Safety & Airspace Regulation Group

CAA Policy and Guidelines on Wind Turbines

CAP 764

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The latest version of this document is available in electronic format at www.caa.co.uk, where you may also register for e-mail notification of amendments.

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Revision History

Issue 1 July 2006

Neither aviation nor the wind energy industry is at a steady state and both can be expected to evolve in ways that may impact the other. Combining the current drive for renewable energy and the increasing number of wind farms with the finite land resource in the UK, means that wind turbines and aviation are being required to operate closer and closer together. However, providing a suitable environment that allows the co-existence of wind turbines and aviation is extremely complicated and new or improved mitigation solutions are being developed all the time. Therefore, it is expected that this CAP will be a living document, which will be updated periodically to reflect the outcome of any further research into the interaction between wind turbine developments and aviation. It will also be revised to take account of changes in regulations, feedback from industry, and recognised best practice.

Issue 2 February 2009

The way in which Aviation Stakeholders and Wind Turbine Developers interact has matured since the initial release of CAP 764 in 2006. This revision includes updates on Government renewable energy policy and details of how all interested parties interact. Additionally, the scope of the document has been widened to include all aspects of aviation that may be affected by Wind Turbines. The appendix detailing the method for determining if a wind turbine is in line of sight of an aeronautical radar station has been simplified.

Issue 3 May 2010

This revision is published to update references to the Air Navigation Order which has been completely re-numbered and to incorporate editorial corrections.

Issue 4 July 2011

This revision follows extensive consultation amongst the aviation and renewable energy communities. Whilst remaining an aviation stakeholder-focused document, CAP 764 has been amended in an attempt to broaden its appeal to all interested wind energy parties with the intention of becoming the ‘go to’ document for aviation and wind energy stakeholders alike. It is important that this document is read in conjunction with the CAA Wind Energy web pages, which provide amplifying information, and which will enable currency and relevancy to be maintained in between the biennial revisions of CAP 764.

A re-issue to issue 4 was made in August 2011 incorporating corrections to the Glossary, Chapter 2, Pages 4, 8 and 9, Chapter 3, Pages 6 and 7.

Revisions included in Amendment 1 to Issue 4

This revision includes changes to Offshore Helicopter Operations, Consultation Zones around Offshore Helidecks, Helicopter Main Routes and Facilitation of Helicopter Support to Offshore Installations.

Issue 5 June 2013

This revision is in the new CAA format and as such paragraph numbering has been updated. In addition, previous paragraphs detailing the impact of wind turbines on aviation and specifically radar have been updated. This is supplemented by an updated overview and analysis of the various mitigation techniques available. It replaces Issue 4 completely.

Issue 6 February 2016

Issue 6 is publicised following a lengthy consultation with both external and CAA stakeholders. It simplifies radar effects paragraphs and returns the more complicated radar detail to the CAP 670. Potential Mitigation Measures were also taken directly from the CAP 670 therefore detailed explanations are removed from the CAP 764 with only a summary retained. Issue 6 also incorporates CAA Policy Statements on the 'Lighting of Wind Turbine Generators in United Kingdom Territorial Waters (22 November 2012)' and the 'Failure of Aviation Warning Lights on Offshore Wind Turbines (27 April 2012)'. CAA Policy Statement 'Lighting of En-Route Obstacles and Onshore Wind Turbines (1 April 2010)' remains extant. Appendices concerning radar assessment methodology and references are removed, the latter being comprehensively covered by hyperlinks and footnotes within the document. It should be noted that hyperlinks were verified on publication. Issue 6 has been comprehensively reviewed and updated where necessary to reflect current information and practices. It replaces Issue 5 completely.

Foreword

Introduction and background

The Department for Transport (DfT) 'Aviation Policy Framework[1], presented to Parliament in March 2013, provided a high level strategy setting out Government objectives for aviation. The aviation sector is seen as a major contributor to the economy and the Government seeks to support its growth within a framework which maintains a balance between the benefits of aviation and its costs, particularly its contribution to climate change and noise.

Whilst recognising the need for further aviation capacity in the UK in order to promote economic growth, the strategy is also based on the requirement for a balanced approach which addresses the wider impacts of aviation and the need for sustainable development.

The Government is also committed to reducing greenhouse gas emissions within the UK and, in turn, this means there is now a shift towards economically viable renewable energy sources rather than carbon fuels. The 2008 Climate Change Act established the world's first legally binding climate change target which aims to reduce the UK's greenhouse gas emissions by at least 80% (from the 1990 baseline) by 2050. In addition, Directive 2009/28/EC of the European Parliament and of the Council set the national overall target for the share of energy from renewable energy by 2020 as 15% for the UK. However, it is UK Government policy that 30% of the UK's electricity supply should come from renewable sources by 2020; the Scottish parliament has adopted a more ambitious 100% electricity demand equivalent from renewables by 2020.

It is anticipated that wind energy will provide a significant contribution to renewable energy targets. In order to harness this energy supply, both on- and offshore wind turbine developments are being constructed, which range in size from single structures to developments encompassing many hundreds of wind turbines. Moreover, the installation of Micro Wind Turbines (MWT) is becoming increasingly prevalent. The physical characteristics of wind turbines, coupled with the size and siting of the developments, can result in effects that can have a negative impact on aviation.

Both wind energy and aviation are important to UK national interests and both industries have legitimate interests that must be balanced carefully. Therefore it is important that the aviation community recognises the Government aspiration for wind turbine developments to play an increasing role in the national economy. As such, the aviation community must engage positively in the process of developing solutions to potential conflicts of interest between wind energy and aviation operations. In a similar vein, wind turbine developers

[1] DfT Aviation Policy Framework March 2013

must understand the potential impact of developments on aviation, both at a local and a national level, and to fully engage with the aviation industry to develop suitable mitigation solutions.

Those involved in addressing wind energy and aviation issues must do so in a positive, co-operative and informed manner. Whilst the aims and interests of the respective industries must be protected, a realistic and pragmatic approach is essential for resolving any conflicts between the Government’s energy, transport and defence policies.

Aim of this publication

Being a CAP, this document is aimed primarily at providing assistance to aviation stakeholders to help understand and address wind energy related issues, thereby ensuring greater consistency in the consideration of the potential impact of proposed wind turbine developments. However, it is acknowledged that other users such as Local Planning Authorities (LPAs)[2], wind energy developers and members of the general public will also refer to it.

Consequently, it is hoped that some of the issues and questions often posed by these groups have, where appropriate, also been discussed.

Scope

This document provides CAA policy and guidance on a range of issues associated with wind turbines and their effect on aviation that will need to be considered by aviation stakeholders, wind energy developers and LPAs when assessing the viability of wind turbine developments.

It is not the intention or purpose of this CAP to provide instruction on the need or means to object to wind turbine developments; this must remain the decision of individual aerodrome operators, service providers or other organisations. Furthermore, it should also be noted that within the framework of these guidelines, specific circumstances will have to be addressed on a case-by-case basis, as it is not possible or appropriate to prescribe a standard solution. This document should be read in conjunction with specific policy and/or legislative documentation as referenced in the text, as well as the CAA Windfarms web pages.

Significant effort has been spent developing a cohesive approach to wind energy across the civil and military spectrum of aviation. It is an aspiration to create a joint and integrated publication that details both civil and military aviation policy on wind turbines. However, until this is achieved, the Ministry of Defence (MoD), through Defence Infrastructure Organisation (DIO), must continue to be consulted separately on all developments that may affect their sites (both aviation and others).

[2] The term ‘LPA’ throughout this document is used generically to refer to Planning Authorities within England, Scotland, Wales and Northern Ireland.

Feedback

Stakeholders are encouraged to provide feedback on their experiences with wind turbine development so that this CAP can be updated appropriately. This CAP will be reviewed biennially and, due to the lengthy process that must be followed, minor amendments cannot be made. However, interim amendments and supplementary guidance will be published through additional CAA Policy Statements or on the CAA Wind Energy web pages to maintain the currency and relevance of CAA guidance and policy.

Contact details

General enquiries concerning this publication can be addressed to windfarms@caa.co.uk. Additional contact details, including postal addresses, are provided at Appendix B.

Glossary

A list of specialised words or terms with their definitions follows:	
AAA	Airspace, ATM and Aerodromes (CAA)
ACP	Airspace Change Process
AD	Air Defence
AIP	Aeronautical Information Publication
ANO	Air Navigation Order
ANSP	Air Navigation Service Provider
AOA	Airport Operators Association
ATC	Air Traffic Control
CAA	Civil Aviation Authority
CAS	Controlled Airspace
CAP	Civil Aviation Publication
CFAR	Constant False Alarm Rate
CNS	Communications, Navigation And Surveillance
DECC	Department Of Energy And Climate Change
DfT	Department For Transport
DIO	Defence Infrastructure Organisation (Formerly Defence Estates)
DME	Distance Measuring Equipment
DTM	Digital Terrain Mapping
DVOF	Defence Vertical Obstruction File
DZ	Dropping Zone
EASA	European Aviation Safety Agency
EM	Electromagnetic
FT	Feet
GA	General Aviation

A list of specialised words or terms with their definitions follows:	
HMR	Helicopter Main Route
IFP	Instrument Flight Procedures
ILS	Instrument Landing System
JAR	Joint Aviation Requirements
KM	Kilometre(S)
LF	Low Flying
LOS	Line Of Sight
LPA	Local Planning Authority (also refers to planning authorities of devolved governments)
m	Metre(s)
MAP	Missed Approach Procedure
MATS	Manual of Air Traffic Services
MHz	Mega Hertz
MoD	Ministry of Defence
Mode S	Mode Select
MSD	Minimum Separation Distance
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
NM	Nautical mile(s) (1853 m or 1.15 Statute Miles)
ODPM	Office of the Deputy Prime Minister
OLS	Obstacle Limitation Surface
PPG	Planning Policy Guidance Note

A list of specialised words or terms with their definitions follows:	
P-RNAV	Precision Area Navigation
PSR	Primary Surveillance Radar
RAM	Radar Absorbent Material
RCS	Radar Cross-Section
RF	Radio Frequency
RNAV	Area Navigation
SARG	Safety and Airspace Regulation Group (CAA)
SID	Standard Instrument Departure
SMS	Safety Management Systems
SSR	Secondary Surveillance Radar
STAR	Standard Instrument Arrival Route
TMZ	Transponder Mandatory Zones
VFR	Visual Flight Rules
VOR	VHF Omni Directional Range

Chapter 1

CAA Responsibilities

General

1.1 The CAA is responsible for safety and airspace regulation of civil aviation in the UK under the Civil Aviation Act 1982 and the Transport Act 2000. The CAA's Safety and Airspace Regulation Group (SARG) is responsible for the regulation of licensed aerodromes and Air Traffic Services (ATS) in the UK; the planning and regulation of all UK airspace, including the communications, navigation and surveillance (CNS) infrastructure, and also has the lead responsibility within the CAA for all wind turbine related issues. Within SARG, wind turbine related issues are addressed by CAA Infrastructure.

