



AVIATION TASK FORCE

Wind Energy,
radar interference
and mitigation strategies

COPENHAGEN OFFSHORE 2019
POST-EVENT SUMMARY
&
KEY TAKE-AWAYS

INTRODUCTION/BACKGROUND

Coleman Aviation Ltd has been commissioned by Wind Europe (WE) to provide a detailed summary of the Aviation Side Event and Conference Session held during WE's Offshore Event 2019 in Copenhagen on 27 November 2019.

The aviation events were held following the successful launch of WE's Aviation Task Force (ATF) earlier in 2019. The ATF was set up following a 'Call to Action' for an aviation focal point within WE during the last WE Wind & Aviation Event held in Hamburg in 2018. The inaugural ATF meeting was held in Bilbao earlier in 2019 where the focus was to determine how the ATF should fit in with WE's priorities and wider work.

The importance of working and collaborating with relevant stakeholders and the support of member nations, in particular National Trade Associations (NTA), was recognised such that learning experiences could be shared in order to harmonise best practice and future-proof potential aviation issues and solutions. Since the inaugural meeting, ATF's primary focus has been to:

- a) Gather evidence from across WE members and NTAs in order to develop a focused work plan for 2020 and beyond, in order to:
 - i. Work with European Union (EU) and pan-European stakeholders, and
 - ii. Investigate the potential for overcoming regional aviation issues;
- b) Review work carried out on Aviation Lighting and Marking;
- c) Support national events (e.g. Renewable UK's Wind & Aviation event).

It was equally recognised that there needed to be a work stream on radar interference and potential mitigation measures. Consequently, the main focus of the aviation sessions during WE Offshore 2019 was on radar issues associated with defence aviation stakeholders (in the Offshore Wind environment), as well as civil stakeholders. Both sessions heard from radar solution providers to understand and meet the requirements of the changing aviation sector and evolving national security needs; all the time recognising the move towards Net Zero, Carbon Neutral or fossil-free generation targets.

SCOPE

This Briefing Note will provide the following:

- Detailed summary notes of the Aviation Side Event and Conference Session;
- Key take-aways from the Side Event and Conference Session;
- An overview of possible solutions and mitigation strategies for radar interference with wind farms;
- Recommendations and next steps and key-actions for WE's ATF as it plans for its short to mid-term work.

SIDE EVENT: WIND ENERGY AND AVIATION

The Wind Energy and Aviation Side Event was chaired by Dujon Goncalves-Collins (Co-Chair, WE ATF) and opened by WE's CEO, Giles Dickson who outlined WE's vision for developing effective work strands for ATF. In particular, the TF's work should take account of the following:

- a) Policy and regulation for offshore wind farms should not run counter to aviation interests;
- b) Wind farm developers and industry bodies should work collaboratively with aviation stakeholders (civilian and military);
- c) Expected developments in offshore wind by 2050 (as outlined in WE's Report '*Our Energy, Our Future*' released on 26 November 2019), include:
 - Expansion of the supply chain (up to 20 GW per year);
 - Expansion of grid connections;
 - Changes of approach in spatial planning;
 - i. Multiple use of sea space;
 - ii. Close co-operation with civilian and military authorities;
 - iii. Fishing rights allowed within offshore wind farms.
- d) Potential growth in European offshore wind by 2050 from 20 GW to 450 GW.

Against this background, the theme of WE's Aviation Event 2019 was moving from 2018's theme 'Conflict to Co-operation' to one of '**Happy Co-existence**' between offshore wind energy and aviation.

In terms of radar issues, it was recognised that there were currently several mitigation measures available that minimise potential effects on the aviation sector and that these eliminate important planning constraints on onshore and offshore wind developments. However, it was also recognised that **development of mitigation processes requires strong political involvement and oversight in order that all relevant stakeholders have constructive dialogue**. This will be particularly relevant in terms of radar interference in the European sector where proactive and collaborative approaches are required between governments and wind energy stakeholders to support selection of appropriate mitigation solutions, not only on a project-by-project basis but on a national, and potentially international, strategic basis.

