Managing the Impact of Wind Turbines on Aviation

Prepared by the Airspace & Safety Initiative Windfarm Working Group in consultation with DCLG, RTPI, and Planning Officers

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- This short presentation has been designed and developed by a multi-disciplinary group of aviation and renewable energy stakeholders, in consultation with experts from the UK planning environment.

- Members of the Airspace and Safety Initiative Windfarm Working Group (ASIWWG) would like to thank DCLG, RTPI and those Planning Officers who were able to assist us in the formulation of this guidance package.

- The ASIWWG consists of representatives from the Civil Aviation Authority (CAA), Ministry of Defence (MOD), Department for Transport (DfT), Department for Energy and Climate Change (DECC), National Air Traffic Services (NATS), General Aviation Awareness Council (GAAC), Airport Operators Association (AOA), RenewableUK and The Crown Estate.

Aim

- To provide concise and useful information for Planning Authorities throughout the UK for use when considering planning proposals that concern wind turbines and their potential impact on aviation

- To be read in conjunction with the National Planning Policy Framework and CAP 764: CAA Policy and Guidelines on Wind Turbines

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- The aim of this short presentation is to provide concise and useful information for Planning Authorities throughout the UK for use when considering planning proposals that concern wind turbines, and their potential impact on aviation.

- It has been designed to complement existing policy and guidance available through the Civil Aviation Authority Publication 764 (CAP 764) and its associated web pages and to be used in conjunction with the National Planning Policy Framework. Information given is aimed at the non-aviation specialist, and intends to impart a flavour of the issues involved, without seeking to turn Planning Officers into instant aviation experts. Where possible, we have aimed to explain technical subjects in as non-technical manner as possible. Further advice and explanation is always available through the aviation stakeholders listed at the end of this presentation.

Scope

- Introduction and Definitions
- Impacts on Aviation
- Mitigations
- Interested Parties and What to Expect
- Relevant Documents and References
- Useful Contacts
- Glossary

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- We will start with some introductions and definitions, which are necessary to gain understanding of the complexity of both the subject matter, and also the stakeholders involved. The impacts on aviation will be explained, and then linked to potential mitigations, although it will be stressed throughout that each situation must be assessed in its own right, and that there is (sadly) no 'one-size-fits-all' solution.
- We will explain in further detail the aviation stakeholders involved, when they should be consulted, and how they might assist. Documents and references will be provided, as well as useful contact numbers and email addresses.

Introduction

- Aviation and Wind Energy industries are both extremely important to the UK Government
- The intent of both industries is to strive for co-existence, not confrontation

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- Both the aviation and the wind energy industries are of significant importance to the UK Government. Whilst we must collectively strive to achieve ever more worthwhile renewable energy targets, we must not forget the importance of the aviation industry to commerce and leisure within the UK and beyond. The safety of flight must remain paramount at all times, and it is appropriate to take a cautious approach to new developments, without losing sight of the requirement for pragmatism.
- The UK has come a long way from the days of outright combat between the wind and aviation industries, and it is essential that this collaborative, proactive and consultative approach is not damaged by poor processes or a lack of communication. What we must strive for is co-existence, not confrontation.

Aviation Planning Considerations for Wind Turbines

UK Airspace Users

- Scope of UK air activity is very broad
  - Commercial
    - Airliners, business jets, helicopters
  - Military
    - Fast jets, transport aircraft, helicopters, training aircraft
  - General Aviation
    - Light aircraft, helicopters, hot air balloons, gliders, paragliders, hang gliders, parachutists, emergency services, pipeline and national grid inspections
- UK airspace is comparatively very small and very complex
  - Close coordination required to enable all users to operate safely

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- The UK is unusual in aviation terms, and provides some very distinct sets of challenges to those seeking to maintain safety, efficiency and effectiveness in the use of its skies:

- Firstly, the scope of air users is extremely broad. We are a small island, with a large population, which leads to 3 main types of air users. Most familiar will be the commercial activity of airliners. Numbers of commercial flights continue to grow year on year, not only with the likes of mainstream and low-cost carriers, but also in the use of business jets and commercial helicopters, as the population continues to rely ever more on aviation as a practical means of transport.

- Added to this is the UK military which, despite being frequently deployed, still retain significant numbers of aircraft in the UK for Air Defence and training purposes. Military aircraft do not operate like civilian aircraft and require special considerations in terms of the activities that they undertake, and the space that they require to conduct their operations, which may involve dozens of aircraft at a time. Equally, military ATC units are required to provide Air Traffic Services to civil aircraft operating within their airspace (Commercial and General Air Traffic (CAT, GAT)).

- All other air traffic is known collectively as 'General Aviation' and this covers an incredible spectrum of activity. General Aviation may fly in small 'light' aircraft, helicopters, gliders, hot air balloons, paragliders or hang gliders. Some may make their living from these activities by providing pleasure flights, or pilot training. Parachutists – both military and civilian – must also be considered as UK airspace users. And there are other airspace users fulfilling important roles, but not covered by the 'commercial transport' mantle, such as helicopters working for the emergency services, helicopter or light aircraft medical evacuation and organ donor delivery aircraft. All of these require consideration when making decisions that may affect their ability to conduct their commercial, military, community or leisure activities, which can involve safety of life activities.

- To add to the complexity is that this long list of users must be fitted into a comparatively very small space. The UK itself is not large. It sits as a natural junction between Continental Europe and Continental USA and so has significant amounts of commercial traffic passing over it. Unlike the rest of Europe, we do not have the luxury of sectioning off airspace in the same way so as to ensure that air activities are kept separate. Instead, we have to dynamically manage what little airspace we have, in order that all airspace users have an appropriate level of access. This requires close coordination amongst all users to achieve and is one of the single biggest challenges to aviation in the UK.

Definitions

- Aerodromes
  - Licensed, unlicensed
    - Differences in where the responsibility for safety lies
  - Safeguarding
    - Official and unofficial
    - CAP 738: Safeguarding of Aerodromes
- Technical Sites
  - Radars
  - Aids to navigation
    - DME, VOR, ILS
  - Radio communications

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- So we have established the complexity of the airspace and its users, but there is an added dimension that must be understood in terms of the airfields from which they fly.

- The CAA, as the independent aviation regulator within the UK, licenses certain aerodromes that are involved with the commercial carriage of fee-paying passengers. It used to be a requirement for all aerodromes that conducted flying training to also be licensed, but this was withdrawn in 2010. All aerodromes that are licensed are responsible to the CAA to maintain the safety of their operations through the upholding of their Safety Case. Unlicensed aerodromes are not regulated by the CAA and, indeed, may not even be known about by the CAA, and so their only safety responsibilities are self-imposed. Despite there being no regulatory oversight of unlicensed aerodromes, it is still imperative that safety considerations for unlicensed aerodromes are appropriately considered during the planning process in order to ensure that flight safety can be maintained.