1.2 Legislative provisions affecting all development, including wind turbines, are set out for England and Wales in Town & Country Planning (Safeguarded Aerodromes, Technical Sites and Military Explosives Storage Areas) Direction 2002 (ODPM Circular 01/2003). Similar provisions are set out for Scotland in the Town & Country Planning Safeguarded Aerodromes, Technical Sites and Military Explosives Storage Areas (Scotland) Direction 2003 (Scottish Planning Circular 2/2003), and for Northern Ireland in the Planning Policy Statement 18: Renewable Energy. These provisions only apply formally to those aerodromes and technical sites that are officially safeguarded; moreover, statutory consultees are limited to the MoD, NATS En Route Ltd (NERL) and affected service providers.

1.3 At all times, responsibility for the provision of safe services lies with the ATS provider or Air Navigation Service Provider (ANSP). It should be noted that the CAA does not have regulatory powers to approve or reject planning applications.

1.4 The CAA policy on wind energy is that:

1. Wind turbine developments and aviation need to co-exist in order for the UK to achieve its binding European target to achieve a 15% renewable energy commitment by 2020, and enhance energy security, whilst meeting national and international transport policies. However, safety in the air is paramount and will not be compromised. As the independent aviation regulator, the CAA is well placed to provide clarification to both the aviation industry and the wind energy industry;

2. Due to the complex nature of aviation operations, and the impact of local environmental constraints, all instances of potential negative impact of proposed wind turbine developments on aviation operations must be considered on a case- by-case basis;

3. It is CAA policy to provide the best and most timely advice to aviation and wider wind development stakeholders through consultation, the publication of CAP 764 and its associated web pages on the CAA web site;
4. Such clarification, advice and guidance is provided through the publication of this and associated official CAA and government documents, along with the CAA Windfarms web pages.

Aerodrome and Communications Navigation and Surveillance (CNS) site safeguarding[3]

1.5 Many civil aerodromes in the UK are certificated in accordance with EU Regulation 139/2014 (Aerodromes) or licensed in accordance with the Air Navigation Order (ANO) 2009 as amended. Under either of these provisions, the CAA is responsible for being satisfied that a certificated or licensed aerodrome complies with the relevant requirements and is safe for use by civil aircraft, having regard in particular to the physical characteristics of the aerodrome and its surroundings. Aerodrome operators are required to have procedures for safeguarding, to monitor the changes in the obstacle environment, marking and lighting, and in human activities or land use on the aerodrome and in the areas around the aerodrome. In addition, a requirement is placed on the licensee to take all reasonable steps to ensure that the aerodrome and its surrounding airspace are safe at all times for use by aircraft.

1.6 'Statutory' or 'official' safeguarding is a process of obligatory consultation between an LPA and consultees and is designed to safeguard technical sites and certain aerodromes in the UK. However, the same process of consultation can take place for aerodromes and technical sites that are not given this statutory protection; this process is known as unofficial safeguarding.

1.7 Certain civil licensed aerodromes (selected by Government on the basis of their importance to the national air transport system) are officially safeguarded. All EASA certificated aerodromes are deemed to be officially safeguarded. In particular, such safeguarding ensures that the operations and development of the aerodromes are not inhibited by buildings, structures, erections or works which infringe protected surfaces, obscure runway approach lights or have the potential to impair the performance of aerodrome CNS. A similar official safeguarding system applies to certain military sites, including aerodromes,

[3] Further information can be found in:
- England and Wales: Joint ODPM, DfT, Planning Circular 1/2003 guidance on Safeguarding, Aerodromes, Technical Sites and Military Explosives Storage Areas
- Scotland: Planning Circular 2 2003
- Graphics of safeguarded technical sites can be found at:
- http://www.nats.aero/services/information/wind-farms/self-assessment-maps/

selected on the basis of their strategic importance.

1.8 In general, aerodrome safeguarding is limited to the vicinity of the aerodrome (the definition of 'vicinity' will vary depending upon the activity that takes place at that aerodrome). The CAA Aerodromes Team conducts oversight audits at certified and licensed aerodromes to confirm compliance to the applicable rules.

1.9 CAP 793 (Safe Operating Procedures at Unlicensed Aerodromes) provides guidance for unlicensed aerodromes.

1.10 Where an Instrument Landing System (ILS) is used at an aerodrome, safeguarding criteria are used to protect the ILS radio signals from corruption. Technical safeguarding aspects are detailed in CAP 670 (Air Traffic Services Safety Requirements) GEN 02.

1.11 Aerodrome operators are responsible for liaising with LPAs to prevent operational airspace being infringed by new development. One significant consideration is the protection of the Obstacle Limitation Surface (OLS)[4] that should be applied for aerodrome safeguarding. The CAA may be required to explain technical matters to local or central government if a contested development proposal is referred to Ministers for decision.

1.12 The safeguarding of unlicensed aerodromes falls within the advice promulgated in the aforementioned national circulars, which, at Paragraph 13 of Annex 2 state: "Operators of licensed aerodromes which are not officially safeguarded and operators of unlicensed aerodromes and sites for other aviation activities (for example gliding or parachuting) should take steps to protect their locations from the effects of possible adverse development by establishing an agreed consultation procedure between themselves and the local planning authority or authorities. Local planning authorities are asked to respond sympathetically to requests for non-official safeguarding."

1.13 The safeguarding of unlicensed aerodromes is therefore a matter of discussion between the operator and the LPA and the need for constructive liaison from an early stage is evident. CAP 793 provides guidance. Both official and unofficial safeguarding are discussed further in Chapter 3 of this document.

1.14 In all cases, regardless of the status of the aerodrome, any development that causes pilots to experience an increase in difficulty when using an aerodrome may lead to a loss of utility. The CAA considers that if the aerodrome operator

[4] OLS is the hypothetical boundary which indicates the extent of a volume of airspace which should be kept free of obstacles, so far as is reasonably practicable, to facilitate the safe passage of aircraft. It is used collectively to refer to other terms which are fully defined in Chapter 4 of Annex 14 to the Chicago Convention and incorporated into UK civil aviation regulation within CAP 168. OLS comprises of: approach surface, balked landing surface, conical surface, inner approach surface, inner horizontal surface, inner transitional surface, take-off climb surface and transitional surface.

advises that the aerodrome's established amenity would be affected by a development, their advice can generally be considered as expert testimony in the context of the operation of the aerodrome. However, such comment requires robust evidence, and may be subjected to scrutiny by the CAA (or any other party with equivalent expertise), should disagreement between the aviation operator and the wind energy developer arise. Notwithstanding that the CAA has no regulatory oversight of unlicensed aerodromes it is recommended that developers and planning authorities give similar consideration to comments and evidence from the operators of unlicensed aerodromes.

1.15 It is recommended that aerodrome operators that are not officially safeguarded have agreed unofficial safeguarding maps with LPAs.

1.16 The safety of aircraft in UK airspace is often dependent on ground-based navigation and radio aids. DfT Circular 1/2003 and Scottish Circular 2/2003 provides for the safeguarding of civil technical sites currently owned by NERL and military technical sites owned by the Secretary of State for Defence.

Airspace management

1.17 SARG, as the airspace regulatory authority, is responsible for developing, approving, monitoring and enforcing policies for the safe and efficient allocation and use of UK airspace and its supporting infrastructure, taking into account the needs of all stakeholders, national security and environmental issues.

1.18 SARG is directed by the Secretary of State for Transport to act with impartiality to ensure that the interests of all airspace users (including General Aviation (GA) stakeholders) and the community at large are taken into account in respect of how UK airspace is managed. To this end, formal consultation with airspace users, service providers and other relevant bodies shall be conducted with the aim of obtaining consensus, wherever possible, before making changes in the planning or design of UK airspace arrangements. The environmental impact of proposals for change shall be taken into consideration by ensuring that consultation is conducted with the appropriate authorities, to lessen or mitigate such impact to the maximum extent possible.

1.19 The Airspace Change Process (ACP) is mandatory for the majority of airspace change requests. It is a robust process that ensures that all appropriate stakeholders are consulted; CAP 725 refers.

Approvals for equipment and service provision

1.20 In order to provide an ATS in the UK, a service provider must be granted an approval by the CAA. EC 1035/2011, EC 550/2004 and relevant sections of the ANO (2009) as amended apply.

1.21 Where service providers use a remote feed of surveillance data from a contracted source, they remain responsible for gaining the requisite approvals for the use of data as part of a surveillance service. ANSPs must have effective processes and procedures to:

1. Safeguard their service through being able to recognise when wind turbine developments may affect their service, and by participating in planning activities;
2. Be able to assess the likely effect of a wind turbine development on their service. It is not automatically the case that a wind turbine development will result in a degradation to the service. The service provider must first assess whether the planned development will technically impact upon the CNS systems used. Where it is assessed that there will be a technical impact, the service provider must then assess whether this has any operational significance (see also Chapter 2);
3. Be able to establish what reasonable measures may be put in place to mitigate the effect of a wind turbine development. At all times, a collaborative approach between the service provider and the wind turbine developer is required to ensure an appropriate (i.e. reasonable, achievable and timely) mitigation is identified.

1.22 Where a service provider has to make a change to equipment or operational procedures in order to safely accommodate a wind turbine development then the following must be addressed:

1. The service provider must perform a safety assessment on the change. The final safety assessment cannot be made until all changes have been implemented and wind turbine developments are operational;
2. As part of the safety assessment, the service provider should at least consider the issues raised in Chapter 2 of this CAP concerning the impact of wind turbines on aviation;
3. Where considering mitigations to address the impact of the wind turbine development, service providers are advised to review the issues and limitations summarised in Chapter 2. Full details are available in the CAA CAP 670;
4. All significant changes to an ATS must be notified by an ANSP to their SARG Regional Inspector who may wish to see evidence that the change has been managed safely and in accordance with the ANSPs change management processes. Where appropriate, an updated or amended Safety Case may be required;
5. ANSPs that fail to properly address the effects of a wind turbine development on a service may have the existing Certificate withdrawn by the CAA, or

variations applied to the Designation which may result in the closure of that service.

Advice to Government

1.23 In discharging its role as an independent regulator, the CAA is required to provide advice to Government as required. To this end, the CAA is proactive with appropriate Government departments in respect of wind energy related issues. The CAA is a member of the DECC (Department of Energy and Climate Change) Aviation Management Board and its sub-groups to provide expert input on aviation aspects of the Government's renewable energy programme. Details of these groups are contained in Appendix A.

Chapter 2

Impact of wind turbines on aviation

Introduction

2.1 The development of sites for wind turbines has the potential to cause a variety of negative effects on aviation. These include (but are not limited to): physical obstructions; the generation of unwanted returns on Primary Surveillance Radar (PSR); adverse effects on the overall performance of CNS equipment; and turbulence. Whilst it is generally the larger, commercial turbines that have the greatest impact on aviation, the installation of other equipment may also affect operations. Smaller turbines, and the preliminary activities for larger turbines (such as the erection of anemometer masts on potential development sites), could have a negative impact on aviation and so require assessment. Moreover, the cumulative effects of wind turbines on aviation need to be assessed if developments proliferate in specific areas.

