Dear Caroline,

Having read, absorbed and considered the information so generously provided by the CAA, the strong opinion is of one fundamental question remaining, namely, who has the ultimate responsibility for aircraft safety in the UK, including how this responsibility is exercised/implemented in practice. What follows is the reasoning behind this concern. I have concluded by taking the liberty of making a number of suggestions to clarify the role of the CAA. Thanks are also offered for the time taken by your expert Mr. James Walker and yourself in compiling the response. Having also had a separate call from another branch of the CAA to make sure that the contact had been made, I am copying James with this email as his further thoughts on the subject will obviously be valued.

These are the notes of the telephone conversation held with Mr. Walker:

1. It was stated that the FoI questions will be answered in whatever manner possible under the terms of the FoI rules which are to provide information held.

2. Also provided will be an explanatory coverage of the subject to avoid the impression being given that the CAA is unwilling to answer outstanding concerns.

3. No effective software is on the market just yet.

4. If planning permission is granted for any turbines – the Airport is fully responsible for passenger safety. It was stated that if any future software which is developed which can effectively differentiate between turbines and aircraft, that would provide mitigation not for the wind farm, but for the airport.

5. I believe agreement (albeit reluctant) was reached that gliders are at particular risk from wind farms as they have little no control over where they land if the thermals on which they ride disappear. If this happens to be in the vicinity of a large wind farm, that could present them with a problem. The same of course would apply to any aircraft suffering engine failure which is on a glide path for a crash landing.

The conversation included comments relating to visual flight rules being such that heights of 6,500 ft. have to be kept to if pilots are not talking to Air Traffic Control (ATC). If conditions are good they may fly lower. All wind farms are plotted on maps which enable pilots to fly around developments. This is where the 2 types of radar in use become relevant.

Type 1. Primary radar – sending out radio transmissions which bounce back and are seen as returns on the radar screen.

Type 2. Secondary radar – sends out signals to aircraft for purposes of identification, picked up by on-board transponders.
The transponder is carried on the aircraft, and “squawks” on a known frequency to the tower. The transponder’s squawk is picked up by the tower, which squawks back. This enables each to know the position of the other. Transponders are not yet compulsory on all General Aviation aircraft, but they are on passenger, freight and military aircraft.

It was re-affirmed that no software has been approved anywhere - but that it is being developed - to assist ATC. A transponder mandatory zone is likely to be imposed for most airports to assist ATC. If permission for a wind farm is applied for, the airport will be required to respond as a consultee. In the case of military establishments, this is done by Defence Estates

End of notes.

To me it is clear that the effects of turbines in close proximity to airports have already required a huge amount of expensive 'accommodation.' We could not agree that the software in question (yet to be developed/approved) as an 'assistance' to ATC must therefore be an enhancement of passenger safety.

The questions/points arising are as follows:

Say that a wind farm is planned, and the CAA, or NATS En Route, or the MoD through Defence Estates objects on the grounds of possible interference with ATC (or MoD) radar. The position of the turbines cannot be altered significantly. The airport concerned, which employs the CAA or NATS En Route to run its ATC function, says that it cannot withdraw its objection. What happens?

Ans.1. The wind farm developer withdraws his application.

Ans.2. The wind farm developer tries to argue that there there is a "reasonable prospect" of the development of a new radar which will work and can differentiate between wind farm clutter and incoming aircraft, say within three years. A suspensive condition is then applied which says that "when the (new) radar is operational" and "commissioned" then and only then can the wind farm be built.

Ans.3 The airport and the developer develop a "switch off protocol" which allows the airport to demand WF switch off for periods when the clutter is (in the opinion of the CAA/NATS) causing such difficulty to ATC operations that the two cannot coexist. Wind farm developers are unlikely to support such an option, but there is at least one example where they have at Harburnhead, in West Lothian).

So the discussion I first had only appeared to confirm that there is no failsafe, and no radar equipment yet available which is *guaranteed* to do the job. We are left with the situation that no radar supplier is going to guarantee that human life will not be placed in danger.