- Aerodromes can be safeguarded, either officially or unofficially. Certain civil aerodromes deemed to be of sufficient interest are officially safeguarded by legislation; all of these aerodromes are licensed by the CAA. Defence aerodromes are also officially safeguarded. However, there are many licensed aerodromes which are not eligible for official safeguarding, as well as many unlicensed aerodromes which are also not eligible for official safeguarding. All non-officially safeguarded aerodromes – irrespective of whether they are licensed or unlicensed – are encouraged to lodge unofficial safeguarding requirements with their respective planning authorities. In turn, UK legislation (ODPM Government Circular 1/2003 and Scottish Government Circular 2/2003) encourages planning authorities to take heed, wherever possible, of these unofficial safeguarding requirements. Of course, this necessarily requires that aerodromes are proactive in terms of contacting their planning authority and having pragmatic and measured discussions with the relevant planning officers so that their operations and associated requirements are well understood. It is also incumbent upon aerodromes to ensure that they are balanced in their requests.

- But it is not just aerodromes that require protection if the safety of flight in the UK is to be maintained. In addition, certain technical sites receive official safeguarding – much akin to certain licensed and defence aerodromes – in order that the Communications, Navigation and Surveillance systems are unaffected by proposed developments. Of these, the most well known equipment is radar, which will be discussed in more detail during this presentation. But other equipment is also essential to flight safety, and potentially at risk of interference from proposed developments – basically anything that relies on radio waves. Unfortunately not all issues are well understood yet, and so the extent of potential interference on navigational aids for aircraft (such as Distance Measuring Equipment (DME), Very High Frequency (VHF) Omni-directional Ranging (VOR) and Instrument Landing Systems (ILS)), and radio communications between air traffic controllers and aircraft are not yet properly understood.

Impact on Aviation

- Direct
  - Physical
  - Technical
  - Operational
- Indirect
  - Economic
  - Environmental
- Cumulative
- Chapter 2 of CAP 764 provides more detail

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- Having gained a brief oversight of the complexity of the scope of users and airspace within the UK, as well as the different types of aerodromes and equipment involved in UK aviation, we will now move onto explore the potential impacts of aviation from wind turbine developments.

- These can be assessed in 3 areas: those that have a direct impact, an indirect impact, or a cumulative impact on aviation interests and operations.

Direct Impact - Physical

- Any physical structure that could be an issue to the safety of flight
  - Aerodrome (principally approach and departures)
    - Presence within an air traffic zone (ATZ) does not automatically mean an aviation objection is appropriate
  - En-route obstacles

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- Of the direct impacts, the most obvious being that of structures providing a physical obstruction to the continued safety of flight. Principally this would be where aircraft are closest to the ground, for example, on take-off and landing from or to aerodromes, or when taking part in low flying activities such as military low flying. This does not mean, however, that physical structures cannot be erected near aerodromes, just that their location and height must be carefully controlled. For officially safeguarded aerodromes, including defence aerodromes the extent of their Obstacle Limitation Surface (OLS) is protected from development. This is a map depicting where structures are permissible (or not), which is based upon the height above the surface that needs to be protected in order for aviation operations to continue safely. All other licensed aerodromes will also hold an OLS, but it will not be statutorily protected in the same way as officially safeguarded aerodromes. Unlicensed aerodromes are also encouraged to produce safeguarding maps and lodge them with their planning authority. It is important to note that, just because a proposed development lies within the limits of an Air Traffic Zone (ATZ), this does not, in itself, provide a reason for an aviation objection to be raised against it; what is important is its location and size in relation to the OLS (where it exists), or its potential impact on aviation operations.

- The introduction of obstacles in the vicinity of an aerodrome, particularly one that is used for flying training purposes, can reduce the areas available for pilots to use in the event of a forced landing, such as an engine failure after take-off. Even if the safety impact of new obstacles can be mitigated there may be a resulting loss in amenity due to the mitigation, or the perceived effect of the obstacle, that makes the aerodrome less attractive for potential users, with a corresponding financial impact.

- Physical structures away from aerodromes, 'en-route obstacles', may also interfere with safe flight. Whilst aviation legislation (Rule 5 of the Air Navigation Order) precludes civil aircraft from flying within 500 ft of the ground or any obstacle, the presence of excessively tall structures may still present an en-route hazard. Only structures over 300 ft are required to be displayed on aeronautical charts, therefore anything smaller, could be a surprise to pilots flying at or near that altitude. En-route obstacles lower than 300 ft may also affect Military Low Flying, therefore there is a requirement to inform the Defence Geographic Centre of their presence prior to construction, so that they may be included on military flying charts.

- It is not just wind turbines that require planning consideration for their potential effects on aviation. Any tall structure can have an impact including, in particular, anemometer masts which are tall slender objects making them difficult to identify. This is causing concern to the aviation community as they can be erected very quickly creating sudden and unexpected changes to the aviation environment and they are generally below the height that triggers their inclusion on aviation charts. A key element of maintaining a safe aviation environment is knowledge of obstacles in the area, in keeping with this, planners and developers are encouraged to highlight the potential presence of anemometer (meteorological) masts to local aviation stakeholders at the earliest opportunity. In addition, notifying the Defence Geographic Centre of new obstacles to ensure aviation stakeholders (including those who may be visiting the area) are aware of the presence of new and existing hazards.

Aviation Planning Considerations for Wind Turbines

Direct Impact - Physical

- Turbulence
  - Current CAA guidance in CAP 764, Ch 2, Para 2.46:

"research shows measurements at 16 rotor diameters downstream of the wind turbine indicating that turbulence effects are still noticeable"

  - Poorly understood but research ongoing
  - Significantly greater impact on slower and lighter aircraft

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- Another direct physical impact of wind turbines on aviation is that of turbulence. Whilst the effect of aircraft-induced turbulence is well understood, as is the effect of wind turbine-induced turbulence on other wind turbines, the potential effects of wind turbine-induced turbulence on aircraft has not been adequately or appropriately researched to date. In 2013 the CAA commissioned independent research into the potential effects of wind turbine-induced turbulence on aircraft; however, until the findings of this research are published (expected in 2014), it is impossible to provide guidance on what distances are required between aircraft and wind turbines to avoid the potential for down-stream air turbulence that is detrimental to flight safety. At the moment, all instances must be considered on their own merits, considering the type of aircraft, their operations, the size of turbines, and the prevailing wind conditions. It is known, for example, that slow and/or light aircraft are likely to be most affected by instances of wind turbulence.

Flight Paths

- Differ with aircraft type and performance
  - Gliders
  - Helicopters (Rotary)
  - Fixed Wing Aircraft
- Civil aircraft need to avoid any person, vessel, vehicle or structure by 500 feet except when landing and taking off in accordance with normal aviation practice
- Military aircraft can be authorised to fly to smaller separation distances, typically 250 feet.
- Best understood by direct engagement with local aviation stakeholders

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Aviation Planning Considerations for Wind Turbines

Direct Impact - Technical

- Critical question: can the aviation equipment 'see' the turbine?
  - Acknowledge different LOS parameters
- Distances
- Diffraction
- Affects en-route (airways) and terminal (Airport) environments

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- Moving on from the physical obstructions of wind turbines, the most significant issue with aviation – and that which is tying up the most significant amount of potential electrical generating capacity throughout the UK – is their ability to interfere with technical equipment.