2.2 This chapter aims to provide a summary of the issues that aviation stakeholders should consider when assessing the impact of a proposed wind turbine development. It is not intended to be exhaustive because local circumstances may raise issues that are unique to a specific case. For this reason, the local aerodrome operator, ANSP and ATS providers may be best qualified to interpret what this impact might be; however, they must demonstrate a thorough assessment of how it will affect the safety, efficiency and flexibility of their specific operations. Robust evidence may be required: see also para 1.14.

Wind turbine effects on PSR[5]

2.3 The following section describes the various effects that wind turbines have caused on Air Traffic Control (ATC) PSRs during the trials conducted as part of many research projects around the UK and the rest of the world.

2.4 ANSPs must therefore consider the possibility that their radars be affected by each of these phenomena as a result of wind turbines within the coverage range of their surveillance systems.

2.5 In basic terms, a PSR transmits a pulse of energy that is reflected back to the radar receiver by an object that is within its Line of Sight (LOS)[6]. The amount of reflected energy picked up by the receiver will depend upon a number of factors

[5] The following paragraphs are intended as a summary only. Full explanations and detailed technical discussion are available in the CAA CAP 670: ATS Safety Requirements at SUR 13.

[6] Note radar line of sight is different to visual line of sight.

such as the size, shape and orientation of the object[7], as well as receiver sensitivity and the weather. In general terms, the larger a wind turbine is, the more energy will be reflected and there is an increased chance of it creating false returns to radar (i.e. returns that are not aircraft). These unwanted returns are known as 'clutter'[8]. Issues may be compounded by increasing numbers of wind turbines which could potentially cause greater areas and densities of clutter.

2.6 Providing that it remains within radar LOS, generally the closer a wind turbine is to a radar station, the greater the likelihood its reflected energy will be picked up by the radar receiver. It also follows that the taller a turbine is, the greater the distance from the radar that it will remain within radar LOS (unless the turbine is hidden by terrain). A characteristic that makes wind turbines more unpredictable is the fact that because the turbines rotate to follow the wind, the cross-sectional area presented to the radar at any given time, and therefore the RCS of the turbine, will vary depending upon wind direction. This presents challenges to generating a 'standard' turbine RCS for radar modelling purposes. Given that aviation safety issues are involved, a conservative approach should generally be adopted.

2.7 Typically, radar returns from a wind turbine comprise reflections from both stationary and moving elements: these provide different challenges for the radar. While the reflected radar signal from stationary elements, such as the tower, can be removed using stationary clutter filters in the radar processor, rotating wind turbine blades can impart a Doppler shift to any radar energy reflecting off the blades. Doppler shifts are used by a number of radars to differentiate between moving objects, namely aircraft, and stationary terrain with the latter being processed out and not displayed to the operator. The radar may therefore detect Doppler returns from moving wind turbine blades and display them as returns on the radar screen. Furthermore, at sites with more than one turbine, the radar may illuminate a blade or blades from one turbine on one antenna sweep, then illuminate the blades of a different turbine on the next sweep. This can create the appearance on the radar screen of returns moving about within the area of the wind farm, sometimes described as a "twinkling" appearance or "blade flash effect". These moving returns can appear very similar to those that would be produced by a light aircraft. The appearance of multiple false targets in close proximity can trick the radar into initiating false aircraft tracks. False PSR returns can also 'seduce' real aircraft tracks away from their true returns as the radar attempts to update an aircraft track using the false return. This can lead to degradation of radar tracking capability.

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7 Which together contribute to the Radar Cross Section (RCS) of the obstacle.

8 Note that the term 'clutter' refers simply to unwanted false returns and can be generated by a number of means, not simply from wind turbines.

2.8 The large RCS of wind turbines and the blade flash effect can also lead to a decrease in radar sensitivity. This can result in the loss of small targets and a reduction in the maximum range at which the smallest targets can be detected. Wind turbines can also create a shadow above and beyond the wind farm so that aircraft flying within this shadow may go undetected.

Wind Turbine Effects on secondary surveillance radar (SSR)[9]

2.9 In general terms, SSRs differ from PSRs as rather than measuring the range and bearing of targets through detecting reflected radar signals, an SSR transmits an interrogation requesting a dedicated response. Upon receiving an interrogation, the aircraft then transmits a coded reply which the SSR can use to ascertain the aircraft's position as well as decode other information contained within the response.

2.10 Wind turbine effects on SSR are traditionally less than those on PSRs but can be caused due to the physical blanking and diffracting effects of the turbine towers, depending on the size of the turbines and the wind farm. These effects are typically only a consideration when the turbines are located very close to the SSR i.e. less than 10 km.

2.11 SSR energy may be reflected off the structures during both the interrogation and reply phases. In effect, the signals are bounced off the wind turbines and can therefore arrive at the intended target from a false direction. This can result in aircraft, which are in a different direction to the way the radar is looking, replying through the reflector and tricking the radar into outputting a false target in the direction where the radar is pointing, or at the obstruction.

Surveillance service impact assessment

2.12 Prediction of the effect of wind turbines on any particular radar site is a complex task depending on many factors including terrain, the weather, the maximum height of both radar and wind turbines, radar LOS, the operational range of affected radars, diffraction and antenna beam tilt.

2.13 There are a number of models that are employed to demonstrate potential impacts of wind turbine developments on radar. Such models are constantly developing and will offer some guidance as to the likelihood of wind turbines presenting a radar return; although the nature of wind turbine operations vary due to the unpredictability of different turbine types, variable turbine rotation speed and the times of operation of individual turbines. Therefore, the degree of certainty as to whether a turbine, or group of turbines, will be displayed or not in marginal ‘radar/radio LOS’ cases cannot be guaranteed. In such cases, and

[9] The following paragraphs are intended as a summary only. Full explanations and detailed technical discussion are available in the CAA CAP 670: ATS Safety Requirements at SUR 13.

where aviation safety is a potential issue, safety consideration should always be applied in a conservative manner.

2.14 The CAA does not endorse any one specific radar modelling tool. Nor, given the multitude of factors affecting RCS, can a ‘standard’ RCS be identified for micro, medium and large wind turbines. It is strongly suggested that developers engage with the appropriate ANSP prior to commissioning a propagation assessment in order to ensure that the proposed model is suitable and is acceptable to the ANSP. Failure to do this could result in later disagreement and conflict once results are released. ANSPs are encouraged to consider publishing clear guidance as to which radar models they would consider acceptable to their requirements.

2.15 Eurocontrol has provided basic international guidelines on how to assess the effects of wind turbines on radar. It should be noted that these guidelines do not overwrite national planning jurisdictions or requirements, but are included here as a source of further potential information.

2.16 If the radar station likely to be affected by a proposed wind turbine development belongs to NATS, useful self assessment guidance is available at: http://www.nats.aero/services/information/wind-farms/self-assessment-maps/.

2.17 If the wind turbine development is likely to affect an MOD radar station; it is recommended that the MOD should be contacted at the earliest opportunity. Further guidance can be found on the MOD Windfarms Safeguarding web site

Mitigation

2.18 The following paragraphs give a summary of some of the mitigation methods that are available to help counter the effects of wind turbines, primarily on PSR and SSR related issues. More detailed explanations and analysis of mitigation techniques are contained within the CAA CAP 670: ATS Safety Requirements at SUR 13. Not all the mitigation methods will be suitable in all circumstances and more than one method may be required to mitigate risks to an acceptable level. The definition of ‘acceptable’ will have to be made on a case by case basis.

2.19 It is the responsibility of the developer to consult with the aviation stakeholder to discuss whether mitigation is possible and, if so, how it would best be implemented. It must also be noted that most mitigation methods would be subject to a standard safety assessment process by the ANSP who, in turn, would need to demonstrate that the system is safe in order to gain CAA approval (where applicable). Accordingly, where a wind turbine development is likely to impact upon the provision of an ATS, then the developer and ANSP should co-operate to mitigate such impacts wherever possible.

2.20 In determining the appropriateness of radar mitigations, stakeholders need to be aware of the potential impact of the Government’s Spectrum Release

Programme. This work stream, overseen by the Government Public Expenditure Committee (Assets) seeks to release 500MHz of spectrum from “public infrastructure” use by 2020 to boost growth in the UK economy. The CAA has been tasked to undertake a major piece of work in support of this programme. This aims to deliver a release from 2.7-2.9MHz (which is currently used by S-Band PSR) by reviewing how non-cooperative surveillance can be best delivered to meet the operational and safety requirements of ANSPs and consistent with the Future Airspace Strategy (FAS). In parallel, there is an aspiration to use this opportunity to develop a strategic approach to windfarm mitigation in how non-cooperative surveillance is deployed. This significant programme is being managed as a phased approach with GO/NO GO decision points at appropriate milestones. The CAA will be providing updates on progress via the web page listed at footnote 13, below, at suitable intervals to keep stakeholders informed.

Summary of mitigation techniques

2.21 Mitigation techniques can be categorised in to several key types. This section provides a summary of each category. More detailed explanation is available in the CAP 670: ATS Safety Requirements.

Work-rounds

2.22 Work-rounds are interim measures which would enable an ANSP to continue providing an ATS using surveillance radar, potentially under reduced operational efficiency or an increased level of risk, whilst a long-term full mitigation solution is being progressed. Work-rounds can include moving the locations of the wind turbines (where feasible), introducing sector blanking, re-routing traffic, or using SSR only.

In-fill radars

2.23 Several manufacturers are known to have developed in-fill solutions specifically designed for the purpose of wind farm mitigation on ATC radars. This either involves combining the target data from a radar that does not have line-of-sight to the wind farm or from a radar with a smaller coverage area that is situated somewhere within the wind farm or where the wind farm is within its within LOS such that the airspace above the wind farm area can be monitored using the in-fill radar, therefore a complete air situation picture can be produced by combining the two results.

Three- Dimensional radars

2.24 Traditional ATC primary radars measure only the range and bearing of the target and do not measure altitude data. They are therefore classed as two dimensional radars. Some PSRs can provide three-dimensional information and can therefore be used as in fill radars above wind farm affected areas.

High Pulse Repetition Frequency (PRF) radars

2.25 Some manufacturers have also developed radars that utilise a high transmitter PRF. This technique makes it possible to discriminate between aircraft and wind turbines by analysing their Doppler signatures and remove the turbine clutter from the display. Such radars may be used as in-fills or if sufficient range is achievable, the radar may be used as an alternative to a conventional PSR.

Spectrum filters

2.26 Some manufacturers have attempted to develop a solution that is based on modifying their existing radars by incorporating software to compare target return Doppler signatures with the aim of giving the system the ability to discriminate between turbines and aircraft.

Predictive and multi-sensor trackers

2.27 There have been proposals to employ specialist tracking systems to overcome the impact of wind turbine farms on radar. Such solutions offer the addition of plot extraction and predictive tracking to any compatible radar. Although this may not provide a complete solution to address all potential effects they may offer some potential for the radar processing system to make a semi-intelligent assessment of returns from the vicinity of a wind turbine farm in order to distinguish clutter, including that induced by turbines, from aircraft.

