection using a statistical M detections from N pulses algorithm.

- **Sliding window** - Most systems determine detection using a statistical M detections from N pulses algorithm.
- **MTI-MTD Filtering** – Most PSR systems now employ MTI or MTD to discard returns from stationary objects based on Doppler filtering.
- **Tracking Algorithms** - Plot-extracted systems will only provide plot information should a series of echoes over a number of scans pass certain tracking criteria.

[7] *The radar cross section of the wind turbine, although the term is not fully relevant because the wind turbine is not in free space but put on the ground, represents the fraction of EM power transmitted by the radar that is reflected back (mono-static) or scattered in another direction (bi-static) by the wind turbine. This parameter depends a lot on the attitude of the wind turbine with respect to the direction of the EM wave transmitted by the radar, in particular on the orientation of the nacelle and on the orientation of the blades that are varying in accordance with the wind conditions. Furthermore in the case of the bi-static RCS, it depends on the considered directions (incidental and scattered)*

ANNEX C PSR Equations (reflection)

C.1 Radar Equations in case of reflected signals

There are 4 cases of configuration radar/wind turbine/aircraft where additional echoes due to reflected signal can be detected by the radar. They are illustrated on Figure 15 to Figure 18.

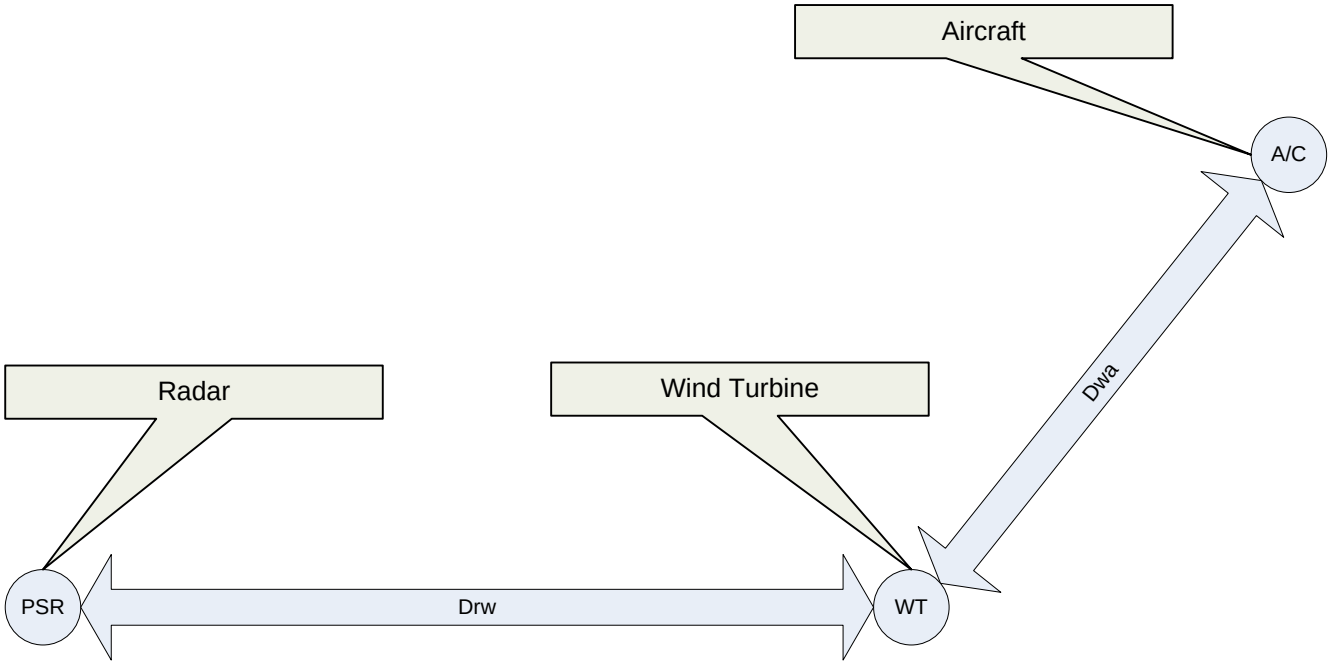

Figure 15: PSR reflection case 1

In case 1, the reflection is located in the azimuth of the wind turbine, the reflected signal is received through the radar antenna main beam.

In this case, the power reflected back will be equal to:

$$P_{r\,ef} = \frac{\sigma_a.\sigma_{w1}.\sigma_{w2}.F_{rw}^{\ 2}.F_{wa}^{\ 2}.G_t.P_t.G_r.\lambda^2}{(4.\pi.)^5.D_{rw}^{\ 4}.D_{wa}^{\ 4}}$$ Equation 7

Comparing this power to the radar receiver detection threshold one can derive the volume around a wind turbine where aircraft must be located to cause a reflection.

$$R_1 = \sqrt[4]{\frac{\sigma_a.\sigma_{w1}.\sigma_{w2}.F_{rw}^{\ 2}.F_{wa}^{\ 2}.G_t.P_t.G_r.\lambda^2}{(4.\pi.)^5.D_{rw}^{\ 4}.P_{thresh}}}$$ Equation 8

Worst case estimation can be calculated assuming $F_{rw} = F_{wa} = 1$, $G_t = G_r = G$ and $\sigma_{w1} = \sigma_{w2} = \sigma_w$.

$$R_1 = \sqrt[4]{\frac{\sigma_a.\sigma_w^2.G^2.P_t.\lambda^2}{(4.\pi.)^5.D_{rw}^{\ 4}.P_{thresh}}}$$ Equation 9

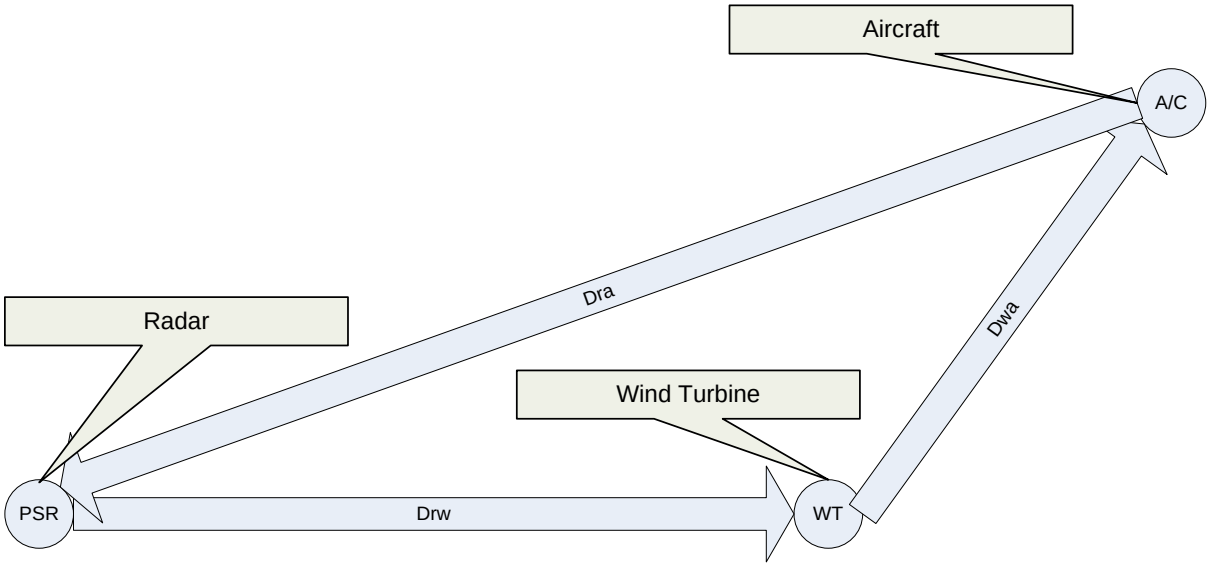

Figure 16: PSR reflection case 2

In case 2, the reflection is located in the azimuth of the wind turbine, the reflected signal is received through the radar antenna sidelobes.

In this case, the power reflected back will be equal to:

$$P_{r\,ef} = \frac{\sigma_{a2}.\sigma_{w1}.F_{rw}.F_{wa}.F_{ar}.G_t.P_t.G_{rs}.\lambda^2}{(4.\pi.)^4.D_{rw}^{\ 2}.D_{wa}^{\ 2}.D_{ra}^{\ 2}}$$ Equation 10

Comparing this power to the radar receiver detection threshold one can derive the volume around a wind turbine where aircraft must be located to cause a reflection.

$$R_2 = \sqrt[2]{\frac{\sigma_{a2}.\sigma_{w1}.F_{rw}.F_{wa}.F_{ar}.G_t.P_t.G_{rs}.\lambda^2}{(4.\pi.)^4.D_{rw}^{\ 2}.D_{ra}^{\ 2}.P_{thresh}}}$$ Equation 11

Worst case estimation can be calculated assuming $F_{rw} = F_{wa} = F_{ar} = 1$, $\sigma_{a2} = \sigma_a$ and $\sigma_{w1} = \sigma_w$.

Equation 12

$$R_2 = \sqrt[2]{\frac{\sigma_a.\sigma_w.G_t.P_t.G_{rs}.\lambda^2}{(4.\pi.)^4.D_{rw}^{\ 2}.D_{ra}^{\ 2}.P_{thresh}}}$$

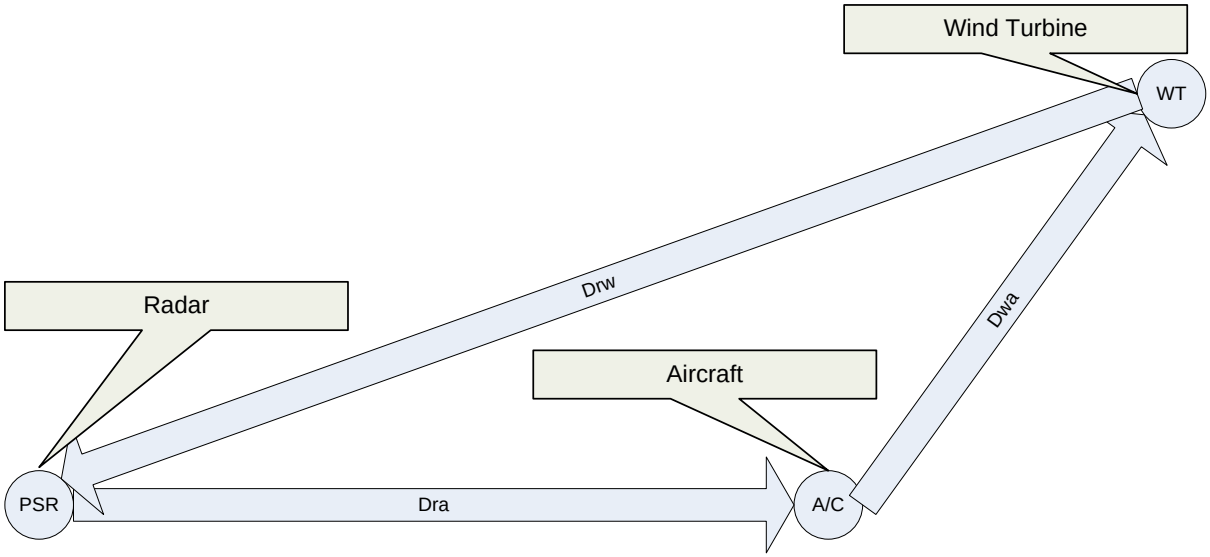

Figure 17: PSR reflection case 3

In case 3, the reflection is located in the azimuth of the aircraft, the reflected signal is received through the radar antenna sidelobes.

In this case, the power reflected back will be equal to:

$$\mathrm{P_{r\,ef}} = \frac{\sigma_{a1}.\sigma_{w2}.F_{ra}.F_{aw}.F_{wr}.G_t.P_t.G_{rs}.\lambda^2}{(4.\pi.)^4.D_{ra}{}^2.D_{wa}{}^2.D_{rw}{}^2}$$ Equation 13

Comparing this power to the radar receiver detection threshold one can derive the volume around a wind turbine where aircraft must be located to cause a reflection.

$$R_3 = \sqrt[2]{\frac{\sigma_{a1}.\sigma_{w2}.F_{ra}.F_{aw}.F_{wr}.G_t.P_t.G_{rs}.\lambda^2}{(4.\pi.)^4.D_{ra}{}^2.D_{rw}{}^2.P_{thresh}}}$$ Equation 14

Worst case estimation can be calculated assuming $F_{ra} = F_{aw} = F_{wr} = 1$, $\sigma_{a1} = \sigma_a$ and $\sigma_{w2} = \sigma_w$.

$$R_3 = \sqrt[2]{\frac{\sigma_a.\sigma_w.G_t.P_t.G_{rs}.\lambda^2}{(4.\pi.)^4.D_{ra}{}^2.D_{rw}{}^2.P_{thresh}}}$$ Equation 15

Note that there exists a certain volume around the radar and wind turbine where these types (types 2 and 3) of reflections could occur (see Figure 19). There also exists a critical distance between radar and wind turbine for which these volumes start to merge.

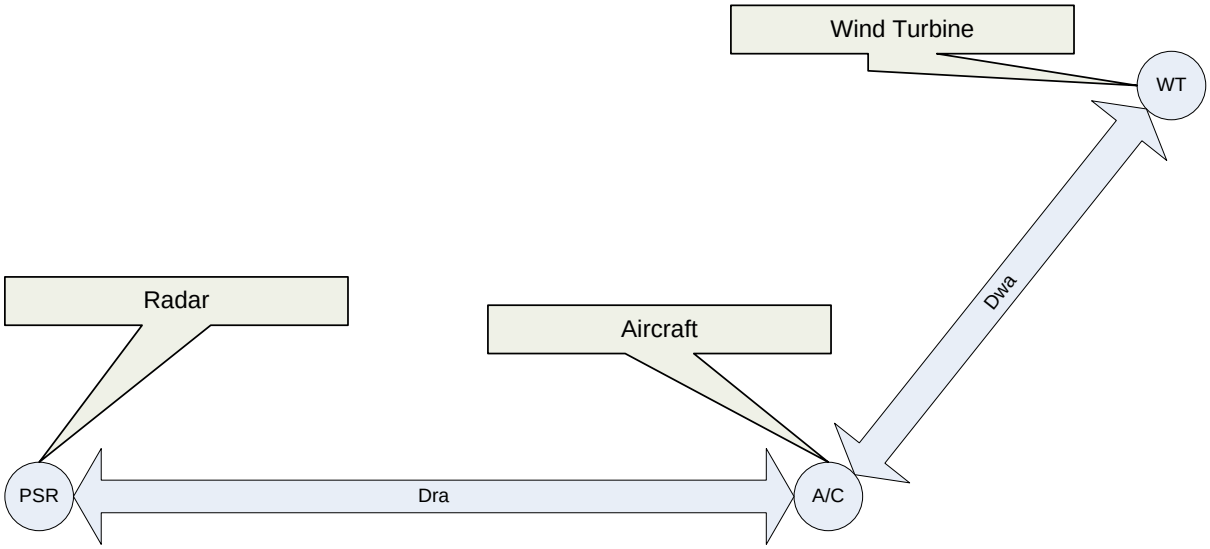

Figure 18: PSR reflection case 4

In case 4, the reflection is located in the azimuth of the aircraft, the reflected signal is received through the radar antenna main beam.

In this case, the power reflected back will be equal to:

$$P_{r\,ef} = \frac{\sigma_w.\sigma_{a1}.\sigma_{a2}.F_{ra}{}^2.F_{aw}{}^2.G_t.P_t.G_r.\lambda^2}{(4.\pi.)^5.D_{ra}{}^4.D_{wa}{}^4}$$ Equation 16

Comparing this power to the radar receiver detection threshold one can derive the volume around a wind turbine where aircraft must be located to cause a reflection.

$$R_4 = \sqrt[4]{\frac{\sigma_w.\sigma_{a1}.\sigma_{a2}.F_{ra}{}^2.F_{aw}{}^2.G_t.P_t.G_r.\lambda^2}{(4.\pi.)^5.D_{ra}{}^4.P_{thresh}}}$$ Equation 17

Worst case estimation can be calculated assuming $F_{ra} = F_{aw} = 1$, $G_t = G_r = G$ and $\sigma_{a1} = \sigma_{a2} = \sigma_a$.

$$R_4 = \sqrt[4]{\frac{\sigma_a^2.\sigma_w.G^2.P_t.\lambda^2}{(4.\pi.)^5.D_{ra}{}^4.P_{thresh}}}$$ Equation 18

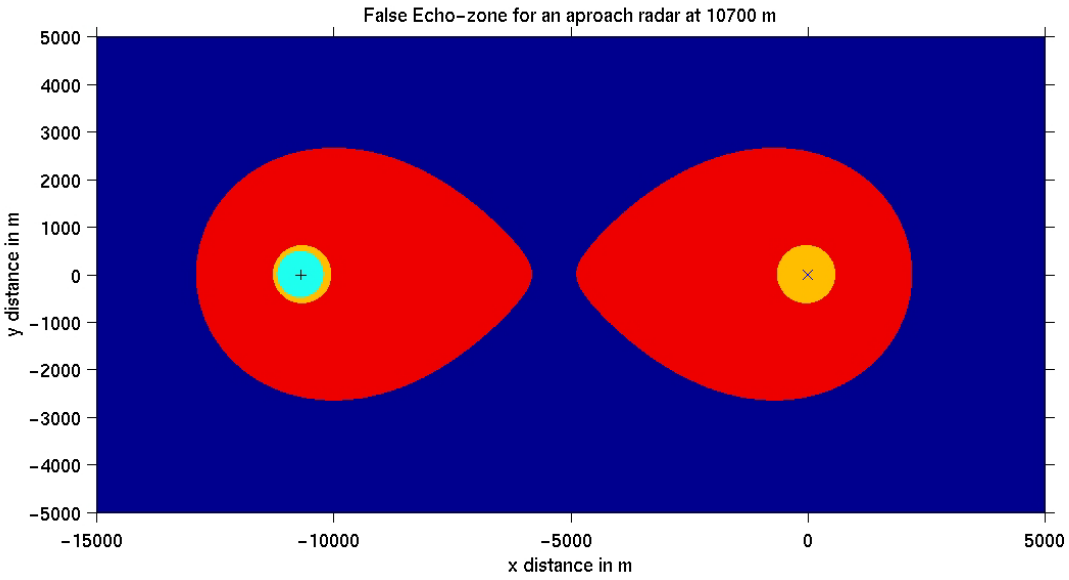

Figure 19: Example of calculation of aircraft locations where reflection can occur (horizontal)

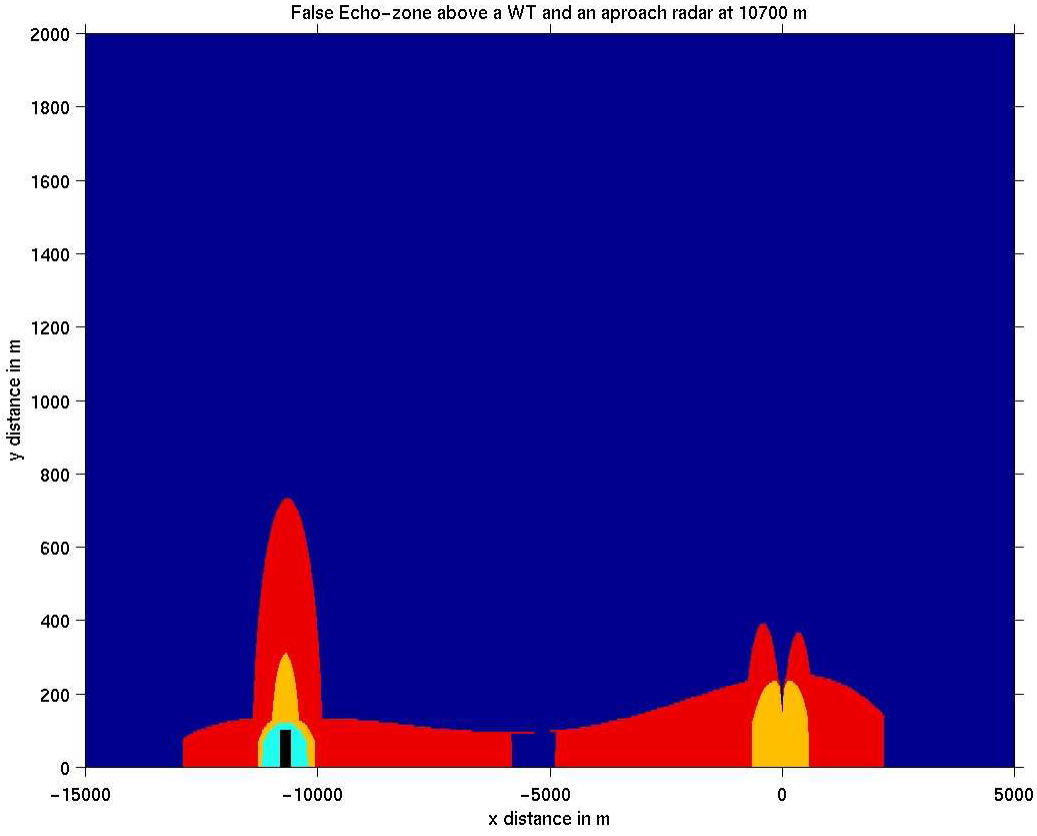

Figure 20: Example of calculation of aircraft locations where reflection can occur (vertical)

Figure 19 and Figure 20 provide a typical example of the computation of the different reflection zones (radar location marked with x; wind turbine location marked with +). The cyan area corresponds to aircraft locations where case 1 can happen. The orange areas correspond to aircraft locations where case 4 can happen. The red areas correspond to aircraft locations where case 2 or 3 can happen.

In equations 6 to 17 the symbols have the following meanings

P_{ref}	The power of the reflected signal arriving at the radar (W)
P_t	Transmitted power (W)
P_{thresh}	Radar receiver detection threshold (W)
G_t	Transmit antenna gain
G_r	Receive antenna gain (main beam)
G_{rs}	Receive antenna gain (side lobes)
σ_a	The mono-static RCS of the aircraft (m^2)
σ_w	The mono-static RCS of the wind turbine (m^2)
σ_{a1}	The bi-static RCS of the aircraft from radar to wind turbine (m^2)
σ_{a2}	The bi-static RCS of the aircraft from wind turbine to radar (m^2)
σ_{w1}	The bi-static RCS of the wind turbine from radar to aircraft (m^2)
σ_{w2}	The bi-static RCS of the wind turbine from aircraft to radar (m^2)
$F_{rw} = F_{wr}$	Terrain induced attenuation factor between radar and wind turbine.
$F_{wa} = F_{wa}$	Terrain induced attenuation factor between wind turbine and aircraft.
$F_{ra} = F_{ar}$	Terrain induced attenuation factor between radar and aircraft.
D_{rw}	Distance radar to wind turbine (m)
D_{wa}	Distance wind turbine to aircraft (m)
D_{ra}	Distance radar to aircraft (m)
λ	Signal wavelength (m)

C.2 Further Processing

Whilst at its most basic the remainder of the radar can be modelled as a simple threshold detector by comparing P_{ref}, above, to a defined threshold (P_{thresh})for the radar under test this is a huge simplification for a modern radar system.

Other than to state that where possible as much of the radars internal processing should be taken into account it is not intended to go further within this document as data processing varies so widely from radar to radar and the relevant algorithms are often difficult to obtain or model. Some of the issues which may affect the probability of detection of aircraft reflection include the following items[8]:

[8] MTI-MTD filtering is not applicable in this case as the reflected signal will have the same Doppler characteristics as the direct aircraft echo.

- **Sliding window** - Most systems determine detection using a statistical M detections from N pulses algorithm;
- **Tracking Algorithms** - Plot-extracted systems will only provide plot information should a series of echoes over a number of scans pass certain tracking criteria.

ANNEX D Justification of the recommended SSR protection range

D.1 Introduction

The selection of the recommended SSR protection range is based on the assessment of 3 impacts that a single wind turbine could have on the SSR performance:

- Position detection and Mode A/Mode C code detection performance characteristics.
- Multiple target reports performance characteristic.
- Azimuth accuracy performance characteristic.

D.2 2D position detection and Mode A/Mode C code detection

As for PSR (see 0), SSR is affected by a shadow region behind the wind turbine where the 2D position detection and the Mode A and Mode C code detection may be degraded. In the case of SSR the shadow length can be calculated.

The protection range has been calculated in such a way that the volume represented by region 1 (width, height and length) remains tolerably small.

SSR interrogations/responses can all be modelled as one-way communication links and probabilities of signal detection can be derived by from received signal power, P_r, and receiver sensitivity. P_r can be found by initially determining the power density, P, at a range of D from a transmitter radiating a signal with a power of P_t:

$$P = \frac{F.G_t.P_t}{4.\pi.D^2} \qquad \text{Equation 19}$$

The radar's ability to collect this power and feed it to its receiver is a function of its antenna's effective area, A_e, and P_r is therefore given by the equation;

$$\mathrm{P_r} = P.A_e \qquad \text{Equation 20}$$

Replacing A_e with its actual value gives:

$$\mathrm{P_r} = \frac{P.G_r.\lambda^2}{4.\pi} \qquad \text{Equation 21}$$

Replacing P with the terms of Equation 19 gives:

$$\mathrm{P_r} = \frac{F.G_t.P_t.G_r.\lambda^2}{(4.\pi.D)^2} \qquad \text{Equation 22}$$

when this signal is reflected off an object with bi-static radar cross section of σ, e.g. a wind turbine, rather than received directly, this equation can be modified to

$$\mathrm{P_{r\,ef}} = \frac{\sigma.F_{tw}.F_{wr}.G_{tw}.P_t.G_{rw}.\lambda^2}{(4.\pi.)^3.D_{tw}{}^2.D_{wr}{}^2} \qquad \text{Equation 23}$$

where the symbols have the following meanings

P_{ref}	The power of the reflected signal arriving at the receiver
P_t	Transmitted power
G_{tw}	Transmit antenna gain in the direction of the wind turbine
G_{rw}	Receive antenna gain in the direction of the wind turbine
σ	The bi-static RCS of the wind turbine as in Figure 21.
F_{tw}	Terrain induced attenuation factor between transmitter and wind turbine.
F_{wr}	Terrain induced attenuation factor between wind turbine and receiver.
D_{tw}	Distance transmitter to wind turbine
D_{wr}	Distance wind turbine to receiver
λ	Signal wavelength

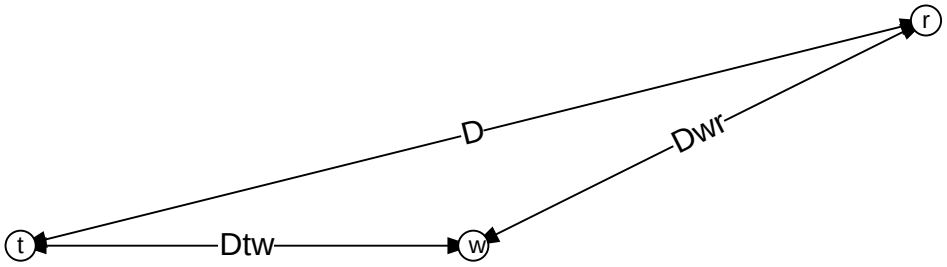

Figure 21: Direct and reflected signal paths

By replacing the power received, P_{ref}, with the threshold of the receiving system, P_{thresh}, the range from the turbine for a given turbine/transmitter geometry where the reflected signal is likely to be detected is given by:

$$D_{wr} = \sqrt{\frac{\sigma.\mathrm{F_{tw}}.\mathrm{F_{wr}}.\mathrm{G_{tw}}.\mathrm{G_{wr}}.\mathrm{P_t}.\lambda^2}{(4.\pi)^3.D_{tw}.P_{thresh}}}$$ Equation 24

For certain assessments the ratio of the power received via the direct path D has to be compared to the power received via the indirect path. Combining Equation 19 and Equation 23 yields:

$$\frac{P_{direct}}{\mathrm{P_{r\,ef}}} = \frac{F_{dir}.G_t.G_r.4.\pi.{D_{tw}}^2.{D_{wr}}^2}{\sigma.G_{tw}.G_{wr}.D^2.F_{tw}.F_{wr}}$$ Equation 25

By inverting Equation 25 we get the ratio between direct signal and reflected signal behind a turbine:

$$\frac{\mathrm{Pr}\,ef}{Pdirect} = \frac{\sigma.Gtw.Gwr.D^2.Ftw.Fwr}{Fdir.Gt.Gr.4.\pi.Dtw^2.Dwr^2}$$ Equation 26

For point “A”, directly behind the turbine, we can use the following relationships:

$G_{tw} = G_t$

$$G_{wr} = G_r$$

$$D = D_{tw} + D_{wr}$$

$$F_{dir} = F_{tw}.F_{wr}$$

$$\sigma = \frac{4.\pi.L^2.S^2}{\lambda^2}$$

$$L^2 = \frac{\lambda}{\frac{1}{D_{tw}} + \frac{1}{D_{wr}}}$$

Where L is the dimension of the 1st Fresnel zone and S is the diameter of the mast, this gives us:

$$\frac{P_{ref}}{P_{direct}} = \frac{S^2.D}{D_{tw}.D_{wr}.\lambda}$$ Equation 27

Using the relationship between field strength and power loss, PL, we get:

$$PL = \left(1 - \sqrt{\frac{P_{ref}}{P_{direct}}}\right)^2 = \left(1 - S.\sqrt{\frac{D}{D_{tw}.D_{wr}.\lambda}}\right)^2$$ Equation 28

Which can be rearranged to give:

$$D_{wr} = \frac{D_{tw}}{\left(\frac{D_{tw}.\lambda}{S^2}.\left(1 - \sqrt{PL}\right)^2 - 1\right)}$$ Equation 29

Which is the length of the shadow region for a given acceptable 1-way power loss PL.