- Many critical aviation systems rely upon radio waves. Any object that is encountered by an emitted radio wave is said to be within the equipment's Line of Sight. It is easiest to consider radio waves as tending to travel in straight lines, although they can be bent or altered from their path by a number of different natural and non-natural environmental factors. What they cannot do is see through a solid object. Therefore, any wind turbine (or other obstacle) that is within Line of Sight of aviation equipment will affect the flow (the transmission and reception) of radio waves and so could adversely affect the equipment.

- Planners should be aware that there are a number of methods of calculating whether an object is within Line of Sight of aviation equipment, and it is not unknown for overly simplified methods to be used in evidential support for planning applications that therefore produce a false result. If an object is within Line of Sight, the next most important factor to determine is its distance from the radar. Radio waves lose energy as they travel and so, if an object is at a considerable distance from the radar head, the radio wave may not have the energy to reach it in the first place, in which case it will not be detected and displayed to the controller. It is for this reason that small obstacles can sometimes cause the same issues as larger objects – if their location is close enough to the radar to enable them to be detected.

- It was mentioned earlier that radio waves tending to travel in straight lines, but that they can be bent or altered from their path by a number of different natural and non-natural environmental factors. One natural phenomenon is diffraction, which bends radio waves, and can result in objects that are below the straight line path of the radio wave is, in fact, still detected. Diffraction is not always incorporated into methods of synthetically modelling radar line of sight, and this remains one of the biggest areas of contention between developers and aviation operators. The CAA and MOD suggest that all methods and variables of modelling the predicted radar behaviour with respect to a specific turbine application are agreed between both parties before the modelling is undertaken.

Aviation Planning Considerations for Wind Turbines

Direct Impact - Technical

- Primary Surveillance Radar (Non Cooperative)
  - False Returns
  - Desensitisation
  - Track Seduction
  - Shadowing
- Secondary Surveillance Radar (Cooperative)
  - Shadowing
  - Inaccurate position information (scattering/reflection)

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- In order to detect aircraft, radar (in its simplest form) sends out radio waves which are reflected back from whatever solid matter they encounter; basic calculations then work out how far the radio waves have travelled before being bounced back to the radar receiver and, from this, distances to the object can be ascertained. This is known as Primary Surveillance Radar (PSR), and is a non-cooperative method of identifying aircraft; this means that the aircraft systems do not participate in their detection. ATC PSR within the UK is predominantly 2 dimensional, meaning that the PSR can detect where an aircraft is in relation to the radar head by direction and distance only – it cannot identify what height the aircraft is at. Military Air Defence PSR detect aircraft in 3 dimensions, and are therefore able to identify the distance, direction and height of an aircraft in relation to its position, and all simply through the basic tenet of reflected radio waves.

- Cooperative radar systems are different in that they require an action from the aircraft systems. Secondary Surveillance Radar (SSR) is the principal form of cooperative radar system. Effectively, this is a system that sends out an interrogation into the ether, and any aircraft system that detects it will provide a response. The radar effectively asks a blanket 'who are you?' question and those that detect it respond with a specific 'I am X, and my height is Y'. This valuable information enables air traffic controllers to utilise all heights of the airspace, and separate aircraft safely into different height bands. Whilst SSR is not affected by wind turbine interference to the same extent as PSR (because of its interrogative nature), there is still the possibility for radio waves to be deflected from their path and, therefore, to give the right information, but attribute it to the wrong location in the sky.

- So what does radar interference look like? As has been mentioned, the principle impact is on non-cooperative, Primary Surveillance, radar. Without requiring the cooperation of an aircraft, radar will interpret everything moving in its path as a potential aircraft. 'False' aircraft will be displayed as the tips of the blades of the wind turbines appear, to radar, to be moving through the air – at speed – very like an aircraft. All false returns are known as 'clutter' and they can be caused by a number of objects – static or moving. Their effect on the controller is to provide a distraction and to lessen his or her ability to correctly identify what is a real aircraft (which therefore needs to be avoided by aircraft under their control) from what is not.

- Modern systems attempt to process out as much clutter as possible. Clutter caused by constant returns from a stationery object (such as a large building) is routinely filtered out by computer processing, which means that, whilst the radar response is received at the radar head, it is not presented to the operator (the air traffic controller). Poor weather can increase clutter responses received at the radar head, and so modern processors are able to fine tune the strength that a returned signal needs to be in order for it to be taken as a valid radar response, i.e. not one from a known static structure, which is then filtered out from the air traffic controllers display. When wind turbines produce dense clusters of clutter, the radar processor can be tricked into raising the threshold at which it accepts a response as being valid. Whilst this rids the controller's screen of static clutter and wind turbine clutter, it could also prevent actual aircraft returns from being displayed. Any aircraft that is difficult for the radar to 'see' because of its distance from the radar head, its size or what it is made from, could fail to break through the minimum response level and, therefore, be discarded. This is known as de-sensitisation.

- Another issue is that of track seduction. Modern radar processors are designed to 'link' primary and secondary radar returns that belong to the same aircraft. This means that a controller can look at a combined response on their screens, and enables both cooperative and non-cooperative tracking of an aircraft's location. When an aircraft enters an area of significant clutter, it is possible that the processor can lose the ability to link the secondary response of an aircraft to its primary response, and instead links it to the false response from a non-aircraft return – for example, the response caused by a wind turbine. This again means that the information presented to the air traffic controller - upon which they base their critical flight safety decision – is misleading and, fundamentally, false.

- Clearly, clutter in general, and de-sensitisation and track seduction in particular, are detrimental to the ability for controllers to maintain high levels of flight safety. These all occur because a wind turbine is detected by aviation radars.

Direct Impact - Technical

- Navigation aids
  - inaccuracy
- Ground-Air-Ground communications
  - Interference
  - Distortion
  - Fragmentation

- Other technical equipment that may be affected are navigation aids. Systems such as Distance Measuring Equipment (DME), VHF Omni-directional Radio (VOR) beacons, and Precision Approach Radar (PAR) are also known to be susceptible to radio wave interference. These systems are used in a variety of ways, but all contribute to aircraft being able to accurately identify their location and are therefore safety critical to aviation operations. Unfortunately, the exact effects on these systems are not always fully understood, and there is inadequate research to pinpoint the proximities at which interference could begin to occur; until such time as this is better understood, it is always necessary to err on the side of caution, whilst maintaining a pragmatic approach.

- Recent research has highlighted potential interference with air to ground radio communications. Research is ongoing into the possible effects of interference. Clearly, interference that leads to degradation in the ability of a controller to talk to a pilot (and vice versa) would be detrimental to flight safety.

- The reason that some areas of potential technical interference are only now becoming of concern are that the 'easiest' sites (e.g. at a distance from communities, aviation and environmental constraints but with good access to the grid network) have largely been used up and attention has turned to the more challenging sites.