Transponder Mandatory Zones (TMZ) and surveillance by co-operative ground sensor

2.28 Under current UK regulations or proposals not all UK airspace will require an SSR transponder to be fitted and used by aircraft. However it is recognised that in certain circumstances and in certain areas, mandatory transponder carriage can provide significant safety benefits. The CAA has regulatory powers to create TMZs for a number of reasons, one of which may be to help mitigate wind turbine effects on a PSR. External bodies can also request TMZs; however, the Airspace Change Process (ACP) (CAP 725) must be followed. The ACP ensures that the requirement for a TMZ is fully justified and that the effect upon all airspace users is fully consulted and assessed. Proposals for a TMZ should be submitted to CAA Airspace Regulation[10]. A CAA case officer will assess the proposal and make recommendations to CAA Director SARG (formerly Director Airspace Policy) as appropriate. Consideration of the feasibility of a TMZ to mitigate a specific and identified risk should include: effect on other airspace users; the creation of ‘choke points’ within Class G airspace; whether the affected ATC system is capable of PSR blanking; and the likelihood of the CAA approving SSR-only operations.

[10] Contact via AROps@caa.co.uk

2.29 Offshore SSR Only and TMZ. Despite offshore uncontrolled airspace being largely free of non-transponder equipped aircraft, this cannot be taken to mean that SSR only operations, or TMZs, would enjoy an easier approval process. In many instances, the ability to identify non-transponding aircraft (for example, following equipment failure) will be required to maintain safety cases.

2.30 Effect of TMZ on ATS Provision. TMZs are only viable when it is acceptable that the use of a non-co-operative surveillance technique (such as PSR) is not necessary for security reasons or for the detection of targets that are possibly undetected by SSR or other co-operative surveillance technique being used. It must be noted that, for Air Defence reasons, TMZs may not be suitable in all areas.

2.31 ANSPs may choose to provide surveillance by a suitable co-operative sensor over the wind farm area, in addition to the main PSR, as mitigation to the wind farm clutter on a surveillance display.

Risk assessment and mitigation of possible hazards introduced by wind turbines

2.32 Any new hazards should be identified and assessed to determine if mitigations are adequate to reduce risks to an acceptable level; this should be in accordance with the service provider's Safety Management System (SMS) Risk Assessment and Mitigation process. Ultimately, failure to address such issues may result in withdrawal or variation of the article 169/ 205 Approval/Designation thereby preventing the provision of the air navigation service.

2.33 In assessing proposed developments and mitigations submitted by wind turbine developers, it is not unreasonable for an aviation stakeholder/ANSP to request sufficient technical information from the developer that would support the production of an adequate safety case. The responsibility for completing the safety case lies with the ANSP. However its completion should be a co-operative effort between the developer and the ANSP with any necessary commercial considerations subject to agreement between the two.

Aeronautical navigation aids and communication systems

2.34 A wide range of systems, including aids such as ILS, VOR/DME, and Direction Finders, together with air-ground communications facilities, could potentially be affected by wind turbine developments. Wind turbines can affect the propagation of the radiated signal from these navigation and communication facilities because of their physical characteristics, such as their situation and orientation in relation to the facility. As a result, the integrity and performance of these systems can, potentially, be degraded.

2.35 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. Accordingly, as a work-stream under the DECC Aviation Management Board, the CAA are working in conjunction with NATS and others to test a variety of civil VHF aircraft radios and a smaller number of military UHF airborne radios against a simulated wind farm signature waveform. This research will be published in due course and in the interim, updates will be provided to the Aviation Management Board[11]. 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 ANSPs are advised to consider each proposal carefully and if necessary, seek specific technical advice.

Air Traffic Services

2.36 Where an ANSP determines that it is likely that a planned wind turbine development would result in any of the above effects on their CNS infrastructure, this may not, in itself, be sufficient reason to justify grounds for rejection of the planning application. The ANSP must determine whether the effect on the CNS infrastructure has a negative impact on the provision of the ATS. The developer should pay for an assessment of appropriate mitigating actions that could be taken by the ANSP and/or wind energy developer to deal with the negative impact. The position of an ANSP at inquiry would be significantly degraded if they had not considered all potentially appropriate mitigations. It is essential that wind energy developers form a relationship with the relevant ANSP in order to deal with the impact that their development may have, prior to making an application.

2.37 Where possible, it can be beneficial for the ANSP to record or plot real traffic patterns over a period of time using the radar system, and to use this to identify the prevalent traffic patterns. This can then be compared to the location of the proposed wind turbine development. Where appropriate and feasible, the recorded traffic data above a particular project may be released for further analysis.

2.38 When examining the effects of wind turbines on ATS, particular attention should be paid to the following:

[11] Minutes of meetings and other information can be found on the Aviation Management Board Web Page https://www.gov.uk/government/groups/aviation-management-board-aviation-advisory-panel-and-fund-management-board

1. Departure Routes including Standard Instrument Departures;
2. Standard Instrument Arrival Routes;
3. Airspace Classification.
4. Area Navigation (RNAV) and Precision Air Navigation routes;
5. Sector Entry and Exit points;
6. Holding points (including the holding areas);
7. Missed Approach Routes;
8. Radar Vectoring Routes;
9. Final Approach Tracks;
10. Visual Reporting Points;
11. Published Instrument Flight Path for the aerodrome;
12. Potential impact on navigation aids and voice communications;
13. Future airspace and operational requirements where aerodrome growth is anticipated (Para 2.49 provides comment on future requirements).

2.39 Factors such as the type of radar service being applied and the airspace classification must also be considered when trying to assess the adverse impact of wind turbine effects.

Offshore helicopter operations

2.40 Wind energy developments (including anemometer masts) within a 9 NM radius of an offshore helicopter installation could introduce obstructions that would have an impact on the ability to safely conduct essential instrument flight procedures to such facilities in low visibility conditions. Consequently, any such restrictions have the potential to affect not only normal helicopter operations but could also threaten the integrity of offshore installation safety cases where emergency procedures are predicated on the use of helicopters to evacuate the installation.

2.41 Chapter 3 provides background information on the issues related to wind energy developments and offshore helicopter activities including Helicopter Main Routes (HMRs).

Maritime and Coastguard Agency (MCA)

2.42 The MCA’s mission is to deliver safety at sea, counter pollution response and the coordination of maritime Search and Rescue (SAR) throughout the UK SAR Region and UK Pollution Control Zone. In the context of aviation, the MCA will (from early-2016) provide the SAR helicopter service for the UK.

2.43 The increasing numbers and geographical extent of offshore wind farms not only has the potential to increase the probability of a maritime SAR incident but also could constrain the MCA's ability to respond to such an incident. It is therefore strongly recommended that developers consult with the MCA at the earliest opportunity such that mitigating measures can be designed in from the outset. The following guidance has been provided by the MCA but should not be taken as being exhaustive and does not remove the recommendation to consult; further detail can be found in Maritime Guidance Note 371 and contact details for the MCA are listed at Appendix B.

2.44 The nature of SAR activity necessitates the requirement to conduct SAR within the confines of offshore wind turbine developments. Given the distance offshore of some UK windfarms, helicopters may be the only viable means of SAR. While in clear weather, searches can be conducted from above the maximum blade tip height, operations in poor weather and rescues themselves may necessitate SAR operations within a windfarm below blade tip height. As technology progresses and turbine heights increase, this issue is exacerbated. Furthermore, when faced with the prospect of long transits to a SAR area, the presence of adjacent windfarms along the transit route can provide obstacles to SAR helicopters if conditions do not permit transits to be flown above maximum blade height.

2.45 The MCA has provided the following guidance to mitigate SAR risks:

1. Turbines are positioned in straight lines with a common orientation across the whole development, creating safe lanes for SAR access.
2. Safe lanes are constructed across the width of the development rather than the length.
3. Curved or non-linear designs should be avoided.
4. High density perimeter turbines can compromise the safe lanes and should be avoided.
5. The wind farm should be fitted with lighting that is controllable from the development control room and which is NVG compatible.
6. The control room for the development should be equipped with VHF (air and maritime) communications with remote antennas in the wind farm to facilitate SAR communications.
7. Turbines should be marked with geographically logical numbering to facilitate navigation within the wind farm.
8. Substations and meteorological masts should be aligned with turbines so as not to impede SAR lanes.

9. Where possible, SAR lanes should be aligned with those of adjacent wind turbine developments or buffer zones created.

Cumulative effects

2.46 There is no doubt that, while developments with small numbers of wind turbines can have an adverse effect on aviation operations, it is the proliferation of developments, and the resulting cumulative effect, that is of far more significant concern. It may be possible to successfully mitigate the effects of a single turbine or small development; however, the combined effect of numerous individual turbines or multiple wind turbine developments can be hard, if not impossible, to mitigate. Therefore it is feasible that ANSPs may lodge objections to subsequent developments in areas where they had previously been able to accommodate proposed wind turbine developments.

2.47 The cumulative effect of geographically separated wind turbine developments may have more impact on aviation than if such developments were located in close proximity to each other. For example, individual areas of clutter separated by 5 NM could have more impact on the provision of ATS than one slightly larger area of clutter. This does not mean to suggest that large areas of clutter are always more preferable; however, this should be taken into consideration and discussed with the ANSP.

2.48 For aerodrome operators or en route service providers, there is a difficulty in protecting aviation activity from these cumulative effects, in part because planning applications are generally dealt with on a ‘first come, first served’ basis. All approved applications[12] must be taken into account when considering future applications. This could lead to a situation whereby viable applications are objected to on the grounds of cumulative effect even though other, potentially less viable, projects have not been completed due to the inability, for a variety of reasons, to satisfactorily resolve suspensive conditions.

2.49 The basis for an objection based on cumulative effect would be that the safety and efficiency of the aerodrome or en-route service may not be maintained or that the growth of an aerodrome or en-route service may be constrained. However, the decision concerning how firm these future plans have to be in order to be considered would be within the remit of the LPA. Nevertheless, airports are encouraged to produce ‘Master Plans’ indicating their future development plans. It is anticipated that these may be taken into consideration by an LPA.

2.50 It is recognised that many potential developments fail to reach maturity within the formal planning stage. Nevertheless, it is in the interests of aviation stakeholders

[12] Including developments subject to 'suspensive conditions': where planning approval is granted subject to final agreement between an aviation stakeholder and a developer concerning an appropriate mitigation solution.

to take all developments about which they are aware into account until they have been formally notified that a proposal has been abandoned. Therefore, it is in a wind turbine developer's interest to inform all involved parties when such developments are abandoned or postponed.

Turbulence

2.51 Turbulence is caused by the wake of the turbine which extends down-wind behind the blades and the tower, from a near to a far field. The dissipation of the wake and the reduction of its intensity depend on the convection, the turbulence diffusion, the topography (obstacles, terrain etc.) and the atmospheric conditions.