Assuming that a 3 dB power loss is tolerable in the case of an SSR and a mast diameter of 6 m and taking into account $D_{tw} \geq 16$ km, the maximum length of the shadow region is equal to 1600 m.

At 1600 m behind the wind turbine the shadow height (see Annex A.2) is equal to 310 m assuming a wind turbine height of 200 m (nacelle height + half rotor blade diameter) and that the wind turbine altitude is 50 m higher than the SSR.

Using Equation 4 the width of the shadow region can be calculated and is equal to 45 m.

Under these conditions and assumptions the volume of the SSR shadow region behind a wind turbine (l 1600 m x w 45 m x h 310 m) is sufficiently small to be operationally tolerable.

The above assessment has been performed for a single wind turbine. Would there be multiple wind turbines located in a radar beam-width, the resulting shadow zone would be larger. Nevertheless it is believed that the 16 km limit is a valid figure for the border between SSR zone 2 (detailed assessment) and SSR zone 4 (no assessment).

D.3 Multiple target reports

Here the calculation is based on the conditions to get a reply from a transponder when the interrogation has been reflected onto a wind turbine.

Because of the ISLS implementation, the transponder will be insensitive during a 35 µs (see § 3.1.1.7.4 [RD 2]) period after the reception of a radar interrogation through radar sidelobes. Therefore any aircraft/transponder located closer than 5250 m (half of the distance corresponding to 35 µs) will not reply to reflected interrogations because in this case the path difference between the direct (through sidelobes) and the reflected signal will always be smaller than 35 µs.

When the aircraft transponder is located further than 5250 m from the wind turbine, the minimum power received by the transponder from a reflected interrogation can be calculated (using Equation 23) and can be compared with the minimum transponder receiver threshold (smaller specified value -77 dBm § 3.1.1.7.5 [RD 2]). Therefore the minimum distance between the SSR and the wind turbine can be calculated as follows:

$$D_{tw} = \sqrt{\frac{\sigma.\mathrm{F_{tw}}.\mathrm{F_{wr}}.\mathrm{G_{tw}}.\mathrm{G_{wr}}.\mathrm{P_t}.\lambda^2}{(4.\pi)^3.D_{wr}^2.P_{thresh}}}$$ Equation 30

P_{thresh} = -77 dBm = $10^{-10.7}$ W

P_t = 2 kW = 2000 W

$F_{tw} = F_{wr} = 1$

σ = 35 dBm^2 = $10^{3.5}$ m^2

G_{tw} = 27 dB = $10^{2.7}$

$G_{wr} = 1$

D_{wr} = 5250 m

λ = 0.2913 m (corresponding to 1030 Mhz)

It gives:

D_{tw} = 15698 m

Therefore when the wind turbine is 16 km away from the SSR if the aircraft/transponder is located closer than 5250 m from the wind turbine the transponder will not reply to reflected interrogations because of ISLS implementation and when further than 5250 m the power of the reflected interrogation will be below the transponder receiver threshold and the transponder will not reply either.

It must be noted that the rationale above is only valid for Mode A/C operations.

D.4 Azimuth accuracy

Here the calculation is based on the azimuth error due to a wind turbine for aircraft located behind the wind turbine.

As explained in paragraph 4.4.11, azimuth error may happen when there is a small path difference (less than 0.25 µs = 75 m) between the direct and the reflected signals as illustrated on Figure 22 below.

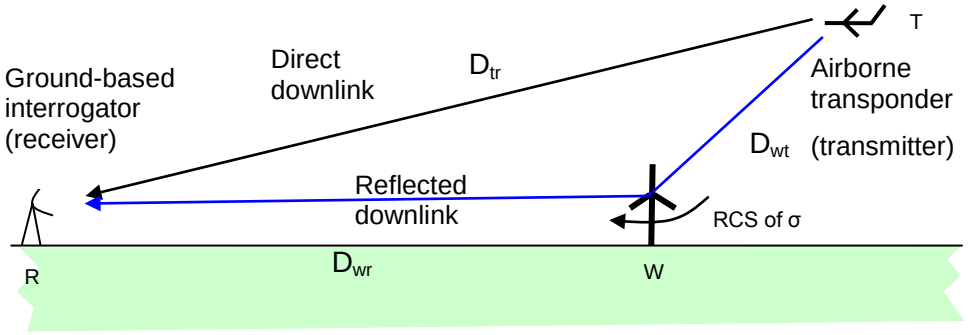

Figure 22: SSR downlink reflection

If the above criterion on path difference is met, this will have an impact on the azimuth measurement if the ratio C/I between the direct signal (C – Carriage) and the reflected signal (I – Interference) is smaller than a given threshold.

The C/I ratio can be calculated as follows assuming that:

- The propagation losses to the wind turbine and to the aircraft from the SSR ground system are the same;
- The propagation losses between the transponder and the wind turbine and the transponder and the SSR ground system are the same;
- The transponder gain in the direction of the wind turbine is the same in the direction of the SSR ground system;
- The SSR ground system receive gain is the same in the direction of the wind turbine as in the direction of the transponder.

If the above assumptions are met then:

$$\frac{C}{I} = \frac{D_{tw}^2 D_{wr}^2}{D_{tr}^2} \frac{4\pi}{\sigma}$$ Equation 31

Where σ is the wind turbine bi-static RCS as in Figure 22.

As $D_{tw} \leq D_{tr,}$, it can be derived that:

$$\frac{C}{I} \leq \frac{4\pi}{\sigma} . D_{wr}^2$$ Equation 32

Therefore, taking into account that a C/I ratio of 50 dB is largely sufficient to ensure a good discrimination between the direct signal and the reflected signal, one can derive the minimum D_{wr} for a given (maximum) bi-static wind turbine RCS (e.g. σ = 35 dBm^2).

D_{wr} = 5016 m

Consequently, when the wind turbine is more than 16 km away from the SSR, the impact on azimuth accuracy is tolerable irrespective of the path difference between the direct and the reflected signal.

The above assessment has been performed for a single wind turbine. It should be noted that would there be multiple wind turbines located in a radar beam-width and at a larger distance than 5 km, the resulting SSR azimuth error could be significant.

ANNEX E Wind energy project description pro-forma

The pro-forma below is based on a form currently in used; it can be adapted in accordance with national regulations and practice (see yellow shaded cell).

Wind Farm Name	
Also known as:	

Developers reference	
Application identification No.	

Related/previous applications (at or near this site): Provide reference names or numbers	

Developer Information	
Company name:	
Address:	
Contact:	
Telephone:	
Facsimile:	
e-mail:	

Relevant Wind Turbine Details			
Wind turbine manufacturer:			
Wind turbine model:			
Wind farm generation capacity (MW)		**Number of turbines**	
Blade manufacturer			
Number of blades			
Rotor diameter		Metres	
Rotation speed (or range)		Rpm	
Blade material including lightning conductors			
Wind turbine hub height		Metres	
Tower design (* delete as required)	* Tubular	* Lattice	
Tower base diameter/dimensions		Metres	
Tower top diameter/dimensions		Metres	

Comments Are there any details or uncertainties that may be helpful to add?

Turbine Locations

Please provide as much information as you can. The base position and tower height above sea level of every wind turbine if available, the site boundary if not.

Please number the turbines or boundary points on the map, to correlate with the information provided below.

Copy this page as necessary to account for all turbines or boundary points

Wind farm **Name & Address:**	

Turbine no.		**Height** above a known reference (m) of tower base				
	Degrees		Minutes		Seconds	
Latitude						
Longitude						
Turbine no.		**Height** above a known reference (m) of tower base				
	Degrees		Minutes		Seconds	
Latitude						
Longitude						
Turbine no.		**Height** above a known reference (m) of tower base				
Grid Reference			100 km square letter(s) identifier			
Latitude						
Longitude						
Turbine no.		**Height** above a known reference (m) of tower base				
	Degrees		Minutes		Seconds	
Latitude						
Longitude						

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From: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Sent: Monday 28 February 2022 12:50
To: Peter Barry
Cc: Paul Hennessy; BYRNE Jonathan; Valerie Heffernan; DOYLE Fergal; ARTHURS Fergal; OLOUGHLIN Charlie; CORRIGAN Gary; FLYNN Mark; SYMMANS Terry; Planning; Paul Hennessy
Subject: 220228 Proposed Ballycar Wind Farm ANSP Update (2)
Attachments: CL-5715-RPT-002 V1.0 Ballycar Windfarm IFP Opinion.pdf; CL-5715-RPT-002 V1.0 Ballycar Wind Farm Aviation Technical Assessment.pdf

Importance: High

Dear Peter,

Many thanks for the attached reports.

1. In relation to the IFP Opinion (Attachment 1) I'm happy to accept that the proposed turbines will not affect the Shannon Airport Instrument Flight Procedures and nothing further is required from this perspective.
   Note: If planning is granted and the construction goes ahead, these turbines will need to be notified to the IAA Aviation Safety Regulator, each being higher than 100m elevation
2. Technical Assessment Report:
   - Building Restricted Areas: SAA's Paul Hennessy copied for information
   - NAVAIDs: The report conforms no issues for Airport NAVAIDs: Fergal Doyle copied to confirm this

   - ***Surveillance:*** *The report notes that mitigations are required for the Shannon PSR and the Woodcock Hill MSSR most particularly not prevent false targets and ghost signals respectively. While the report outlines how these mitigations could be applied, this must be assessed by our surveillance team (Charlie O'Loughlin and his team copied).*

This last item will be the main issue for then IAA ANSP in my experience. This proposed development is one of multiple application in the same general area which is all cases is leading to an assessment of Surveillance impacts. While in isolation "filtering" of PSR and /or updates to the reflector file for Woodcock Hill MSSR may seem straightforward, it may be of significant cost to the ANSP and if required for multiple developments, lead to a realistically unusable radar system for aircraft targets between 3500 and 10000 feet, which would be the altitude band serving Shannon Airport. Added to this, such system upgrades have not been planned for in the Surveillance work programme.

I suggest that Charlie and his team will need to assess and revert with their position. Please follow up with me in a week's time and I'll in turn check with Surveillance.

Best regards,

Cathal
Cathal Mac Criostail
Údarás Eitlíochta na hÉireann / Irish Aviation Authority
The Times Building, 11-12 D'Olier Street, Dublin 2, D02 T449, Ireland
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☎ ~~+353 (0)1 6031173~~
+353 (0)86 0527130
www.iaa.ie
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From: Peter Barry <Peter.Barry@mwp.ie>
Sent: Friday 25 February 2022 14:47
To: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>; Planning <planning@iaa.ie>
Subject: RE: 220214 Proposed Ballycar Wind Farm ANSP Update

Hi Cathal,

Thank you for below. We are proceeding with the application.

I attached a couple of reports which we commissioned by Cyrrus. You might review and we could discuss the findings and recommended mitigation. There have been a couple of iterations of the layout since, but the mitigation measures should be the same.

Do we need to have a meeting to discuss the attached?

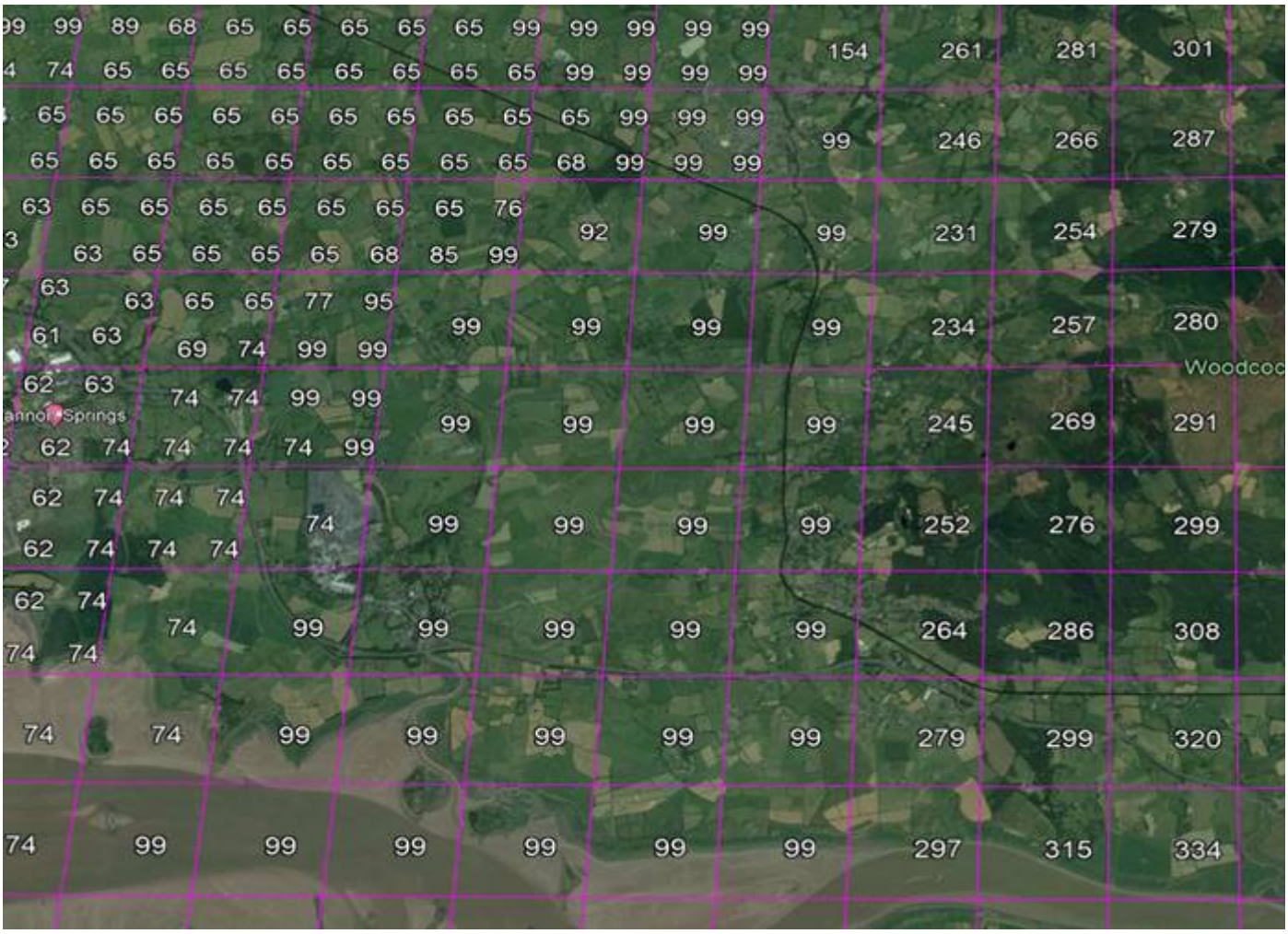
From: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Sent: Monday 14 February 2022 17:44
To: Peter Barry <Peter.Barry@mwp.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>; Planning <planning@iaa.ie>
Subject: 220214 Proposed Ballycar Wind Farm ANSP Update
Importance: High

Dear Peter,

Many thanks for the email and the attached detailed outline of the proposed Turbine co-ordinates and AMSL elevations. Thanks also for the phone-call by way of reminder on this.

As I outlined there are three areas of concern for us the IAA Air Navigation Service Provider:

1. **Instrument Flight Procedures (IFPs) surfaces:** Below is a Google Earth outline of the turbines with our IFP safeguarding girds overlayed:



As you can see the guide (IFP) elevation which does not affect the IFPs, is exceeded for many of the proposed turbines. This does not mean that this is not acceptable. It does however require an IF assessment to be carried out by a certified IFP designer to assess possible impacts. When you're ready to engage on this I can advise on which companies are certified for this work. The result should confirm no impact, or recommend mitigations, e.g. lowering of some turbines elevations possibly

2. **Navigation Aids:** The nearest turbine proposed is c. 16.5 km from Shannon Airport and as such should be outside area of concern for our ground-based navigation aids. This may need to be confirmed by the company who carry out flight checking if these systems. Fergal Arthurs and Fergal Doyle, Could you review and provide an opinion please?
3. **Surveillance:** The turbines as proposed are close to our surveillance systems at Woodcock Hill and will need to be considered for an effect on these systems. Attached is some guidance material and I'll refer this element to my colleague Charlie O'Loughlin for a view on this.

If you are proceeding to planning application, could you advise all copied please and we can assess where we are at that point?

I hope this all makes sense.

Kind regards,

Cathal
Cathal Mac Criostail
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The Times Building, 11-12 D'Olier Street, Dublin 2, D02 T449, Ireland
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☎ ~~+353 (0)1 6031173~~
+353 (0)86 0527130
www.iaa.ie
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From: Peter Barry <Peter.Barry@mwp.ie>
Sent: Thursday 13 January 2022 15:16
To: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>
Subject: RE: 220112 Proposed Ballycar Wind Farm

Hi Cathal,

Attached table with Lat/ Long coordinates included. Also, to clarify the column *rotor diameter* was labelled wrong in the earlier table I emailed, it should have been labelled *blade length*, rotor diameter is then double. Corrected table attached with AMSL as requested.

We are happy to discuss findings once you have had a chance to carry out your internal studies. We are still in the design and assessment stage.

Let me know if I can do anything else.

Peter

From: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Sent: Thursday 13 January 2022 13:41
To: Peter Barry <Peter.Barry@mwp.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>
Subject: 220112 Proposed Ballycar Wind Farm
Importance: High

Dear Peter,

Happy New Year and many thanks for the data supplied in the attached file.

There are a number of surfaces that the IAA Air Navigation Service Provider (ANSP) are responsible for safeguarding around Shannon Airport, including Navigation Aids, Surveillance Radar and Instrument Flight Procedures (IFPs).

In regard to the IFP surfaces, I am responsible for safeguarding here and we have a safeguarding grid to guide as to whether there is a potential impact on the IFP surfaces, generated by new obstacles, such as the proposed (12) wind turbines.

Below is a depiction of this safeguarding grid with a pin at Ballycar:

The values each grid cell represent an Above Mean Sea Level (AMSL: Site elevation + Height of obstacle) elevation value, above which, an IFP impact assessment will be required. In the case of the Ballycar area and taking the highest turbine height supplied, 254m added to an approximate site elevation of 240m, gives an AMSL elevation of in excess of 400m, which is above the safeguarding values in this area.

Separately, the heights proposed will likely impact the Surveillance Radar at Woodcock Hill and navigation aids for approaches to Shannon Airport. I've copied colleagues from the ANSP in these areas, for information.

This is not the only wind turbine proposal for this area and to be completely upfront, nearly all are creating issues for the surfaces referenced.

If you could supply confirmation of the AMSL elevations of the turbines and give co-ordinates in WGS 84 format (Latitude and Longitude), this would be appreciated and will allow me to give greater clarity on requirements for the ANSP and indeed SAA. If I have picked up on information incorrectly, please do correct me.

Kind regards,

Cathal
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From: Peter Barry <Peter.Barry@mwp.ie>
Sent: Thursday 13 January 2022 10:35
To: O'LEARY Geraldine <Geraldine.O'LEARY@IAA.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>
Subject: RE: Proposed Ballycar Wind Farm

Hi Geraldine,

Please find attached the turbine coordinates, hub height, rotor diameter and ground elevation as requested (email thread below).

If you need any more information, please let me know.

I would appreciate if you would acknowledge receipt of this email.

Peter Barry
BSc MSc CEnv

Principal Environmental Scientist

e peter.barry@mwp.ie m +353 86 4474440
t +353 (0)66 7123404 w www.mwp.ie

Reen Point, Blennerville,
Tralee, Co. Kerry, V92 X2TK, Ireland

From: O'LEARY Geraldine <Geraldine.O'LEARY@IAA.ie>
Sent: Wednesday 5 January 2022 14:04
To: Peter Barry <Peter.Barry@mwp.ie>
Subject: Proposed Ballycar Wind Farm [Filed 07 Jan 2022 11:03]

"Dear Mr. Barry,

Thank you for your letter and scoping report and request for comments in relation to a proposed wind farm on lands at and near Ballycar, Co. Clare.

As the blade tip height proposed is not included, nor specific turbine positions and the ground elevation of each site is not provided, Safety Regulation Division - Aerodromes cannot make any specific comments at this time.

The development appears to be approximately 16km East of Shannon Airport, as such, the applicant should engage with Shannon Airport Authority and the IAA's Air Navigation Service Provider (ANSP) as a matter of urgency to undertake a preliminary screening assessment to confirm that the proposed wind farm and the associated cranes that would be utilised during its construction would have no impact on instrument flight procedures, communication and navigation aids or flight checking at Shannon Airport. Contact details are as below:

Aerodrome Operator – Shannon Airport:	**IAA-ANSP:**	**Shannon Tower Business Unit**
Mr. Paul Hennessy Safety Compliance and Environment Manager Shannon Airport Authority DAC t: +353-61-712471 m: +87-2382453 e: paul.hennessy@shannonairport.ie	Mr. Cathal Mac Criostail Airspace & Navigation Manager Údarás Eitlíochta na hÉireann / Irish Aviation Authority The Times Building, 11-12 D'Olier Street, Dublin 2, D02 T449, Ireland cathal.maccriostail@iaa.ie +353 (0)1 6031173 +353 (0)86 0527130	Mr. Jonathan Byrne Operations Manager STBU/CTBU Air Traffic Control Irish Aviation Authority jonathan.byrne@iaa.ie +353 61 703704 +353 87 9375486

Subject to any study noting a potential impact on the safety of operations at Shannon Airport, during the formal planning process, the Safety Regulation Division – Aerodromes would likely make the following general observation:

In the event of planning consent being granted, the applicant should be conditioned to contact the Irish Aviation Authority to: (1) agree an aeronautical obstacle warning light scheme for the wind farm development, (2) provide as-constructed coordinates in WGS84 format together with ground and tip height elevations at each wind turbine location and (3) notify the Authority of intention to commence crane operations with at least 30 days prior notification of their erection.

Yours sincerely

Deirdre Forrest
Corporate Affairs

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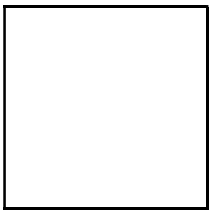

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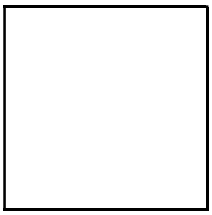

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Ballycar Wind Farm Aviation Technical Assessment

Greensource Limited

05 November 2021

CL-5715-RPT-002 V1.0

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Executive Summary

Cyrrus Limited has been engaged by Malachy Walsh and Partners to undertake an Aviation Study for the proposed Ballycar Wind Farm development in County Clare in the West of Ireland. The proposal comprises 12 wind turbines with a maximum tip height of up to 156.5m Above Ground Level.

An assessment of the Building Restricted Areas associated with the Instrument Landing Systems and Distance Measuring Equipment installed at Shannon Airport shows that the proposed turbines will have no impact on these navigation facilities.

Detailed radar modelling of the indicative layout against the combined Primary Surveillance Radar/Monopulse Secondary Surveillance Radar (PSR/MSSR) facility at Shannon Airport shows the following:

- Radar Line of Sight (RLoS) exists between Shannon PSR and 11 of the 12 proposed turbines;
- There is a high probability that Shannon PSR will detect turbines T1 to T9 and turbines T11 and T12, leading to turbine-induced clutter and false targets, and track seduction of aircraft targets;
- It is unlikely that Shannon PSR will detect turbine T10;
- Mitigation for Shannon PSR may be required;
- The proposed turbine sites are outside the Eurocontrol recommended 16km turbine assessment zone for Shannon MSSR, therefore an impact assessment for the facility was not required;
- No mitigation measures are necessary for Shannon MSSR.

Detailed radar modelling of the indicative layout against the MSSR at Woodcock Hill shows the following:

- RLoS exists between Woodcock Hill MSSR and all 12 proposed turbine towers;
- Aircraft between 5,250m and 10,536m from the proposed turbines may respond to bistatic reflections from these turbine towers, resulting in false targets on the bearings of the turbines;
- Provided the MSSR reflector file is updated with the turbine positions, the MSSR should be able to process out false targets caused by reflections from the turbine towers;
- The maximum heights of shadow regions from the turbines will be below published Air Traffic Control surveillance minimum altitudes and should therefore be operationally tolerable.

It is recommended that mitigation options are discussed with the Irish Aviation Authority (IAA), specifically Air Traffic Services. It is the surveillance network and operational use that will largely influence a suitable mitigation.

Possible mitigation solutions for Shannon PSR include blanking of PSR transmissions over the wind farm. This can be combined with the application of a Transponder Mandatory Zone in the affected airspace, or with in-fill data from a remote radar source.

Existing remote PSR data can be used as in-fill provided it has suitable airspace coverage and does not have visibility of the turbines. This relies on suitable terrain screening and can be problematic in terms of synchronisation and slant range errors.

In-fill mitigation can be provided using a dedicated 2D radar from a company such as Terma. The mitigation radar must be located in close proximity to the airport PSR and be synchronised with it. Terma radars filter out turbines while continuing to track aircraft.

The Aveillant Holographic Radar™ offers a 3D radar mitigation solution that can discriminate turbines from aircraft without the need for masking. It does not require locating close to the airport PSR and its target output can be coordinate transformed to the PSR origin without slant range errors.

Abbreviations

AGL	Above Ground Level
AMSL	Above Mean Sea Level
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
BRA	Building Restricted Area
CFAR	Constant False Alarm Rate
DME	Distance Measuring Equipment
DOC	Designated Operational Coverage
DTM	Digital Terrain Model
ICAO	International Civil Aviation Organisation
ILS	Instrument Landing System
MSSR	Monopulse Secondary Surveillance Radar
MWP	Malachy Walsh and Partners
NM	Nautical Miles
PD	Probability of Detection
PSR	Primary Surveillance Radar
RCS	Radar Cross Section
RLoS	Radar Line of Sight
RPM	Revolutions Per Minute
TMZ	Transponder Mandatory Zone
VPD	Vertical Polar Diagram

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List of tables

1. Introduction

1.1. Overview

1.1.1. A new wind farm development, Ballycar Wind Farm, is being proposed in County Clare in the West of Ireland. The proposed development is planned to comprise 12 wind turbines with a maximum tip height of up to 156.5m Above Ground Level (AGL).

1.2. Aviation Study

1.2.1. Cyrrus Limited has been engaged by Malachy Walsh and Partners (MWP), on behalf of Greensource Limited, to undertake an Aviation Study for the development.

1.2.2. This report is concerned with the possible impacts the turbines may have on aviation navigation and surveillance facilities and includes an assessment of the Instrument Landing System (ILS) and combined Primary Surveillance Radar/Monopulse Secondary Surveillance Radar (PSR/MSSR) installations at Shannon Airport, and the MSSR at Woodcock Hill.

1.2.3. A review of the Building Restricted Areas (BRAs) that safeguard the ILS Localiser, Glidepath and Distance Measuring Equipment (DME) facilities at Shannon Airport will be used to determine the likelihood of any impact from the turbines.

1.2.4. Radar Line of Sight (RLoS) assessments will determine the degree of visibility of the proposed turbines to each of the radars and detailed Probability of Detection (PD) calculations will assess the likelihood of an impact on radar caused by signal reflections from the turbine blades and towers.

2. Evaluation Tools Used

2.1. Software

- ATDI HTZ communications v23.4.2 x64;
- Global Mapper v21.1;
- ZWCAD+ 2015 SP1 Pro v2014.11.27(26199).

2.2. Terrain Data

- ATDI 20m Digital Terrain Model (DTM), 2020, Irish Grid projection.

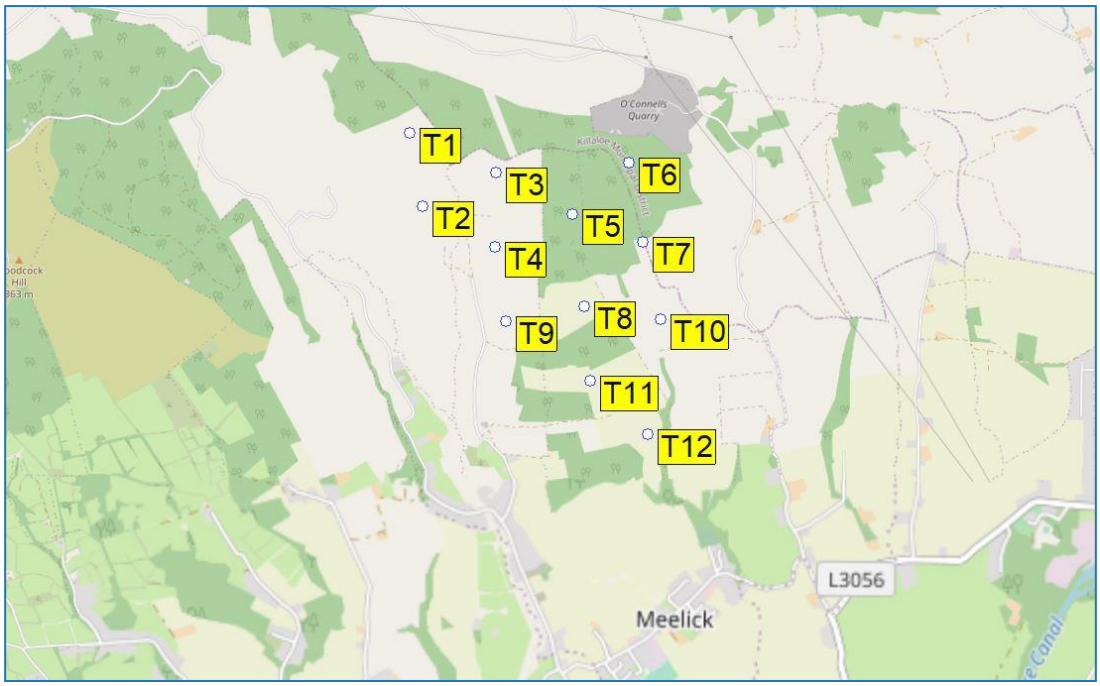
2.3. Data Provided by the Client

- 22156-MWP-00-00-SK-C-0003-P01 Site Location.pdf;
- Turbine Layout 2021-09-29.xls.