Aviation Planning Considerations for Wind Turbines

Direct Impact - Operational

- Impact of ability of air traffic controllers to provide safe flight
  - Increase in controller workload due to poor radar
    - Avoidance of radar clutter
    - Degraded detection of other aircraft
  - Increase in controller workload due to poor comms
  - Increase in pilot workload due to poor comms
  - Decrease in controller capacity
- Impact on available airspace
  - Re-routing (potential for choke points)
  - Limiting volume available

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- Moving onto the direct operational affects that wind turbines can cause to aviation operations. The technical and operational causes for concern with clutter, desensitisation and track seduction have already been alluded to. Anything displayed to a controller that is either incorrect or confusing could lead to a flight safety incident. Therefore, controllers will usually have to avoid allowing aircraft to fly through areas of clutter on their screens, as it would mean them being temporarily unable to rely on the information presented to them for the reasons already described.

- The additional act of having to consider the false returns in itself is detrimental to safe control. Controlling aircraft can be challenging and demanding. Anything that increases the list of tasks that a controller must do will, by human nature, decrease the amount of spare capacity that a controller has to react to other stimuli. So, for example, if a controller is working hard trying to ensure that they route one of their aircraft around an area of clutter, their attention may be distracted from the activity of another aircraft which, ultimately, could end up conflicting with the flight path of another aircraft as a result. Increasing controller workload results in decreasing their capacity to respond in a timely and appropriate manner. Whenever their awareness of the situation is challenged, and they have to use valuable thinking time and capacity to regain their understanding of what is happening on their screen, this has the potential to result in an unsafe situation.

- Aside from the operational impacts on the controllers, we must also consider the impact on the airspace that is available for manoeuvring aircraft. By potentially creating 'no go zones' – areas that must be avoided because of the presence of clutter, aircraft would need to be re-routed and follow a different flight path. If the areas of clutter are extensive, either through large windfarms or through large numbers of individual wind turbines in close proximity to each other, then it may be that the volume of airspace available for control of aircraft is significantly reduced. This in itself may result in a 'funnelling' of aircraft – increasing the concentration of aircraft likely to be routed through a particularly narrow piece of airspace at the same time. Equally such no go zones may impact military operations and military training areas, rendering them unusable due to the inability to safely provide required Air Traffic or Air Defence radar services. Clearly, the more space that controllers have available to them to manoeuvre aircraft and keep them separate, the better and safer the procedures will be.

- Similarly the presence of wind turbines creates an obstacle that must be avoided by the mandated separation distances, where other airspace restrictions limit the height at which the turbines can be overflown this can render areas unusable, or inaccessible, with further funnelling affecting the concentration of aircraft in nearby airspace.
- So, having assessed the potential direct impacts of wind turbines on aviation, we will now consider the potential indirect ones.

Aviation Planning Considerations for Wind Turbines

Indirect Impact - Economic

- Routing efficiency
  - Increased fuel costs
  - Increased time
- Aerodrome existence
  - Value to local community
- Aerodrome development
  - Master Plans

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- We have already mentioned the fact that aircraft may be re-routed in order to avoid flying over an area of clutter and therefore maintain the controller's understanding of the air situation. In doing so, there can be an indirect economic impact on aviation activity.

- Increasing what is known as 'track miles' – the miles that an aircraft flies, has a corresponding increase in the amount of fuel burnt; this, in itself, has a financial cost which must be either passed onto the customer or absorbed by the operator whose profits will decrease. Increasing the distances flown will also increase the time taken for flights. This is highly undesirable for passengers, and can also have a significant economic impact on airlines, which operate on extremely tight schedules in order to make their pricing strategies feasible and remain profitable.

- It must be remembered that aerodromes provide value to the local community in which they sit. If the viability of an aerodrome reduces to the point of being uneconomical, in this case it would most likely be a mid or small sized regional aerodrome, and then there is the threat of significant job losses, as well as a likely reduction in the amount of revenue coming into the area. Commercial aerodromes have to be financially viable to survive, and it is a business that typically has small margins. Therefore, financial impacts on the flights themselves could well jeopardise the future of the aerodromes that they serve.

- In terms of future expansion, the UK government encourages aerodromes to identify their potential future development by developing Master Plans and making them available to planning authorities. Whilst this guidance is predominantly directed at officially safeguarded aerodromes, it is also recommended for all other aerodromes. These should, of course, be reasonable and pragmatic.

Aviation Planning Considerations for Wind Turbines

Indirect Impact - Environmental

- Increased miles
  - Increased CO2 emissions
- Noise footprint

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- The environmental impact if an aircraft has to be re-routed must also be considered:
- If you increase the amount of miles flown, then there is a resultant increase in CO_2 emissions, which is clearly contrary to the whole rationale about why we are trying to increase green energy throughout the world. Significant increases in track miles flown could, in itself, make the viability of a small wind farm unfeasible, and this aspect should not be ignored.
- And in terms of effect on other non-involved people, the potential re-routing should be considered, as altered flight paths may have an unwanted and untenable effect through the changed noise foot print of aviation activity.

Aviation Planning Considerations for Wind Turbines

Cumulative Effects

- Any size, any number can cause an effect
  - Bespoke analysis
  - Some turbine sites will have a greater impact on aviation than others
- Acceptance of prior applications does not equate to future approval
  - Tipping point (saturation – 'the straw')

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- So far we have considered direct and indirect issues, and the final area to consider for potential effects is that of cumulative effects.
- We have already established that there is no formula for what size, number or locations of turbines will cause an issue to aviation operators: all have to be considered on a case-by-case basis in relation to the specific aviation operations that they may affect.
- Therefore it must be understood that there should be no acceptance of later turbine applications based on the precedence of earlier turbine installations.
- Where possible, aviation stakeholders attempt to accommodate wind turbine developments as they recognise the importance of the government's aims on sustainable energy. As a result, there are times when, even though a turbine is visible to their radar, they are able to accommodate it, either because it is under airspace that they do not use, or because they utilise various means of mitigating it so that the impact on their operations is negligible or totally negated. However, there are often a finite number of times that such mitigations can be used, or their effects accommodated. In terms of saturating the system, there may well come a time when one application is the straw that breaks the camels back of acceptable accommodation or mitigation of wind turbines.

Impact - Aerodrome

- Loss of amenity for community
  - Aviation Policy Framework
- Financial impact on local economy
- Potential loss of protected habitat (flora and fauna)

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- As a result of wind turbine developments an aerodrome (military or civil) may find that the limitations required to continue to operate safely render that location unviable as an airfield. This may have a number of effects which should be considered. Closing the aerodrome is what we are trying to avoid, as we seek to achieve co-existence, not confrontation. However, planning officers should be aware of the very real threat posed to GA aerodromes, which frequently lack the funds, expertise and manpower to fight planning applications from large, powerful wind energy companies.

- The loss of the flight training facilities provided at such aerodromes could have an impact on the future availability of new pilots and aviation aware personnel for the wider aviation industry, including the armed forces. There would also be a corresponding loss of engineering employment and apprenticeship training.

Mitigation

- Early discussions regarding aviation mitigations are essential between applicants and aviation stakeholders and should have been undertaken prior to the submission of a planning application.
- Planning Authorities should be aware that these discussions can take considerable time to conclude and their purpose is to identify acceptable mitigation proposals by which potential impacts on aviation may be addressed.