2.52 There is evidence of considerable research activity on modelling and studying the wake characteristics within wind developments, using computational fluid dynamics techniques, wind tunnel tests and on site LIDAR measurements. A literature survey was recently conducted by the University of Liverpool and CAA[13] to establish the scale and the advances of current research on this front.

2.53 It is recognised that aircraft wake vortices can be hazardous to other aircraft, and that wind turbines produce wakes of similar, but not identical, characteristics to aircraft. Although there are independent bodies of knowledge for both of the above, currently, there is no known method of linking the two. Published research shows measurements at 16 rotor diameters downstream of the wind turbine indicating that turbulence effects are still noticeable[14]. Measurement work has been focused on the near wake due to technical challenges of the experimental set up, while modelling studies are capable of examining the wake turbulence further downstream[15][16]. Although models can be used to study the effects of the far wake, verification and validation processes of these models are still ongoing[17].

2.54 There are currently no Mandatory Occurrence Reports (MOR)[18] or aircraft accident reports related to wind turbines in the UK. However, the CAA has received anecdotal reports of aircraft encounters with wind turbine wakes

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[13] http://www.liv.ac.uk/flight-science/cfd/wake-encounter-aircraft/

[14] Wind Turbine Wake Analysis, L.J. Vermeer, J.N. Sorenson, A Crespo, Progress in Aerospace Sciences, 39 (2003) 467-510.

[15] Calculating the flow field in the wake of wind turbines, J.F. Ainslie, Journal of Wind Engineering and Industrial Aerodynamics, 27 (1988) 213-224.

[16] Turbulence characteristics in wind-turbine wakes, A Crespo and J Hernandez, Journal of Wind Engineering and Industrial Aerodynamics 61 (1996) 71-85.

[17] Investigation and Validation or Wind turbine Wake Models, A Duckworth and R.J. Barthelmie, Wind Engineering, 32 (2008) 459-475. Also http://www.liv.ac.uk/flight-science/cfd/wake-encounter-aircraft/

[18] CAP 382 - The Mandatory Occurrence Reporting Scheme - comment verified against CAA database up to 30 June 2015.

representing a wide variety of views as to the significance of the turbulence. Although research on wind turbine wakes has been carried out, the effects of these wakes on aircraft are not yet known. Furthermore, the CAA is not aware of any formal flight trials to investigate wake effects behind operating wind turbines. In the UK wind turbines are being proposed and built close to aerodromes (both licensed and unlicensed), including some developments on aerodrome sites, indicating an urgent need to assess the potential impact of turbulence on aircraft and in particular, to light aircraft and helicopters.

2.55 The CAA has so far investigated the effects of small wind turbine wakes on GA aircraft[19]. The results of this study show that wind turbines of rotor diameter (RD) of less than 30m should be treated like an obstacle and GA aircraft should maintain a 500ft clearance. Regarding wind turbines of larger RD than 30m; these are subject to further investigations. Until the results of these investigations are available, discussions between aerodrome managers and wind farm developers are encouraged, taking note of existing CAA safeguarding guidance. As the results of this research become available the CAA Wind Energy web pages will be updated.

2.56 Pilots of any air vehicle who firmly believe that they have encountered significant turbulence, which they believe to have been caused by a wind turbine, should consider the need to report this through the existing MOR scheme.

2.57 Until the result of further research is known, analysis of turbulence can only be undertaken on a case-by-case basis, taking into account the proximity of the development and the type of aviation activity conducted. Whilst being a consideration for all aircraft (particularly in critical stages of flight), turbulence is of particular concern to those involved in very light sport aviation such as gliding, parachuting, hang-gliding, paragliding or microlight operations as in certain circumstances turbulence could potentially cause loss of control that is impossible to recover from.

Wind turbine wake physics

2.58 Wind turbine wake is dependent on many parameters. The thrust generated by rotor, the tip velocity ratio (blade tip velocity to wind speed), wind direction and speed, turbulence level in free stream, weather condition and the geometry of wind turbine all have impacts on the characteristics of the wake. Due to all these parameters, it is difficult to scale wake results from a small to a large wind

[19] http://www.liv.ac.uk/flight-science/cfd/wake-encounter-aircraft/

turbine. For this reason the work carried out by Liverpool University[20] is, at present, restricted to small wind turbines of less than 30m of RD.

2.59 The wake of a wind turbine can be divided into a near and a far region. The near wake is the area just downstream of the rotor up to one RD, where the effect of the rotor properties, including the blade aerodynamics and geometry determine the flow field. Near wake research is mainly focused on the wind turbine's performance and the physics of power extraction. The far wake is the region beyond the near wake, where the details of the wake are less dependent on the rotor design. The main interest in this area is the wake interference with other wind turbines (e.g. in a wind farm) or passing-by aircraft (wind turbine wake encounter). Here, flow convection and turbulent diffusion are the two main mechanisms that determine the flow field.

2.60 LIDAR field measurements on a WTN250 wind turbine at East Midlands Airport, UK, indicated that statistically, the wake velocities recovered to 90% of the free stream velocity at the downstream distance of 5 RD. It is expected that the work conducted by Liverpool University will continue with LIDAR surveys of larger wind turbines to provide reliable wake data to allow the study of the encounters using flight simulations. These results will be made public as soon as they become available.

2.61 Based on the models described in the Liverpool University Research Paper[21], schematics of the wake region for small wind turbines are given in the following figures. The figures show the zone where wake encounter has potential to cause severe impact on the encountering GA aircraft.

Figure 1: Schematic of the wind turbine wake. The effect of wake is weaker beyond 5-RD downwind for the wind turbines of diameter < 30m.

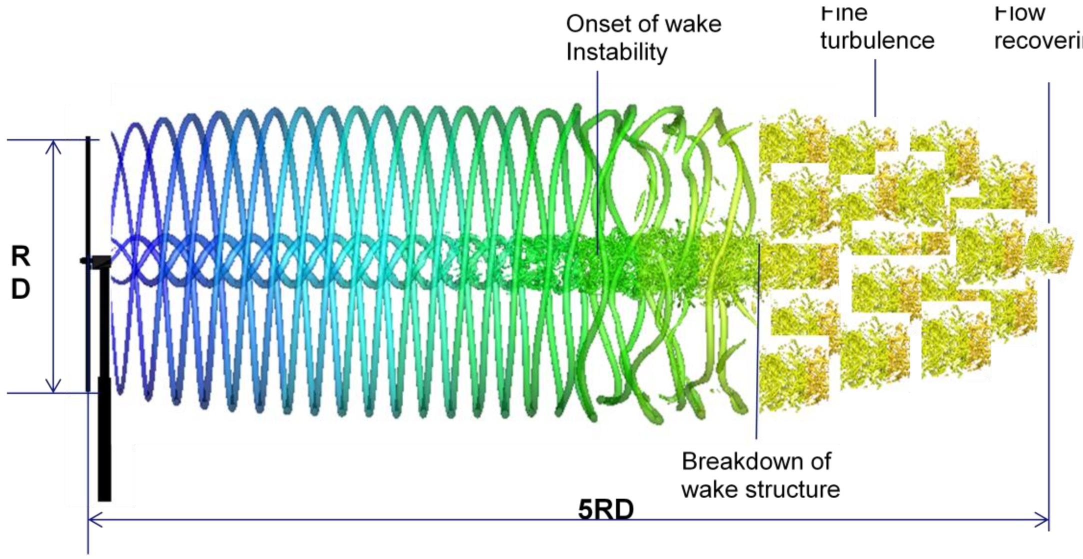
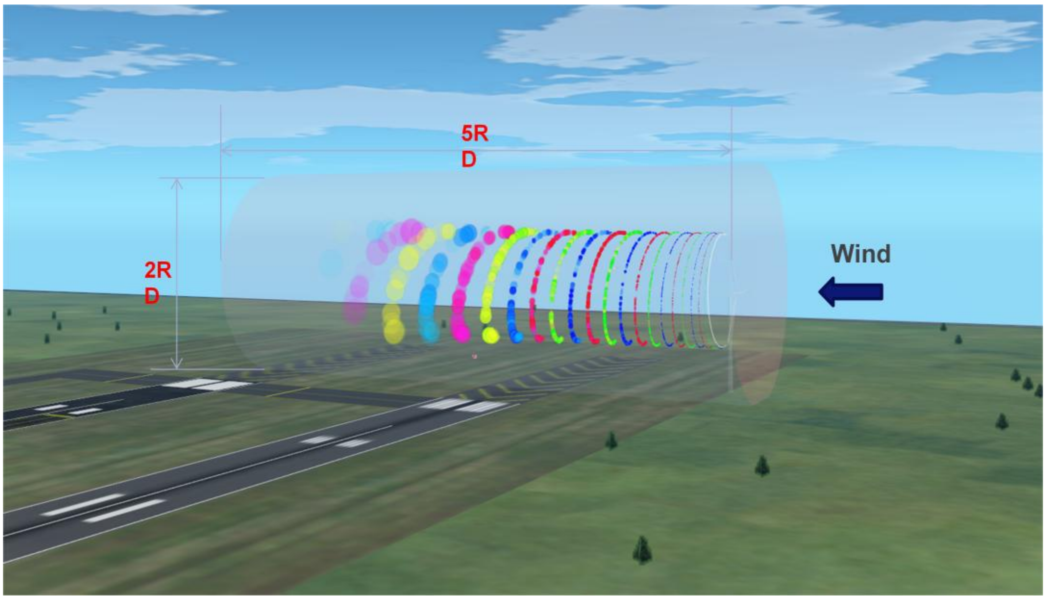


Figure 1:

[20] http://www.liv.ac.uk/flight-science/cfd/wake-encounter-aircraft/

[21] http://www.liv.ac.uk/flight-science/cfd/wake-encounter-aircraft/

Figure 2: The cylindrical region downwind the rotor should be avoided. Its size is 5RD (downwind) by 2RD (vertical). Coloured helices indicate wake vortices and decay.



Economic issues

2.62 As a result of the role and responsibilities of the CAA and aviation stakeholders, action will be taken to maintain the high standards of safety, efficiency and flexibility. However, it is possible that aviation activity might have to be constrained as a consequence of proposed wind energy developments. Even in circumstances where a proposed development may not affect a current activity, future expansion (for example, as listed in an Aerodrome Master Plan) may be restricted were it to go ahead. This could eventually have an economic impact on the aerodrome, ANSP or activity, and this aspect should be taken into consideration when assessing the impact of any proposed wind turbine development. Therefore, it is considered entirely appropriate for an aerodrome to include an assessment of the economic impact that may arise from a proposed wind turbine development. However, it is important to note that comments made in this respect need to be unambiguous in order to allow an LPA to ensure that this important aspect is taken into account appropriately.

En-route obstructions

2.63 It is possible that an existing or proposed wind turbine development that does not infringe an aerodrome OLS may nevertheless have a potential impact upon local aviation activity. For example, a development beyond an OLS, but only marginally clear (laterally or vertically), of Controlled Airspace (CAS), might be assessed as having a potential adverse impact upon operations within Class G (uncontrolled) airspace due to the potential for the creation of ‘choke points’ where aircraft are forced into a reduced volume of available airspace

2.64 Whilst the CAA will highlight such issues away from the immediate vicinity of aerodromes, aerodrome operators/licensees should be cognisant of these issues when engaging with other parties on wind turbine associated matters. Further related comment is contained at Chapter 3 (Obstructions, Lighting and Marking).