3. Development

3.1. Location

3.1.1. The indicative 12 turbine layout used for the modelling is shown in Figure 1.



© OpenStreetMap contributors

Figure 1: Indicative turbine layout

3.2. Turbine Data

3.2.1. Turbine T10 has a planned hub height of 83m AGL and blade length of 66.5m, to give a tip height of 149.5m AGL.

3.2.2. The other turbines have a planned hub height of 90m AGL and blade length of 66.5m, to give a tip height of 156.5m AGL.

3.2.3. Location data for the 12 proposed turbines has been supplied by MWP. The Irish Transverse Mercator grid coordinates for each turbine are presented in Table 1, together with each site elevation Above Mean Sea Level (AMSL).

Turbine ID	Easting (m)	Northing (m)	Site Elevation AMSL (m)
T01	554531.3	664275.1	234
T02	554604.7	663847.3	207
T03	555029.9	664043.7	238
T04	555027.2	663611.2	198

Turbine ID	Easting (m)	Northing (m)	Site Elevation AMSL (m)
T05	555475.6	663803.6	243
T06	555804.8	664103.9	254
T07	555885.7	663643.1	198
T08	555546.9	663267.0	160
T09	555090.4	663180.2	166
T10	555989.9	663191.0	124
T11	555582.0	662836.6	113
T12	555912.5	662520.8	77

Table 1: Turbine location data

4. ILS Assessment

4.1. Locations of Turbines and Shannon Airport

4.1.1. The closest turbine within the proposed development lies approximately 17.3km east of the centre of the main runway at Shannon Airport, as shown in Figure 2.

Figure 2: Locations of turbines and Shannon Airport

4.2. Building Restricted Areas

4.2.1. The navigation facilities under consideration at Shannon Airport are the ILS Localisers, Glidepaths and DMEs that provide guidance for aircraft landing on runways 06 and 24. The minimum safeguarded areas for these facilities are defined by the International Civil Aviation Organisation (ICAO) in the document ICAO EUR DOC 015[1].

[1] ICAO EUR DOC 015 European Guidance Material on Managing Building Restricted Areas, Third Edition 2015

4.2.2. Figure 3 shows an example of the BRA shape for directional facilities such as ILS Localisers, Glidepaths and DMEs, as depicted in ICAO EUR DOC 015 Figures 3.1, 3.2, 3.3 and 3.4.

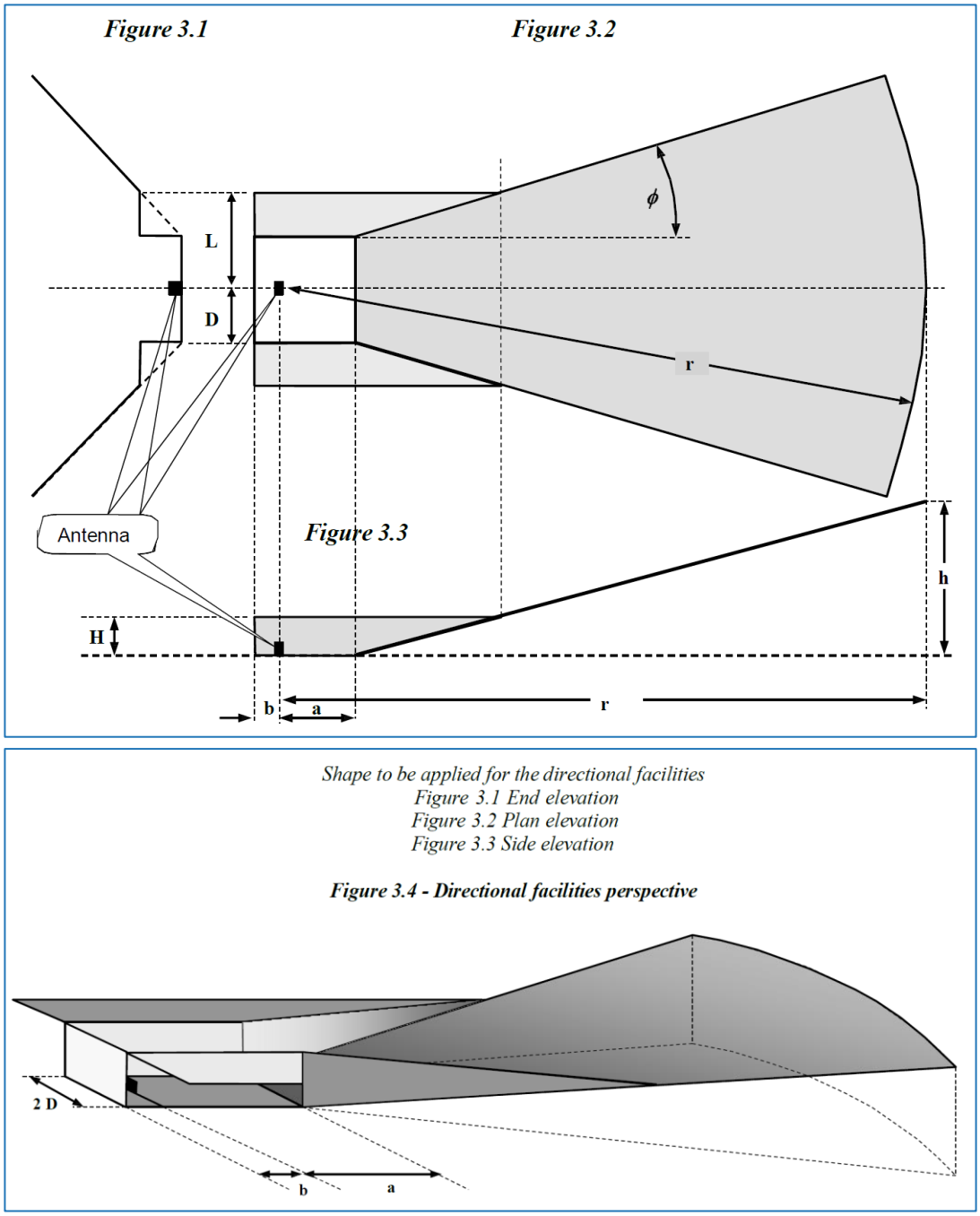


Figure 3: ICAO EUR DOC 015 Figures 3.1-3.4 – BRA shape for directional facilities

4.2.3. Applicable dimensions to be applied for the various directional navigation facilities are reproduced in Figure 4.

*Type of **navigation** facilities*	***A*** *(m)*	***b*** *(m)*	***h(m)***	***r*** *(m)*	***D*** *(m)*	***H*** *(m)*	***L*** *(m)*	***ϕ*** *(°)*
ILS LLZ (medium aperture single frequency)	Distance to threshold	500	70	a+6000	500	10	2300	30
ILS LLZ (medium aperture dual frequency)	Distance to threshold	500	70	a+6000	500	20	1500	20
ILS GP M–Type (dual frequency)	800	50	70	6000	250	5	325	10
MLS AZ	Distance to threshold	20	70	a+6000	600	20	1500	40
MLS EL	300	20	70	6000	200	20	1500	40
DME (directional antennas)	Distance to threshold	20	70	a+6000	600	20	1500	40

Figure 4: ICAO EUR DOC 015 Table 2 – Harmonised guidance figures for directional navigation facilities

4.2.4. The purpose of the safeguarded areas is to identify developments with the potential for causing unacceptable interference to navigation facilities. Developments that infringe a safeguarded area must undergo technical assessments to determine the degree of interference, if any, and whether the interference will be acceptable to the Airport operator.

4.2.5. The ILS Localiser, Glidepath and DME safeguarded areas for runways 06 and 24 are shown in Figure 5 and Table 2.

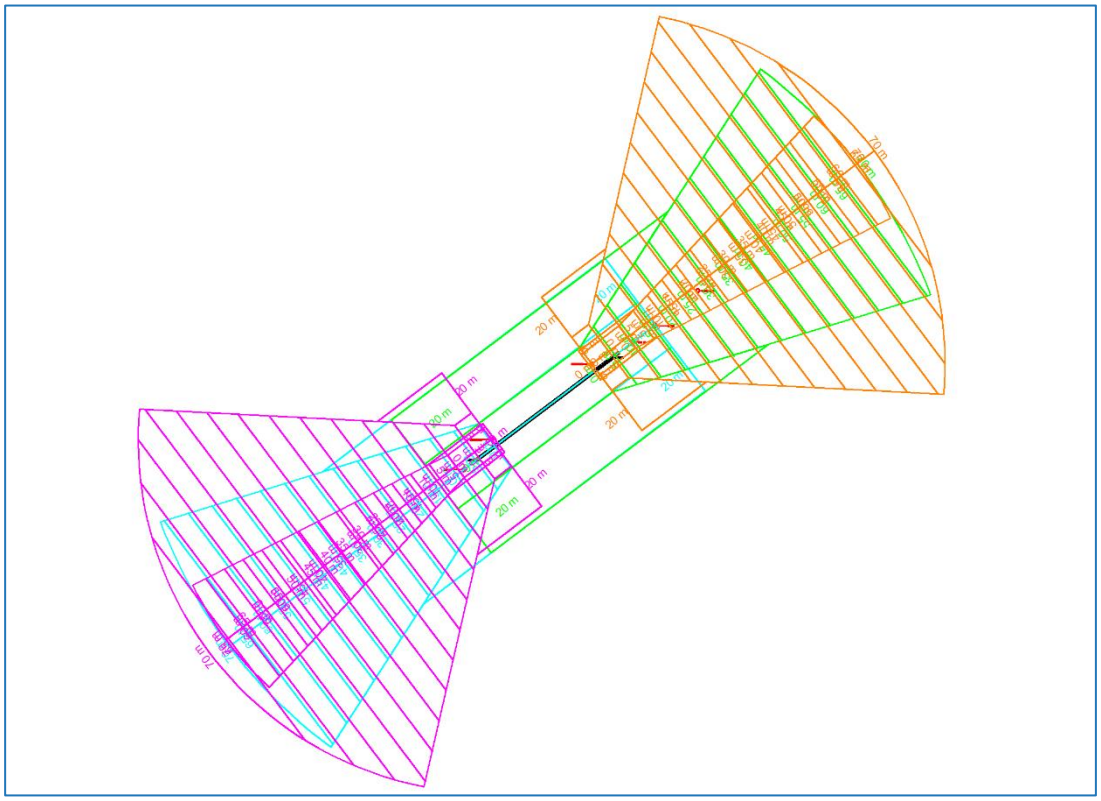


Figure 5: ILS safeguarded areas at Shannon Airport

Area Colour	Description
Magenta	Glidepath/DME 06
Orange	Glidepath/DME 24
Cyan	Localiser 06
Green	Localiser 24

Table 2 - Safeguarded areas colour reference

4.2.6. The same safeguarded areas are shown in Figure 6 relative to the proposed turbines.

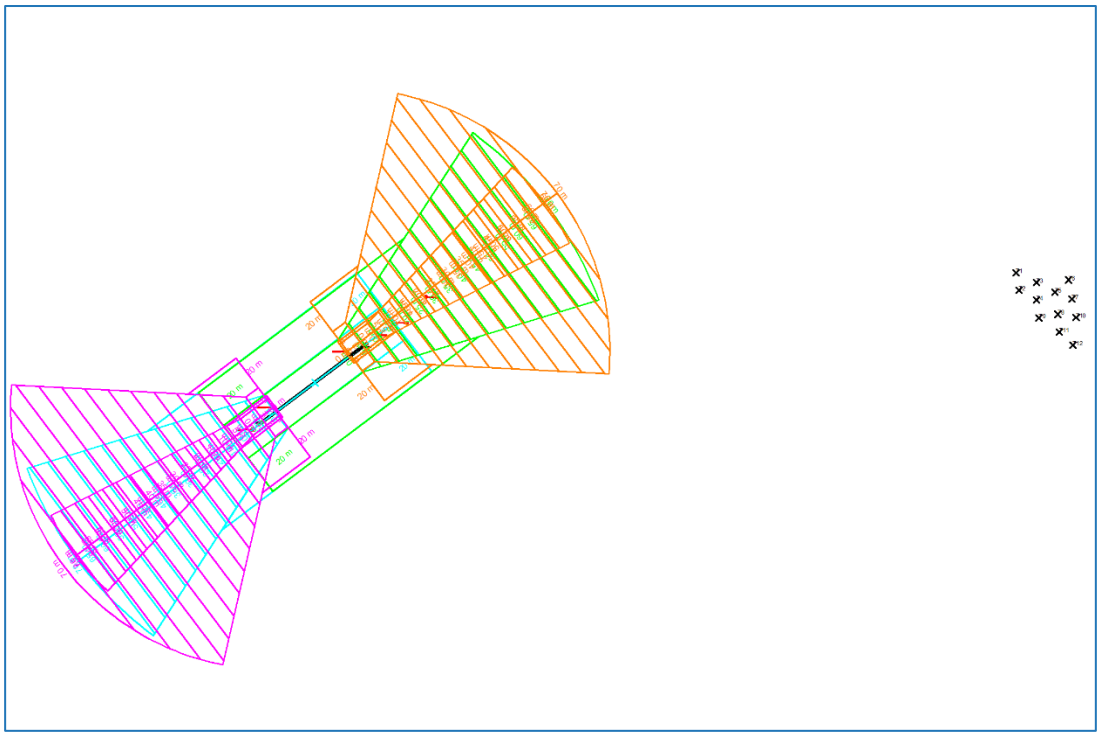


Figure 6: ILS safeguarded areas relative to proposed turbines

4.2.7. The proposed turbines lie outside the ILS safeguarded areas and will have no impact on ILS signals. No further technical assessment for the ILS facilities at Shannon Airport is required.

5. Radar Assessment

5.1. Potential Impact of Wind Turbines on PSR

5.1.1. A PSR transmits pulses of energy that are reflected back to the radar's receiver by objects that are within RLoS. Wind turbines can act as reflectors presenting a static target to the radar system. This phenomenon is no different to any other reflection received from ground obstacles (buildings, electricity pylons etc) except that each turbine structure reflects an amount of energy several orders of magnitude larger than that caused by an aircraft. This has the potential effect of causing a shadow behind the obstacle rendering the receiver blind to wanted targets in the immediate area beyond the turbine. It is thus not possible to reduce the gain of the radar in this range cell and still see the wanted targets.

5.1.2. PSRs will 'see' any reflecting object that the radar energy illuminates. To discriminate wanted targets (aircraft) from the unwanted clutter, the radar ignores static objects and only displays moving targets. The rotating blades of a wind turbine impart a Doppler frequency shift to the reflected radar pulse, which the radar receiver 'sees' as a moving target; these targets are then presented on the Air Traffic Control Officers (ATCOs) radar display as primary radar returns, indistinguishable from those returns originating from aircraft. This is not a steady effect but has dependency on the axis of rotation of the turbine in relation to the radar. Such unwanted radar returns are known as 'clutter'.

5.1.3. PSRs are usually designed to manage the amount of clutter within defined cells using Constant False Alarm Rate (CFAR) algorithms. In areas of high clutter returns, as experienced from wind turbines, the CFAR action is to reduce the sensitivity of the receiver. Whilst this has the positive benefit of keeping the displayed data usable by the ATCOs rather than being totally swamped with clutter returns, it does have the adverse effect of reducing the PD of aircraft within the affected cells.

5.1.4. A consequence of these effects is that the tracking mechanism in the radar processing is no longer able to reliably report the aircraft's passage in the vicinity of the turbines. The aircraft's track is liable to either be lost or 'seduced' by the turbine returns to create an erratic course.

5.1.5. If the radar cannot distinguish a wanted target (aircraft) amongst the returns originated by the turbines it can result in an undecipherable data display to the ATCO. In the worst case, the presence of a real aircraft, possibly in confliction with another aircraft under control, may be hidden by turbine-induced clutter or a desensitized receiver thereby increasing the risk of collision. Furthermore, false targets when presented on the ATCO's radar screen may appear as conflicting traffic to other real aircraft, resulting in the issuance of unnecessary avoiding action. In addition, the establishment by the ATCO of aircraft identity may be delayed or subsequently lost altogether in the vicinity of a wind farm.

5.2. Potential Impact of Wind Turbines on MSSR

5.2.1. Unlike PSR, MSSR is an 'active' system. It operates by the radar transmitting a coded pulse sequence which is received and decoded by suitably equipped aircraft. The aircraft responds with a coded pulse sequence on a different frequency which is received by the MSSR. Range and azimuth information is derived in the same way as PSR, but additional information in

the coded reply allows the identification of a particular aircraft and its height. Other data may also be made available dependant on the mode of operation.

5.2.2. MSSR is immune to direct reflections (monostatic back scatter) from large objects such as wind turbines because the transmitted and received frequencies differ and the message structure is different for transmit and receive paths.

5.2.3. Bistatic reflection is where the signal transmitted by the radar is 'forward' reflected to an aircraft, and the aircraft reply is also reflected back to the radar. The effect of this is best understood by considering the following diagrams.

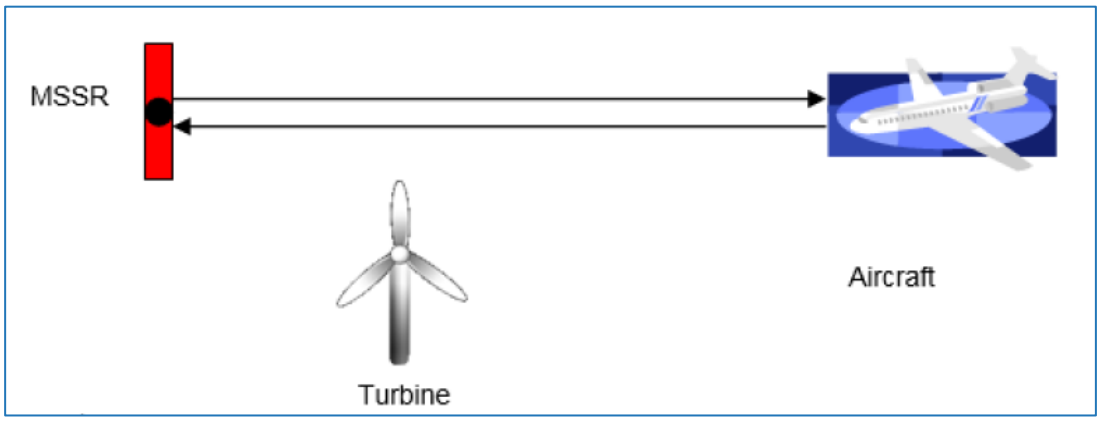


Figure 7: Direct interrogation and reply pulses

5.2.4. In Figure 7, the MSSR transmits an interrogation pulse sequence and the aircraft, on receiving the interrogation sequence, replies with a coded pulse sequence. The time delay between interrogation and receipt of reply is proportional to the distance of the aircraft from the radar. The bearing of the aircraft is the physical bearing of the radar antenna.

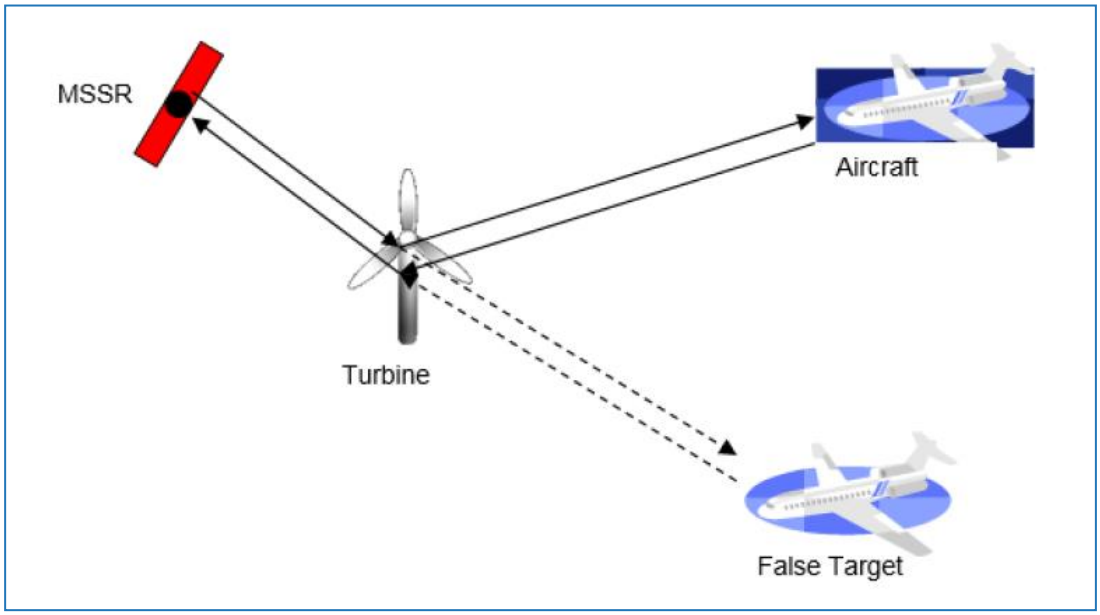


Figure 8: Reflected interrogation and reply pulse

5.2.5. In Figure 8, the MSSR beam illuminates a wind turbine which reflects the interrogation to an aircraft on a different bearing. The aircraft transponder replies, and this is received by the radar via the turbine. The radar processes this as a false target on the bearing of the wind turbine and at a distance proportional to the path length, which is slightly longer than the direct path length.

5.2.6. Objects can produce a radar shadow in the airspace behind the object. As a wind turbine is narrow compared to the radar beam width, assuming the turbine is >2km from the radar, the shadow will be relatively small, and will reduce with increasing distance behind the turbine. Shadowing effects are likely to be insignificant but, due to diffraction of the beam around the turbine tower, small azimuth angular errors may be introduced. Aircraft targets in this area can potentially be subject to track jitter causing the returns to meander from side to side. This can only occur where the turbine is in the direct RLoS between the radar and the aircraft target.

5.3. Shannon Airport Radar

5.3.1. The radar at Shannon Airport is a combined head with co-mounted PSR and MSSR antennas.

5.3.2. The PSR model is a Thales Star 2000, operating in the S-Band frequency, turning at 15 Revolutions Per Minute (RPM) and with an instrumented range of 60 Nautical Miles (NM). As with all PSRs of this type, it is vulnerable to the adverse effects of wind turbines, however, Thales claim to have newer processing capabilities which are more turbine tolerant.

5.3.3. The MSSR model is a Thales RSM 970 S. It meets the current standard of MSSR capability to the European Mode S Functional Specification[2] and has an instrumented range of 256NM.

Image © 2021 Google © 2021 Europa Technologies

Figure 9: Shannon PSR/MSSR

5.3.4. The WGS84 coordinates for the radar are: 52° 42' 05.03'' N, 08° 56' 11.74'' W

5.3.5. The PSR antenna height is 16m AGL, the MSSR antenna height is 18m AGL.

[2] EUROCONTROL European Mode S Station Functional Specification v3.11, May 2005

5.3.6. The location of Shannon PSR/MSSR is shown in Figure 10.

Figure 10: Location of Shannon PSR/MSSR

5.4. Woodcock Hill Radar

5.4.1. The radar at Woodcock Hill is a Thales RSM 970 S MSSR and is housed in a polycarbonate radome.

Figure 11: Woodcock Hill MSSR

5.4.2. The WGS84 coordinates for the radar are: 52° 43' 15.77'' N, 08° 42' 26.78'' W

5.4.3. The MSSR antenna height is 10m AGL.

5.4.4. The location of Woodcock Hill MSSR is shown in Figure 12.

Figure 12: Location of Woodcock Hill MSSR

5.5. Locations of Turbines and Radars

5.5.1. The relative locations of the proposed turbines and the radars at Shannon Airport and Woodcock Hill are shown in Figure 13.

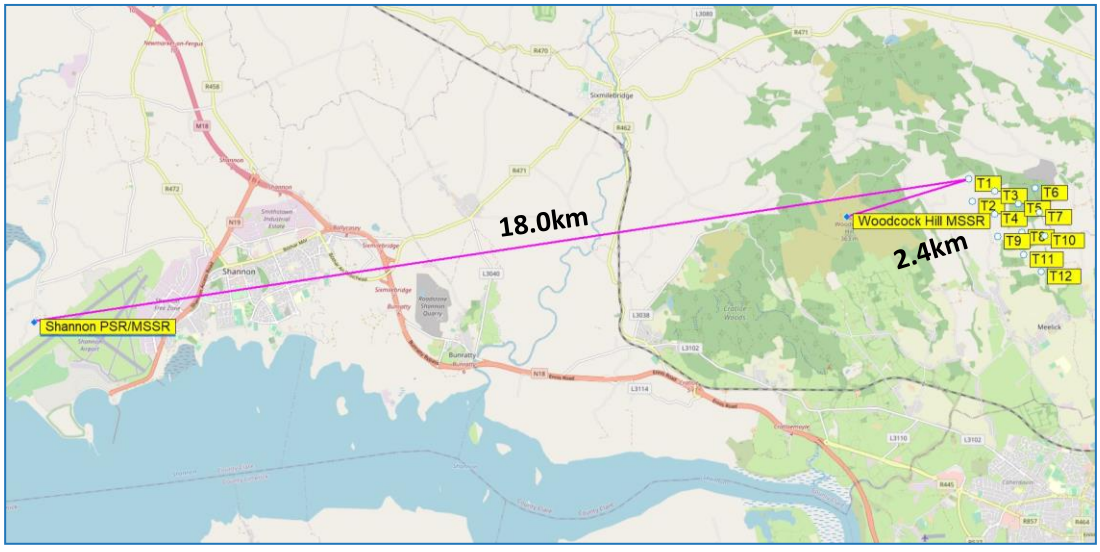


Figure 13: Locations of radars and proposed turbines

5.5.2. The closest proposed turbine within Ballycar Wind Farm (T1) is 18.0km from the Shannon PSR/MSSR, and 2.4km from Woodcock Hill MSSR.

5.5.3. In accordance with Eurocontrol Guidelines[3], the wind turbine assessment zone for MSSR facilities extends to 16km. Beyond this range the impact of a wind turbine is considered to be tolerable. Therefore, an assessment of the impact on the Shannon MSSR is not required.

5.6. Radar Line of Sight Modelling

5.6.1. RLoS is determined from a radar propagation model (ATDI HTZ communications) using 3D DTM data with a 20m horizontal resolution. Radar data is entered into the model and RLoS to the turbines from the radars is calculated.

5.6.2. Note that by using DTM no account is taken of possible further shielding of the turbines due to the presence of structures or vegetation that may lie between the radars and the turbines. Thus, the RLoS assessments are worst-case results.

5.6.3. For PSR, the principal sources of adverse wind farm effects are the turbine blades, so for Shannon PSR RLoS is calculated for the maximum tip height of the turbines, i.e. 156.5m AGL.

5.6.4. In the case of MSSR, adverse effects are generated by the turbine towers, so for Woodcock Hill MSSR RLoS is calculated for the maximum hub height of the turbines, i.e. 90m AGL.

5.6.5. A 3D view of the turbines and the terrain model, as viewed from Shannon PSR/MSSR, is shown in Figure 14.

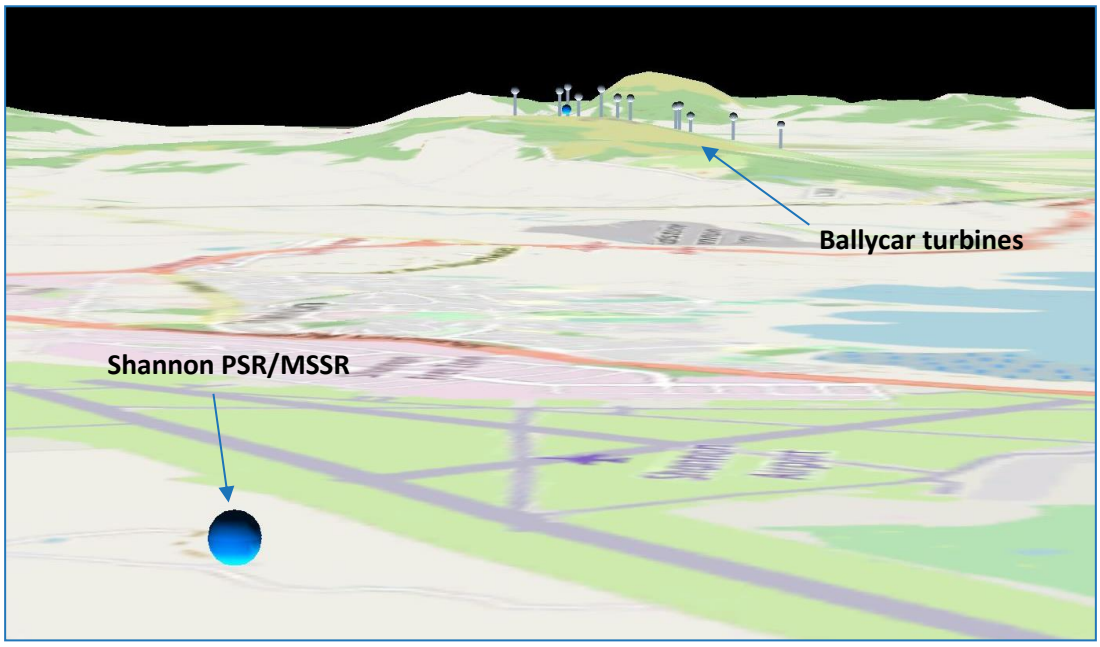


Figure 14: 3D view from Shannon PSR/MSSR towards turbines

[3] EUROCONTROL Guidelines for Assessing the Potential Impact of Wind Turbines on Surveillance Sensors, EUROCONTROL-GUID-0130 Edition Number 1.2, September 2014

5.6.6. The magenta shading in Figure 15 illustrates the RLoS coverage from Shannon PSR to turbines with a blade tip height of 156.5m AGL.