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- So what do we do about this interface between aviation and wind turbine? The crux of the answer is to communicate – and do it early. Consultation should not arise during the planning process, as a by-product of an objection having been lodged. Developers should be proactive in identifying which aviation interests may be affected, investigating the potential extent of effect, and then working with the aviation stakeholders to identify viable and feasible solutions.

- Planning authorities should be aware that discussions of this nature can take months to conclude, particularly as they will often stall until a specific technical assessment has been carried out.

- Mitigations must always be considered on a case-by-case basis, as each situation has an individual profile of aviation activity and requirements, facilities and technology, location, terrain, finances … The list goes on and on.

- However, conditions and/or planning obligations are sometimes deemed to be appropriate to specific planning consents. There are some major concerns within the aviation community concerning the use of suspensive conditions, however. Whilst it is true that the interests of the aviation stakeholder are protected by a suspensive, or Grampian, condition, they are extremely unhelpful in that they muddy the waters of what is likely to be built and what is not. When considering later applications, aviation stakeholders must consider them against all previously consented applications, irrespective of whether they are considered to be fully viable and likely to come to fruition. There is always the danger of later, more realistic, applications being objected to by aviation stakeholders on the grounds of cumulative effect, or lack of capacity to accept any further mitigation, due to the success, on suspensive grounds, of earlier, less feasible applications.

- Lastly, it is worth noting that the identification of appropriate mitigations must remain the reserve of the aviation stakeholder, in consultation with the developer. It is the aviation operator who best understands their requirement, and who is likely to be more aware of the potential mitigations on offer that may prove to be suitable. It is understandable, but unhelpful, for consents to be granted specific to particular technologies, as these may not be the most appropriate.

Mitigation of Direct Effects - Physical

- Re-site
  - Typically turbines but could be aviation equipment
- Re-size
  - Smaller turbines may have less of an impact
- Reduce
  - Less turbines may sufficiently reduce the impact
- Redesign
  - Sectorise developments
- Lighting and/or Marking
  - A legal requirement in some circumstances

AIRSPACE & SAFETY INITIATIVE

- We'll now look at some of those potential mitigations in turn, linked to the potential effects that have already been discussed.

- In terms of mitigating the direct effects of wind turbines on aviation operations, the mantra is to consider re-siting, re-sizing, reducing, redesigning and/or lighting the turbines. If turbines are physically in the way of aviation operations, or else can be 'seen' by aviation technology (and therefore, potentially, cause interference) then it may be easiest to re-site the turbines. Making use of natural terrain which hides the turbines from the view of aviation systems, or moving locations to where a turbine does not become a physical obstruction to safe flight, should be considered as early as possible. Sometimes quite small differences in siting can have positive effects. Similarly, reductions in the size of rotor diameters should also be considered. There is also the potential for re-siting the location of aviation technology, but this tends to be more difficult and more expensive.

- By re-sizing, we typically mean reducing the hub height of a turbine in order to lower its profile. However, it should be noted that there will always be areas where no turbine, of any height, can be tolerated by aviation.

- Reducing the number of turbines can sometimes achieve resolution of aviation objections, as can redesigning the lay out. The developer might still manage to install the same number of turbines, but in a different configuration, perhaps splitting them into separate sites.

- Lastly, in all situations the subject of lighting must be considered. There are clear regulations which detail at what height lighting regulations become mandatory. The use of high visibility markings may also address concerns associated with the daytime visibility of tall structures. However, there is scope for smaller turbines to be lit or marked in order to remove an aviation objection; this may be particularly true for the military who must consider their requirements for low flying throughout the UK.

Aviation Planning Considerations for Wind Turbines

Technical Mitigation of Direct Effects – Radar

- Improve the radar
  - Modify or replace with a 'turbine tolerant' radar
- Implement 'blanking' or Non-Automatic Initiation Zones (NAIZ)
  - Blocks out all responses from an area so clutter is not seen (neither are aircraft)
  - Limits on the number and proximity of blanking areas
- Use another radar – 'in-fill'
  - Requires blanking in affected area
  - Using another (new or existing) radar that cannot 'see' the turbines
  - Limits on the number of in-fills that can be safely used

AIRSPACE & SAFETY INITIATIVE

- In terms of mitigating the technical effects on aviation, there are a multitude of possibilities, and significant commercial resources are going into further developing this area. It is essential that developers work with aviation stakeholders when attempting to identify potential technical mitigations. Aviation systems differ markedly, and poor understanding of the aviation requirement or technical compatibility can be showstoppers for potential mitigation options. Depending on the age and the technology of the radar in question some of the following technical mitigation options may not be available. Equally, emerging technical solutions may not deliver the desired effect, or be suitable for all circumstances, therefore any technical mitigation solution needs to demonstrate both the ability to provide the required mitigation, and be capable of being safely integrated into the affected aviation system, including the appropriate Safety Case documentation to retain the existing levels of safe and efficient provision of air traffic and navigation services.

- Planning officers should always look for evidence of appropriate consultation and collaboration between developers and aviation stakeholders when considering all planning applications and potential mitigations, but particularly when technical solutions are required. Each aviation operation is different and local circumstances may raise issues that are unique to a specific case. For this reason, the local aerodrome operator, ANSP and ATS providers are best qualified to provide expert interpretation of what this impact will be and how it will affect the safety, efficiency and flexibility of their specific operations.

- So what can be done? When considering the primary technical issue, which is primary surveillance radar 'seeing' the wind turbine, the options are either to improve the radar so that it can recognise what is a turbine and what is an aircraft, or to ensure that either the radar or the operator does not see the turbine clutter.

- It is also possible to simply blank out the area of the turbines. This means that all responses from the given area of the wind turbine development is either not processed at the radar, or not displayed to the controller. Either way, again, the controller has a 'clean' screen to work from. Some systems can also be configured so that they implement a Non-Automatic Initiating Zone (NAIZ). Within a defined area, the processor will not display any information from 'new' responses, but will continue to allow established responses as they transit through.

- It is sometimes possible to use another radar that is located in such a way that it does not see the turbines, and patchwork quilt their radar picture into the radar that is affected and currently sees the turbines. The idea is that the 'clean' radar picture for the area over the turbines ensures that the controller is looking at a non-cluttered image. This is known as using an 'in-fill' solution.

- Unfortunately, however, there are issues with all these potential mitigations. Sadly, there is no 'silver bullet' solution.

- Improving the radar to the point where it is able to discern between aircraft and turbine blades is proving extremely difficult. Whilst there is significant progress being made, little technology is yet available in the commercial market. The military have received a new Air Defence radar – the TPS 77, paid for by developers, which should release or prevent objections to specific wind farm proposals. However, this technology is not suitable for civil air traffic use. There is a major project underway with Raytheon to produce a software upgrade to NATS' En Route radar which could similarly unlock many civil objections. Neither technology, as yet, has a solid in service date.

- However, when looking for solutions to radars at aerodromes, there is currently no solution yet available in the commercial market.