Experience from the UK in particular, where certain technologies are now available to mitigate the effects of wind farms on radar systems, is that the cost of these technologies is sometimes prohibitively high and that they have only been implemented on a case-by-case basis; not by means of a single, widely deployable mitigation solution. With this in mind, a range of presentations were provided by developers and technology suppliers with updates on their involvement in development of radar mitigation solutions.

Landscape Setting. Hywel Roberts from Orsted provided an industry outlook on the challenge of co-existence between offshore wind and aviation radar service providers; this included a UK-case study involving Air Defence Radar (ADR) mitigation. The key points from this presentation were as follows:

1. The ADR problem:

- a) Wind turbines produce complex clutter on ADR radar displays, desensitisation and impairment of tracking function;
- b) Co-existence requires credible mitigation options (both operational and technical);
- c) Competing national policies (aviation, defence and energy) make this a societal challenge;
- d) Resolution can only be achieved with:
 - i. Early engagement;
 - ii. Cooperation; and
 - iii. Collaboration.

2. UK Case-Study – TPS-77 ADR¹:

- a) UK ADR mitigation for TPS-77 radars (purchased for UK Ministry of Defence [MOD] by wind farm developers) with built-in mitigation technology now being re-considered by UK MOD;
- b) Processes currently in place for existing TPS-77 mitigation (3-Dimensional Non-Automatic Initiation Zones [3-D NAIZ]) but alternative solutions now need to be considered;
- c) Alternative solutions need to be agreed with MOD and updated processes put in place for delivering new solutions;
- d) Problem is one of timescale with numerous offshore developments due to be constructed within 3-5 years;
- e) UK developers reaching out to understand and resolve challenge (through a Market Survey);
- f) Aviation Task Force set up jointly between Offshore Wind Industry Council (OWIC) and MOD; now meeting monthly;
- g) Concept Demonstrations of potential solutions, organised by MOD, expected Q3-Q4 2020. Interim solutions being considered for developments building within next 3-5 years;
- h) Collaboration between developers and MOD is key and will continue to be so.

¹ The AN/TPS-77 is a three-dimensional, tactical transportable, long-range air surveillance radar with the range of 470 km.

Technical Solution Providers. Updates were provided from some of the technical solution providers for radar mitigation. The key points from their presentations were as follows:

1. **Trelleborg – Stealth Technology.** Dr Adam Nevin from Loughborough University provided an update on the Knowledge Transfer Partnership initiated between Loughborough University and Trelleborg to develop stealth technology:
 - a) Advances have been made in developing effective Radar Absorbent Materials² (RAMs);
 - b) Potential to provide some certainty to the industry and prevent electromagnetic interference saturation;
 - c) Known as Full Radar Absorbing Materials and Equipment (FRAME):
 - Loughborough research has discovered fillers for future RAMs;
 - Fillers are incorporated in polyurethane to give 'FRAME' product;
 - Claimed to absorb over 99% of radar wave to make the coated object 'stealthy';
 - Compatible with multi radar frequency bands;
 - d) Trial carried out in September 2019 using L-Band radar against single turbine. Results successful;
 - e) Suggested for use as part of a 'toolbox' of solutions. Potentially in conjunction with radar filtering;
 - f) Can be provided at low cost although cost models not yet devised;
 - g) Potentially commercially available within 1-2 years.

2. **Thales.** Steve Smith, Windfarm Sector Lead, Thales Land & Air Systems (and Co-Chair, WE ATF) provided a technology provider's view of radar mitigation deployment concepts, development of requirements and evaluation and testing. The key points were as follows:
 - a) Thales part of ongoing programme to replace all UK MOD ATC radars (Project MARSHALL) and involved in Project GREEN BLADE (Scottish Power Renewables trial to develop and test the Aveillant Theia 3-D Holographic radar against offshore wind farms);
 - b) Meeting immediate needs for UK MOD ADR offshore windfarm mitigation and onshore/ATC radar mitigation will provide reference solutions that can be replicated within Europe;
 - c) Work to meet Dutch defence windfarm performance requirements have commenced.

² Radar-absorbing material (RAM) is a specialist class of polymer-based material applied to the surface of stealth military aircraft to reduce the radar cross-section and thereby make them harder to detect by radars ([Introduction to Aerospace Materials, 2012](#)).