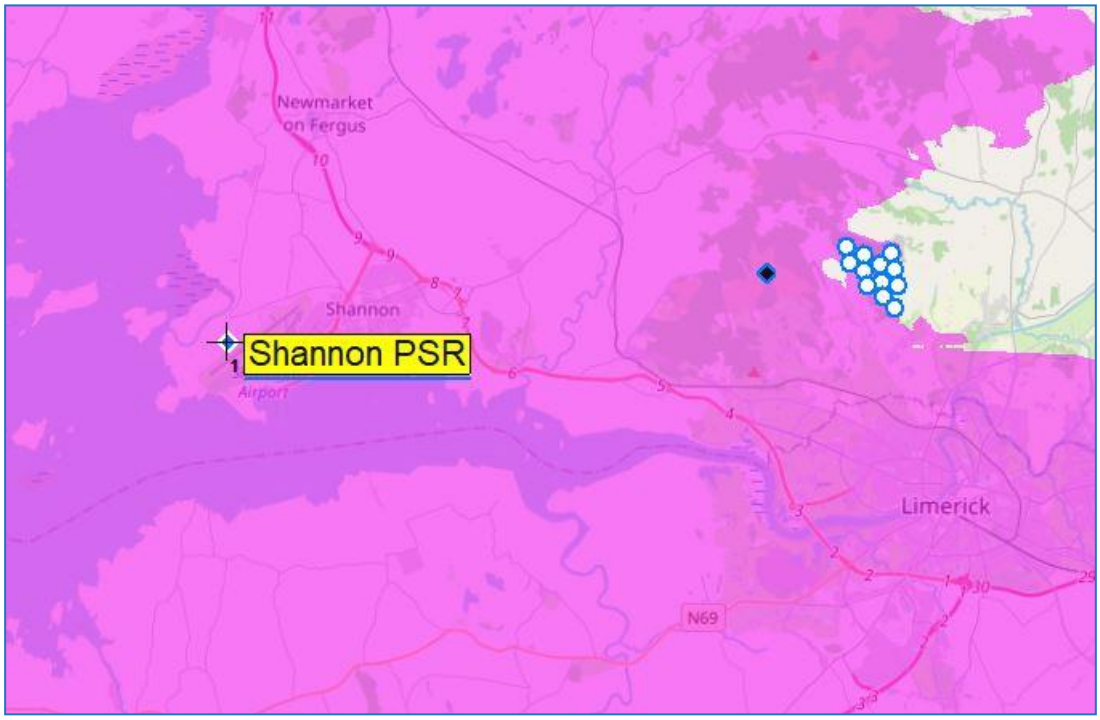


Figure 15: Shannon PSR RLoS to 156.5m AGL

5.6.7. A zoomed view of the RLoS coverage in the vicinity of the proposed turbines is shown in Figure 16.

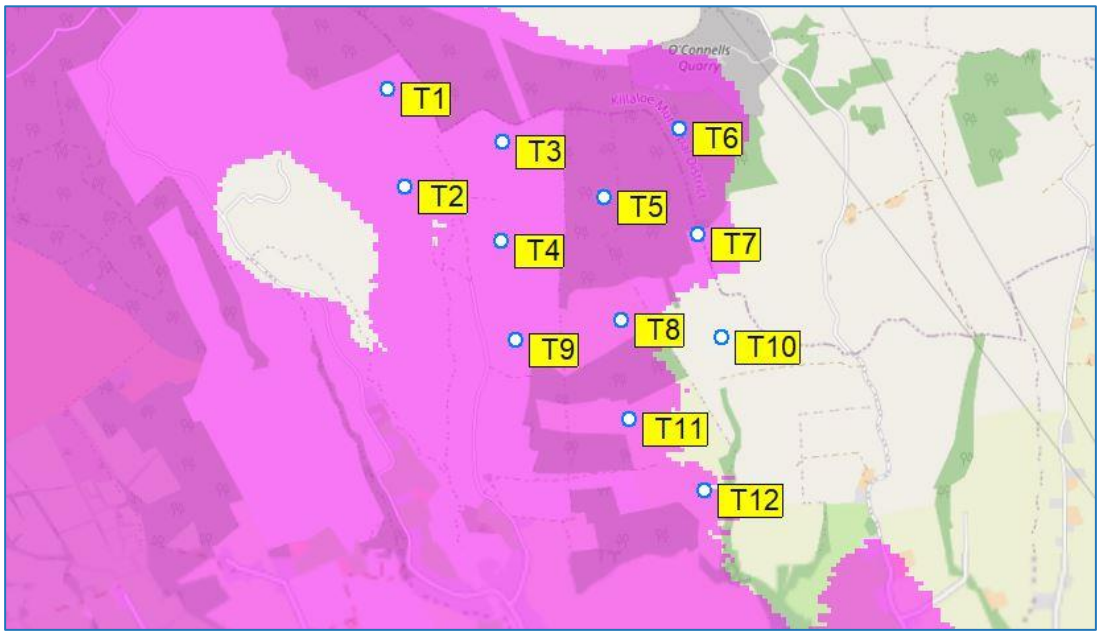


Figure 16: Shannon PSR RLoS to 156.5m AGL – zoomed

5.6.8. The magenta shading indicates that RLoS exists between Shannon PSR and all the turbines except turbine T10 in the indicative layout. The planned turbine T10 tip height is 149.5m AGL. RLoS will not exist between Shannon PSR and turbine T10 at the lower tip height.

5.6.9. Where RLoS exists it can be assumed that the PSR will detect the turbines, and where there is no RLoS it can generally be assumed that the turbine will not be detected. However, this can only be confirmed by analysing the path profiles between the PSR and each turbine and calculating the PD using known PSR parameters. This is undertaken in Section 5.7.

5.6.10. A 3D view of the turbines and the terrain model, as viewed from Woodcock Hill MSSR, is shown in Figure 17.

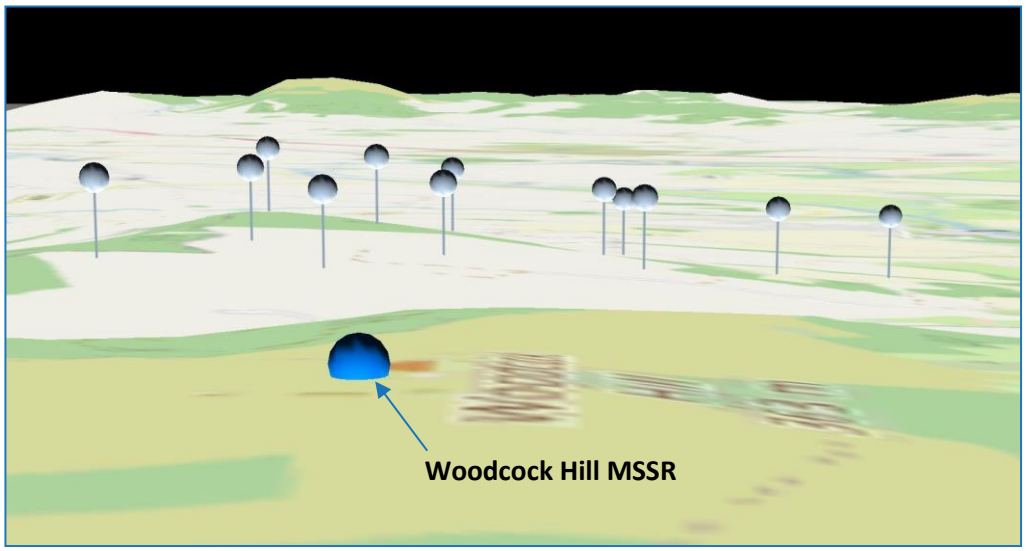


Figure 17: 3D view from Woodcock Hill MSSR towards turbines

5.6.11. The magenta shading in Figure 18 illustrates the RLoS coverage from Woodcock Hill MSSR to turbines with a tower hub height of 90m AGL.

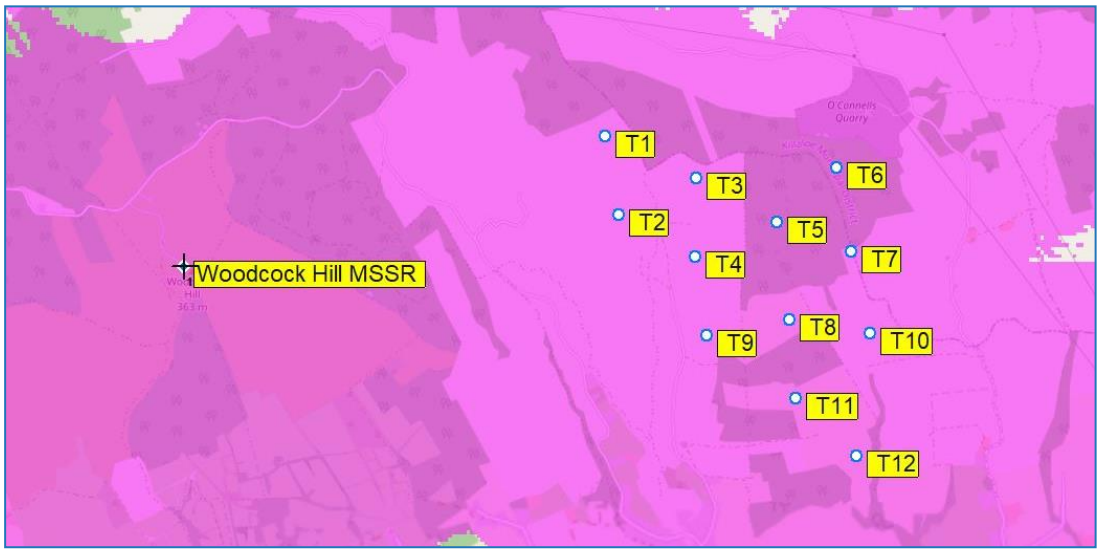


Figure 18: Woodcock Hill MSSR RLoS to 90m AGL

5.6.12. RLoS at 90m AGL exists between Woodcock Hill MSSR and all the turbines in the indicative layout.

5.6.13. To account for the reduced T10 hub height, RLoS coverage at 83m AGL is shown in Figure 19.

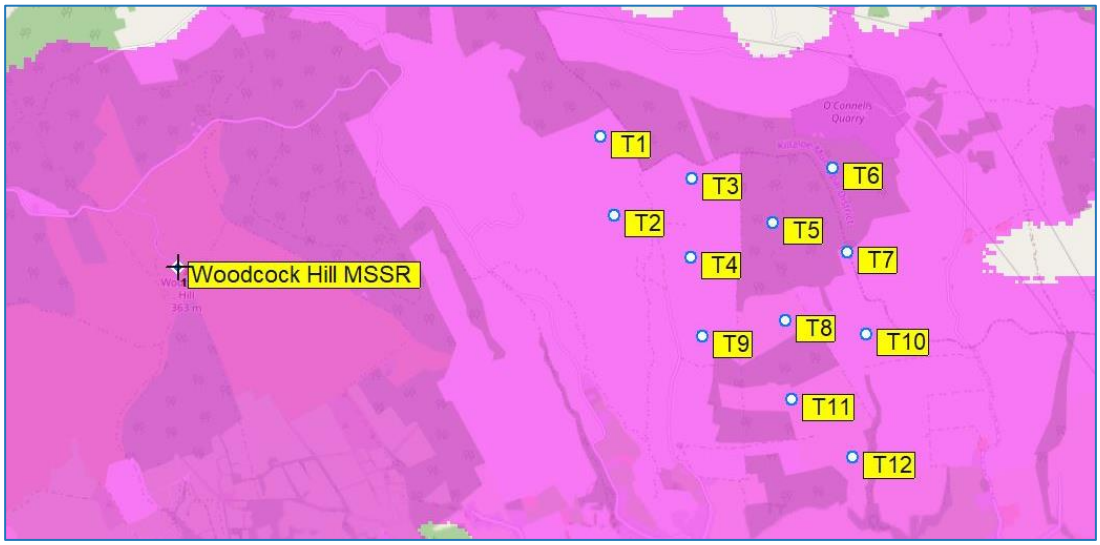


Figure 19: Woodcock Hill MSSR RLoS to 83m AGL

5.6.14. RLoS between Woodcock Hill MSSR and turbine T10 still exists at the reduced hub height of 83m AGL.

5.7. Shannon PSR Path Loss and Probability of Detection

5.7.1. Using the radar propagation model the actual path loss between Shannon PSR and various parts of each turbine can be determined.

5.7.2. An illustration of the path loss profile between Shannon PSR and the tip of turbine T1 is shown in Figure 20. Shannon PSR has uninterrupted RLoS to the turbine tip.

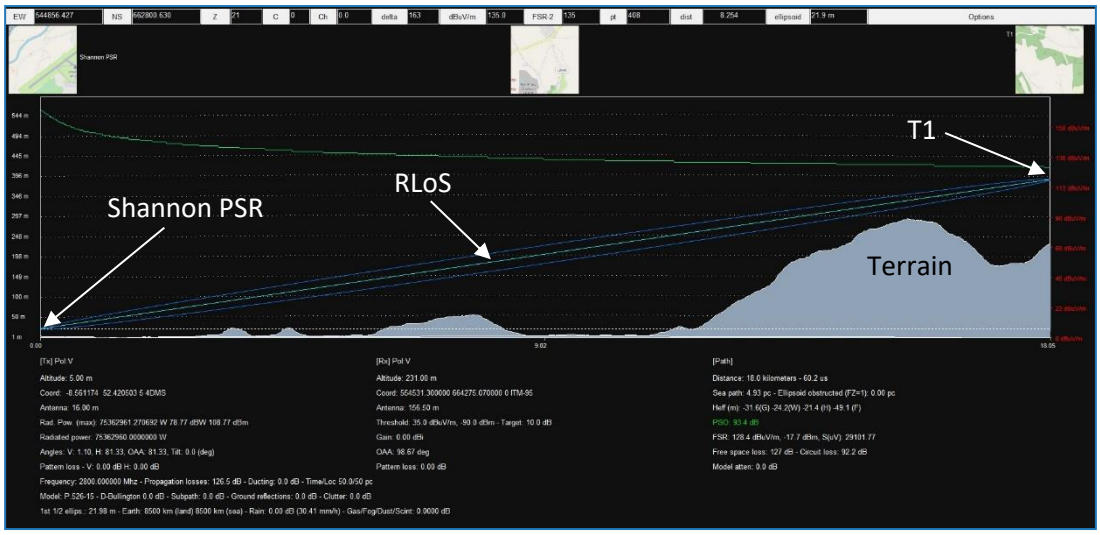


Figure 20: Path loss profile between Shannon PSR and tip of turbine T1

5.7.3. The path loss profile between Shannon PSR and the tip of turbine T10 is shown in Figure 21. In this case there is intervening terrain which blocks RLoS.

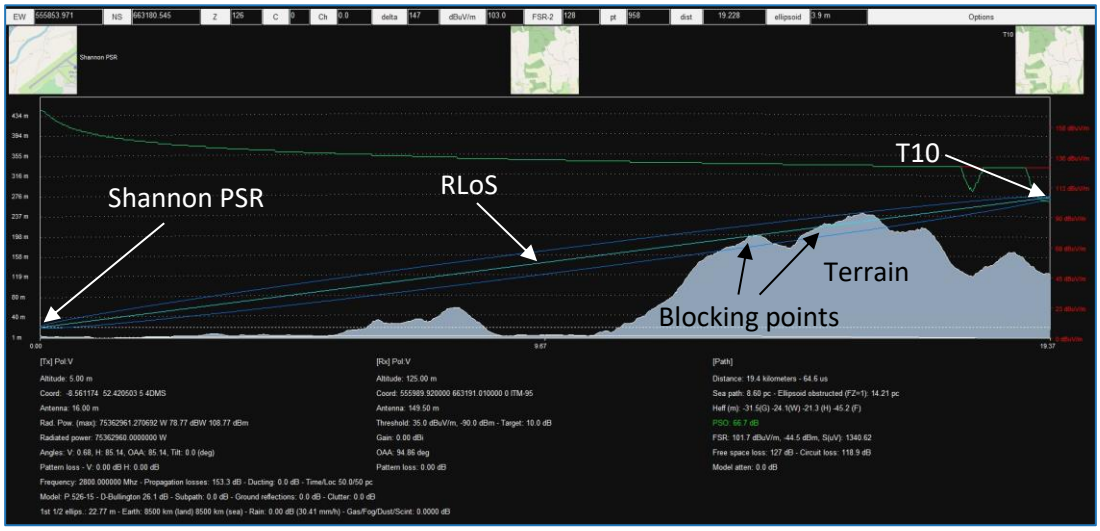


Figure 21: Path loss profile between Shannon PSR and tip of turbine T10

5.7.4. All the path profiles between Shannon PSR and the 12 Ballycar turbines are shown in Annex A of this report.

5.7.5. Even with no intervening terrain between the PSR and the turbines, the probability that a turbine will be detected by the radar is still dependant on several factors including the radar's power, the angle of antenna tilt and distance to the turbine.

5.7.6. The radar propagation model can determine the actual path loss between the PSR and various parts of the turbine. By knowing the PSR transmitter power, antenna gain, 2-way path loss, receiver sensitivity and the turbine Radar Cross Section (RCS) gain, the probability of the radar detecting the target (PD) can be calculated.

5.7.7. The static parts of the turbine (tower structure) are ignored in the calculation as these will be rejected by the radar Moving Target filter. In this refined model, 3 parts of the turbine blade are considered: the hub, the blade tip, and a point midway along the turbine blade. Each part of the turbine blade is assigned an RCS of 50m^2 based on a blade length of 66.5m. Path loss calculations are made to all turbines. The received signal at the radar from each component part of the turbine is then summed to determine the total signal level.

5.7.8. The path loss calculation carried out for each turbine component is as follows:

	Tx Power	dBm
+	Antenna Gain	dB
-	Path Loss	dB
+	RCS Gain	dB (60m^2 ~ +47dB)
-	Path Loss	dB
+	Antenna Gain	dB
=	Received Signal	dBm

5.7.9. The received signal is then compared with the radar receiver Minimum Detectable Signal level.

5.7.10. An example of the calculation from Shannon PSR to turbine T1 is shown in Figure 22.

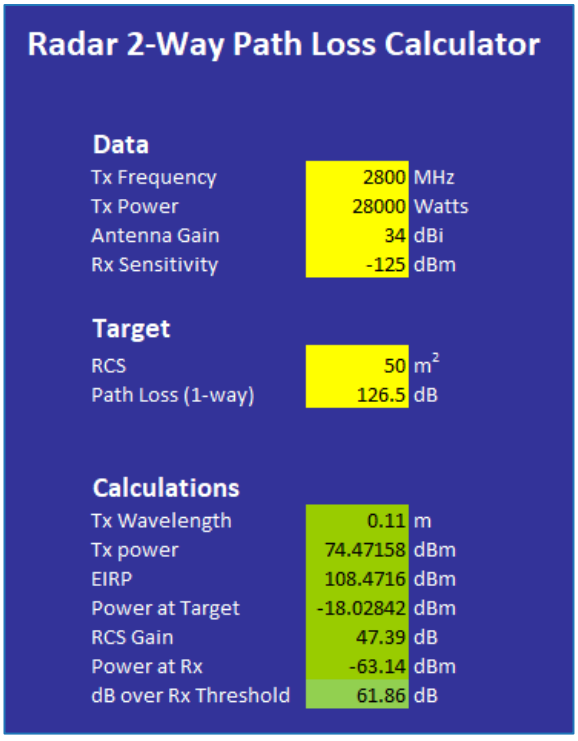


Figure 22: Example path loss calculation

5.7.11. The two-way path losses from the turbine components are tabulated and combined to give total radar received signals from each turbine. The results are colour-coded to indicate the likelihood of detection. Radar returns >3dB above the detection threshold are coloured green as these values show a high probability of detection. Those between +3dB and -3dB

are coloured yellow and indicate a possibility of detection. Between -3dB and -6dB, results are coloured orange to show only a small possibility of detection. Signals >6dB below the threshold of detection are shaded red as these values show that detection is unlikely.

5.7.12. Using this representation provides a ready visual comparison of different scenarios. The result is shown in the final column (TOTAL) of each colour-coded chart.

5.7.13. The results of the Shannon PSR PD calculations for each turbine are shown in Table 3.

Initial data from '2-Way'			KEY:	Unlikely to be detected
A	126.5	Path Loss		Small possibility of detection
B	61.86	dB over Rx Thr		Possibility of detection
C	50.00	RCS (m^2)		High probability of detection

Turbine	Turbine Nacelle Path Loss dB	Blade mid-point Path Loss dB	Blade Tip Path Loss dB	TOTAL dB over RX threshold
1	152.2	126.5	126.5	64.87
2	161.4	151.1	126.5	61.86
3	155.1	130.2	126.7	62.25
4	160.1	148.3	126.7	61.46
5	154.5	130.0	126.9	62.00
6	152.6	127.1	127.1	63.67
7	160.6	152.0	127.1	60.66
8	160.5	150.6	126.9	61.06
9	158.0	139.9	126.7	61.47
10	165.5	161.3	153.3	8.39
11	161.6	152.7	126.9	61.06
12	162.5	155.5	137.0	40.86

Table 3: Shannon PSR PD results

5.7.14. From Table 3 it appears that there is a high probability that Shannon PSR will detect all the Ballycar turbines.

5.7.15. The above calculations are based on the optimum performance of the radar, however the gain of a radar antenna in the vertical axis is not uniform with elevation angle. The beam is a complex shape to minimise ground returns by having low gain at elevations close to the horizontal but having high gain at elevations just a few degrees above the horizon.

5.7.16. The Star 2000 PSR has a dual beam antenna. At short ranges the radar uses a high beam to reduce the effects of close-in ground clutter. Beyond these ranges a low beam is used. It is likely that the proposed wind farm lies in Shannon PSR's high beam area.

5.7.17. The maximum high beam gain for a Star 2000 antenna usually occurs at an elevation angle of 6.5° above the horizontal and the maximum low beam gain at about 3°. If the mechanical tilt of the antenna is altered, then the angles of maximum gain will change by a corresponding amount. The mechanical tilt of the antenna is set at the commissioning of the radar to achieve the best compromise between suppressing ground returns and detecting low altitude aircraft targets. Gain falls off rapidly at lower elevation angles as a function of the antenna Vertical Polar Diagram (VPD). Radar VPD data can be plotted as a smoothed line of elevation versus gain to enable intermediate values of antenna gain to be determined.

5.7.18. The Star 2000 VPD data gives the graph shown in Figure 23.

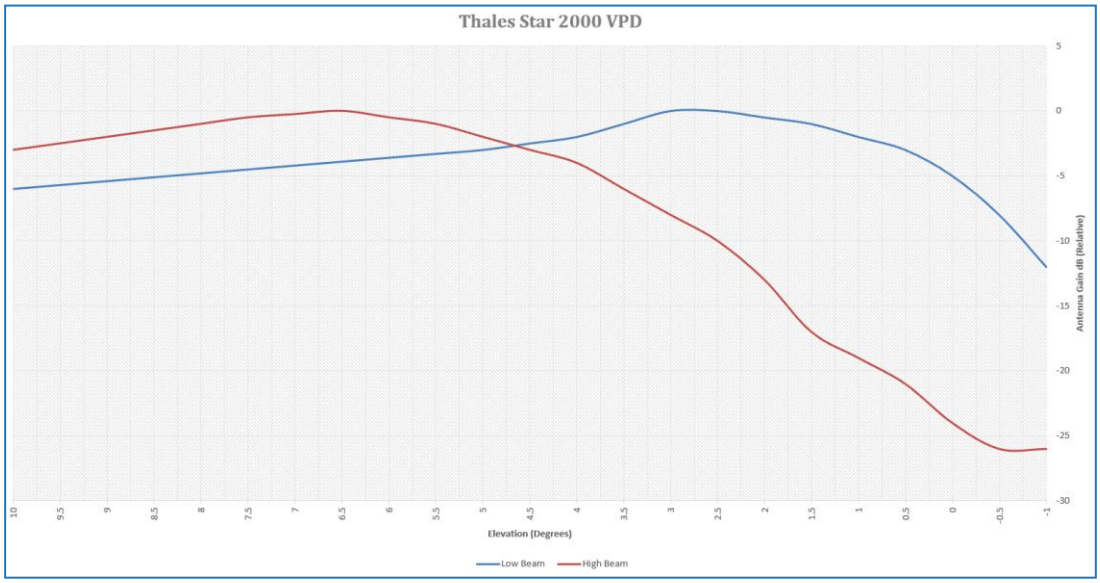


Figure 23: Thales Star 2000 VPD

5.7.19. The vertical angle from Shannon PSR to the tips of the turbines varies between 0.57° (turbine T12) and 1.10° (turbine T1). If a 0° mechanical antenna tilt is assumed, this means a high beam gain reduction of approximately -20dB and a low beam gain reduction of approximately -3dB at these elevations. Table 4 shows the results of the PD calculations incorporating the reduction in antenna gain.

Initial data from '2-Way'			KEY:	Unlikely to be detected
A	126.5	Path Loss		Small possibility of detection
B	38.86	dB over Rx Thr		Possibility of detection
C	50.00	RCS (m^2)		High probability of detection

Turbine	Turbine Nacelle Path Loss dB	Blade mid-point Path Loss dB	Blade Tip Path Loss dB	TOTAL dB over RX threshold
1	152.2	126.5	126.5	41.87
2	161.4	151.1	126.5	38.86
3	155.1	130.2	126.7	39.25
4	160.1	148.3	126.7	38.46
5	154.5	130.0	126.9	39.00
6	152.6	127.1	127.1	40.67
7	160.6	152.0	127.1	37.66
8	160.5	150.6	126.9	38.06
9	158.0	139.9	126.7	38.47
10	165.5	161.3	153.3	-14.61
11	161.6	152.7	126.9	38.06
12	162.5	155.5	137.0	17.86

Table 4: Shannon PSR PD results – corrected for VPD

5.7.20. With the gain reduction, it is unlikely that Shannon PSR will detect turbine T10. However, there is still a high probability that Shannon PSR will detect the rest of the Ballycar turbines.

5.8. Woodcock Hill MSSR Path Loss

5.8.1. Using the radar propagation model the actual path loss between Woodcock Hill MSSR and the tops of the Ballycar turbine towers can be determined.

5.8.2. An illustration of the path loss profile between Woodcock Hill MSSR and turbine T1 is shown in Figure 24. As with all the other Ballycar turbines, Woodcock Hill MSSR has uninterrupted RLoS to the top of the turbine tower.

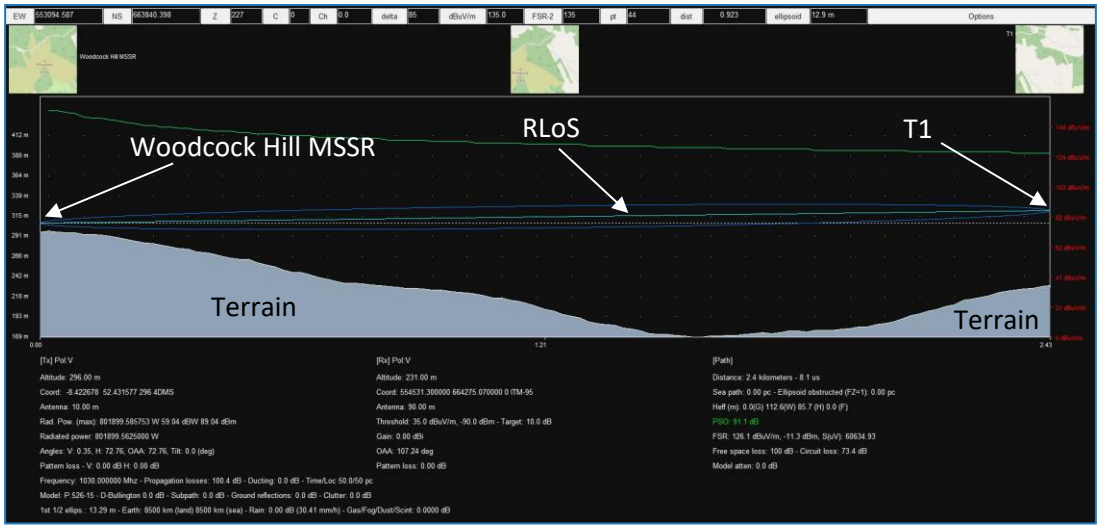


Figure 24: Path loss profile between Woodcock Hill MSSR and top of turbine tower T1

5.8.3. All the path profiles between Woodcock Hill MSSR and the 12 Ballycar turbines are shown in Annex B of this report.