Figure 3: Difficulties in visually acquiring anemometer masts.

2.65 Wind turbine developers should be aware that anemometer masts are often difficult for pilots to acquire visually (see Figure 3 above), and so aviation stakeholders may assess that individual masts should be considered a significant hazard to air navigation and may request (either during the planning process, or post-installation) that masts be lit and/or marked. Typically, there is no legal mandate for structures smaller than 150 m (492 ft) to be lit. Whilst the CAA would not in isolation make any case for lighting and/or marking of structures that is not required under existing regulation, the CAA would typically support related aviation stakeholder proposals to aid the visual conspicuity of anemometer masts on a case by case basis. Individual cases should not set a precedent for future requests. The MCA is likely to require that all offshore masts are lit to mitigate the risks to SAR helicopters. In addition, onshore masts have to potential to pose a risk to general aviation. To that end, the General Aviation Awareness Council (on behalf of other GA representative bodies) and a number of helicopter operators, with the in principle agreement of RenewableUK (the

UK's leading not for profit renewable energy trade association), have asked that the following request be relayed by the CAA on their behalf[22]:

"Anemometer masts and/ or their guy wires should be equipped with aids to increase their daytime visual conspicuity where a risk based proposal demonstrating specific need for such measures has been submitted by the aviation stakeholder. Noting that the deployment of any such measure can only be mandated by the relevant Planning Authority, it is acknowledged that such visual conspicuity aids should not impact upon the integrity of the structure itself, the data generated or risk to personnel these aspects are for the developer to consider/assess.

The most effective means of achieving this may be the use of orange marker buoys on the guy wires, such as those that may be fitted to overhead power cables (the use of which has some basis in international regulatory direction). However it is noted that in some locations the structural loads imposed by such markers may be unacceptable. In such cases, the goal of increasing the visual conspicuity of masts and supporting guys might be achieved by different means, which generally place little or no additional structural load on the mast/guy combination. Such means include:

1. *Painting all or part of the mast; options could include alternate contrasting stripes, such as orange and white, or a single contrasting colour (noting that it may need to contrast with terrain, or sky, or both) and/or,*
2. *Reflective bird flight deflectors of minimum 120mm diameter fitted to the guy wires at intervals, and/or*
3. *High visibility sheaths enveloping the supporting guy and/or*
4. *Ground mats, or construction such as a box, of a contrasting colour scheme to the ground at the foot of the mast.*

Whichever method is chosen it will need to satisfy all other relevant planning considerations. For example, bird deflectors may be required for bird protection reasons, and visual intrusion concerns may need to be taken into account. It is envisaged that the norm would be that one method would suffice."

It is recommended that agreement should be sought, through dialogue between the aviation stakeholder, the developer and the LPA regarding the most appropriate method of mitigation. However, should the LPA require further input regarding the general requirement for increasing the visual conspicuity of lattice masts or the specific need in any particular case, enquiries should be forwarded

[22] This text is routinely replicated in CAA Correspondence when asked to comment on related planning applications.

to the GAAC at GAAC, Bicester Airfield, Skimmingdish Lane, Bicester, Oxon, OX26 5HA (e-mail planning@gaac.org.uk).

2.66 Where such obstacles affect operations on an aerodrome, it is the responsibility of the aerodrome operator to ensure appropriate publication in the UK Aeronautical Information Publication (AIP), and to ensure that they establish an effective working relationship with their LPA to ensure that they are consulted when appropriate.

Emergency Services Aviation Support Units (ASUs)

2.67 Since the inception of emergency aviation, there has been a dramatic rise in the number of police and air ambulance operators as well as a small number of fire brigade operations. Due to their unique operating nature, it is difficult to predict the impact of wind turbine developments on these ASUs. It is important, therefore, for emergency service ASUs to engage with all relevant LPAs within their operating area to ensure that they are consulted when planning applications are made. The CAA encourages developers and LPAs to consult with local ASUs, and would be supportive of claims to mark or light turbines that do not fall under article 219 of the ANO where a case by case assessment demonstrates there is a justifiable benefit.

2.68 Police ASUs are licensed by the CAA to operate below 500 feet Above Ground Level (AGL) in order to carry out their duties. Police helicopters will routinely follow main roads and motorways but may also transit along open land, sometimes in difficult weather conditions, during their operations and may need to land anywhere; although they will also have specifically designated landing sites. It should be noted that while some Police ASUs fly with Night Vision Goggles (NVGs), their use is not currently universal. Police Aviation in England and Wales is centrally coordinated by the National Police Air Service (NPAS) which is administered by the West Yorkshire Constabulary. Maps showing NPAS helicopter bases can be found on the NPAS Website. NPAS have recently established a single email address for windfarm consultations and advice: npas.obstructions@npas.pnn.police.uk which should be used for correspondence. The Scottish Police ASU, based in Glasgow, is not currently part of NPAS and should be contacted directly where appropriate.

Military impact

2.69 Wind turbine developments can have a detrimental effect on military operations. Military aviation operations predominantly take place in Class G airspace and can differ markedly from civil operations, particularly with respect to operational low flying, and the sensitivity of military CNS facilities. The DIO are to be consulted in all cases where a proposed wind turbine development may affect military operations. More information is available from the DIO Website.

Chapter 3
Safeguarding considerations

General considerations

3.1. There are a significant number of certificated or licensed aerodromes in the UK. In the region of one third of these, along with en-route CNS, have been designated by the Government as aerodromes to be safeguarded by statutory process, this is known as 'official safeguarding'. As part of this process, CAA certified maps of these officially safeguarded aerodromes and en route technical sites are produced and a Statutory Direction obliges associated LPAs to consult the aerodromes operators about proposed developments that fall within the boundaries specified on the maps.

3.2. Those aerodromes and CNS sites that are not safeguarded by statutory process can be unofficially safeguarded by agreeing protection measures with their LPA.

3.3. Further information about aerodrome safeguarding can be found on the Publications Section of the CAA website.

Safeguarding maps

3.4. Maps of officially safeguarded aerodromes and en route CNS technical sites are produced and submitted to LPAs. These maps denote the areas where consultation should take place with the aerodrome operator.

3.5. Other aerodromes may produce a safeguarding map and request that their LPA recognise their wish to be included in consultation for planning purposes. It is the published advice of the Government[23] that all aerodromes should take steps to protect their locations from the effects of possible adverse development by agreeing a safeguarding procedure with the LPA.

Wind turbine safeguarding maps

3.6. In order to assist the consultation process with wind turbine developers and in providing a diagrammatic illustration of the related aviation issues in discussion with LPAs, a number of aerodromes have developed specific wind turbine safeguarding maps, which graphically depict the aviation operator's assessment of the desirability and feasibility of wind turbine developments. Areas are shown where development would be either undesirable, undesirable but possible, or acceptable (albeit potentially with constraints to address cumulative effects and

[23] The Town and Country Planning (Safeguarded Aerodromes, Technical Sites and Military Explosives Storage Areas) Direction 2002

proliferation issues). Other aerodromes have simply prepared radar consultation zone maps, given the dynamic nature of cumulative effects.

Safeguarding of technical sites

3.7. There is a statutory process to safeguard certain sites which are integral to the provision of en-route ATS. Radar and radio stations, navigation beacons and some microwave communications links are subject to such arrangements[24]. LPAs have an obligation to consult the operators of such sites as defined in official safeguarding maps. Developers may also request discussion with site operators in order to provide necessary mitigation. The International Civil Aviation Organization (ICAO) Eur Doc 015 and CAP 670 are sources of guidance to provide a basis for such discussion.

Obstructions, lighting and marking

3.8. The treatment of land-based obstacles to air navigation is covered by existing legislation. Obstacles located close to licensed aerodromes are covered under Section 47 of the Civil Aviation Act 1982. Government aerodromes are similarly covered under the Town & Country Planning Act (General Permitted Development) Order 2000. article 219 of the ANO 2009 details the requirement for the lighting of land-based tall structures located outside of the safeguarded areas of licensed and government aerodromes.

3.9. Onshore Obstacle Lighting Requirement ICAO regulations (Annex 14 Chapter 6) and article 219 of the ANO 2009 require that structures away from the immediate vicinity of an aerodrome, which have a height of 150 m (492 ft) or more AGL are:

1. Fitted with medium intensity steady red lights[25] positioned as close as possible to the top of the obstacle[26], and also equally spaced at intermediate levels, so far as practicable, between the top lights and ground level with an interval not exceeding 52 m;
2. Illuminated at night, visible in all directions and any lighting failure is rectified as soon as is reasonably practicable;

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24 ICAO EUR DOC 015 recommends safeguarding zones for VORs.

25 'Medium intensity steady red light' means a light that complies with the characteristics described for a medium intensity type C light as specified in Volume 1 (Aerodrome Design and Operations) of Annex 14 (Third edition November 1999) to the Chicago Convention.

26 In relationship to wind turbines, the requirement to fit aviation obstruction lighting 'as close as possible to the top of the obstacle' is typically translated to mean the fitting of lights on the top of the supporting structure (the nacelle) rather than the blade tips. However, any case by case study related to onshore turbines with a maximum height at or above 150m AGL may conclude that additional or amended lighting specifications are required.

3. Painted appropriately: the rotor blades, nacelle and upper 2/3 of the supporting mast of wind turbines that are deemed to be an aviation obstruction should be painted white, unless otherwise indicated by an aeronautical study.

3.10. In addition, the CAA will provide advice and recommendations regarding any extra lighting requirements for aviation obstruction purposes where, owing to the nature or location of the structure, it presents a significant hazard to air navigation. However, in general terms, structures less than 150 m (492 ft) high, which are outside the immediate vicinity of an aerodrome, are not routinely lit; unless the ‘by virtue of its nature or location’ argument is maintained. UK AIP ENR 1.1 para 5.4 'Air Navigation Obstacles' refers.

3.11. When input is sought, the CAA routinely comments to the effect that, in respect to a proposed wind turbine development, there might be a need to install aviation obstruction lighting to some or all of the associated turbines, when specific concerns have been expressed by other elements of the aviation industry; i.e. the operators. For example, if the MoD or a local aerodrome suggest and can support such a need, the CAA (sponsor of policy for aviation obstruction lighting) would wish, in generic terms, to support such a claim. However, this would only be done where it can reasonably be argued that the structure(s), by virtue of its/their location and nature, could be considered a significant navigational hazard. That said, if the claim was clearly outside credible limits (i.e. the proposed turbine(s) was/were many miles away from any aerodrome or it/they were of a height that was unlikely to affect even military low flying), the CAA would play an ‘honest-broker’ role. It is unusual for the CAA, in isolation, to make a case for aviation warning lighting unless article 219 demands such lighting.