- d) Numerous authorities involved (MOD, Civil ATC) but do not have definitive technical requirements which results in wide variety of deployment concepts being considered; with a range of costs and benefits;
- e) Requirements need to be pragmatic and detailed but feasible.

Note: *If every stakeholder / jurisdiction / authority originates on requirements, it may prove impossible solutions to meet this ‘super-set’ of differentiated solutions; unnecessarily complex/costly outcomes.*

Potential role for WE ATF: *attempt to collate a ‘lowest common denominator’ set of requirements to avoid a tendency towards the ‘highest common denominator’*

- f) Existing radar technologies can be adopted and adapted to provide effective mitigation in an offshore environment;
- g) Test and evaluation of a range of solutions is needed that are suitable for different situations – results should be shared;
- h) Regional solutions should be considered;
- i) Best practice should be shared between aviation stakeholders (convergence/economy of scale);
- j) Dialogue between all stakeholders in a neutral environment is essential to establish trust;
- k) Funding is critical and political engagement essential.

3. **Terma.** Michael Riis from Terma provided an update on use of the Terma Scanter 4002 radar for wind farm mitigation. Key points as follows:

- a) Terma radar now deployed at 7 locations in the UK and one location in the Netherlands:
 - Chester Hawarden Airport;
 - Newcastle Airport;
 - Edinburgh Airport;
 - Prestwick Airport;
 - Glasgow Airport;
 - Durham Tees Valley Airport;
 - Southampton Airport; and
 - Wemeldinge (Woensdrecht Air Force Base).

b) Provides 360° coverage up to 40 nautical miles (nm) range; based on existing product which is commercially available:

- High resolution;
- High dynamic range;
- Advanced tracker capability;
- Adaptive clutter maps;
- Adaptive Constant False Alarm Rate (CFAR).

c) Terma technology also successfully in operation for Obstruction Light Control (OLC):

- 4 systems in operation (in Denmark);
- 13 systems ordered (Denmark and North America).

d) Challenges have been:

- Different regulations in different countries;
- Different requirements (civil/military);
- Individual requirements (user/site specific);
- Creating shared/common interest among stakeholders.

e) Lessons learned – Importance of:

- Collaboration with stakeholders;
- Inclusion of all stakeholders;
- Political interest/engagement.

4. **Aveillant (Project Green Blade).** Anne Mackenzie (Scottish Power Renewables) provided an update on development of the Aveillant Theia 3-D Holographic Radar for Project GREEN BLADE. Key points as follows:

- a) Configurable and scalable 3D staring radar;
- b) Also used for detection and tracking of small Unmanned Aerial Systems - e.g. drones;
- c) Aveillant acquired by Thales in November 2017;
- d) Project GREEN BLADE Phase 1 complete – operating range successfully extended to 54nm;
- e) Phase 2 (trial against offshore wind farms) to be conducted Q3 2020 to Q2 2021;
- f) Theia technology lends itself to a network approach to surveillance;
- g) Predicted to have through-life costs lower than traditional radar systems.

Panel and Audience Interaction Discussion. A lively interactive discussion followed the presentations in which topics were introduced by the Chair (Dujon Goncalves-Collins, Vattenfall and co-chair of the ATF):

1. **WE Influence over EU Regulations.** Discussion points as follows:
 - a) Growth of offshore wind (to 450 GW) seen as a ‘game-changer’ in terms of European Infrastructure;
 - b) Wind farms are now an enduring part of the environmental landscape;
 - c) National policies need to be introduced to ensure government departments (Defence, Energy and Transport) work collaboratively together;
 - d) Funding for technology development (radar mitigation) should be centrally managed with costs shared across governmental departments;
 - e) Netherlands has introduced a similar model; smaller countries can demonstrate way forward to larger countries.
2. **Development of Technical Requirements.** Discussion points as follows:
 - f) Are they required? Consensus that Requirements are required but must not be overly restrictive; detailed yet pragmatic;
 - g) ‘Tool-box’ approach. Individual countries need to work out their own specific needs;
3. **Nationally Critical Infrastructure.** Discussion points as follows:
 - h) Should Offshore wind farm be declared, and treated as, Nationally Critical Infrastructure?;
 - i) Could funding for mitigation/security be held at the highest government level (Treasury via government Energy department)?;
 - j) Could Risks be managed by means of National Risk Registers; understanding that offshore wind farms can be located outside national boundaries?