5.8.4. As explained in Section 5.2, multipath, or bistatic, reflections from turbine towers can potentially cause 'ghost' targets on MSSR. This occurs when an aircraft replies through a signal reflected from an obstruction; the radar attributes the response to the original signal and outputs a false target in the direction of the obstruction, which can lead to ATCOs deconflicting real traffic from targets that do not physically exist.

5.8.5. The likelihood of bistatic reflections can be determined by knowing the MSSR transmitter power, antenna gain, path loss to the turbine tower, RCS gain and aircraft receiver sensitivity.

5.8.6. The amount of signal reflected by a turbine tower is a function of the tower's RCS. A typical RCS value for a 100m steel tower of 8m diameter is 3,000,000m^2. However, a 0.5° taper of the tower can reduce this figure from millions to hundreds of square metres.

5.8.7. EUROCONTROL Guidelines[4] recommend an RCS value of $10^{3.5}$m^2 or 35dBm^2 for a turbine tower which equates to an RCS gain of 57dB at the MSSR uplink frequency of 1030MHz.

[4] EUROCONTROL Guidelines for Assessing the Potential Impact of Wind Turbines on Surveillance Sensors, EUROCONTROL-GUID-0130 Edition Number 1.2, September 2014

5.8.8. The following calculation can be used to determine the power of a radar signal reflected by a wind turbine tower:

	Tx Power	dBm
+	Antenna Gain	dB
-	Path Loss	dB
+	RCS Gain	dB (35dBm^2 ~ +57dB)
=	Reflected Power	dBm

5.8.9. Free Space Path Loss can be used to calculate the maximum distance from the reflecting obstacle an aircraft can be in order for the reflected signal to trigger a response from the aircraft transponder.

5.8.10. The maximum range at which a reflection can trigger a response is proportional to the reflected power of the signal. From the above calculation, reflected power is greatest when the path loss between the MSSR and a turbine is the least.

5.8.11. Using the radar propagation model the actual path loss between Woodcock Hill MSSR and the tops of the Ballycar turbine towers can be determined.

5.8.12. The path loss results between Woodcock Hill MSSR and the tops of the 12 Ballycar turbine towers are shown in Table 5.

Turbine	Path Loss (dB)
T1	100.4
T2	100.4
T3	101.8
T4	101.7
T5	103.0
T6	103.9
T7	104.0
T8	103.2
T9	102.0
T10	104.3
T11	103.4
T12	104.4

Table 5: Woodcock Hill MSSR path loss results

5.8.13. From Table 5 the worst-case or smallest path loss is 100.4dB to turbines T1 and T2.

5.8.14. The Tx Power for a Thales RSM 970 S MSSR is 60.35dBm at the antenna input. As with the PSR, MSSR antenna gain varies with elevation angle, with peak gain of 27dB at an elevation of between 8° and 9° above the horizontal, as shown in Figure 25.

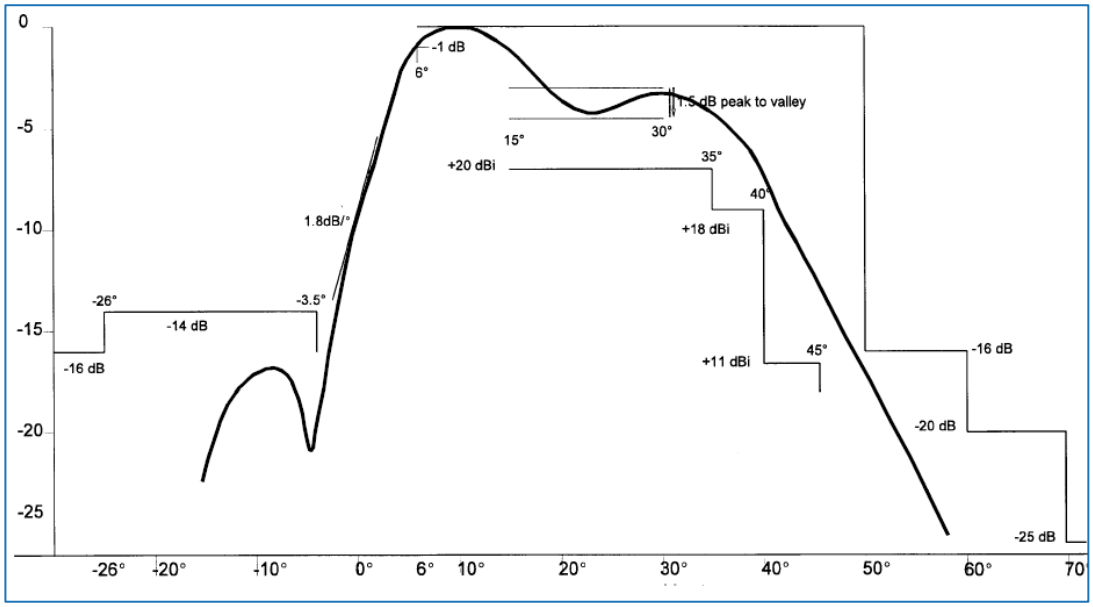


Figure 25: Thales RSM 970 S VPD

5.8.15. The vertical angle from Woodcock Hill MSSR to the hub of turbine T1 is 0.35° and to the hub of turbine T2 is -0.27°. If a mechanical tilt of 0° is assumed this means a reduction in gain of -7.5dB for T1 and -8.5dB for T2 at these elevations.

5.8.16. The T1 reduction in gain will be worst-case, and results in a reflected power of 36.2dBm from turbine T1.

5.8.17. If an aircraft receiver sensitivity of -77dBm is assumed, the reflected signal will not trigger a response if the Free Space Path Loss from the turbine to the aircraft is more than 77+36.2=113.2dB.

5.8.18. The Free Space Path Length for an MSSR frequency of 1030MHz and path loss of 113.2dB is 10,536m. This means that aircraft beyond this distance from the turbine will not detect a reflected signal. Reflected signals from other Ballycar turbines will only be detected at ranges less than 10,536m.

5.8.19. Annex D of the EUROCONTROL Guidelines states that an airborne transponder will be insensitive for 35µs following reception of a radar interrogation through radar sidelobes. Thus, an aircraft closer than 5,250m (half of the distance corresponding to 35µs) to the source of a reflected interrogation will not reply to reflected interrogations because the path length between the direct and reflected signals will always be smaller than 35µs.

5.8.20. Aircraft between 5,250m and 10,536m from the proposed turbines may respond to reflected Woodcock Hill MSSR interrogations, potentially resulting in MSSR ‘ghost’ targets.

5.8.21. The calculations can be repeated to determine the maximum reflection ranges for all the Ballycar turbines, as shown in Table 6.

Turbine	Maximum Reflection Range (m)
T1	10,536
T2	9,390
T3	8,967
T4	8,085
T5	7,810
T6	7,041
T7	6,204
T8	5,724
T9	6,571
T10	4,243
T11	4,443
T12	3,738

Table 6: Woodcock Hill MSSR maximum reflection ranges

5.8.22. Table 6 shows that for turbines T1 to T9 the maximum reflection range is more than 5,250m. Reflections from these turbines may result in MSSR 'ghost' targets.

5.8.23. The maximum reflection ranges for turbines T10 to T12 are less than 5,250m. An aircraft will not respond to reflected Woodcock Hill MSSR interrogations from these turbines as they will only be detected when the aircraft is within 5,250m of the turbines.

5.8.24. An array of turbines can create a radar shadow in the space beyond it from the radar. The EUROCONTROL Guidelines provides a means of calculating the dimensions of this shadow region.

$$Dwr = Dtw/[\lambda.\frac{Dtw}{S^2}\left(1-\sqrt{PL}\right)^2 - 1]$$

- *Dwr* = depth of the shadow region.
- *Dtw* = distance of turbines
- λ = wavelength (0.29m)
- S = diameter of support structures (6m)
- PL = acceptable power loss (0.5/3dB as per guidelines)

5.8.25. The EUROCONTROL Guidelines also provide equations for calculating the width and height of the shadow regions.

5.8.26. The volumes of the Woodcock Hill MSSR shadow regions created by each of the Ballycar turbines are shown in Table 7.

Turbine	Depth of shadow region (km)	Width of shadow region (m)	Height of shadow region AMSL (m)
T1	3.6	65	352
T2	3.6	65	285
T3	2.9	58	351
T4	3.0	59	270
T5	2.6	55	355
T6	2.4	53	370
T7	2.3	52	277
T8	2.5	54	210
T9	2.9	58	208
T10	2.3	52	147
T11	2.5	54	128
T12	2.3	52	83

Table 7: Woodcock Hill MSSR shadow regions

5.8.27. The depth of the shadow regions beyond the Ballycar turbines will vary between 2.3km and 3.6km for Woodcock Hill MSSR, with widths of up to 65m and with a maximum height of 352m or 1,155 feet AMSL.

5.8.28. Figure 26 shows an extract of Shannon Airport's ATC Surveillance Minimum Altitude Chart, as published by the Irish Aviation Authority in the current Integrated Aeronautical Information Publication[5]. The Ballycar turbine locations are overlaid on the chart, which shows that turbines T1 to T10 are within Sector 1 where the minimum altitude is 2,300 feet AMSL. Turbines T11 and T12 are in Sector 2 where the minimum altitude is 3,000 feet AMSL. Aircraft at these minimum altitudes will not be low enough for the shadow regions to have any impact, and therefore the shadow regions that may be generated beyond the proposed turbines should be operationally tolerable.

[5] ATC SURVEILLANCE MINIMUM ALTITUDE CHART – ICAO, EINN AD 2.24-16.1, 17 JUN 2021

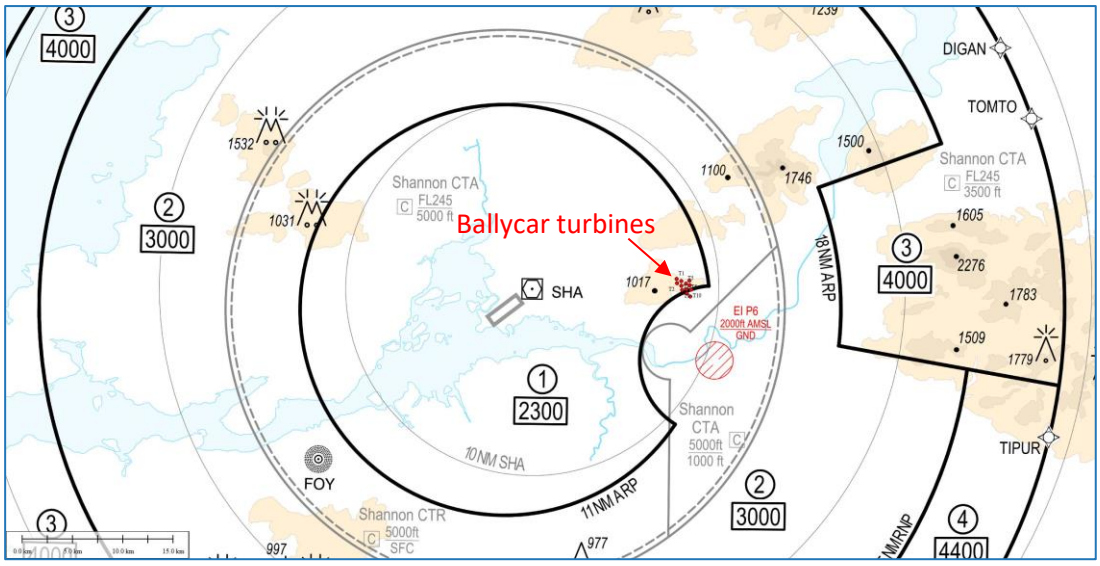


Figure 26: Shannon Airport ATC Surveillance Minimum Altitude Chart

5.9. Conclusions

5.9.1. All the proposed Ballycar turbines except turbine T10 are likely to be detected by Shannon PSR. This can result in turbine-induced clutter and false targets. In such areas of high clutter, the radar receiver sensitivity is reduced which can lead to track seduction of genuine aircraft targets in the vicinity of the turbines. A form of mitigation for Shannon PSR over the proposed Ballycar development may be required and this is discussed in Section 6.

5.9.2. All the proposed sites for the Ballycar turbines are outside the Eurocontrol recommended 16km turbine assessment zone for Shannon MSSR, therefore an impact assessment on this facility was not required. No mitigation measures are therefore necessary for Shannon MSSR.

5.9.3. Calculations have shown that false targets due to bistatic reflections from the turbine towers may occur for Woodcock Hill MSSR. Aircraft between 5,250m and 10,536m from the proposed turbines may respond to reflected Woodcock Hill MSSR interrogations, potentially resulting in MSSR 'ghost' targets appearing on the bearings of the turbines.

5.9.4. The Woodcock Hill MSSR has a reflection processing capability which enables the positions of permanent reflecting objects, such as the turbine towers, to be stored in a 'reflector file'. Once the reflector file is updated it should eliminate any false targets caused by reflections from the turbine towers.

5.9.5. The maximum heights of shadow regions from the turbines will be below the published ATC surveillance minimum altitudes and should therefore be operationally tolerable.

6. Shannon PSR Mitigation

6.1. Mitigation Strategy

6.1.1. It is generally not tolerable for an airport to have to cope with a variety of mitigation solutions, each tailored for individual wind farm developments. Ideally, an airport is best served by a single coherent strategy which will cope with the turbine developments foreseen within its designated operational coverage (DOC). New development applications can then be assessed on whether they will be covered by that strategy. Terms of inclusion within the strategy can then be negotiated with the developer as part of the planning approval process. This approach keeps the airport in control of its destiny and able to work positively with the renewables industry, rather than reacting against each application on the grounds that it will cause interference.

6.1.2. It is recommended that mitigation options are discussed with the Irish Aviation Authority (IAA), specifically Air Traffic Services. It is the surveillance network and operational use that will largely influence a suitable mitigation.

6.2. Mitigation Solutions

6.2.1. Physical PSR mitigation options include blanking of PSR transmissions in the azimuth sector over the proposed wind farm, or suppressing radar returns in the wind farm range azimuth sector. Both of these options may need to be combined with in-fill of the blanked sector from another source of radar information.

6.2.2. An operational PSR mitigation solution could involve the application of a Transponder Mandatory Zone (TMZ) in the airspace over the PSR blanked area. A TMZ means detecting aircraft using MSSR facilities only and requires aircraft within the TMZ to be equipped with a functioning transponder.

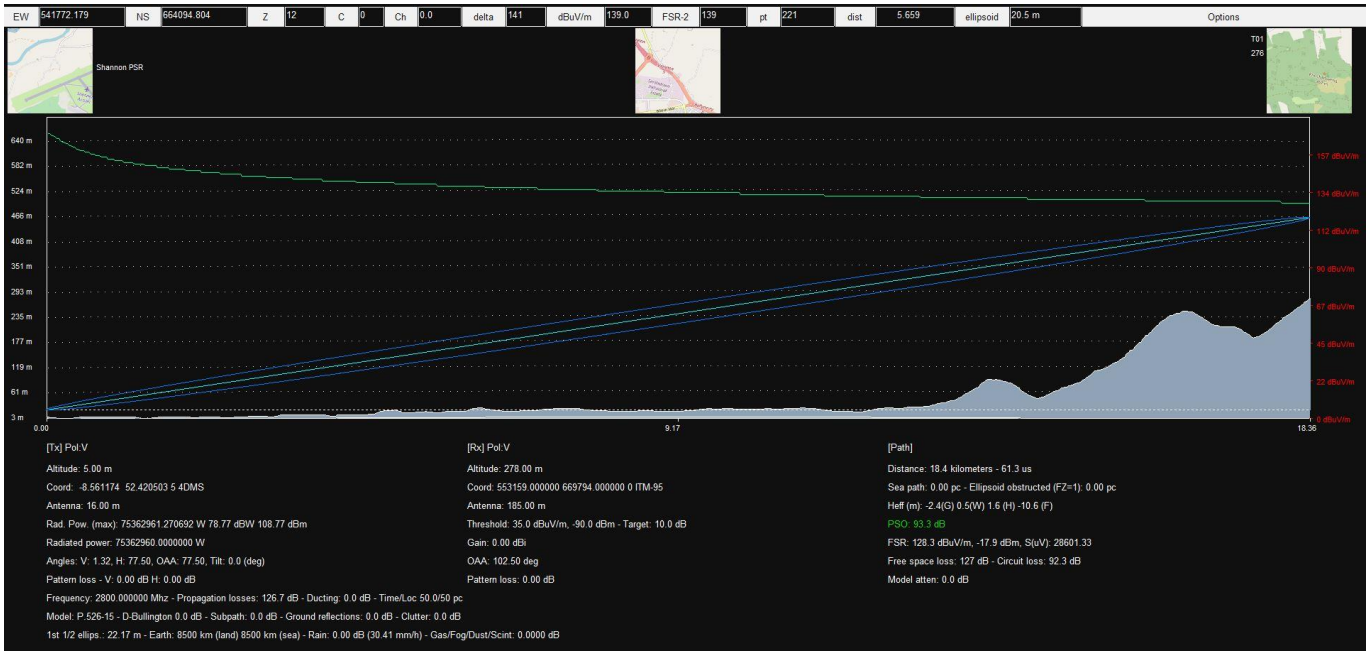
6.2.3. In-fill solutions using existing remote PSR data rely on the remote radar having suitable airspace coverage in the blanked area without having visibility of the turbines and depends on suitable terrain screening. A remote in-fill radar may also introduce problems of synchronisation with Shannon PSR and slant range errors.

6.2.4. Companies such as Terma offer dedicated 2D in-fill radar solutions for wind turbines. The in-fill radar must be located in close proximity to the airport PSR and be synchronised to it, enabling the mitigation radar to be used instead of the Airport PSR in the wind farm area. Terma radars have a narrow beamwidth that enables them to filter out turbines while continuing to track aircraft and can provide mitigation to a range of up to approximately 40NM.

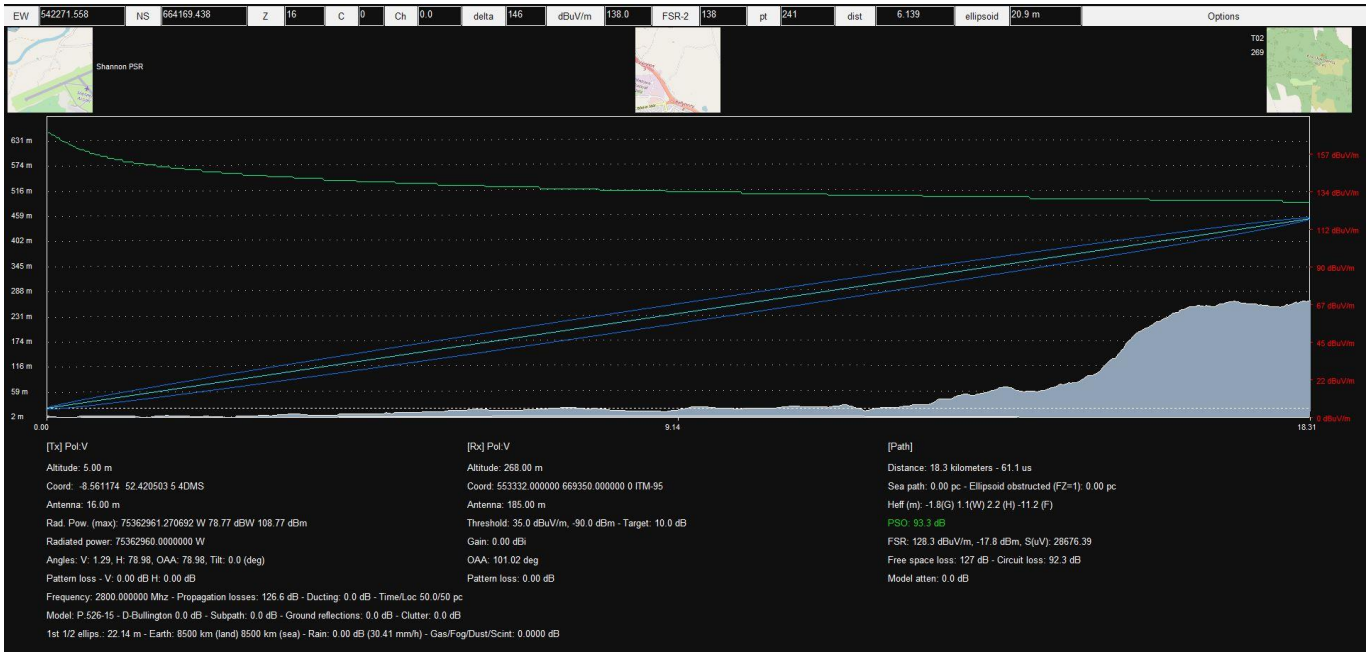
6.2.5. Aveillant offer a 3D radar mitigation solution with their Holographic Radar™. It is quite different to 2D mitigation radars as it has no rotating antenna and has continuous surveillance throughout its coverage volume. It can discriminate the distinct Doppler signatures of turbines from aircraft and as a result does not need to mask turbine returns to eliminate their false reports. The 3D output of this mitigation radar means that it does not need to be located in close proximity to the airport PSR and its target output can be coordinate transformed to the PSR origin without introducing slant range errors.