3.12. All parties should be aware that, in any case where a wind turbine development lies (or would lie) outside any aerodrome safeguarding limits and the turbine height was less than 150 m (492 ft) (and therefore the provisions of article 219 of the ANO 2009 would not apply), the aviation industry, including the CAA, is not in a position to demand that the turbines are lit. In such cases the decision related to the fitting of aviation warning lighting rests with the relevant LPA, which will necessarily need to balance the aviation lighting requirement against other considerations (e.g. environmental). If deemed as an aviation obstruction, and thus requiring a specific marking scheme, the CAA advice on the colour of wind turbines would align with ICAO criteria.

3.13. Whilst anemometer masts are likely to remain below the threshold that requires they be lit, there may be instances where their lighting is deemed prudent.

Offshore obstacle requirements

3.14. Whilst the mandated requirement for the lighting of wind turbines generators in UK territorial waters[27] is set out at article 220 of the UK ANO (2009) as amended, additional guidance is provided below.[28]

3.15. The article requires medium intensity (2000 candela) steady red lighting mounted on the top of each nacelle and requires for some downward spillage of light. The article also allows for the CAA to permit that only turbines on the periphery of any wind farm need to be equipped with aviation warning lighting. Such lighting, where achievable, shall be spaced at longitudinal intervals not exceeding 900 metres[29]. There is no current routine requirement for offshore obstacles to be fitted with intermediate vertically spaced aviation lighting, however, given the potential increase in maximum height of the next generation of offshore wind turbines with nacelle heights potentially approaching 150m above sea level, additional lighting may be required. The CAA will consider such applications on a case by case basis.

3.16. To resolve concerns from the maritime community, work has been undertaken to develop an aviation warning lighting standard which is clearly distinguishable from maritime lighting. Where it is evident that the default aviation warning lighting standard (article 220) may generate issues for the maritime community, a developer can make a case, that is likely to receive CAA approval, for the use of a flashing red Morse Code Letter 'W' instead. There is, however, no intent to change the lighting intensity specifications set out in article 220; indeed those specifications remain the default aviation warning lighting requirement.

3.17. Where flashing lights are used, they are to be synchronised to flash simultaneously[30]. Where the Flashing Morse W standard is approved by the CAA and utilised, the recommendation is for a 5 second long sequence, visually synchronised across aviation and maritime lighting sequences.

3.18. Attention is drawn to the provisions that already exist within article 220 that require the reduction in lighting intensity at and below the horizontal and allow a further reduction in lighting intensity when the visibility in all directions from every wind turbine is more than 5km. All offshore wind turbine developers are expected

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[27] Taken to apply to any wind turbine generator or meteorological mast that is situated in waters within or adjacent to the United Kingdom up to the seaward limits of the territorial sea. However, the CAA will provide similar planning advice related to the lighting of wind turbines and meteorological mast beyond the limits of UK Territorial Waters.

[28] This guidance replaces CAA Policy Statements 22 November 2012 'Lighting of Wind Turbine Generators in United Kingdom Territorial Waters' and 27 April 2012 'Failure of Aviation Warning Lights on Offshore Wind Turbines'.

[29] ICAO Annex 14 Volume 1 paragraph 6.3.14.

[30] ICAO Annex 14 Volume 1 paragraph 6.4.3.

to comply fully with the requirement aspect and to make full use of the additional allowance that exists within article 220.

3.19. In addition to the article 220 mandated lighting, there may also be lighting requirements associated with winching and SAR operations. The lighting needed to facilitate safe helicopter hoist operations to wind turbine platforms is set out in CAP 437. Information on SAR Requirements can be found in Maritime Guidance Note 371 and a summary of relevant aspects can be found in Chapter 2 of this document. It is recommended that SAR lighting requirements are agreed with the MCA at the earliest possible opportunity.

3.20. As offshore wind farms are developed, meteorological masts may be deployed to ascertain the wind resource characteristics. These masts can be in excess of 100 m tall and are extremely slender rendering them potentially inconspicuous to aviators flying over the sea, particularly when there are no other structures nearby. This is potentially hazardous, particularly during helicopter operations when it may be necessary to descend in order to avoid icing conditions. Consequently the CAA recommends that all offshore obstacles (regardless of their location within or outside of territorial waters) that are over 60 m (197 feet) above sea level should be fitted with one medium intensity steady red light positioned as close as possible to the top of the obstacle.

3.21. The CAA does not typically request specific markings for offshore obstacles. However, any aviation stakeholder that considered a particular structure to be a significant navigational hazard could make a case for it to be lit and/or marked to increase its visual conspicuity. The request (as opposed to mandate) for such lighting and/or marking would need to be negotiated with the owner of the structure or, if at the planning stage, the relevant planning authority. If asked for comment, it would be unlikely that the CAA would have any fundamental issue associated with an appropriate aviation stakeholder's case for lighting/marking of any structure that could reasonably be considered to be a significant hazard.

3.22. For military aviation purposes the MoD may suggest an additional offshore lighting requirement. Whilst it is possible that the lighting standard described above will meet the MoD needs, it is recommended that in all cases developers additionally seek related input from the DIO.

Failure of offshore lighting

3.23. Article 220 (7) of the ANO 2009 states “In the event of the failure of any light which is required by this article to be displayed by night the person in charge of a wind turbine generator must repair or replace the light as soon as reasonably practicable.” It is accepted that in the case of Offshore Obstacles there may be occasions when meteorological or sea conditions prohibit the safe transport of staff for repair tasks. In such cases International Standards and Recommended Practices require the issue of a Notice to Airmen (NOTAM).

3.24. The CAA considers the operator of an Offshore Wind Farm as an appropriate person for the request of a NOTAM relating to the lighting of their wind farm. Should the anticipated outage be greater than 36 hours then the operator shall request a NOTAM to be issued by informing the NOTAM section (operating 24 hours) of the UK Aeronautical Information Service (AIS) by telephoning +44 (0) 20 8750 3773/3774 as soon as possible. AIS will copy the details of the NOTAM to the operator and to the CAA.

3.25. The following information should be provided:

1. Name of wind farm (as already recorded in the AIP[31]).
2. Identifiers of affected lights (as listed in the AIP) or region of wind farm if fault is extensive (e.g. North east quadrant/south west quadrant/ entire or 3 NM centred on position 515151N 0010101W).
3. Expected date of reinstatement.
4. Contact telephone number.

3.26. Note that if the turbine or wind farm does not have a listing in the AIP then it will not be possible to issue a NOTAM. Typically all offshore turbines of a maximum blade tip height of 300 feet or more will be recorded within the AIP.

3.27. In order to expedite the dissemination of information during active aviation operations the wind farm operator may also consider establishing a direct communication method with aviation operators in the area. These may include:

1. Air Traffic Service Units e.g. Aberdeen Radar or Anglia Radar.
2. Local airports.
3. Local helicopter operators.

3.28. The information will be the same as in the NOTAM request, and should also include a note that a NOTAM has been requested, or if available, the NOTAM reference.

3.29. If an outage is expected to last longer than 14 days then the CAA shall also be notified directly at windfarms@caa.co.uk (normal working hours) to discuss any issues that may arise and longer term strategies.

Consultation zones around offshore helidecks

3.30. For many years, the CAA has emphasised the importance of operators and developers taking into consideration all existing and planned obstacles around offshore helicopter destinations that might impact on the safe operation of

[31] UK Aeronautical Information Publication (www.ais.org.uk) En Route Supplement 5.4.

associated helicopter low visibility approaches in poor weather conditions. In order to help achieve a safe operating environment, a consultation zone of 9 NM radius exists around offshore helicopter destinations. This consultation zone is not a prohibition on development within a 9 NM radius of offshore operations, but a trigger for consultation with offshore helicopter operators, the operators of existing installations and exploration and development locations to determine a solution that maintains safe offshore helicopter operations alongside the proposed development. This consultation is essential in respect of established developments. However, wind energy lease holders, oil and gas developers, and petroleum licence holders are advised to discuss their development plans with each other to minimise the risks of unanticipated conflict at a later date. Topics for discussion within any such consultation should include, but are not limited to:

1. Prevailing weather conditions, including predominant wind direction;
2. Manning status of the installation;
3. Frequency of flights to the installation and predominant routes;
4. Performance limitations of offshore helicopter types utilising the helideck;
5. Established helicopter instrument and low visibility approach procedures;
6. Mandated constraints on approaches to helidecks on installations;
7. Long term access to well and subsea infrastructure;
8. Concurrent wind farm operations and oil and gas operations to well and subsea infrastructure;
9. SAR operations to the installation in the event of an emergency;
10. Location and height of potential obstacles including proposed wind turbines.

3.31. The following paragraphs provide, in layman’s terms, an explanation of the reasoning behind the need for the 9 NM consultation zone. While procedures will differ depending upon the installation, operator and aircraft type involved, the following notes are based upon Commission Regulation (EU) No 965/2012 (the European Air Operations Regulation), improved flight procedure documentation and the practical application of such requirements:

1. Basic Requirement. The 9 NM consultation zone aims to provide a volume of obstacle-free airspace within which a low visibility approach profile and, in the event of a pilot not being able to complete his approach, a missed approach can be flown safely. Such profiles must allow for an acceptable pilot workload, a controlled rate of descent, one engine inoperative performance and obstacle clearance.

2. Approach. Routinely, helicopters making manually flown radar/GPS approaches and, in the future, autopilot-coupled approaches, to offshore installations will commence the approach from not below 1500 ft Above Mean Sea Level (AMSL) or 1000 ft above obstacles, whichever the higher. As helicopters approaching offshore installations must make the final approach substantially into wind, the approach could be from any direction. The obstacle-free zone must, therefore, extend throughout 360° around the installation to prevent restrictions being placed on the direction of low visibility approaches and departures. Additionally, during the approach, all radar contacts have to be avoided by at least 1 NM which could interfere with the necessary stable approach path if manoeuvring is required. The approach sequence and descent below 1500 ft routinely commences from about 8 NM downwind of the destination installation and the final approach starts at around 5–6 NM and 1000–1500 ft. The helicopter descends to a minimum descent height (at least 200 ft by day and 300 ft at night), which is commonly achieved within 2 NM of the helideck having descended on a 'glide path' of between 3–4°. Thereafter, it flies level at that height towards the Missed Approach Point (MAPt). As the helicopter approaches the MAPt, a minimum of 0.75 NM from the offshore destination, the pilot must decide whether or not he has the required the necessary visual references to proceed to land or, if not, conduct a go-around following a missed approach procedure.

3. Go-Around and Missed Approach Procedure (MAP). Upon initiating a go-around, the pilot will follow a MAP whereby the helicopter is either turned away from the destination structure by up to 45° and climbs, or climbs straight ahead depending on the procedure being used. The anticipated rate of climb during the missed approach phase is based upon one engine inoperative performance criteria and could be quite shallow (1–2°). For obvious safety reasons, a go-around involving a climb from the minimum descent height needs to be conducted in an area free of obstructions as this procedure assures safe avoidance of the destination structure.