- In-fill radars are reliant on another radar being available that is located so that it does not see the turbines, but still is able to see the airspace above them, where it must be able to detect aircraft. Alternatively, a new radar can be installed but this is subject, not only to considerable cost for the developer, but also to restrictions on the amount of spectrum that is available to support the radar. Lastly, all infill technology is reliant on being able to seamlessly integrate the new radar picture into the old. Technology within this area is also nascent and this should be considered when assessing potential mitigations.

- Blanking was offered as a potential mitigation and, in certain circumstances, is an appropriate and effective mitigation tool. However, the strength of this method is also its weakness. Blanking means that everything in the defined area is not visible to the operator: turbines, aircraft or any other clutter is not displayed to the controller. Therefore, any aircraft flying into this area will not be seen by the controller, thus it is not suitable for airspace where aircraft must be controlled by an air traffic controller. Similarly, implementing a NAIZ will not be suitable for all areas of airspace, depending upon what aviation activity occurs within the area in question.

- There is a growing area of research to change the turbines so that the radar cannot detect them. This is colloquially known as 'stealth wind turbines' or 'stealth blades'. The intent is to significantly reduce the likelihood that the radar will see the wind turbines in the first place –

again, the controller will have a 'clean' screen. With stealth technology, the issue is that of maturity of technology. Certain companies are developing this technology, and a turbine planning application based on its use has been consented. This has been agreed by the aviation stakeholder as a test bed case, in order to prove (or not) the effectiveness of the new technology. It is not yet at the stage whereby it can be confidently relied upon as a mitigation solution.

- Clearly, much of what we have been discussing about technology could be out of date by the time that you are experiencing this presentation, so if in doubt, please speak with an aviation expert who should be aware of the matured technologies. Again, it is worth stressing that the choice of mitigation is not one for planning officers to make - it requires close consultation and agreement between developers and aviation stakeholders to agree the details. For this reason, approvals granted once the means of mitigation have been agreed between both parties in infinitely preferable to approvals with suspensive conditions.

Mitigation of Direct Effects - Operational

- Change flight paths
  - Avoid flying over the turbines
- Change the procedures
  - Alter minimum operating height so radar looks up
- Implement a Transponder Mandatory Zone (TMZ)
  - Relies on Secondary Radar and cooperative 'targets'
  - Dependent upon Airspace Change Process - consultation

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- In terms of operational mitigations, changing the flight path of aircraft so that they do not overfly the turbines means that they cannot get 'lost' in the clutter. The clutter would still be on the screen but the controller need not take aircraft through it. Under certain Air Traffic Services, controllers are required to provide a 5nm separation zone around unidentified targets/clutter and aircraft under their control. An increase in unidentified targets/clutter appearing on the radar screen will invariably lead to lengthier re-routes around these areas and therefore reduce the available airspace for manoeuvring aircraft.

- Similarly, if it is possible to alter the procedures so that aircraft fly higher, then it may also be possible to tilt the radar so that it looks higher up, effectively looking over the top of the turbines and keeping them from being in view. This would result in the radar not seeing the turbines and no clutter being presented to the controller.

- Transponder Mandatory Zones (TMZ) are a means of relying on radar surveillance that is less affected by turbines. Within a TMZ, aircraft must carry a transponder, which is the means by which an aircraft responds to the blanket interrogation from cooperative radar systems such as Secondary Surveillance Radar. Therefore the controller will not see any aircraft from the non-cooperative Primary Surveillance Radar source, but will see everything that is transmitting the appropriate information via the Secondary Surveillance Radar.

- But what else needs to be considered about these potential mitigations for operational effects? When changing flight paths, it is likely that additional track miles will result as routes are already planned to be as direct and efficient as possible. Therefore, consideration of the environmental factors of increased CO_2 emissions must be taken into account.

- Changing procedures will only be acceptable in certain areas, dependent on what the classification is of the airspace, and what service air traffic controllers are expected to deliver in that area. Implementing a TMZ has a significant effect on other airspace users.

Whilst most aircraft in the UK are required to be fitted with a transponder in order to ensure that cooperative systems produce the most complete picture, not every aircraft will carry one. General Aviation users, who generally operate within the open FIR, may choose not to buy and carry a transponder. Therefore, once a TMZ is implemented, they will effectively be denied access to that element of airspace. This is not generally an issue out over the sea (where most GA choose not to fly, given the consequences of having nowhere safe to land in the event of an emergency).

Mitigation of Indirect Effects - Economic

- Financial compensation
  - Some aerodromes may be happy to take more difficult or undesirable mitigation solutions if the developer is prepared to provide financial compensation for their cooperation

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- Mitigating the economic effects is difficult as the impact of increased fuel and time directly affects the aircraft operators, but it is the aerodrome that suffers when those operations become untenable. However, there remains the possibility that some aerodromes may be willing to take on less palatable mitigation solutions if the developer is prepared to provide adequate financial compensation.

Mitigation of Indirect Effects - Environmental

- Re-site
  - – New site may remove aviation objections
  - – May move the problem onto another stakeholder

- A new site or a change to the layout including turbine heights may allow aviation objections to be removed without the need to increase track miles of aircraft and hence a potential increase in emissions. Unfortunately, however, this presents the potential problem of moving the issue onto another stakeholder. This is particularly true for noise complaints.

Mitigation of Cumulative Effects

- Identifying and recognising the saturation point when no further development is tenable
  - Sometimes difficult to predict
- Numbers or sizes of wind turbine developments may need to be limited within the proximity of aviation assets

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- The only mitigation for over accumulation of turbines is to cease or limit additional turbines in the area of concern. The problem is that this is sometimes very difficult to predict.

Aviation Planning Considerations for Wind Turbines

Drawbacks of Potential Mitigations

- Availability and timescale of technology
- Economic constraints
- Appropriateness of TMZ to airspace users and ATC requirements
- Airspace Change Process likely to be a lengthy and no guarantee of success
- Consideration required for impact of mitigation on other airspace or airspace users
  – Re-siting, loss of low level radar cover, differences in military and civil requirements

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- To summarise the potential pitfalls and drawbacks of potential mitigations then, we can say that: technological mitigations are frequently subject to development, availability or timescales issues – and sometimes all 3.

- Economic constraints affect all parties: some mitigation options are extremely expensive for the developer to consider, and some may affect the economic health of the aviation operator.

- Transponder Mandatory Zones are not the silver bullet, as they are not applicable to all areas, and they can have a significant negative impact on other airspace users. Implementing a TMZ requires that the Airspace Change Process is followed, which can take a considerable period of time. Further information regarding the Airspace Change Process can be found at CAP 725.

- Consideration is always required of the second order effect: whilst the requirements of the initial aviation stakeholder may be fulfilled by the mitigation for a particular development site, there may be some knock-on effect to other airspace users. Such as: losing low level coverage for military use if a radar is tilted up to avoid looking at turbines; or denying access to pieces of airspace to general aviation users etc.

- Airspace in the UK is a valuable commodity, in relatively short supply, and subject to significant pressures from the amount of people seeking to use it. Mitigations for wind turbine developments must never be considered in isolation. Early and wide consultation from the outset is essential. Whilst this is the responsibility of the developer, planning authorities can assist by questioning applicants as to the depth of their consultations.