Panel Members Key Take-Aways:

- Policy/regulation to be understood for protection of offshore wind farms as Nationally Critical Infrastructure;
- Governments’ commitments to wind farm GW output need to be rationalised cross-government;
- Provide ATF with tasks to progress influence of WE in EU policy/regulations;
- Political engagement seen as key to resolving wind farm/aviation issues smoothly;
- Security of wind farm energy supply needs to be protected and authorised at the highest level – Is there potential for introduction of EU regulations on radar mitigation?

CONFERENCE SESSION: HAPPY CO-EXISTENCE – AVIATION AND MILITARY

The aviation conference session was themed *'Happy Co-existence between Aviation and the Military'*. Presentations were provided by:

- **Kåre Clemmesen, Deputy Director General, Danish Transport** on *'The regulators perspective; Aviation safety and the wind industry'*. This presentation focussed entirely on Aviation Lighting and Marking;
- **Captain (GS) Jan De Beurme, Chief of Staff, Belgian Navy** on *'Maritime security, governmental operations and windfarms'*;
- **Rose Galloway Green, UK Department for Business, Energy & Industrial Strategy (BEIS)** on *'Mitigating Air Defence Issues through the Offshore Wind Sector Deal'* (due to UK General Election protocols known as *purdah*, Dujon Goncalves-Collins who is leading the OWIC Aviation Workstream represented the Sector Deal work on the panel in lieu of Rose);
- **Anne Mackenzie, Scottish Power Renewables (SPR)** on *'Project Green Blade'*;
- **Dr Adam Nevin, Loughborough University and Trelleborg** on *'Stealth technology'*.

The presentations were followed by a panel discussion with the presenters responding to questions from the audience interacting via Slido. Much of the presentation content re-iterated the issues discussed during the Side Event, however, the key discussions points from other presentations were as follows:

1. Kåre Clemmesen's presentation made the point that there were no over-arching EU regulations (outside Aerodromes) for Aviation Lighting and Marking. This had resulted in different implementation of International Civil Aviation Organisation (ICAO) Standards and Recommendations; something which would be useful to consider in development of radar mitigation strategies.
2. Captain (GS) Jan De Beurme's presentation provided an excellent example of how the Belgian Navy had embraced the presence of offshore wind farms and developed procedures and practices to the benefit of all maritime users. Belgian Navy tasks include Coastal Security, Naval Mine Countermeasures, Surface Combat and Harbour Protection.

Key discussion points were as follows:

- a) Belgian Navy had been pro-active in engaging with wind farm developers;
- b) Chose (not directed by government) to engage early which has resulted in day-to-day dialogue with wind farm operators and the Coastal Security Operations Centre;
- c) Mature Coastal Security capability has been developed;

- d) National military departments need to accept that wind turbines exist and are only set to expand;
- e) Belgian Navy extremely pleased that WE reached out for a military perspective;
- f) WE could play a key role in collaboration with the European Defence Agency (EDA) and potentially EU Aviation Safety Agency (EASA);
- g) Other nations' Defences/Navies should adopt the roles of protecting offshore wind farms as Nationally Critical Infrastructure;
- h) Key issues to success:
 - Co-ordination (2-way) to involve mutual use of networks, radars and data-sharing;
 - Co-operation between government departments and at the operational level;
 - Counter-threats including use of civilian and military-operated assets (drones, radars etc).

3. Rose Galloway Green's (BEIS) presentation outlined the UK's Offshore Wind Sector Deal that was launched in March 2019 with commitments on continued support for offshore wind as well as targets on diversity and the UK supply chain.

Key discussion points as follows:

- a) Sector Deal is a partnership between the offshore wind sector and UK government. Builds on UK leadership in offshore wind, maximising advantages from clean growth. Follows 9 other sector deals, such as nuclear/rail aimed at boosting productivity, employment, innovation and skills;
- b) Sector Deal makes specific mention of radar/aviation issues and government commitment to work collaboratively with the offshore wind industry;
- c) UK MOD has 'signed up' to the Sector Deal which is an important step in getting the MOD to recognise offshore wind farms as part of the nation's existing and future environment. Resulted in recent creation of joint MOD/OWIC ADR Task Group;
- d) BEIS recognise that there may not be a 'silver bullet' in terms of radar mitigation; but turbines are set to increase in height which will only compound the impact on radar systems.