A. Annex A – Shannon PSR Path Profiles

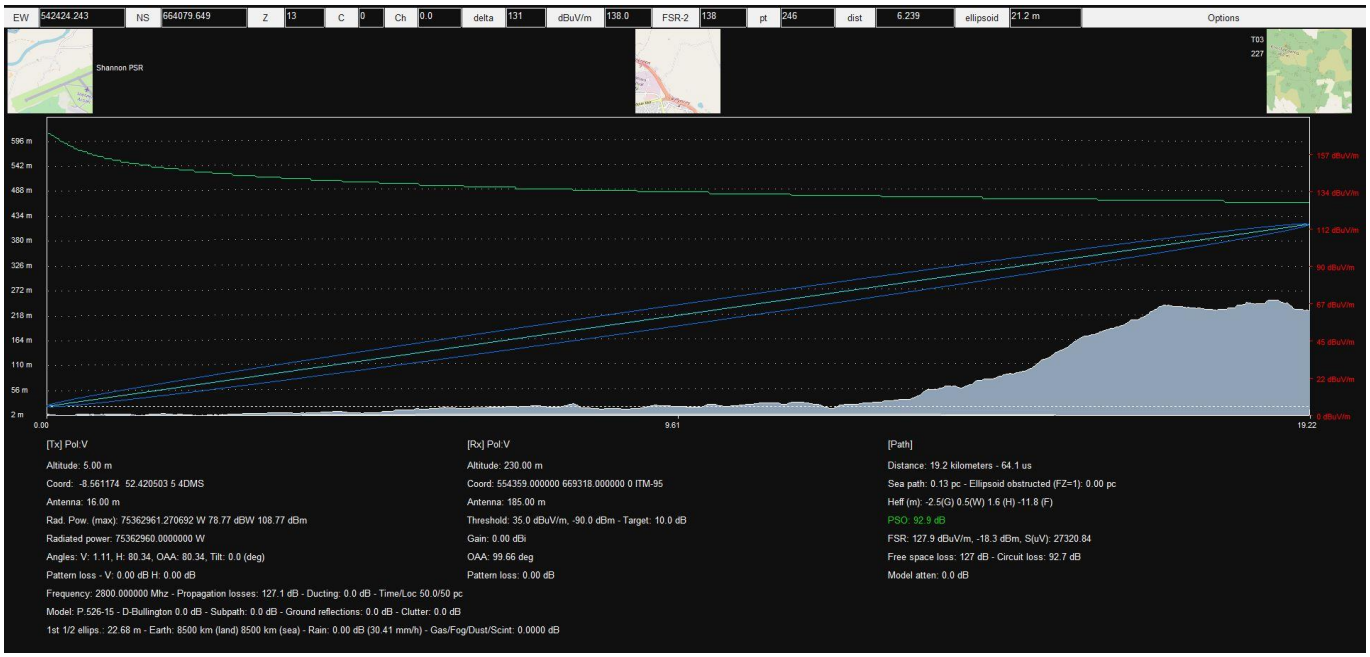
A.1. Turbine T1



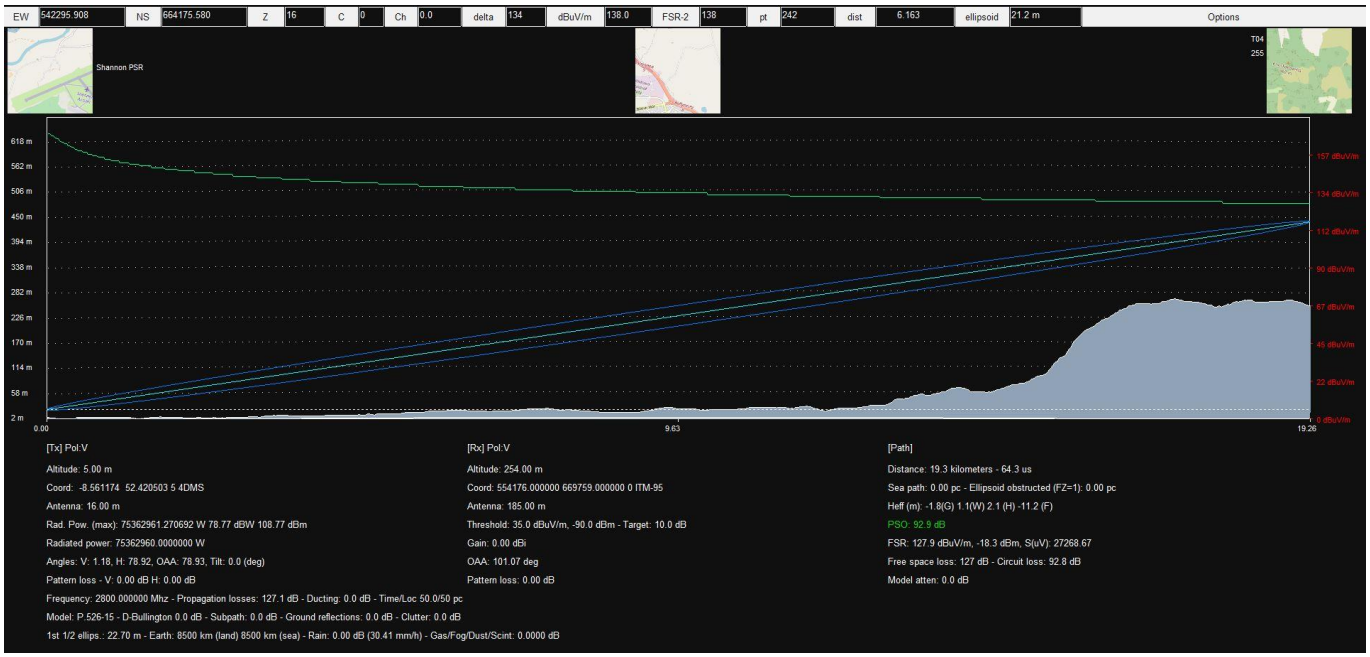
A.2. Turbine T2



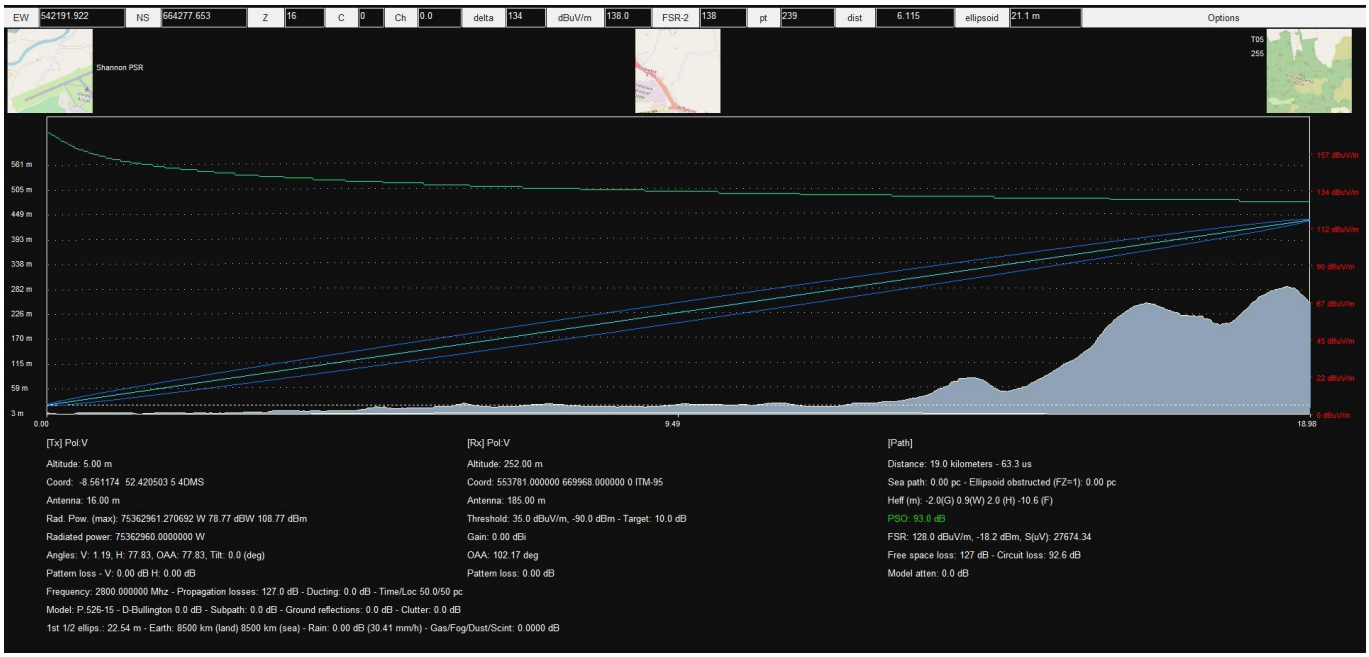
A.3. Turbine T3



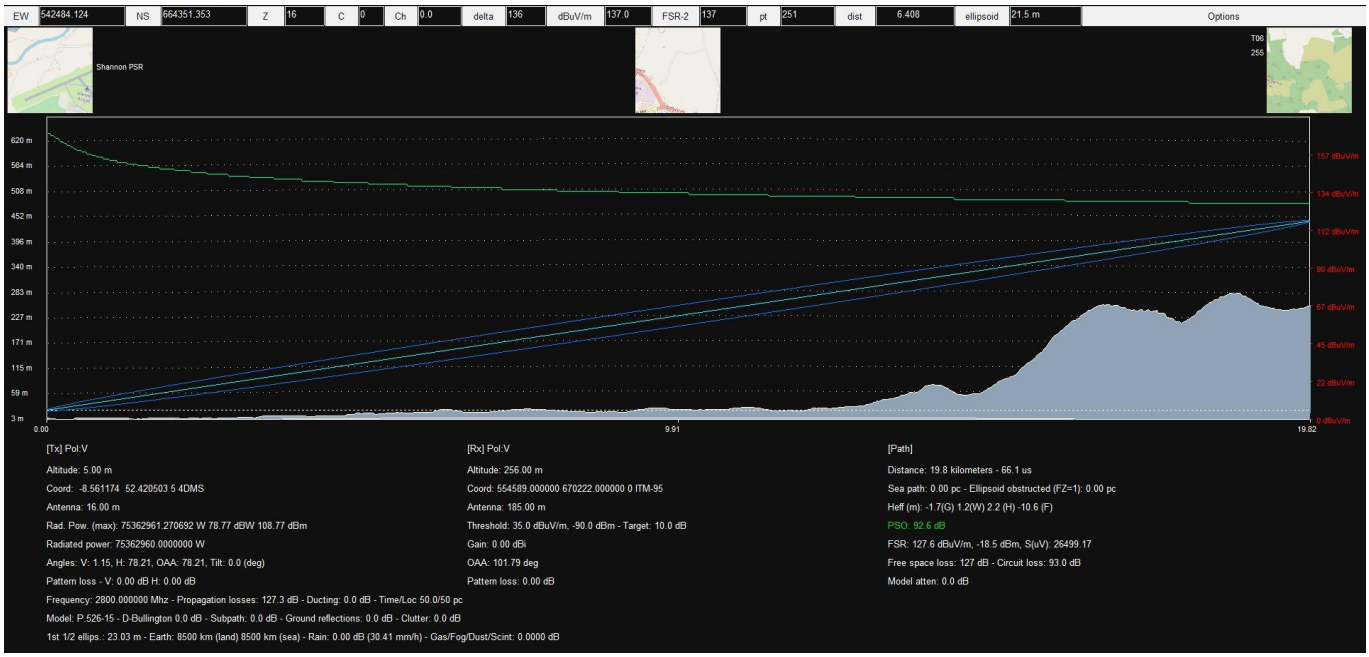
A.4. Turbine T4



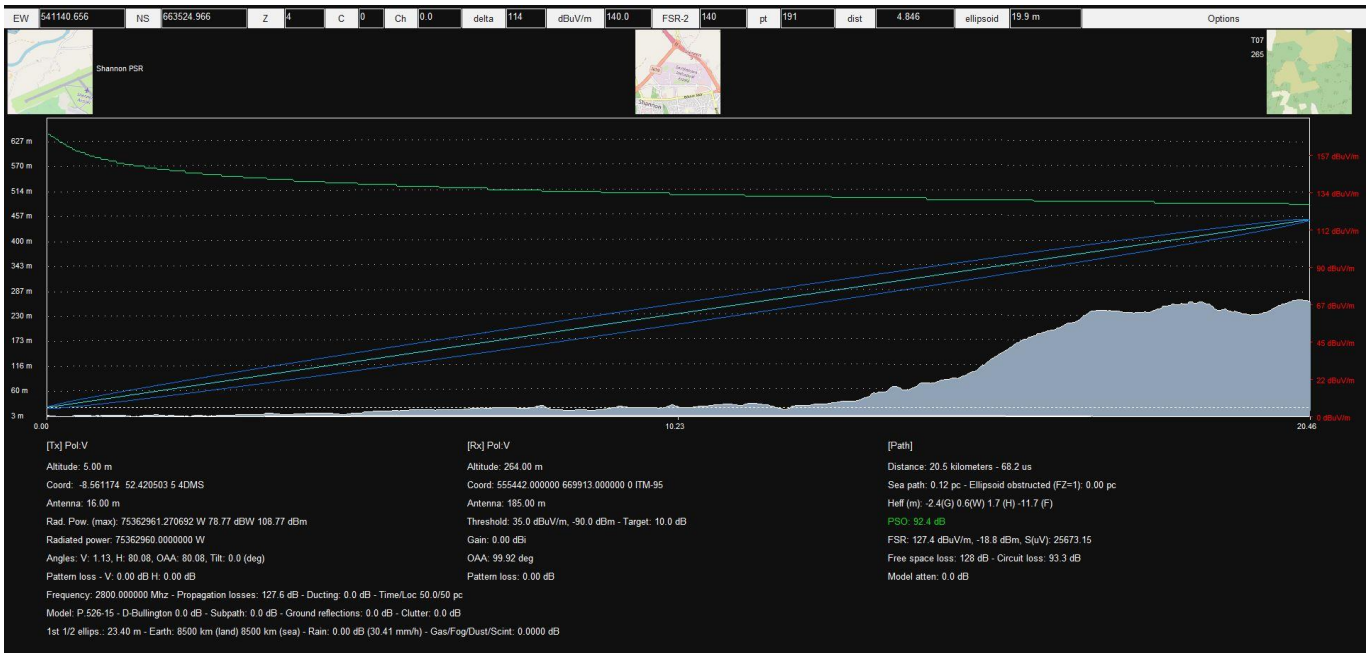
A.5. Turbine T5



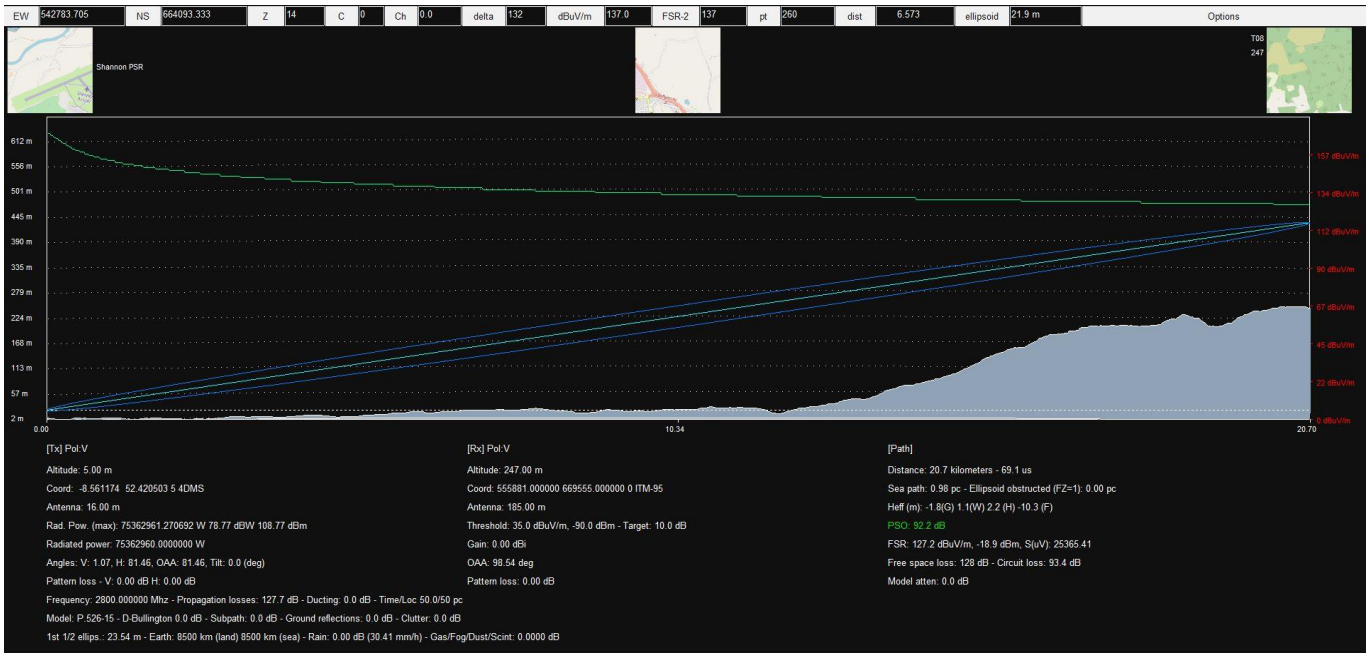
A.6. Turbine T6



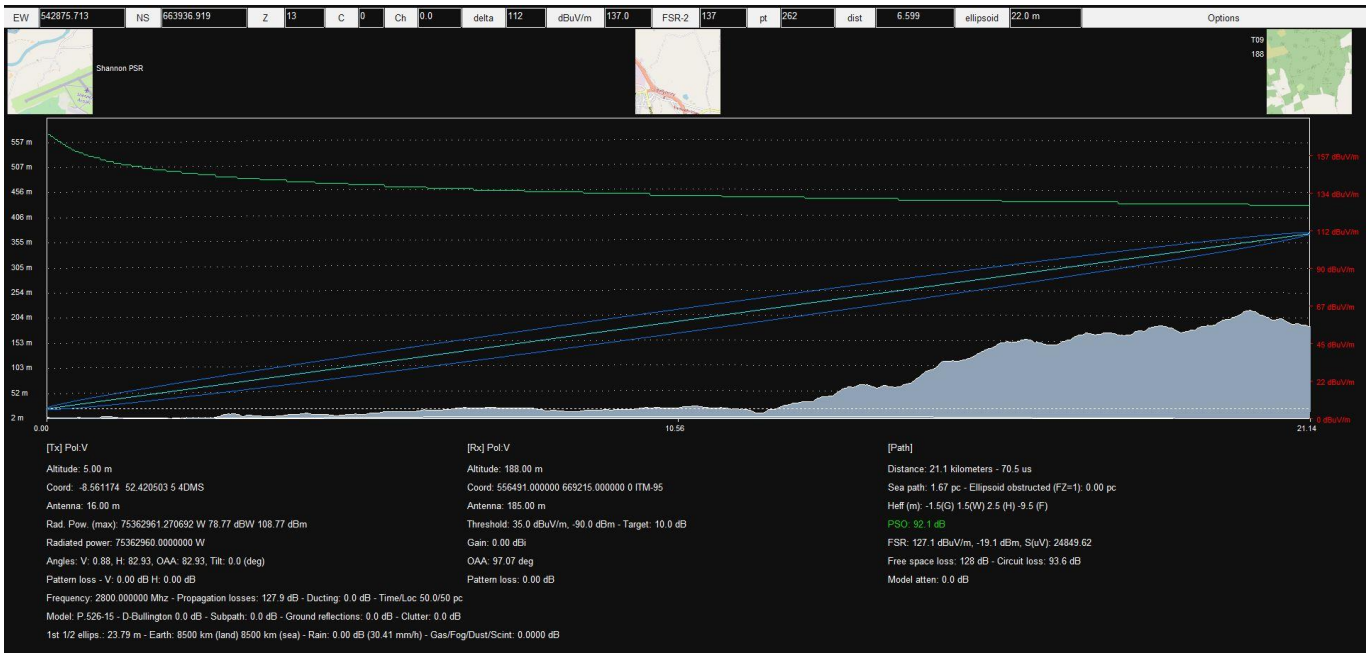
A.7. Turbine T7



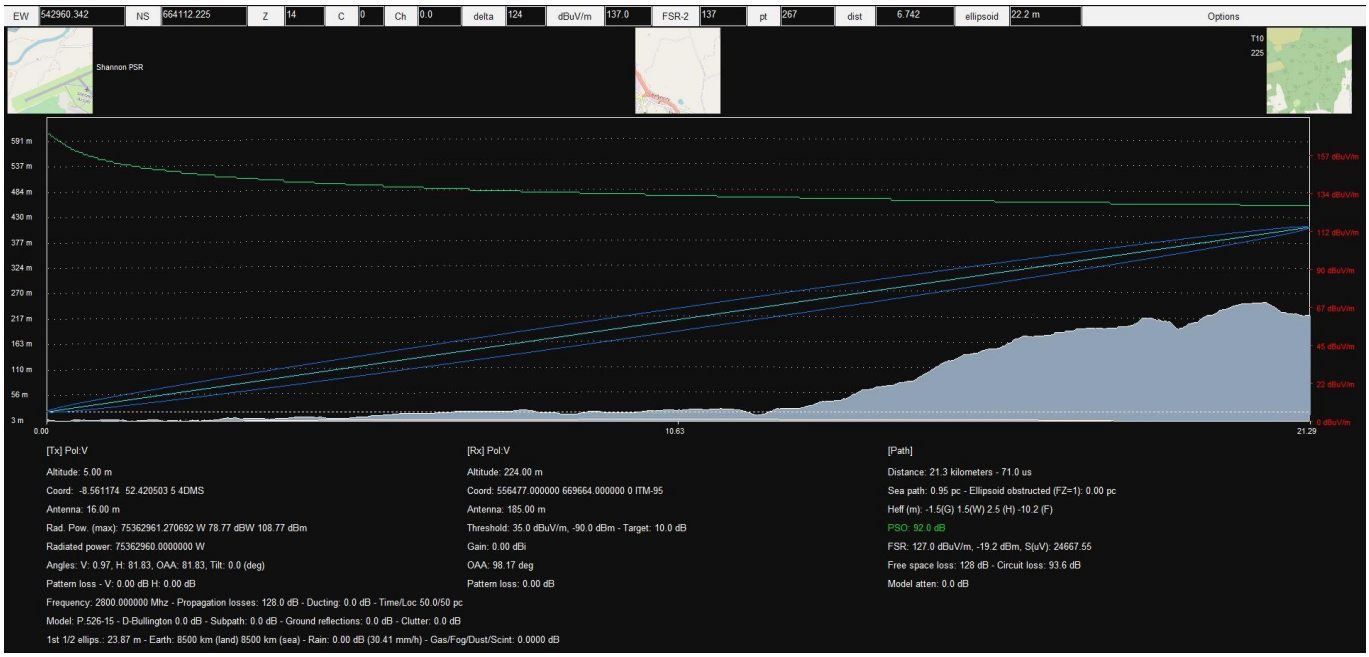
A.8. Turbine T8



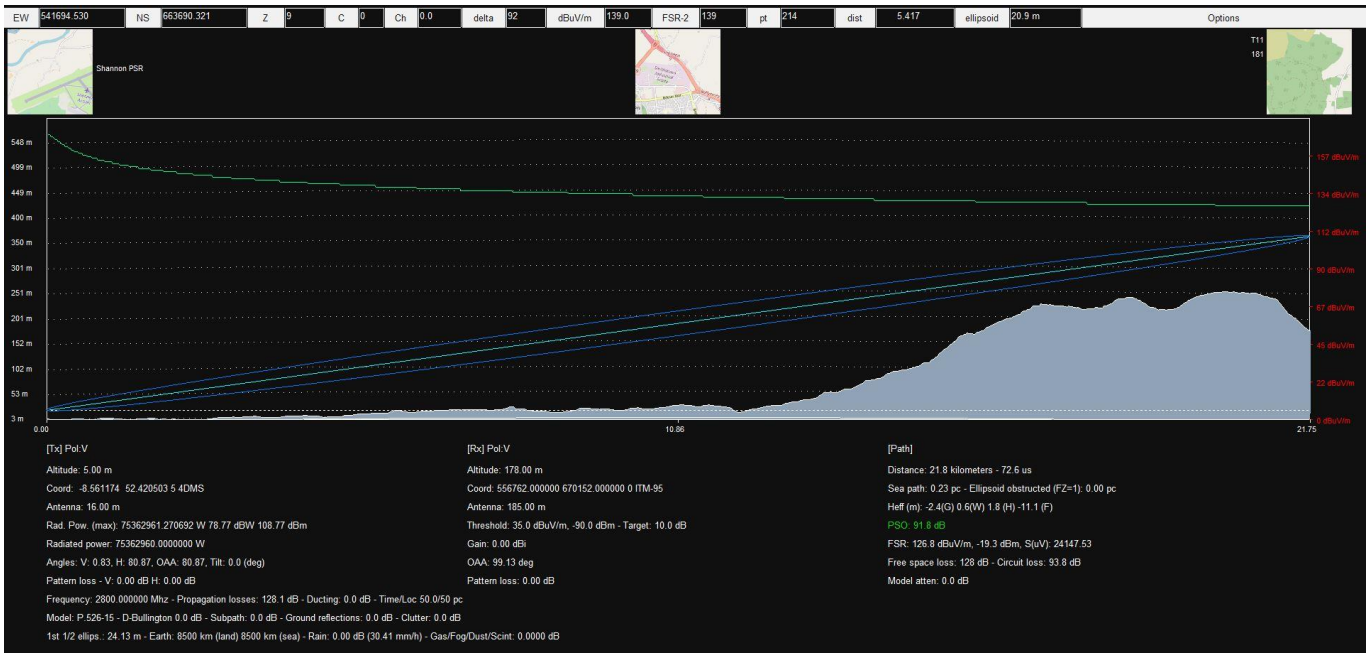
A.9. Turbine T9



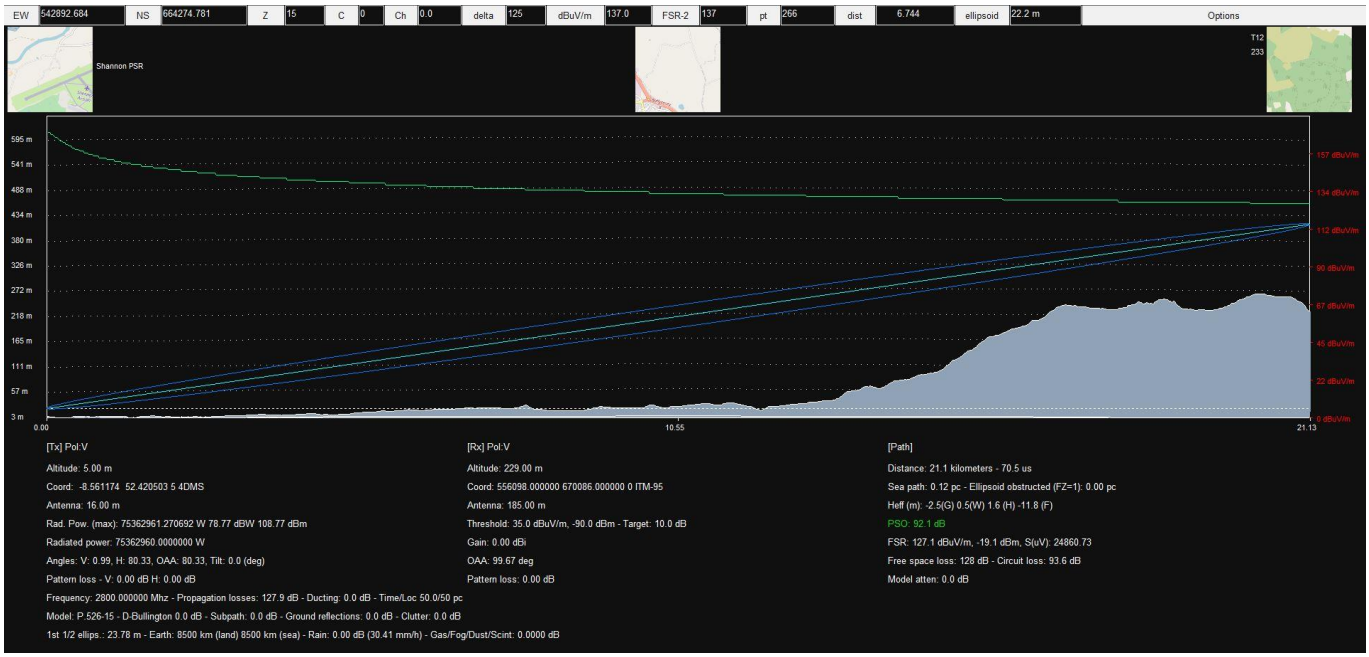
A.10. Turbine T10



A.11. Turbine T11

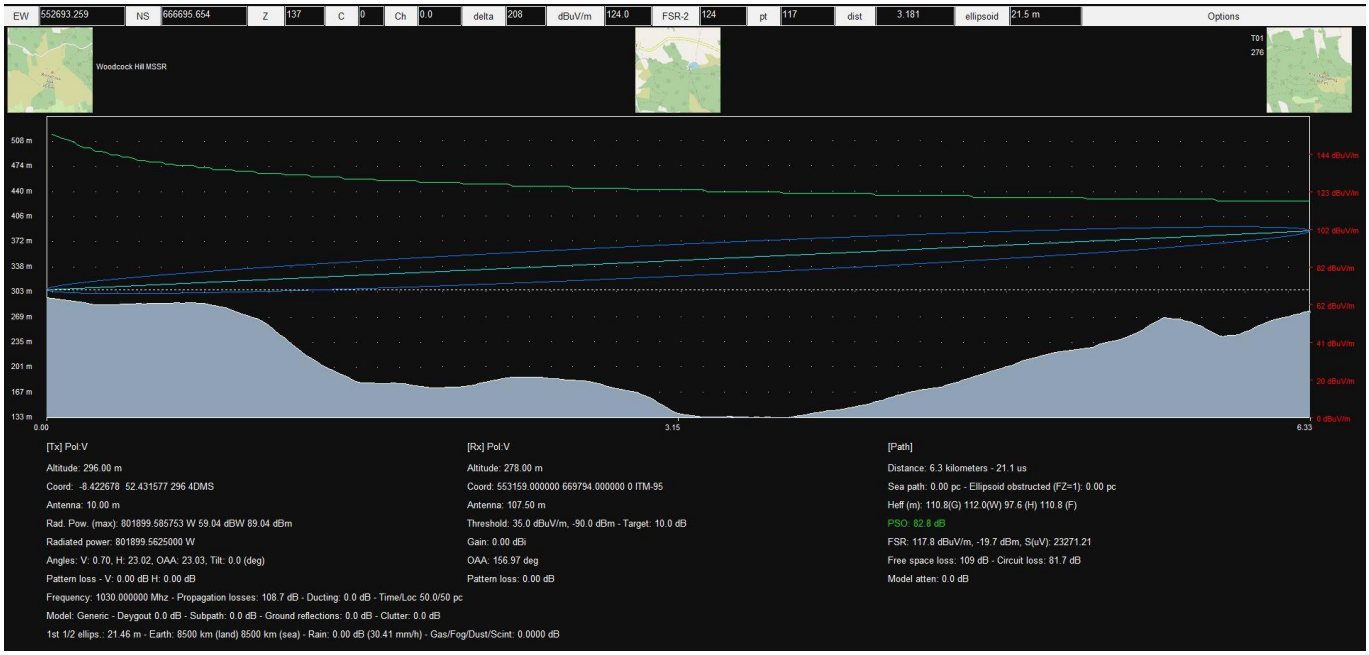


A.12. Turbine T12

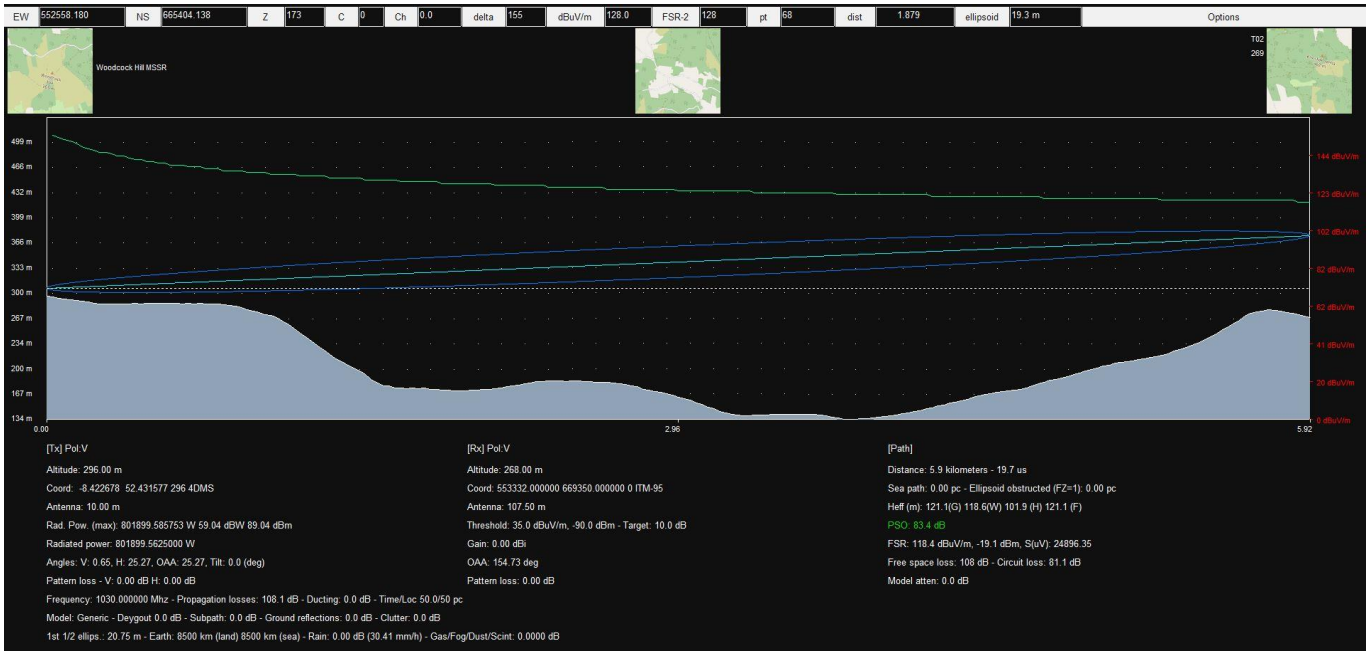


B. Annex B – Woodcock Hill MSSR Path Profiles

B.1. Turbine T1

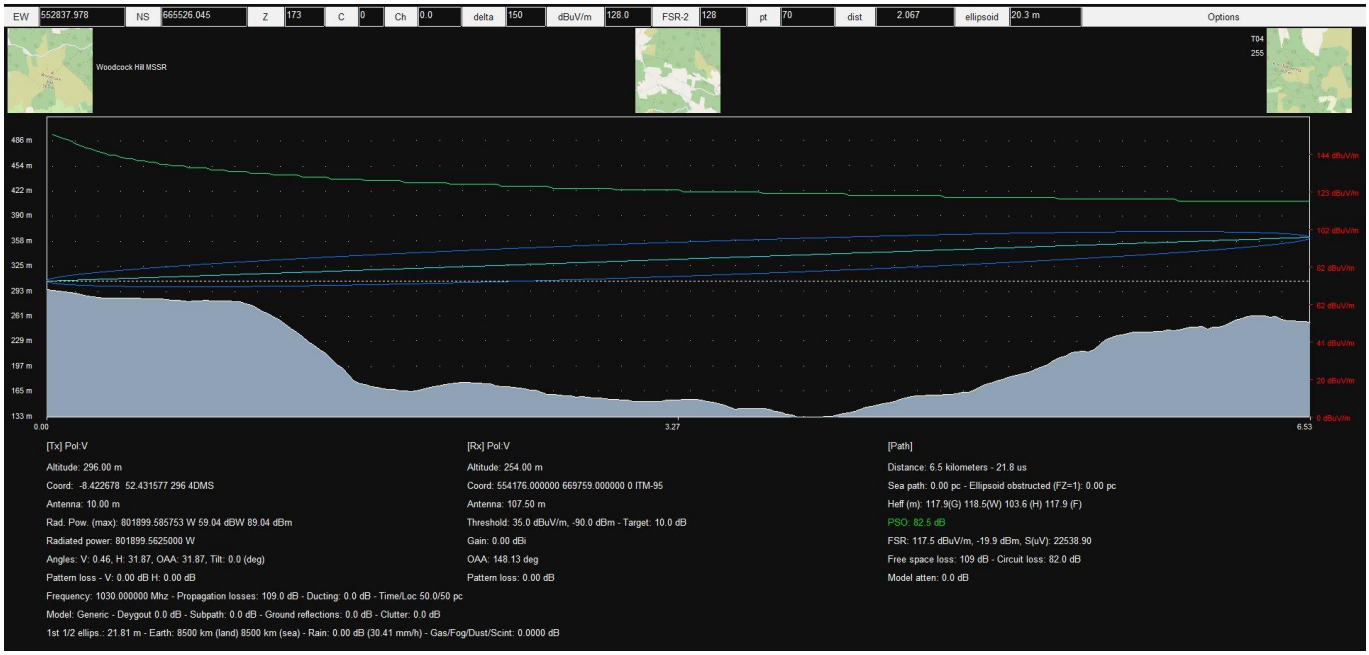


B.2. Turbine T2



B.3. Turbine T3

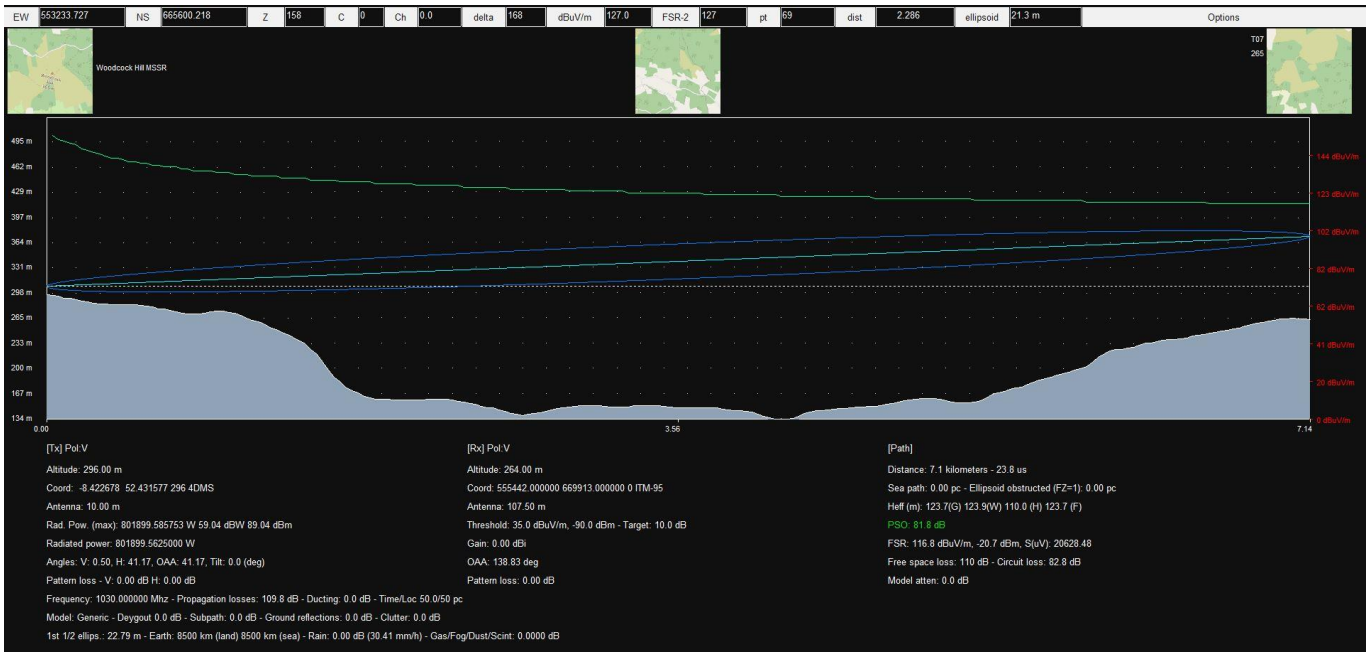
B.4. Turbine T4



B.5. Turbine T5

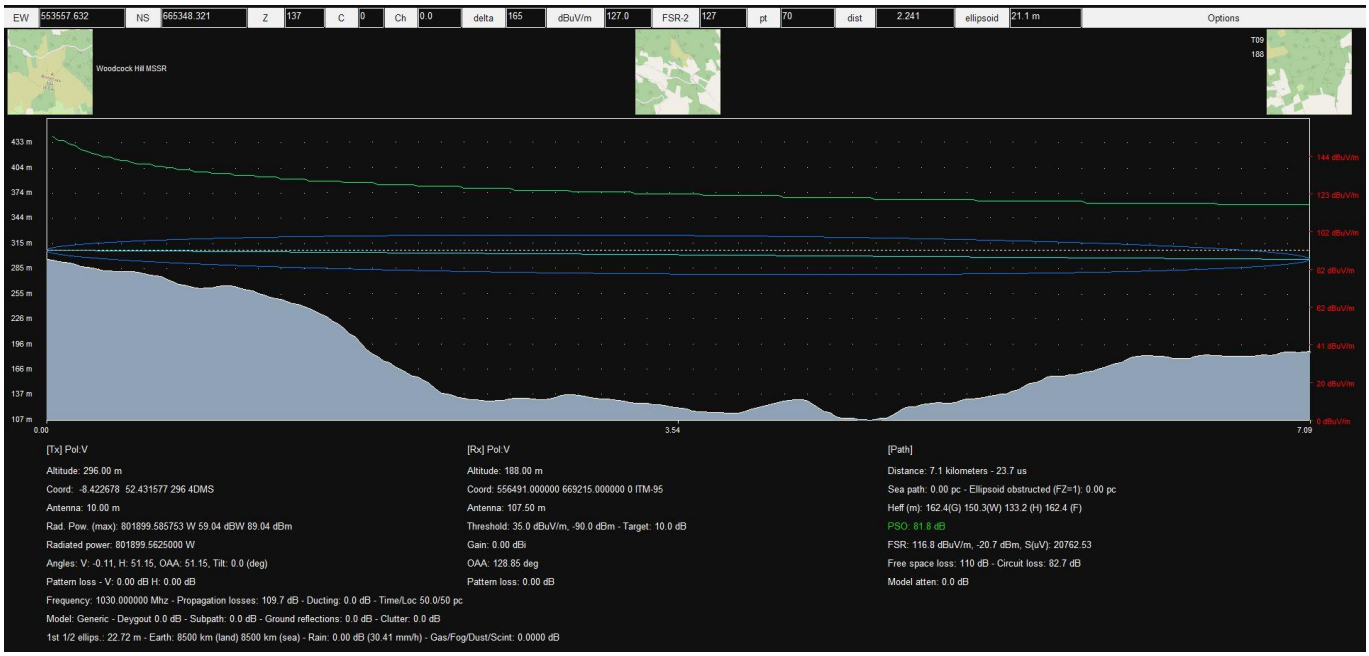
B.6. Turbine T6

B.7. Turbine T7



B.8. Turbine T8

B.9. Turbine T9



B.10. Turbine T10

B.11. Turbine T11

B.12. Turbine T12

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IFP Opinion

Ballycar Wind Farm

Shannon Airport

05 November 2021

CL-5715-RPT-002 V1.0

www.cyrrus.co.uk

info@cyrrus.co.uk

Executive Summary

MWP (hereafter referred to as the Client) has requested an Instrument Flight Procedure (IFP) review in respect of a proposed windfarm development (Ballycar) near Shannon Airport.

The process of providing an 'opinion' still requires a review of the applicable IFP lateral and horizontal surfaces. This process only determines whether there is a 'surface penetration' and not whether the obstacle impacts the IFP. If there is a penetration a full IFP assessment will be noted.

The proposed development is approximately 10NM north-east of Shannon Airport, as shown in Figure 1.

The windfarm does impact to the current published IFPs for Shannon Airport but is only limited to the ATC Surveillance Minimum Altitude Chart. Although a full IFP assessment is normally required for any identified impact, it is recommended to submit this report to the IAA for consideration whether a full assessment is required.

Figure 1: Wind Farm Position from Threshold 24

IFP's Assessed

The following IFPs, as published in the IAA Aeronautical Information Publication (AIP) were assessed.

- RNAV STANDARD INSTRUMENT DEPARTURES RWY06
- RNAV STANDARD INSTRUMENT DEPARTURE RWY24
- RNAV STANDARD ARRIVALS RWY06
- RNAV STANDARD ARRIVALS RWY24
- INSTRUMENT APPROACH ILS OR LOC RWY06
- INSTRUMENT APPROACH VOR RWY06
- INSTRUMENT APPROACH ILS CAT I & II OR LOC RWY24
- INSTRUMENT APPROACH VOR RWY24
- ATC SURVEILLANCE MINIMUM ALTITUDE

Data

The assessment undertaken by Cyrrus has been based upon the latest promulgated aeronautical information for Shannon contained in the Ireland AIP, reference EINN AD Section 2.

The following data was used for the assessment:

- Irish AIP – AIRAC 10/2021 effective 26 August 2021
- Email titled "RE_CYB1329 –Ballycar Wind Farm Aviation Studied.msg"

Table 1 below provides the base co-ordinates of the Turbines, the co-ordinates were provided in Irish Transverse Mercator (ITM) and converted to World Geodetic System 84 (WGS84) using the ordinates survey's GridInQuestII conversion tool.

Turbine No	Easting (ITM)	Northing (ITM)	Lat (UTM29N)	Long (UTM29N)
1	554531	664275	522072.59	5842025.21
2	554605	663847	522152.51	5841598.38
3	555030	664044	522574.63	5841801.22
4	555027	663611	522577.64	5841368.32
5	555476	663804	523023.81	5841567.49
6	555805	664104	523348.54	5841871.96
7	555886	663643	523435.91	5841412.23
8	555547	663267	523102.25	5841031.65
9	555090	663180	522646.61	5840938.34
10	555990	663191	523546.15	5840961.83
11	555582	662837	523143.2	5840602.28
12	555912	662521	523477.48	5840290.97

Table 1: Positional Data

Turbine dimensions as indicated in Table 2 were used.

In the absence of surveyed ground elevations, a vertical tolerance of 10 m was added.

Turbine No	Hub Height (m)	Rotor (m)	Ground Elevation (m)	Vertical Tolerance (m)	Max Tip Height
1	90	66.5	234	10	400.5
2	90	66.5	207	10	373.5
3	90	66.5	238	10	404.5
4	90	66.5	198	10	364.5
5	90	66.5	243	10	409.5
6	90	66.5	254	10	420.5
7	90	66.5	198	10	364.5
8	90	66.5	160	10	326.5
9	90	66.5	166	10	332.5
10	83	66.5	124	10	283.5
11	90	66.5	113	10	279.5
12	90	66.5	77	10	243.5

Table 2: Data used for the Assessment

Conclusion

The proposed wind farm does impact the current published procedures at Shannon airport. This is however limited to the ATC Surveillance Minimum Altitude Chart.

Although a full IFP assessment is normally required for any identified impact, it is recommended to submit this report to the IAA for consideration whether a full assessment is required.

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From: DOYLE Fergal <FERGAL.DOYLE@IAA.ie>
Sent: Monday 28 February 2022 13:34
To: MACCRIOSTAIL Cathal; Peter Barry
Cc: Paul Hennessy; BYRNE Jonathan; Valerie Heffernan; ARTHURS Fergal; OLOUGHLIN Charlie; CORRIGAN Gary; FLYNN Mark; SYMMANS Terry; Planning; Paul Hennessy; ALIU Basri; O'CONNOR Brendan; O'CONNELL Liam
Subject: RE: 220228 Proposed Ballycar Wind Farm ANSP Update (2)

HI Cathal,
We reviewed the Cyrrus report and accept the windfarm will not have an effect on ILS signals.
We request that a separate report be completed by FCSL (our flight check service provider) that accesses the potential impact of this development on the flight check profiles for navaids at Shannon airport. I can provide contact details for FCSL.

Regards
Fergal Doyle
Navaids ATM Specialist
Irish Aviation Authority
Ballycasey
Shannon
Co. Clare
Eircode V14 C446
Phone: +353 (0)61 366055
Mobile: +353 (0)87 2919665

From: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Sent: 28 February 2022 12:50
To: Peter Barry <Peter.Barry@mwp.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; CORRIGAN Gary <GARY.CORRIGAN@IAA.ie>; FLYNN Mark <Mark.FLYNN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>; Planning <planning@iaa.ie>; Paul Hennessy <paul.hennessy@shannonairport.ie>
Subject: 220228 Proposed Ballycar Wind Farm ANSP Update (2)
Importance: High

Dear Peter,

Many thanks for the attached reports.

1. In relation to the IFP Opinion (Attachment 1) I'm happy to accept that the proposed turbines will not affect the Shannon Airport Instrument Flight Procedures and nothing further is required from this perspective.

Note: If planning is granted and the construction goes ahead, these turbines will need to be notified to the IAA Aviation Safety Regulator, each being higher than 100m elevation

2. Technical Assessment Report:
    - Building Restricted Areas: SAA's Paul Hennessy copied for information
    - NAVAIDs: The report conforms no issues for Airport NAVAIDs: Fergal Doyle copied to confirm this

    - ***Surveillance:*** *The report notes that mitigations are required for the Shannon PSR and the Woodcock Hill MSSR most particularly not prevent false targets and ghost signals respectively. While the report outlines how these mitigations could be applied, this must be assessed by our surveillance team (Charlie O'Loughlin and his team copied).*

This last item will be the main issue for then IAA ANSP in my experience. This proposed development is one of multiple application in the same general area which is all cases is leading to an assessment of Surveillance impacts. While in isolation "filtering" of PSR and /or updates to the reflector file for Woodcock Hill MSSR may seem straightforward, it may be of significant cost to the ANSP and if required for multiple developments, lead to a realistically unusable radar system for aircraft targets between 3500 and 10000 feet, which would be the altitude band serving Shannon Airport. Added to this, such system upgrades have not been planned for in the Surveillance work programme.

I suggest that Charlie and his team will need to assess and revert with their position. Please follow up with me in a week's time and I'll in turn check with Surveillance.

Best regards,

Cathal
Cathal Mac Criostail
Údarás Eitlíochta na hÉireann / Irish Aviation Authority
The Times Building, 11-12 D'Olier Street, Dublin 2, D02 T449, Ireland
✉ cathal.maccriostail@iaa.ie
☎ ~~+353 (0)1 6031173~~
+353 (0)86 0527130
www.iaa.ie
Do you *really* need to print this?

From: Peter Barry <Peter.Barry@mwp.ie>
Sent: Friday 25 February 2022 14:47
To: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>; Planning <planning@iaa.ie>
Subject: RE: 220214 Proposed Ballycar Wind Farm ANSP Update

Hi Cathal,

Thank you for below. We are proceeding with the application.

I attached a couple of reports which we commissioned by Cyrrus. You might review and we could discuss the findings and recommended mitigation. There have been a couple of iterations of the layout since, but the mitigation measures should be the same.

Do we need to have a meeting to discuss the attached?

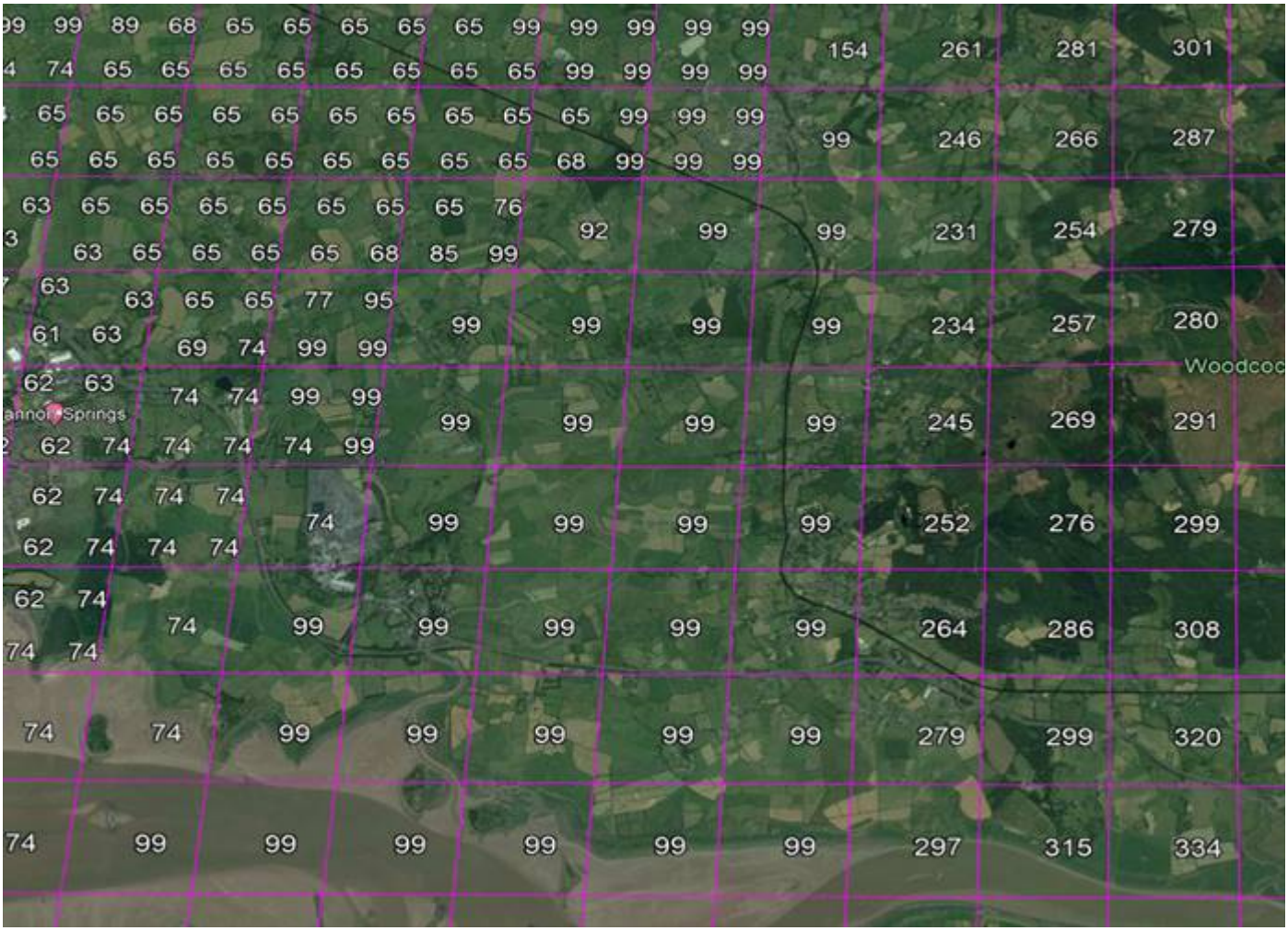
From: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Sent: Monday 14 February 2022 17:44
To: Peter Barry <Peter.Barry@mwp.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>; Planning <planning@iaa.ie>
Subject: 220214 Proposed Ballycar Wind Farm ANSP Update
Importance: High

Dear Peter,

Many thanks for the email and the attached detailed outline of the proposed Turbine co-ordinates and AMSL elevations. Thanks also for the phone-call by way of reminder on this.

As I outlined there are three areas of concern for us the IAA Air Navigation Service Provider:

1. **Instrument Flight Procedures (IFPs) surfaces:** Below is a Google Earth outline of the turbines with our IFP safeguarding girds overlayed:



As you can see the guide (IFP) elevation which does not affect the IFPs, is exceeded for many of the proposed turbines. This does not mean that this is not acceptable. It does however require an IF assessment to be carried out by a certified IFP designer to assess possible impacts. When you're ready to engage on this I can advise on which companies are certified for this work. The result should confirm no impact, or recommend mitigations, e.g. lowering of some turbines elevations possibly

2. **Navigation Aids:** The nearest turbine proposed is c. 16.5 km from Shannon Airport and as such should be outside area of concern for our ground-based navigation aids. This may need to be confirmed by the company who carry out flight checking if these systems. Fergal Arthurs and Fergal Doyle, Could you review and provide an opinion please?
3. **Surveillance:** The turbines as proposed are close to our surveillance systems at Woodcock Hill and will need to be considered for an effect on these systems. Attached is some guidance material and I'll refer this element to my colleague Charlie O'Loughlin for a view on this.

If you are proceeding to planning application, could you advise all copied please and we can assess where we are at that point?

I hope this all makes sense.

Kind regards,

Cathal
Cathal Mac Criostail