Aviation Planning Considerations for Wind Turbines

Interested Parties (1)

- Aerodromes (Officially safeguarded Statutory)
  - Significance of licensed status
  - Physical obstructions
  - Maintaining safety of air traffic control provision
  - Lighting and charting
- NATS En Route Ltd (NERL)
  - Statutory consultee. Regulated licensee responsible for all en-route air traffic operations
- NATS Systems Ltd (NSL)
  - provides air traffic services at a number of UK airports, safeguards as required by airport operator

- So who should you be contacting for input into the planning process?

- Contacting officially safeguarded aerodromes is a statutory requirement. However, we strongly recommend that all aerodromes that are potentially impacted by a proposed wind turbine development are contacted, irrespective of their status. Wherever possible, it is helpful if there can be a push of information from the planning authorities to appropriate aviation consultees, rather than individuals having to pull the relevant information from the plethora of non-applicable planning applications in the system. Clearly, the opinion of a licensed and officially safeguarded aerodrome will carry more weight; however, given that all aerodromes are involved in preserving the safety of flight, their opinion must be sought and fully considered.

- Physical obstructions can affect all aerodromes and must be properly considered. All aerodromes are encouraged in UK planning legislation and CAA guidance to lodge appropriate safeguarding maps with their Local Planning Authorities.

- For those aerodromes that utilise radar, radio communication and navigation aids, there is an additional requirement to safeguard their continued use and thereby maintain adequate flight safety. Aerodromes will be able to discuss their requirements and, in most cases, will be able to lodge appropriate mapping with your authorities, detailing their requirements.

- Lastly, whilst in many cases there will be no statutory requirement for lighting and charting of wind turbines, there is still scope for aerodrome owners or Air Navigation Service Providers to request lighting outwith the scope of current legislation if they can present a strong case that it will improve the safety of flight and operations from their aerodrome.

- National Air Traffic Services is split into 2 operations:

- NATS En Route Ltd (NERL), which supports all commercial traffic movement throughout the UK through the provision of Air Traffic Control and associated infrastructure (radar, radios, navigation aids etc).
- NATS Services Ltd (NSL), which is a commercial operation offering terminal control for commercial aerodromes.

- NERL is responsible for the safe provision of its services and is a statutory consultee in all cases. NSL will never be a direct consultee from a planning authority, as its safety case is owned, and therefore protected, by the airport owner/operator that has contracted them, albeit in close collaboration.

- NERL receives statutory protection for its entire communication, navigation and surveillance infrastructure and must be consulted at all times.

Interested Parties (2)

- MOD (Statutory and non-statutory)
  - Defence Infrastructure Organisation (DIO), Air Command, Navy Command, Military Aviation Authority (MAA), Low Flying Operations Squadron, Defence Geographic Centre.
  - Physical obstructions
  - Maintaining safety of air traffic control provision
  - Lighting and charting
  - Low flying (day and night)
  - Air Defence

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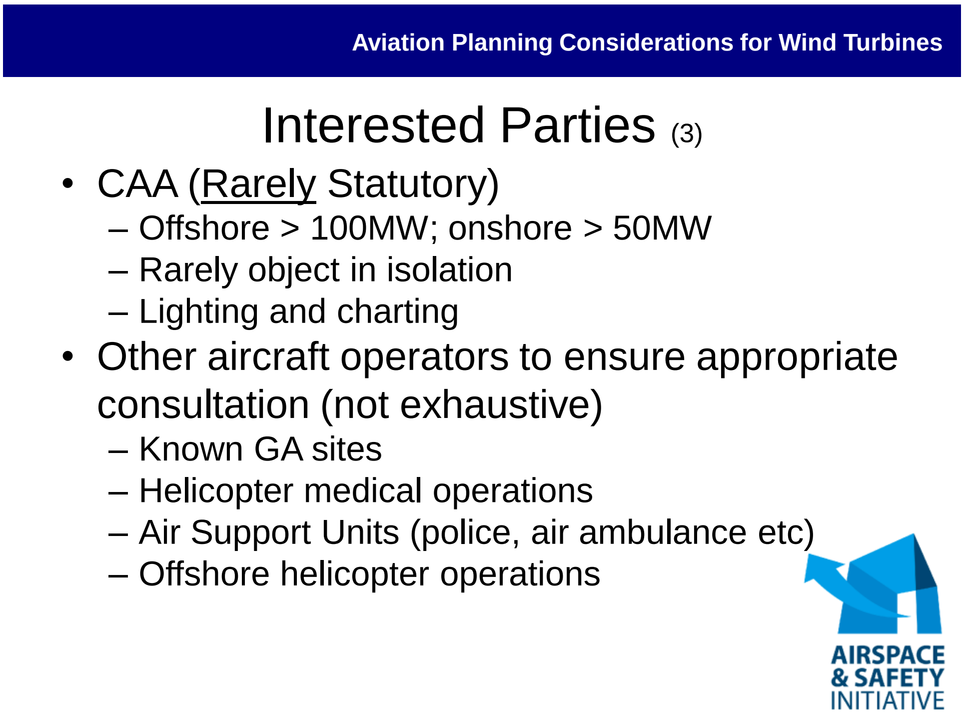
- The Military have many interests in this area, and there are a number of agencies involved: principally it is the Defence Infrastructure Organisation (DIO - formerly Defence Estates) that is required to be consulted with (statutorily or non-statutorily). DIO are a statutory consultee for physical issues (within their safeguarded zones as depicted on the maps lodged with planning authorities). In addition, DIO wish to be consulted on all turbine applications 11m in height and above and/or 2m rotor diameter or greater. Within the separate military organisations there are wind turbine and aviation specialists who are involved in policy development and responding to planning applications and public enquiries. Frequently, DIO and these other bodies are collectively referred to as 'MOD'.

- Like NERL, the MOD is concerned with maintaining the physical integrity of their aerodromes, as well as their communications, navigation and surveillance infrastructure. Some of their infrastructure is notably more complex than that within the civil realm, including the Precision Approach Radar (PAR) which is in use on most military airfields.

- Lighting requirements for the MOD may differ due to their procedures for flying low level, day and night, and may require developers to provide Infra Red lighting that is compatible with the Night Vision Goggles of their pilots.

- The MOD is responsible not only for the Air Traffic Services provided to military aircraft, but also provides a very specific type of control for aircraft that operate in the Air Defence role, maintaining the integrity of the UK airspace, and forming a considerable part of the UK counter terrorism plan. Air Defence radars are more complex than standard Air Traffic Control radars, most notably in that they provide a 3D picture of the airspace, and can ascertain aircraft heights without use of cooperative systems.



- CAA is rarely a statutory consultee: only for large scale developments (over 100 MW offshore and over 50 MW onshore). The CAA lead on wind turbine issues sits within the Safety and Airspace Regulation Group (SARG) (windfarms@caa.co.uk) and is responsible for policy development, planning applications and a number of working groups aimed at progressing the issues. SARG is also responsible for ensuring that aerodrome and air traffic control providers can prove the maintenance of their safety case to the CAA. Note: the Directorate of Airspace Policy and the Safety Regulation Group amalgamated in 2013 to form the Safety and Airspace Regulation Group (SARG).