It would seem that the CAA response perhaps has inherent contradictions within it. For example, if, following the logic of the following quotes from the letter:

a. "The CAA does not claim that industrial wind turbines are not a risk to aviation safety. However, as an independent aviation safety regulator we can only point out the risks that wind turbines can cause to aviation safety and which can directly or indirectly impose a contributory risk to the overall safety of a radar service provided to aircraft."

So does this not render the CAA powerless only being able to stand by and 'wring their hands?'

b."The CAA requires ANSPs to conduct a risk assessment to establish whether they can provide a safe service and submit a safety case to the CAA for our approval. It is not the CAA that will judge that risks exist at a particular turbine site or not."

So again, the CAA ensures that a procedure is followed - but otherwise stand by and watch. The question remaining is how they judge the adequacy of both the risk identification and proposed solutions?

c."Also the CAA, as an independent safety regulator, is not in a position to declare or recommend any one solution by a specific manufacturer."

Can the CAA instead recommend a generic kind of radar solution without a maker's mark? That seems improbable.

d. "It is the provider of the aviation services (the Air Navigation Service Provider (ANSP)) who needs to claim and make arguments that the service they are providing is safe. This claim is based on the number of occurrences of different severity levels that can occur if the mitigation fails to work."

If this is understood correctly, the meaning is that the CAA judge the adequacy of the proposed solution on the results if it does not work, as calculated by the ANSP which has both a vested interest in the approval being sought, but also a vested interest in any solution being effective. This seems to be saying that the ANSP is both poacher and gamekeeper, whilst the CAA does not test the validity of the claims. Is that a correct conclusion?

e."It is the ANSP that has to take ownership of the safety argument that they present to the CAA, and this is to ensure that the risk is mitigated to an acceptable level and it is no guarantee that no occurrences will happen as a direct result of wind turbine interference on radar systems. Both ANSPs and vendors of such solutions are only required to comply with European law...and are not required to provide specific guarantees."

This makes it clear that "the buck stops" with the ANSP, but that the CAA has some oversight. The question is; what is that oversight?

The entire argument above is called into question by stating:

f."If an ANSP in the UK wants to implement any such solution, be it software or other type of mitigations, they are required to submit a safety case to the CAA Northern Regional Office and we will only approve such solution after satisfying ourselves that the risk has been mitigated to an acceptable level and that all arguments and associated evidence are robust." So that must mean that some "standard" or "criteria" is/are applied.

Again, we are left asking - who would purchase a piece of radar software for radar mitigation scheme (RMS) purposes on the basis that it was accurately described as a piece

of software that would do that? If an ANPS buys software that will get planning approval, and that software does not work, what then? The fact remains that a pilot has to plan his altitudes for safety, but aircraft have been known to develop faults and plans have to be changed. If we imagine a struggling aircraft (heavy, light or helicopter) in bad weather with low cloud (therefore a low approach)... will the software save the day? If the developer is challenged about this, he cannot claim this is a solution, it is but an aid. In any event, the likelihood is that a windfarm developer does not have the knowledge. The bottom line is that if it doesn't always work, then it ***should not*** be sold as 'radar mitigation software'.

Of relevance is case PPA-280-2022 :https://www.dpea.scotland.gov.uk/CaseSearch.aspx?T=1
Page 43.

'CONSIDERATION OF POTENTIAL MITIGATION' (My emphasis.)
6. NERL has engaged with the applicant in an effort to identify and agree mitigation measures for the adverse impacts that would be caused by the Proposed Development.
7. No satisfactory mitigation is currently available to NERL for the adverse impacts of the Proposed Development and could not be achieved through use of existing radar infrastructure of NERL.
8. The applicant is suggesting mitigation for impacts through "blanking" works being carried out by NERL, most likely within the Prestwick Centre surveillance data processing and display system in order to remove "false plots" that will be created by the Proposed Development, combined with the provision of replacement data from third party "in-fill" radar feeds.
9. Such mitigation proposal involves modifications to the safety critical infrastructure of NERL which is used in the provision of air traffic management operations, and therefore delivery is outside the control of the Developer. In addition replacement data from suitable third party radar(s) would be required in order to provide satisfactory mitigation. As a consequence, the delivery of mitigation is currently outside the control of both the Developer and NERL.
10. NERL will continue to engage with the Developer regarding potential mitigation for adverse impacts to NERL's infrastructure and operations. In the event that suitable mitigation is not identified and agreed, then NERL will maintain its objection.'