Údarás Eitlíochta na hÉireann / Irish Aviation Authority
The Times Building, 11-12 D'Olier Street, Dublin 2, D02 T449, Ireland
✉ cathal.maccriostail@iaa.ie
☎ ~~+353 (0)1 6031173~~
+353 (0)86 0527130
www.iaa.ie
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From: Peter Barry <Peter.Barry@mwp.ie>
Sent: Thursday 13 January 2022 15:16
To: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>
Subject: RE: 220112 Proposed Ballycar Wind Farm

Hi Cathal,

Attached table with Lat/ Long coordinates included. Also, to clarify the column *rotor diameter* was labelled wrong in the earlier table I emailed, it should have been labelled *blade length*, rotor diameter is then double. Corrected table attached with AMSL as requested.

We are happy to discuss findings once you have had a chance to carry out your internal studies. We are still in the design and assessment stage.

Let me know if I can do anything else.

Peter

From: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Sent: Thursday 13 January 2022 13:41
To: Peter Barry <Peter.Barry@mwp.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>
Subject: 220112 Proposed Ballycar Wind Farm
Importance: High

Dear Peter,

Happy New Year and many thanks for the data supplied in the attached file.

There are a number of surfaces that the IAA Air Navigation Service Provider (ANSP) are responsible for safeguarding around Shannon Airport, including Navigation Aids, Surveillance Radar and Instrument Flight Procedures (IFPs).

In regard to the IFP surfaces, I am responsible for safeguarding here and we have a safeguarding grid to guide as to whether there is a potential impact on the IFP surfaces, generated by new obstacles, such as the proposed (12) wind turbines.

Below is a depiction of this safeguarding grid with a pin at Ballycar:

The values each grid cell represent an Above Mean Sea Level (AMSL: Site elevation + Height of obstacle) elevation value, above which, an IFP impact assessment will be required. In the case of the Ballycar area and taking the highest turbine height supplied, 254m added to an approximate site elevation of 240m, gives an AMSL elevation of in excess of 400m, which is above the safeguarding values in this area.

Separately, the heights proposed will likely impact the Surveillance Radar at Woodcock Hill and navigation aids for approaches to Shannon Airport. I've copied colleagues from the ANSP in these areas, for information.

This is not the only wind turbine proposal for this area and to be completely upfront, nearly all are creating issues for the surfaces referenced.

If you could supply confirmation of the AMSL elevations of the turbines and give co-ordinates in WGS 84 format (Latitude and Longitude), this would be appreciated and will allow me to give greater clarity on requirements for the ANSP and indeed SAA. If I have picked up on information incorrectly, please do correct me.

Kind regards,

Cathal
Cathal Mac Criostail
Údarás Eitlíochta na hÉireann / Irish Aviation Authority
The Times Building, 11-12 D'Olier Street, Dublin 2, D02 T449, Ireland
✉ cathal.maccriostail@iaa.ie
☎ ~~+353 (0)1 6031173~~
+353 (0)86 0527130
www.iaa.ie
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From: Peter Barry <Peter.Barry@mwp.ie>
Sent: Thursday 13 January 2022 10:35
To: O'LEARY Geraldine <Geraldine.O'LEARY@IAA.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>
Subject: RE: Proposed Ballycar Wind Farm

Hi Geraldine,

Please find attached the turbine coordinates, hub height, rotor diameter and ground elevation as requested (email thread below).

If you need any more information, please let me know.

I would appreciate if you would acknowledge receipt of this email.

Peter Barry
BSc MSc CEnv

Principal Environmental Scientist

e peter.barry@mwp.ie m +353 86 4474440
t +353 (0)66 7123404 w www.mwp.ie

Reen Point, Blennerville,
Tralee, Co. Kerry, V92 X2TK, Ireland

MWP

From: O'LEARY Geraldine <Geraldine.O'LEARY@IAA.ie>
Sent: Wednesday 5 January 2022 14:04
To: Peter Barry <Peter.Barry@mwp.ie>
Subject: Proposed Ballycar Wind Farm [Filed 07 Jan 2022 11:03]

"Dear Mr. Barry,

Thank you for your letter and scoping report and request for comments in relation to a proposed wind farm on lands at and near Ballycar, Co. Clare.

As the blade tip height proposed is not included, nor specific turbine positions and the ground elevation of each site is not provided, Safety Regulation Division - Aerodromes cannot make any specific comments at this time.

The development appears to be approximately 16km East of Shannon Airport, as such, the applicant should engage with Shannon Airport Authority and the IAA's Air Navigation Service Provider (ANSP) as a matter of urgency to undertake a preliminary screening assessment to confirm that the proposed wind farm and the associated cranes that would be utilised during its construction would have no impact on instrument flight procedures, communication and navigation aids or flight checking at Shannon Airport. Contact details are as below:

Aerodrome Operator – Shannon Airport:	**IAA-ANSP:**	**Shannon Tower Business Unit**
Mr. Paul Hennessy Safety Compliance and Environment Manager Shannon Airport Authority DAC t: +353-61-712471 m: +87-2382453 e: paul.hennessy@shannonairport.ie	Mr. Cathal Mac Criostail Airspace & Navigation Manager Údarás Eitlíochta na hÉireann / Irish Aviation Authority The Times Building, 11-12 D'Olier Street, Dublin 2, D02 T449, Ireland cathal.maccriostail@iaa.ie +353 (0)1 6031173 +353 (0)86 0527130	Mr. Jonathan Byrne Operations Manager STBU/CTBU Air Traffic Control Irish Aviation Authority jonathan.byrne@iaa.ie +353 61 703704 +353 87 9375486

Subject to any study noting a potential impact on the safety of operations at Shannon Airport, during the formal planning process, the Safety Regulation Division – Aerodromes would likely make the following general observation:

In the event of planning consent being granted, the applicant should be conditioned to contact the Irish Aviation Authority to: (1) agree an aeronautical obstacle warning light scheme for the wind farm development, (2) provide as-constructed coordinates in WGS84 format together with ground and tip height elevations at each wind turbine location and (3) notify the Authority of intention to commence crane operations with at least 30 days prior notification of their erection.

Yours sincerely

Deirdre Forrest
Corporate Affairs

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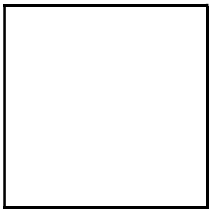

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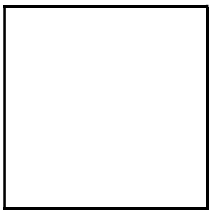

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Ireland A limited liability company
==========
==========

From: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Sent: Wednesday 9 March 2022 10:28
To: Peter Barry
Cc: Paul Hennessy; BYRNE Jonathan; Valerie Heffernan; DOYLE Fergal; ARTHURS Fergal; OLOUGHLIN Charlie; CORRIGAN Gary; FLYNN Mark; SYMMANS Terry; Planning; Paul Hennessy
Subject: RE: 220228 Proposed Ballycar Wind Farm ANSP Update (2)

Many thanks for all this Peter.

I appreciate your proactive engagement on this.

Kind regards,

Cathal
Cathal Mac Criostail
Údarás Eitlíochta na hÉireann / Irish Aviation Authority
The Times Building, 11-12 D'Olier Street, Dublin 2, D02 T449, Ireland
✉ cathal.maccriostail@iaa.ie
☎ ~~+353 (0)1 6031173~~
+353 (0)86 0527130
www.iaa.ie
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From: Peter Barry <Peter.Barry@mwp.ie>
Sent: Wednesday 9 March 2022 09:46
To: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; CORRIGAN Gary <GARY.CORRIGAN@IAA.ie>; FLYNN Mark <Mark.FLYNN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>; Planning <planning@iaa.ie>; Paul Hennessy <paul.hennessy@shannonairport.ie>
Subject: RE: 220228 Proposed Ballycar Wind Farm ANSP Update (2)

Hi Cathal,

Just following up on below, as you advised.

FYI, I have emailed FCSL and am waiting to hear back.

From: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Sent: Monday 28 February 2022 12:50
To: Peter Barry <Peter.Barry@mwp.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie

Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; CORRIGAN Gary <GARY.CORRIGAN@IAA.ie>; FLYNN Mark <Mark.FLYNN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>; Planning <planning@iaa.ie>; Paul Hennessy <paul.hennessy@shannonairport.ie>
Subject: 220228 Proposed Ballycar Wind Farm ANSP Update (2)
Importance: High

Dear Peter,

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1. In relation to the IFP Opinion (Attachment 1) I'm happy to accept that the proposed turbines will not affect the Shannon Airport Instrument Flight Procedures and nothing further is required from this perspective.
   Note: If planning is granted and the construction goes ahead, these turbines will need to be notified to the IAA Aviation Safety Regulator, each being higher than 100m elevation
2. Technical Assessment Report:
   - Building Restricted Areas: SAA's Paul Hennessy copied for information
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   - ***Surveillance:*** *The report notes that mitigations are required for the Shannon PSR and the Woodcock Hill MSSR most particularly not prevent false targets and ghost signals respectively. While the report outlines how these mitigations could be applied, this must be assessed by our surveillance team (Charlie O'Loughlin and his team copied).*

This last item will be the main issue for then IAA ANSP in my experience. This proposed development is one of multiple application in the same general area which is all cases is leading to an assessment of Surveillance impacts. While in isolation "filtering" of PSR and /or updates to the reflector file for Woodcock Hill MSSR may seem straightforward, it may be of significant cost to the ANSP and if required for multiple developments, lead to a realistically unusable radar system for aircraft targets between 3500 and 10000 feet, which would be the altitude band serving Shannon Airport. Added to this, such system upgrades have not been planned for in the Surveillance work programme.

I suggest that Charlie and his team will need to assess and revert with their position. Please follow up with me in a week's time and I'll in turn check with Surveillance.

Best regards,

Cathal
Cathal Mac Criostail
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✉ cathal.maccriostail@iaa.ie
☎ ~~+353 (0)1 6031173~~
+353 (0)86 0527130

www.iaa.ie
Do you *really* need to print this?

From: Peter Barry <Peter.Barry@mwp.ie>
Sent: Friday 25 February 2022 14:47
To: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>; Planning <planning@iaa.ie>
Subject: RE: 220214 Proposed Ballycar Wind Farm ANSP Update

Hi Cathal,

Thank you for below. We are proceeding with the application.

I attached a couple of reports which we commissioned by Cyrrus. You might review and we could discuss the findings and recommended mitigation. There have been a couple of iterations of the layout since, but the mitigation measures should be the same.

Do we need to have a meeting to discuss the attached?