- Planning applications should be sent, preferably electronically to the SARG address provided on the useful contacts slide. It is very rare for the CAA to object to a proposed development in isolation. As the regulator the CAA provides policy and guidance on a range of issues associated with wind turbines and their effects on aviation that will need to be considered by aviation stakeholders, planning authorities and wind turbine developers when assessing the viability of wind turbine developments. The CAA can act as an 'honest broker' and can assist in facilitating discussions between developers and aviation stakeholders when problems arise. It is CAA policy that it is the aviation operator (either of an aerodrome or an air traffic service) that should be treated as the Subject Matter Expert on site-specific requirements and potential impacts of proposed developments.

- SARG can also provide advice and guidance on lighting and charting requirements.

- By consulting with the airport operator, NERL and the MOD, it is often assumed that all aviation stakeholders have been approached. However, there are a significant number of other aviation users who may be affected.

- General Aviation aerodromes are often unlicensed and so are frequently overlooked. However, despite being unlicensed, unregulated and not able to be officially safeguarded, they are still legitimate users of UK airspace and must preserve their safety of flight at all times. GA aerodromes are being actively encouraged through a number of forums to engage with planning authorities so that they can build up a clear understanding of what areas they require protecting in order to preserve their operations. Their locations are usually published in one of a number of publications (AFE’s VFR Flight Guide UK, Pooley’s Flight Guide, and Lockyear’s Farm Strips and Private Airfields Flight Guide), but are not necessarily charted on maps and they are not listed geographically, so it can be very easy for potential developers to overlook their presence when identifying with whom to consult.

- There are a number of aviation operations that ‘roam’ across the UK, going where and when required. Helicopter medical operators, air ambulances, and police support units all tend to operate at low level, and are responsive to requirements, making their activities less predictable. For these reasons they need to be consulted. For example, a proposed development close to the site of an accident blackspot might cause significant operational issues for air ambulance service providers. Such operations will have a defined area of responsibility and the units involved should have made themselves known to the relevant planning authorities. However, developers may not necessarily have considered approaching them for consultation.
- Offshore operators include those aviation organisations that service offshore oil rigs and platforms. It is likely that offshore developers will have consulted with them, given that they are also likely to be using similar services, but again, this should be checked.

Interested Parties – General Aviation (4)

- Representative organisations
  - General Aviation Awareness Council
  - Aircraft Owners' and Pilots' Association
  - National Business Aviation Association
  - Light Aircraft Association
  - British Business and General Aviation Association
  - British Parachuting Association
  - British Gliding Association
  - British Microlight Aircraft Association
  - British Helicopter Association
  - Helicopter Club of Great Britain

AIRSPACE & SAFETY INITIATIVE

- Lastly, there are a number of organisations that represent General Aviation interests which may be able to provide assistance, or explanation of the issues. This is not an exhaustive list.

Relevant Documents and References (1)

- CAP 764 (CAA Guidance on Wind Turbines) provides a more detailed discussion of some of the issues raised in this presentation
- Article 219 and 220 of the Air Navigation Order (2009)
- NATS windfarm website
- Additional aviation information is available in:
  - CAP 670, CAP 168, CAP 793, CAP 738

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- In addition to the national planning documents that you will all be readily familiar with, there are a number of documents provided by the CAA which seek to assist in enabling informed planning decisions.
- Civil Aviation Publication (CAP) 764 is available via the CAA website, and provides guidance and policy on the development of wind turbines with relation to their potential effects on aviation. It has recently been re-written to increase its applicability to wind energy developers, local planning officers and the general public, as well as its usual aviation stakeholder audience. It is intended that this document will be refreshed every 2 years. In the intervening time, should policy or guidance change, it will be promulgated through the CAA Wind Energy Web Pages.

Relevant Documents and References (2)

- CAA Policy Statements on lighting for tall structures:
  - http://www.caa.co.uk/docs/33/20121122PolicyStatementWTG.pdf
  - http://www.caa.co.uk/docs/33/DAP_LightingEnRouteObstaclesAndWindTurbines.pdf
  - http://www.ead.eurocontrol.int/eadbasic/pamslight-12F7B41C44093026F4726315FAC19FD6/7FE5QZZF3FXUS/EN/AIC/P/021-2011/EG_Circ_2011_P_021_en_2011-04-21.pdf

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- In addition to the generic guidance provided in CAP 764, there are specific policy statements on the requirements for lighting of onshore and offshore installations which cover all tall structures, and are not solely linked to wind turbines.
- Lighting requirements are subject to Articles 219 and 220 of the Air Navigation Order (2009).
- Lastly, there are various other CAP documents that are highlighted within CAP 764 that expand on safeguarding issues for licensed and unlicensed aerodromes. These are also available via the CAA web pages.

Useful Contacts/Websites

- CAA

CAA Windfarm Website
Email: windfarms@caa.co.uk

- AOA

The Airport Operators Association Website

- DIO

MOD Safeguarding

- DGC

Defence Geographic Centre
Email: icgdgc-aero@mod.uk

- NATS

NATS Windfarm Website

- RenewableUK

RenewableUK Website

- GAAC

General Aviation Awareness Council Website

- The Crown Estate

The Crown Estate Website

AIRSPACE & SAFETY INITIATIVE

Glossary

- ACP Airspace Change Process
- AD Air Defence
- AIP Aeronautical Information Publication
- ANO Air Navigation Order
- ANSP Air Navigation Service Provider
- ATC Air Traffic Control
- ATS Air Traffic Service
- CAA Civil Aviation Authority
- CAS Controlled Airspace
- CAP Civil Aviation Publication
- CNS Communications, navigation and surveillance
- DfT Department for Transport
- DIO Defence Infrastructure Organisation
- DME Distance Measuring Equipment
- DTI Department of Trade and Industry
- DVOF Defence Vertical Obstacle File
- DZ Dropping Zone
- GA General Aviation
- IFP Instrument Flight Procedures
- ILS Instrument Landing System
- LOS Line of Sight
- LPA Local Planning Authority
- MATS Manual of Air Traffic Services
- MHz Mega Hertz
- MoD Ministry of Defence
- MW Mega Watts
- MWT Micro Wind Turbine
- NAFW National Assembly for Wales
- NAIZ Non-Automatic Initiation Zones
- Navaids Navigation Aids
- NDB Non Directional Beacon
- NERL NATS En Route plc
- ODPM Office of the Deputy Prime Minister
- OLS Obstacle Limitation Surface
- PPG Planning Policy Guidance Note
- P-RNAV Precision Area Navigation
- PSNI Planning Service of Northern Ireland
- PSR Primary Surveillance Radar
- RCS Radar Cross-Section
- RF Radio Frequency
- RNAV Area Navigation
- SID Standard Instrument Departure
- SARG Safety and Airspace Regulation Group (CAA)
- SSR Secondary Surveillance Radar
- VFR Visual Flight Rules
- VOR VHF Omni Directional Range

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