With the above in mind - who then is responsible when/if it all goes wrong? The third party, the developer or NERL?

The opening lines of this letter pointed to the fundamental question, which remains as - who has ultimate responsibility for aircraft safety in the UK? Admittedly, this is not only a radar issue. For example, turbines fail without warning through metal fatigue incidents sometimes involving blades, or nacelle fires, lightning strikes etc., (laughingly termed by the industry as 'component release'!) In respect of such incidents I have attached a submission made to the recent Australian Senate Inquiry as it appears relevant.

It cannot just be the airport, since the aircraft will cross over or near several in its flight. Is it NATS EN Route and the MoD? The individual Air Navigation Service Provider? Is there more than one - and who decides that a consistent approach must be followed? Is this not in fact, the CAA?

May I emphasize that I have no wish to offend by asking these questions, and I do very much appreciate your thoroughness.

Returning to the realm of FoI, which is where I began, may I ask for consideration of the above, and ask these supplementary questions:

1. Is there an overarching responsibility within the UK for setting radar tolerances and standards in this area, delineating in particular the extent to which visible windfarm clutter is permissible?
2. If yes, where can I find it, and who sets these standards?
3. If no, then does the "clutter tolerance level" (my phrase) at any Airport depend, in the ultimate analysis, on the professional judgment of the radar operator in any given situation?

These are serious issues as airport safety clearly matters to all concerned, not least the travelling public. It is especially relevant in Scotland in respect of the ever increasing size & scale of Glasgow Airport's near neighbour, the Whitelee wind farm development, together with any plans to site turbines in similar locations both here & around the world.

This letter is being copied to the Scottish Government in respect of FoI/15/01068 and the M.O.D. in respect of FOI2015/04988. As a recipient of the original FoI, it is hoped that the M.O.D. are also considering the following disturbing possibilities as we (sadly) live in dangerous times. Although we all pray never to see it, should there ever be a situation where a hostile aircraft or helicopter is being sought in the vicinity of a major target with a wind farm nearby, a serious problem would presumably occur. If this is understood correctly, where large numbers of wind turbines exist in proximity to each other, even with the radar mitigation software in place, it is likely that gaps in radar coverage will occur due to clutter and rows of turbines overlapping each other, and that a hostile aircraft would have the opportunity to take advantage of these to 'conceal' themselves from approach radars. This I am told, is what ground attack is all about – use of terrain and obstacles to conceal low-flying aircraft until it is too late for the defences to react. E.g. the low-flying Cruise missiles flying down the streets of Baghdad below the level of nearby buildings and also below the radar which was negated by the obstacles the higher buildings created.

This example is being used to establish that this is what a wind turbine does, but with the added problem of blade movement. Blade movement is understood not to be constant (wind dependent) or identical even for the same turbine, as sometimes the turbine will 'yaw' to 90 degrees to the radar – i.e. sideways on, and so the blades, except in height, are invisible. They then 'yaw' to fully face the radar, and given the size of some of these blades, must be larger than the wings of most aircraft. So unless some kind of coating is developed that reflects radar beams in a different way to distinguish the turbines, or electronic signals equipment is permanently installed to similarly illuminate the turbines in electronic terms, simply 'blanking out' large numbers of turbines is like cutting holes in your television screen – you lose the turbines, but also everything else in that block of screen.

No doubt some bright engineer will eventually come up with a solution, but even this will not solve the problem of a turbine shedding pieces (which is believed to be much more

frequent than admitted) and the pieces moving outside the 'blanked out' area and becoming new radar contacts themselves.

Although still an unwelcome risk, the real concern is less the single-engined aircraft traffic, with a small number of occupants, but rather a 'perfect storm' incident with a large passenger-carrying airliner with several hundred people on board. It will only take the one accident out of the millions of flights into our very cluttered UK airspace. Would we then have the wind industry stating – 'well you shouldn't have approved our proposal if you had doubts about aircraft safety?' This brings us full circle to why the CAA should surely be making the wind industry undertake all the work on the matter, provide the solution and demonstrate that it works, and fund the installation with appropriate guarantees that it *does* work.