Panel Discussion and Slido Audience Questions. Following the presentations, the presenters took part in a panel discussion chaired by Anu Eslas, CEO of the Estonian Wind Power Association (EWPA):

1. **Barriers to 'Happy Co-existence'.** Discussion points as follows:
 - a) National government strategies are not aligned;
 - b) Wind industry tempo much faster than government department tempo;
 - c) Defence need to implement slicker processes; wind industry needs to understand military issues/barriers;
 - d) Private/Public Co-operation; look for ways to share information/assets (radars, cables, data etc);
 - e) No EU policy/regulations;
 - f) Better collaboration required with EU counterparts (defence, civil aviation authorities);
 - g) Offshore wind farms, is there need for them to be designated by nations as Maritime Critical Infrastructure;
 - h) Collaboration between offshore wind and aviation (civilian and military) needs to be promoted as a 'Win-Win' for both sides;

2. **Agencies for Potential Collaboration.** Consideration should be given for WE to liaise/collaborate with the following agencies:
 - a) **NATO.** Collaboration with NATO should be considered;
 - b) **EDA/EASA.** Well suited as established agencies to assist with collaboration across European nations. Innovations by wind industry can be beneficial for defence (e.g. joint funding of radar systems);
 - c) **Centre for the Protection of National Infrastructure.** UK government authority which provides protective security advice to businesses and organisations across the national infrastructure.

OTHER POSSIBLE SOLUTIONS AND RADAR MITIGATION STRATEGIES

The Aveillant and Terma solutions presented at WE Offshore 2019 are widely recognised as likely front-runners in delivery of ATC radar mitigation solutions. In terms of Air Defence Radars (ADR) mitigation however, the requirements are different; ATC radars are 2-Dimensional (2-D) whereas ADRs are 3-D. The Aveillant 3-D Holographic could be a natural fit for ADR mitigation provided it can be developed to the satisfaction of the Air Defence community. There are also numerous other technology providers working on wind farm-tolerant radars with built-in filtering systems. While these filters aim to mitigate the impact of wind turbines on radar displays, they often do so at a cost with the integrity of the radar's performance being compromised; this is where emerging stealth technology could prove useful.

In terms of other technologies with the potential to mitigate radar systems, the UK MOD recently went out to tender for an additional study and potential trial for ADR mitigation. The tender document specifies a *"Paper-based Feasibility Study and Possible Future Demonstration of Mature Solutions for Improving Air Surveillance for the Purposes of Air Defence in Airspace affected by Wind Farms"*. Full details can be found at following [Link](#). Close liaison with UK MOD is recommended to ascertain whether any information from this study can be released. The deadline for tenders was 31 January 2020.

Recommendations and next STEPS

It is recommended that WE ATF:

1. Open up dialogue and liaison with the following international aviation agencies to investigate policy and regulation options associated with wind farm radar mitigation:
 - a) EDA;
 - b) EASA;
 - c) NATO;
 - d) European national Defence agencies;
 - e) Regional/International Defence agencies (e.g. North Sea, Baltic Sea, United States of America);
2. Liaise with a Centre for the Protection of National Infrastructure to understand the potential scope for categorising offshore wind farms as Nationally Critical Infrastructure;
3. Open up dialogue with EU and other relevant non-EU governments regarding recommendations for cross-government funding of national, and potentially international, radar mitigation solutions;
4. WE ATF: attempt to collate a 'lowest common denominator' set of requirements to avoid a tendency towards the 'highest common denominator'?
5. Set up an information hub on WE website for WE members to review latest developments on radar mitigation.

DOCUMENT DETAILS

Title	Wind Europe Offshore 2019-Aviation Side Event and Conference Session-Post-Event Summary & Key Take-Aways
Reference	CAL/WE 20200131
Issue	Draft V3
Date	6 February 2020
Classification	-
Distribution	Dujon Goncalves-Collins (Co-Chair WE ATF), Mattia Cecchinato (WE)