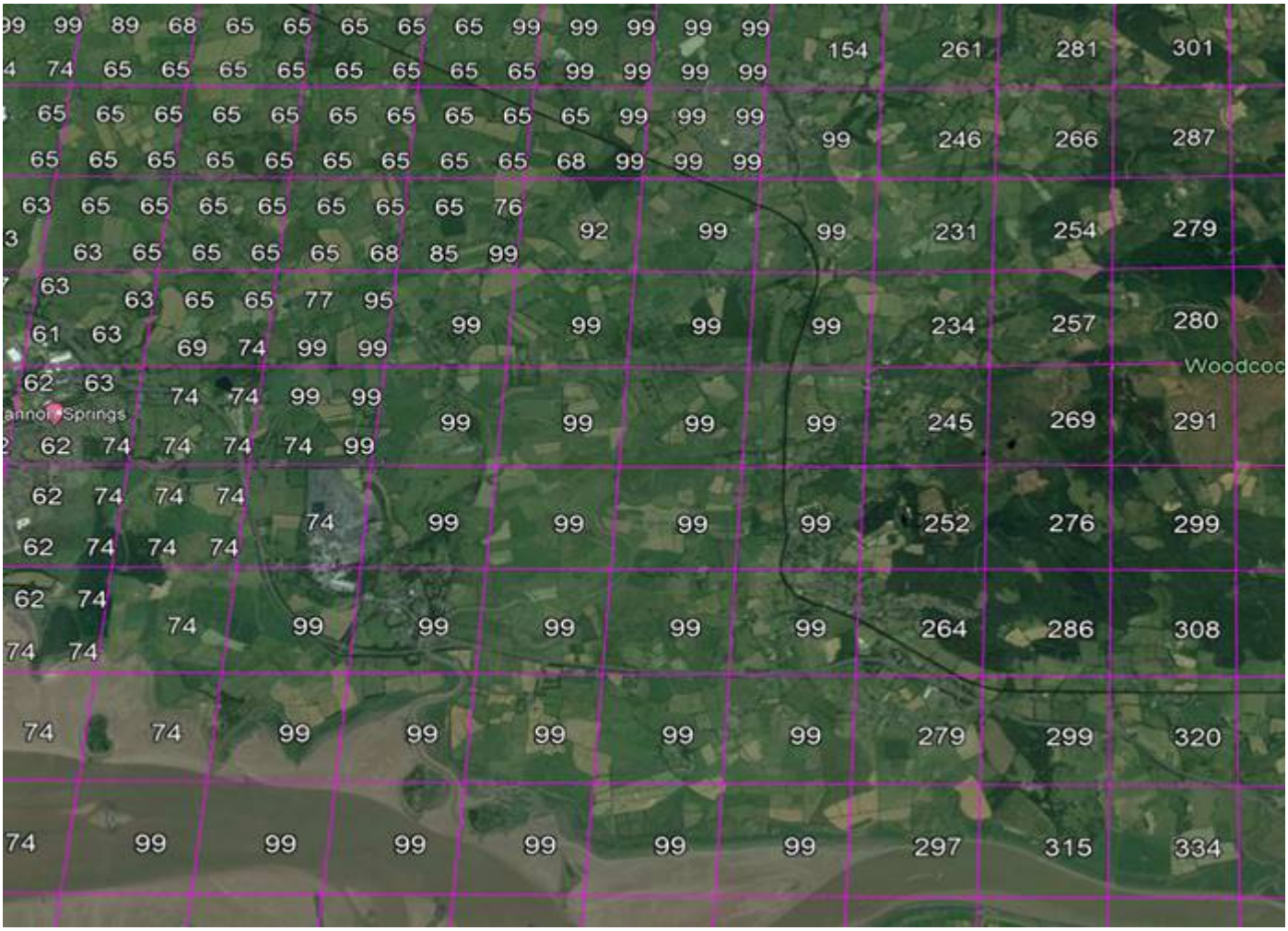
From: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Sent: Monday 14 February 2022 17:44
To: Peter Barry <Peter.Barry@mwp.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>; Planning <planning@iaa.ie>
Subject: 220214 Proposed Ballycar Wind Farm ANSP Update
Importance: High

Dear Peter,

Many thanks for the email and the attached detailed outline of the proposed Turbine co-ordinates and AMSL elevations. Thanks also for the phone-call by way of reminder on this.

As I outlined there are three areas of concern for us the IAA Air Navigation Service Provider:

1. **Instrument Flight Procedures (IFPs) surfaces:** Below is a Google Earth outline of the turbines with our IFP safeguarding girds overlayed:



As you can see the guide (IFP) elevation which does not affect the IFPs, is exceeded for many of the proposed turbines. This does not mean that this is not acceptable. It does however require an IF assessment to be carried out by a certified IFP designer to assess possible impacts. When you're ready to engage on this I can advise on which companies are certified for this work. The result should confirm no impact, or recommend mitigations, e.g. lowering of some turbines elevations possibly

2. **Navigation Aids:** The nearest turbine proposed is c. 16.5 km from Shannon Airport and as such should be outside area of concern for our ground-based navigation aids. This may need to be confirmed by the company who carry out flight checking if these systems. Fergal Arthurs and Fergal Doyle, Could you review and provide an opinion please?
3. **Surveillance:** The turbines as proposed are close to our surveillance systems at Woodcock Hill and will need to be considered for an effect on these systems. Attached is some guidance material and I'll refer this element to my colleague Charlie O'Loughlin for a view on this.

If you are proceeding to planning application, could you advise all copied please and we can assess where we are at that point?

I hope this all makes sense.

Kind regards,

Cathal
Cathal Mac Criostail
Údarás Eitlíochta na hÉireann / Irish Aviation Authority
The Times Building, 11-12 D'Olier Street, Dublin 2, D02 T449, Ireland
✉ cathal.maccriostail@iaa.ie
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+353 (0)86 0527130
www.iaa.ie
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From: Peter Barry <Peter.Barry@mwp.ie>
Sent: Thursday 13 January 2022 15:16
To: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>
Subject: RE: 220112 Proposed Ballycar Wind Farm

Hi Cathal,

Attached table with Lat/ Long coordinates included. Also, to clarify the column *rotor diameter* was labelled wrong in the earlier table I emailed, it should have been labelled *blade length*, rotor diameter is then double. Corrected table attached with AMSL as requested.

We are happy to discuss findings once you have had a chance to carry out your internal studies. We are still in the design and assessment stage.

Let me know if I can do anything else.

Peter

From: MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>
Sent: Thursday 13 January 2022 13:41
To: Peter Barry <Peter.Barry@mwp.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>; DOYLE Fergal <FERGAL.DOYLE@IAA.ie>; ARTHURS Fergal <Fergal.ARTHURS@IAA.ie>; OLOUGHLIN Charlie <Charlie.OLOUGHLIN@IAA.ie>; SYMMANS Terry <Terry.Symmans@IAA.ie>
Subject: 220112 Proposed Ballycar Wind Farm
Importance: High

Dear Peter,

Happy New Year and many thanks for the data supplied in the attached file.

There are a number of surfaces that the IAA Air Navigation Service Provider (ANSP) are responsible for safeguarding around Shannon Airport, including Navigation Aids, Surveillance Radar and Instrument Flight Procedures (IFPs).

In regard to the IFP surfaces, I am responsible for safeguarding here and we have a safeguarding grid to guide as to whether there is a potential impact on the IFP surfaces, generated by new obstacles, such as the proposed (12) wind turbines.

Below is a depiction of this safeguarding grid with a pin at Ballycar:

The values each grid cell represent an Above Mean Sea Level (AMSL: Site elevation + Height of obstacle) elevation value, above which, an IFP impact assessment will be required. In the case of the Ballycar area and taking the highest turbine height supplied, 254m added to an approximate site elevation of 240m, gives an AMSL elevation of in excess of 400m, which is above the safeguarding values in this area.

Separately, the heights proposed will likely impact the Surveillance Radar at Woodcock Hill and navigation aids for approaches to Shannon Airport. I've copied colleagues from the ANSP in these areas, for information.

This is not the only wind turbine proposal for this area and to be completely upfront, nearly all are creating issues for the surfaces referenced.

If you could supply confirmation of the AMSL elevations of the turbines and give co-ordinates in WGS 84 format (Latitude and Longitude), this would be appreciated and will allow me to give greater clarity on requirements for the ANSP and indeed SAA. If I have picked up on information incorrectly, please do correct me.

Kind regards,

Cathal
Cathal Mac Criostail
Údarás Eitlíochta na hÉireann / Irish Aviation Authority
The Times Building, 11-12 D'Olier Street, Dublin 2, D02 T449, Ireland
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☎ ~~+353 (0)1 6031173~~
+353 (0)86 0527130
www.iaa.ie
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From: Peter Barry <Peter.Barry@mwp.ie>
Sent: Thursday 13 January 2022 10:35
To: O'LEARY Geraldine <Geraldine.O'LEARY@IAA.ie>
Cc: Paul Hennessy <paul.hennessy@shannonairport.ie>; MACCRIOSTAIL Cathal <Cathal.MacCriostail@IAA.ie>; BYRNE Jonathan <Jonathan.Byrne@IAA.ie>; Valerie Heffernan <Valerie.Heffernan@mwp.ie>
Subject: RE: Proposed Ballycar Wind Farm

Hi Geraldine,

Please find attached the turbine coordinates, hub height, rotor diameter and ground elevation as requested (email thread below).

If you need any more information, please let me know.

I would appreciate if you would acknowledge receipt of this email.

Peter Barry
BSc MSc CEnv

Principal Environmental Scientist

e peter.barry@mwp.ie m +353 86 4474440
t +353 (0)66 7123404 w www.mwp.ie

Reen Point, Blennerville,
Tralee, Co. Kerry, V92 X2TK, Ireland

From: O'LEARY Geraldine <Geraldine.O'LEARY@IAA.ie>
Sent: Wednesday 5 January 2022 14:04
To: Peter Barry <Peter.Barry@mwp.ie>
Subject: Proposed Ballycar Wind Farm [Filed 07 Jan 2022 11:03]

"Dear Mr. Barry,

Thank you for your letter and scoping report and request for comments in relation to a proposed wind farm on lands at and near Ballycar, Co. Clare.

As the blade tip height proposed is not included, nor specific turbine positions and the ground elevation of each site is not provided, Safety Regulation Division - Aerodromes cannot make any specific comments at this time.

The development appears to be approximately 16km East of Shannon Airport, as such, the applicant should engage with Shannon Airport Authority and the IAA's Air Navigation Service Provider (ANSP) as a matter of urgency to undertake a preliminary screening assessment to confirm that the proposed wind farm and the associated cranes that would be utilised during its construction would have no impact on instrument flight procedures, communication and navigation aids or flight checking at Shannon Airport. Contact details are as below:

Aerodrome Operator – Shannon Airport:	**IAA-ANSP:**	**Shannon Tower Business Unit**
Mr. Paul Hennessy Safety Compliance and Environment Manager Shannon Airport Authority DAC t: +353-61-712471 m: +87-2382453 e: paul.hennessy@shannonairport.ie	Mr. Cathal Mac Criostail Airspace & Navigation Manager Údarás Eitlíochta na hÉireann / Irish Aviation Authority The Times Building, 11-12 D'Olier Street, Dublin 2, D02 T449, Ireland cathal.maccriostail@iaa.ie +353 (0)1 6031173 +353 (0)86 0527130	Mr. Jonathan Byrne Operations Manager STBU/CTBU Air Traffic Control Irish Aviation Authority jonathan.byrne@iaa.ie +353 61 703704 +353 87 9375486

Subject to any study noting a potential impact on the safety of operations at Shannon Airport, during the formal planning process, the Safety Regulation Division – Aerodromes would likely make the following general observation:

In the event of planning consent being granted, the applicant should be conditioned to contact the Irish Aviation Authority to: (1) agree an aeronautical obstacle warning light scheme for the wind farm development, (2) provide as-constructed coordinates in WGS84 format together with ground and tip height elevations at each wind turbine location and (3) notify the Authority of intention to commence crane operations with at least 30 days prior notification of their erection.

Yours sincerely

Deirdre Forrest
Corporate Affairs

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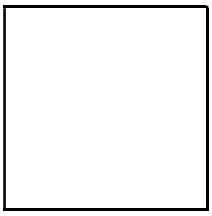

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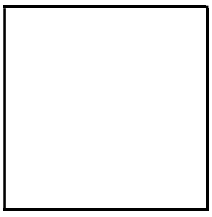

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Valerie Heffernan

From: Peter Barry
Sent: Friday 14 January 2022 12:19
To: Jane Gilleran
Cc: Valerie Heffernan
Subject: RE: EIA Consult Ballycar Wind Farm

Thanks Jane

From: Jane Gilleran <Jane.Gilleran@fisheriesireland.ie>
Sent: Friday 14 January 2022 12:16
To: Peter Barry <Peter.Barry@mwp.ie>
Subject: RE: EIA Consult Ballycar Wind Farm

Dear Peter,

Please find attached comments from IFI in relation to the above proposed wind farm development.

Best regards

Jane

From: Peter Barry <Peter.Barry@mwp.ie>
Sent: Wednesday 12 January 2022 14:13
To: Jane Gilleran <Jane.Gilleran@fisheriesireland.ie>
Cc: Valerie Heffernan <Valerie.Heffernan@mwp.ie>
Subject: RE: EIA Consult Ballycar Wind Farm

Thanks Jane

From: Jane Gilleran <Jane.Gilleran@fisheriesireland.ie>
Sent: Wednesday 12 January 2022 14:08
To: Peter Barry <Peter.Barry@mwp.ie>
Subject: EIA Consult Ballycar Wind Farm

Dear Peter,

Thank you for your consult request we received on December 17th.

I aim to have a response to you by early next week.

Regards

Jane

Jane Gilleran
Fisheries Environmental Officer
Inland Fisheries Ireland - Limerick

Iascach Intíre Éireann
Inland Fisheries Ireland

Tel (061) 300238
Email jane.gilleran@fisheriesireland.ie
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Ashbourne Business Park. Dock Rd. Limerick. V94 NPE0

MWP
Reen Point
Blennerville
Tralee
V92 X2TK

Iascach Intíre Éireann
Inland Fisheries Ireland

14.01.2022

Re. Consultation Request for Proposed Wind Farm Development at Ballycar, Co. Clare

Dear Peter,

Thank you for your letter dated December 17th regarding a request for consultation on the proposed Ballycar wind farm. IFI have no objection in principle to the proposal as indicated but reserve the right to make further submissions as detail emerges.

Please find below our initial concerns and recommendations in relation to this development. These mainly relate be the protection of the aquatic resource and the associated riparian habitat. In particular, the protection of streams such as East Ballycannan, Cappateemore East and Crompaun streams that cross or bound the proposed site and which feed into the Shannon near Coonagh or Quinspool. The turbine site indicated on the map at Ballycannan East to the bottom right of the layout would appear to be sited particularly close to the adjacent stream.

Our general comments to apply to all wind farm developments are as follows:

1. All watercourses that will receive drainage from the construction sites of the turbines or the access roads must be assessed in terms of aquatic biodiversity with particular emphasis on fish, the food of fish, spawning grounds and fish habitat in general. Changes to river morphology should be avoided.

2. The aquatic habitat and physical nature of any watercourse affected by the development must be fully described in detail. This includes areas of open water, pool riffle glide sequences, density and types of aquatic vegetation, description of riparian zones to depth of at least 10 metres on either bank etc. The extent of the surveys should be sufficiently long enough so as to be representative of the habitat contained in that watercourse. There should be a particular focus on sections upstream and downstream of any point where an impact on the watercourse is likely to arise.

3. We are concerned about soils, their structure and types around all the turbines, turbine pads, associated access roads and site development. In particular we have general concerns about the stability of the soils and the impact that works on both the turbines and access roads may have either directly or by vibration on the stability of the soils. IFI are particularly concerned where it is proposed to construct wind turbines on peat soils of which there appears to be some in this general area.

4. IFI strongly recommends that specialist personnel are employed to assess soil strength and suitability of the ground at each site and along any proposed access road. This is particularly important in relation to peat soils. From our experience we will have serious difficulties with developments on peat soils where there is excessive slope and/or where the peat depth exceeds one metre The potential for soil movement and landslides should be assessed fully within the EIS.

5. Particular attention should be paid to the hydrology of any site where excavations, including excavations for borrow pits and road construction are being undertaken. It is important that natural flow paths are not interrupted or diverted in such a manner as to give rise to erosion or instability of soils caused by an alteration in water movement either above or below ground.

6. Attention should be paid to drainage during both the construction phase and the operational phase. This includes waters being pumped from foundations or other excavations. It is particularly important during the construction phase that sufficient retention time is available in any settlement pond to ensure no deleterious matter is discharged to waters. We strongly recommend that settlement ponds are maintained, where appropriate, during the operational phase to allow for the adequate settlement of suspended solids and sediments and prevent any deleterious matter from discharging. In constructing and designing silt traps particular attention should be paid to rainfall levels and intensity. The silt traps should be designed to minimise the movement of silt during intense precipitation events where the trap may become hydraulically overloaded. It is essential that they are located with good access to facilitate monitoring sampling and maintenance. A license to discharge to waters may be required from the local authority.

7. Consideration must be given to the disposal of waste materials such that they will not give rise to discharges to waters. In terms of risk, the placing of soils on watercourse-adjacent ground should not be permitted unless the area has been the subject of a risk assessment. Furthermore, drainage from disturbed and stockpiled soils will have to be considered in advance. It may be necessary to carry out soil stockpiling operations in confined areas only and to ensure vegetation/covering of the soils to prevent wash-out.

8. The use of sedimentary rocks, such as shale, in road construction should be avoided. This type of material has poor tensile strength and is liable to be crushed by heavy vehicles thereby releasing fine sediment materials into the drainage system which are difficult to precipitate and may give rise to water pollution. We recommend that specialist expertise should advise on the type of material required for road construction bearing in mind the pressures that will arise during the construction phase and the necessity to avoid pollution due to fines washing out into the roadside drainage.

9. In relation to watercourse crossings for the road or grid connection please be advised that IFI will require to be consulted well in advance in relation to all watercourse crossings or the use of any temporary diversions. We strongly recommend that these crossings should be kept to a minimum.

We will also require that any instream structures or bridge crossings are approved by the IFI. In designing crossings, the length, slope and width of any instream structure will be important. Clear span bridges are the preferred option for all crossings especially in upland areas.

10. Please also note that any instream works or other works which may impact directly on a watercourse should only be carried out during the open season which is from 1st July to 30th of September in each year (so as to avoid impacting on the aquatic habitat during the spawning season.) It would be important that appropriate scheduling of works is allowed for.
11. The EIAR should indicate proposals to monitor the impact on watercourses within the site. In the event that environmental damage to the aquatic habitat and associated riparian zone is caused, the EIAR should indicate the steps that may be taken to rectify any damage to the aquatic habitat including liaison with the appropriate authorities.
12. In relation to wind farm structures and infrastructure it is important that a sufficient bank side riparian zone is maintained to absorb and attenuate overland flows.

The discharge of polluting or deleterious matter to any watercourse except under and in accordance with a licence may be an offense under the Fisheries Acts and/or under the Water Pollution Acts.

Should works be approved a finalised CEMP must be agreed with Inland Fisheries Ireland before works commence.

Should you require any further information or clarification from IFI, please do not hesitate to contact me.

Yours sincerely,

Jane Gilleran

.....

Jane Gilleran
Fisheries Environmental Officer
Inland Fisheries Ireland - Limerick

Iascach Intíre Éireann
Inland Fisheries Ireland

From: Housing Manager DAU <Manager.DAU@housing.gov.ie>
Sent: Monday 20 December 2021 17:57
To: Valerie Heffernan
Cc: Peter Barry
Subject: RE: EIA Consultation - Proposed Ballycar Wind Farm [Filed 07 Jan 2022 09:27]

Our Ref: G Pre00307/2021 (Please quote in all related correspondence)

A Chara

I acknowledge receipt of your recent consultation.

In the event of observations, you will receive a co-ordinated heritage-related response by email from Development Applications Unit (DAU).

The normal target turnaround for pre-planning and other general consultations is six weeks from date of receipt (plus 2 weeks over Christmas Period). In relation to general consultations from public bodies under the European Communities (Environmental Assessment of Certain Plans and Programmes) Regulations 2004 to 2011, the Department endeavours to meet deadline dates, where requested.

If you have not heard from DAU and wish to receive an update, please email manager.dau@housing.gov.ie.

Regards
Diarmuid

Diarmuid Buttimer
Executive Officer

An Roinn Tithíochta, Rialtais Áitiúil agus Oidhreachta
Department of Housing, Local Government and Heritage
Aonad na nIarratas ar Fhorbairt
Development Applications Unit
Oifigí an Rialtais
Government Offices
Bóthar an Bhaile Nua, Loch Garman, Contae Loch Garman, Y35 AP90
Newtown Road, Wexford, County Wexford, Y35 AP90

—

Diarmuid.Buttimer@housing.gov.ie
Manager.DAU@housing.gov.ie

From: Valerie Heffernan <Valerie.Heffernan@mwp.ie>
Sent: Monday 20 December 2021 10:46
To: Housing Manager DAU <Manager.DAU@housing.gov.ie>
Cc: Peter Barry <Peter.Barry@mwp.ie>
Subject: EIA Consultation - Proposed Ballycar Wind Farm

Good Morning,

Please find EIA Consultation attached for proposed Balllycar Wind Farm.

We look forward to confirmation of receipt of consultation.

Regards,

Valerie Heffernan
BSc, MSc

Environmental Scientist

e Valerie.heffernan@mwp.ie
t +353 (0)66 7123404 w www.mwp.ie

Reen Point, Blennerville,
Tralee, Co. Kerry, V92 X2TK, Ireland

MWP

From: Diarmuid Buttimer (Housing) <Diarmuid.Buttimer@housing.gov.ie>
Sent: Thursday 27 January 2022 16:16
To: Valerie Heffernan; Peter Barry
Subject: G Pre00307/2021 - EIA Consultation - Proposed Ballycar Wind Farm [Filed 27 Jan 2022 17:14]
Attachments: G Pre00307-2021 MWP - 22156.pdf

A Chara,

Please find attached Heritage Related recommendations for the above mentioned pre-planning application.

Regards
Diarmuid

Diarmuid Buttimer
Executive Officer

An Roinn Tithíochta, Rialtais Áitiúil agus Oidhreachta
Department of Housing, Local Government and Heritage
Aonad na nIarratas ar Fhorbairt
Development Applications Unit
Oifigí an Rialtais
Government Offices
Bóthar an Bhaile Nua, Loch Garman, Contae Loch Garman, Y35 AP90
Newtown Road, Wexford, County Wexford, Y35 AP90

—

Diarmuid.Buttimer@housing.gov.ie
Manager.DAU@housing.gov.ie

From: INFO <Information@tii.ie>
Sent: Thursday 23 December 2021 11:07
To: Peter Barry
Subject: Proposed Ballycar Wind Farm - EIA Consultation (Ref PB/22156) [Filed 07 Jan 2022 11:03]

Follow Up Flag: Follow up
Flag Status: Flagged

Dear Mr. Barry,

I refer to your letter of 14 December 2021 regarding the above EIAR Scoping exercise.

TII will endeavour to consider and respond to planning applications referred to it given its status and duties as a statutory consultee under the Planning Acts. The approach to be adopted by TII in making such submissions or comments will seek to uphold official policy and guidelines as outlined in the Section 28 Ministerial Guidelines 'Spatial Planning and National Roads Guidelines for Planning Authorities' (DoECLG, 2012). Regard should also be had to other relevant guidance available at www.TII.ie.

The issuing of this correspondence is provided as best practice guidance only and does not prejudice TII's statutory right to make any observations, requests for further information, objections or appeals following the examination of any valid planning application referred.

National Strategic Outcome 2 of the National Planning Framework includes the objective to maintain the strategic capacity and safety of the national roads network. In addition, Chapter 7 'Enhanced Regional Accessibility' of the National Development Plan, 2021 – 2030, sets out the key sectoral priority of maintaining Ireland's existing national road network to a robust and safe standard for users. This requirement is further reflected in the publication of the Draft National Investment Framework for Transport in Ireland and also the existing Statutory Section 28 Spatial Planning and National Roads Guidelines for Planning Authorities.

With respect to EIAR scoping issues, the recommendations indicated below provide only general guidance for the preparation of an EIAR, which may affect the national road network.

The developer/scheme promoter should have regard, inter alia, to the following;
• Consultations should be had with the relevant Local Authority/National Roads Design Office with regard to locations of existing and future national road schemes,

• TII would be specifically concerned as to potential significant impacts the development would have on the national road network (and junctions with national roads) in the proximity of the proposed development. In accordance with the provisions of official policy, no direct access or intensification of direct access to national roads should occur.

• The developer should assess visual impacts from existing national roads,

• The developer should have regard to any EIAR/EIS and all conditions and/or modifications imposed by An Bord Pleanála regarding road schemes in the area. The developer should in particular have regard to any potential cumulative impacts,

• The developer, in preparing EIAR, should have regard to TII Publications (formerly DMRB and the Manual of Contract Documents for Road Works),

• The developer, in preparing EIAR, should have regard to TII's Environmental Assessment and Construction Guidelines, including the Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes (National Roads Authority, 2006),

• The EIAR/EIS should consider the Environmental Noise Regulations 2006 (SI 140 of 2006) and, in particular, how the development will affect future action plans by the relevant competent authority. The developer may need to consider the incorporation of noise barriers to reduce noise impacts (see Guidelines for the Treatment of Noise and Vibration in National Road Schemes (1st Rev., National Roads Authority, 2004)),

• It would be important that, where appropriate, subject to meeting the appropriate thresholds and criteria and having regard to best practice, a Traffic and Transport Assessment (TTA) be carried out in accordance with relevant guidelines, noting traffic volumes attending the site and traffic routes to/from the site with reference to impacts on the national road network and junctions of lower category roads with national roads. In relation to national roads, TII's Traffic and Transport Assessment Guidelines (2014) should be referred to in relation to proposed development with potential impacts on the national road network. The scheme promoter is also advised to have regard to Section 2.2 of the NRA/TII TTA Guidelines which addresses requirements for sub-threshold TTA. Any improvements required to facilitate development should be identified. It will be the responsibility of the developer to pay for the costs of any improvements to national roads to facilitate the private development proposed as TII will not be responsible for such costs,

• The designers are asked to consult TII Publications to determine whether a Road Safety Audit is required,

• In the interests of maintaining the safety and standard of the national road network, the EIAR should identify the methods/techniques proposed for any works traversing/in proximity to the national road network,

• TII recommends that that applicant/developer should clearly identify haul routes proposed and fully assess the network to be traversed. Where abnormal 'weight' loads are proposed, separate structure approvals/permits and other licences may be required in connection with the proposed haul route and all structures on the haul route through all the relevant County Council administrative areas should be checked by the applicant/developer to confirm their capacity to accommodate any abnormal 'weight' load proposed.

The national road network is managed by a combination of PPP Concessions, Motorway Maintenance and Renewal Contracts (MMaRC) and local road authorities in association with TII.

The applicant/developer should also consult with all PPP Companies, MMaRC Contractors and road authorities over which the haul route traverses to ascertain any operational requirements such as delivery timetabling, etc. and to ensure that the strategic function of the national road network is safeguarded.

Additionally, any damage caused to the pavement on the existing national road arising from any temporary works due to the turning movement of abnormal 'length' loads (e.g., tearing of the surface course, etc.) shall be rectified in accordance with TII Pavement Standards and details in this regard shall be agreed with the road authority prior to the commencement of any development on site.

• Any grid connection and cable routing proposals should be developed to safeguard proposed road schemes as TII will not be responsible for costs associated with future relocation of cable routing where proposals are catered for in an area of a proposed national road scheme. In that regard, consideration should be given to routing options, use of existing crossings, depth of cable laying, etc.

In the context of the existing national road network, in accordance with the National Planning Framework National Strategic Outcome no. 2 'Enhanced Regional Accessibility', there is a requirement to maintain the strategic capacity and safety of the network. This requirement is further reflected in the National Development Plan, the Draft National Investment Framework for Transport in Ireland and also the existing Statutory Section 28 Spatial Planning and National Roads Guidelines for Planning Authorities.

There is around 99,000km of roads in Ireland, the national road network which caters for strategic inter-urban travel consists of only approx. 5.4% of this. There is a critical requirement to ensure the strategic capacity and safety of this national road network is maintained and significant Government investment already made in the national road network is safeguarded.

The provision of cabling along the national road network represents a number of significant implications for TII and road authorities in the management and maintenance of the strategic national road network and TII is of the opinion that grid connection cable routing should reflect the foregoing provisions of official policy. Therefore, TII advises that grid connection cable routing should seek to utilise available alternatives, as opposed to the strategic national road network contrary to the provisions of official policy.

Other consents or licences may be required from the road authority for any trenching or cabling proposals crossing the national road. TII requests referral of all proposals agreed and licensed between the road authority and the applicant which affect the national road network.

Cable routing should avoid all impacts to existing TII infrastructure such as traffic counters, weather stations, etc. and works required to such infrastructure shall only be undertaken in consultation with and subject to the agreement of TII, any costs attributable shall be borne by the applicant/developer. The developer should also be aware that separate approvals may be required for works traversing the national road network.

Notwithstanding, any of the above, the developer should be aware that this list is non-exhaustive, thus site and development specific issues should be addressed in accordance with best practice.

I trust that the above comments are of use in your EIAR preparation.

Yours sincerely,

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