Of interest is Chapter 5. (Aerial Activities) of the recent final report to the Select Committee of the Australian Senate on wind power, which also confirms as highlighted, that in general there are gaps in the overall legislative powers & requirements. These appear to an extent, to be mirrored in the U.K. See Appendix 1. In respect of section 5.39. Please can you confirm that the UK also has a wind turbine exclusion zone around all UK airports? If so, it would also be useful to know what the distance is.

Appendix 2 covers wind turbines vs weather radar. It widens the terms of reference and provides yet another reason for all matters related to this technology to be collated on a global basis.

CAP 764. CAA Policy and Guidelines on Wind Turbines makes for uncomfortable reading resulting in more questions being raised than answers. For example, see Appendix 3 (b)re. Loss of receiver sensitivity. 4.2. In respect of the possibility of wind turbines adversely affecting the quality of radio communication between Air Traffic Controllers and aircraft under their control, it is admitted that there is a need for ***significant*** work to be undertaken.

Whether the public are aware of the stark reality that the CAA are powerless to refuse permission for any wind power development in the U.K. is unknown. It is however notable that (circa 2010/2011) the US Federal Aviation Administration (FAA) refused permission for two 334 ft. wind turbines at the Highland Centre in Truro, MA, USA, within the National Park Service's Cape Cod National Seashore. The decision was unsuccessfully appealed by the developer CCNS - who had previously been informed by the FAA that the maximum permissible height for such a project was "zero feet." Also that the towers would undoubtedly interfere with the operation of the radar and would pose a ***significant health risk*** -- in violation of Occupational Safety & Health Administration (OSHA) rules -- for anyone working on the machine, in the direct beam of the radar.

To prove that the CAA are not being intimidated by the political clout of the wind industry, a statement from the CAA that they oppose any wind turbines in the vicinity of airport runways and flight paths on the grounds of passenger safety, would certainly receive strong general public support. Likewise a letter from the CAA to council planners, advising them that they (the CAA) accepted no liability if the application for a wind farm was approved

over their objections or those of the local airport provider, and that all liability rested with those taking the decision, would concentrate minds wonderfully.

In conclusion, is there any reason why the public should not be asked whether the CAA, the M.O.D. and the Scottish Government should now insist that the wind industry should no longer be able to say, in effect, 'We'll provide the problem and you provide the solution – and at your own cost?'

Yours sincerely,

Christine Metcalfe.

APPENDIX 1. From final report to the Select Committee of the Australian Senate on wind power. (My emphasis.)

5.38 The Civil Aviation Safety Authority (CASA) provided evidence to the committee about the limited role it plays in regulating airspace around wind farms:

We know our responsibilities and the power of our legislation, which is very limited. For the most part, wind turbines are built away from aerodromes and certainly away from federally leased aerodromes. So the only power that we have is to make a recommendation to the planning authority about whether the turbine is going to be an obstacle and, if we decide it is an obstacle, we can make a recommendation as to whether it should be lighted and marked. That is the extent of our power.[47]

5.39 The Crookwell Aerodrome in southern NSW—where a proponent was seeking to develop a wind farm in proximity to the aerodrome—was discussed at the Canberra hearing. Prior to construction of the adjacent wind farm, representations from the AAAA led to CASA recommending an exclusion zone around the aerodrome of 3 600 metres. In this case, 11 wind turbines were not constructed in order to comply with the exclusion zone.[48] This appears to be the extent of CASA's involvement in regulating airspace near wind farms.

5.40 Mr Terry Farquharson of CASA told the committee that 'there are some indications of people who might be close to below the level of the turbines suffering or experiencing some degree of turbulence'. Further to this CASA officials admitted that more research need to be conducted in this area; however, CASA noted that they were currently not resourced to undertake this 'tricky and expensive' research.[49] Turbulence will be discussed in more detail in the crop management section.'

Appendix 2. As reported on the Wind Action site.

Wind Turbines vs. Weather Radar in Tornado Ally (Nebraska showdown)

(10 AUG) NEBRASKA | USA - Accepting these mitigation measures without fully understanding their effectiveness could place the lives and property of Nebraskans at risk. → MORE

Appendix 3. CAP 764. CAA Policy and Guidelines on Wind Turbines (My emphasis.)

'Chap 2. b)
Loss of Receiver Sensitivity
Wind turbines can cause conditions leading to the loss of sensitivity in detection to such an extent that the aircraft returns are completely lost. Radars use an adaptive algorithm to detect target returns against a background of noise, clutter and interference also referred to as CFAR (Constant False Alarm Rate). The received echo at the radar receiver comprises the wanted echo signal
from the aircraft and the unwanted power from internal receiver noise, as well as external clutter and interference. The role of this algorithm is to determine the power threshold above which any return can be considered to probably originate from a target. This threshold may rise and fall depending on the noise, clutter and interference present in various areas within coverage.

Clutter, including wind turbine clutter, can cause the threshold to rise resulting in complete loss of detection of lower energy targets. This can lead to a lowering of the probability of detection of aircraft in the region of the clutter. This unwanted energy reflected back from the wind turbine will remain and affect the thresholds whether or not the turbines are rotating. Although the returns from
the stationary parts of the wind turbine may be filtered out and prevented from being displayed by using the Doppler filtering techniques, the loss of detection capability due to the high receiver thresholds is difficult to prevent;

4.2 The CAA has been made aware of research that indicates the possibility of wind turbines adversely affecting the quality of radio communication between Air Traffic Controllers and aircraft under their control. Significant further work is required to establish the extent, likelihood and severity of the issue. Until further information is available, issues concerning wind turbines and VHF communications should be dealt with on a case-by-case basis and reference made to the guidance contained in Section GEN-01 of CAP 670. Information regarding the technical safeguarding of aeronautical radio stations at aerodromes, including examples of the minimum
dimensions for those areas that must be safeguarded, is contained in GEN-02 of CAP 670. However, aerodrome operators and ATC service providers are advised to consider each proposal carefully and if necessary, seek specific technical advice.'

Acknowledgements.
Although technically qualified in their respective fields, none of the discussion group have specific qualifications in radar, so this subject has been discussed with colleagues using a common sense approach. I should like to acknowledge the particular input and contributions from just some of those involved:
Mr. Dan Kane. ACIS, PgDip MCH, MA, DA.,
Mr. John Joseph Dooley. Engineer.
Mr. George Lindsay. BSc, PhD
Mr. David O'Neill. IT engineer.

Although little is generally yet known in public circles about such issues, rising levels of interest in this subject have been shown to date by experts & citizens in the UK - including from the USA, Australia & Europe, a few of whom are listed below:

Professor Anthony Trewavas FRS. FRSE Institute of Molecular Plant Science	U.K.
Martin Livermore. Scientific Alliance.	U.K.
Angela Kelly. Chairperson Country Guardian.	U.K.
Nigel Willis. Retired M.D.	U.K.
John O'Sullivan, CEO of Principia Scientific International.	U.K.
Susan Crosthwaite. Tourism expert. Community Councillor, EPAW spokesperson	U.K.
Stuart Young. member of Scientific Alliance Scotland and author of "Analysis of UK Wind Power Generation November 2008 to December 2010" ("the John Muir Report")	U.K.
Alun Evans MD. Professor Emeritus Centre for Public Health The Queen's University of Belfast Institute of Clinical Science.	Eire.
Dominic Mette. Retired engineer.	France
Mauri Johansson, MHH Specialist in Community and Occupational Medicine, including Environmental medicine.	Denmark.
Lilli-Ann Green.	U.S.A.
Mark Duchamp. Chairman, World Council for Nature.	France
Mr. Ilkka Alasaarela, MSc. Physics Mr. Janne Alasaarela. Mrs. Virpi Poikolainen, BSc. Physiotherapy	Finland.
Sherri Lange. CEO NA-PAW.	Canada/USA
Madeleine Kura. Cesme.	Turkey