4. Departure Procedure. On departure from an offshore installation the aircraft will be climbed vertically over the deck to a height determined by its performance criteria and is committed to the take off once a nose down attitude is adopted. If during this phase an engine failure is experienced then the anticipated rate of climb will be the same as described above for the MAP; however, the climb could start from as low as 35 ft above sea level dependent on deck height. The distance to climb to a safe altitude by which either a turn can be carried out, or straight ahead, to reach separation from obstacles will be dependent on aircraft one engine inoperative performance criteria. The aircraft can be up to 10º either side of the departure heading and the radius of any turn carried out can be up to 1000 m.

3.32. In summary, obstacles within 9 NM of an offshore destination would potentially impact upon the feasibility to conduct some helicopter operations (namely, low visibility or missed approach procedures) at the associated site. Owing to the obstruction avoidance criteria, inappropriately located wind turbines could delay the descent of a helicopter on approach such that the required rate of descent (at low level) would be excessive and impair the ability of a pilot to safely descend to 200/300 ft by the appropriate point of the approach (2 NM). If the zone is compromised by an obstruction, it should be appreciated that routine low visibility flight operations to an installation may be impaired with subsequent consequences for the platform operator or drilling unit charterer. One such consequence could be that the integrity of offshore platform or drilling unit safety cases, where emergency procedures are predicated on the use of helicopters to evacuate the installation, is threatened. Additionally, helicopter operations to wind farms may impact on oil and gas operations. It is therefore essential that the installation operators, helicopter operators and other interested parties are engaged in the consultation process.

Helicopter Main Routes (HMR)

3.33. HMRs, as defined in the UK AIP, have been in use over the North Sea and in Morecambe Bay for many years. Whilst such routes have no lateral dimensions (only route centre-lines are charted) they provide a network of offshore routes utilised by civilian helicopters. Wind turbine developments could impact significantly on operations associated with HMRs: the effect will depend on the degree of proliferation, and so a small number of individual turbines should cause minimal effect. However, a large number of turbines beneath an HMR could result in significant difficulties by forcing the aircraft to fly higher in order to maintain a safe vertical separation from wind turbines. The ability of a helicopter to fly higher would be dependent upon the 0° isotherm (icing level); this might preclude the aircraft from operating on days of low cloud base if the 0º isotherm was at 2000 ft or below as the aircraft must be able to descend to a clear area below cloud and with a positive temperature to safely de-ice if necessary.

3.34. There should be no obstacles within 2 NM either side of HMRs but where planned should be consulted upon with the helicopter operators and ANSP. The 2 NM distance is based upon: operational experience; the accuracy of navigation systems; and, importantly, practicality. Such a distance (2 NM) would provide time and space for helicopter pilots to descend safely to an operating height below the icing level. For the purpose of transiting wind turbine developments under Visual Flight Rules, corridors may be established that are no less than 1 NM wide. Additionally, helicopters (like all aircraft), are required by Commission Implementing Regulation (EU) No 932/2012 (the Standardised Rules of the Air Regulation) to avoid persons, vessels, vehicles and structures by a minimum distance of 500 ft; this applies equally to the avoidance of wind turbines and any other structure.

3.35. Notwithstanding the above, low level coverage is of particular importance in the provision of full ATS to offshore helicopter operators, and ANSPs will need to give careful consideration to any proposed development that impact on the supporting PSR feed. Moreover, dependent on the level and type of service provided prior to the installation of wind turbines, it may prove necessary to maintain a buffer greater than 2 NM from HMRs in order to maintain the previous service provision by an ATS provider or ANSP. Further guidance is available from SARG.

Facilitation of helicopter support to offshore installations

3.36. In order to facilitate construction or maintenance flights within the boundaries of wind turbine developments, consideration should be given to the use of flight corridors being built into the development layout plans. Such corridors should be oriented and their width designed in consultation with the helicopter operators, given that it will be governed by the VFR performance of the aircraft in use. The layout of the turbines may also need to consider the requirements of the MCA with regards to SAR within the field.

Military requirement for Infra-Red (IR) lighting

3.37. Low flying is a vital element of military operations in areas of conflict, and a large proportion of the flying will be undertaken at night. Low flying training across the UK can take place as low as 100 ft for fast jet aircraft in Tactical Training Areas, and 250 ft in Low Flying Areas. Helicopters fly tactically down to 50 ft and routinely down to100 ft during training sorties in all areas.

3.38. The MoD have recently published Obstruction Lighting Guidance which is also available via the Aviation and Radar page on the RenewablesUK Website. The majority of night time flying by MoD aircraft is undertaken by crews equipped with NVGs; therefore IR vertical obstruction lights will be suitable in most occasions.

3.39. An application for onshore wind turbines will receive notification from DIO indicating whether IR lights will be suitable. In some cases a combination IR / red lighting will be required, for example geographical choke points or to denote the extremities of a larger wind farm.

3.40. Careful attention needs to be taken to ensure that the IR light chosen by the wind developer meets the MoD’s requirements, as some IR (Light Emitting Diode) lights are not compatible with military NVGs.

3.41. Requests for clarification should be addressed to the DIO. Contact details are included in Appendix B.

Parachute drop zones

3.42. Parachutists drop from heights up to 15,000 ft AGL within a published Drop Zone (DZ), normally out to a minimum of 1.5 NM/2.8 km radius from the centre of the Parachute Landing Area (PLA).

3.43. Hazards to PLAs are categorized as:

1. Special Hazard. A hazard which could constitute a special risk to parachutists and if parachutists were to come into contact with may result in serious or fatal injury" e.g. stretches of open water, deep rivers, electricity power lines, wind turbines of a height greater than 15m to blade tip at its highest point, densely built up areas, cliffs and quarries.
2. Major Hazard. Obstacles, either natural or artificial, which because of their size may be difficult to avoid and which, if struck by a parachutist, may result in injury; i.e. large hangars, buildings, woods etc.;
3. Minor Hazard. Any object, either natural or artificial, which should be easily avoided but which if struck by a parachutist may result in injury; i.e. hedges, fences, ditches etc.).

3.44. CAP 660 (Parachuting) refers.

3.45. Wind turbines pose a special risk to parachutists and if parachutists were to come into contact with may result in serious or fatal injury; those over 15 m high are considered by the British Parachute Association (BPA) to be a Special Hazard. Wind turbines of 15 m or below are considered Major Hazards.

3.46. PLAs to be used by all designations of parachutists should provide a large open space of reasonably level ground, which can contain a circle of 250 m radius free from Major Hazards and largely free from Minor Hazards. These PLAs should be bordered on at least three sides by suitable overshoot areas, where parachutists may land if they are unable to land on the PLA: these overshoot areas should be free from Special Hazards and largely free of Major Hazards.

3.47. Wind turbines over 15 m high (50 feet) are considered a rotating special hazard and as such if located within the designated DZ would likely result in restrictions being placed upon any parachute activity within that DZ.

3.48. It is worthy of note that any obstacle over 300 ft (91.4 m) in height is no longer considered by the BPA to be just a ground obstacle to parachutists, but also an air obstacle, given that it protrudes into airspace within which parachutists (particularly in an emergency situation) may not yet have taken control of their canopies, and so could result in an aerial collision.

Very light aircraft

3.49. Due to the potential for sudden loss of lift within areas of turbulence, very light aircraft are operated away from areas of known turbulence or only in areas where turbulence is consistent and predictable (such as hill sites used by hang-gliding/paragliding clubs). Introducing a wind turbine to a location that is frequented by very light aircraft may result in that location becoming unviable or less attractive to visiting pilots if the turbine generates turbulence that may exceed the aircraft's operating limits.

Chapter 4

Wind turbine development planning process

Pre-planning and consultation

4.1. The weight of relevant knowledge accrued by wind turbine developers and ANSPs over the past decade has been substantial: issues are better understood, and proper procedures for effective consultation are in place. Developers are required to undertake their own pre- planning assessment of potential civil aviation related issues. It should also be noted that NATS, the MoD and certain airports also offer pre-planning services. Table 1 provides an overview of considerations, and the following paragraphs detail what developers will need to consider, conducting associated consultations as appropriate.

Table 1: Overview of consultation considerations

	CNS Facilities	**Obstacle Considerations**
Aerodrome *(Consultation required with aerodrome licensee/manager)*	▪ Safeguard PSR and SSR ▪ Safeguard Approach Aids ▪ Safeguard Navigation Beacons ▪ Safeguard VHF	▪ OLS ▪ Impact on procedures ▪ Need for lighting to aid night time conspicuity ▪ Anemometer masts
En Route *(Consultation required with MoD and NERL)*	▪ Safeguard PSR and SSR ▪ Safeguard Navigation Beacons ▪ Safeguard VHF	▪ >300 ft/91 m Chart and entry to AIP ▪ >150 m (492 ft) Lighting in accordance with article 219 of ANO (2009) ▪ Marking of turbine (upper 2/3 white in accordance with ICAO guidance) ▪ Potential for additional lighting requirements where turbines may be considered as a significant hazard to air users ▪ Anemometer masts ▪ Emergency Service ASUs and HEMS (including MCA in remote areas)
Offshore *(Consultation*	▪ Safeguard PSR and SSR	▪ Offshore Lighting in accordance with article 220 of ANO (2009) and CAP

	CNS Facilities	Obstacle Considerations
required with MoD NERL and MCA)	▪ Safeguard Navigation Beacons ▪ Safeguard VHF	764 ▪ HMR ▪ Operations around oil and gas platforms ▪ Anemometer masts ▪ Search and Rescue requirements

4.2. Aerodromes. Whilst not definitive, it should be anticipated that any wind turbine development within the following criteria[32] might have an impact upon civil aerodrome[33] - related operations:

1. Unless otherwise specified by the aerodrome or indicated on the aerodrome's published wind turbine consultation map, within 30 km of an aerodrome with a surveillance radar facility. The distance can be far greater than 30 km depending upon a number of factors including the type and coverage of the radar and the particular operation at the aerodrome;
2. Within airspace coincidental with any published Instrument Flight Procedure (IFP) to take into account the aerodrome's requirement to protect its IFPs;
3. Within 17 km of a non-radar equipped licensed[34] aerodrome with a runway of 1100 m or more;
4. Within 5 km of a non-radar equipped licensed aerodrome with a runway of less than 1100 m;
5. Within 4 km of a non-radar equipped unlicensed aerodrome with a runway of more than 800 m;
6. Within 3 km of a non-radar equipped unlicensed aerodrome with a runway of less than 800 m.

[32] Aerodrome criteria are generically based upon the safeguarding requirements and guidance contained in Regulation EC 139 of 2014, CAP 168 and CAP 793 (both current and historical). The ranges quoted are for guidance only. If proposed developments lie marginally outside the ranges highlighted, but nevertheless in close proximity to other developments, developers are advised to consider the potential proliferation issues. The object of any pre-planning process is to identify all possible aviation concerns to the developer at an early stage and as such, the assessment should err on the side of caution.

[33] In this context the term 'aerodrome' includes any site used regularly by aircraft (including helicopters and gliders) for take-off and landing. The CAA-sponsored, NATS-produced VFR charts depict all such sites known to the CAA, although effects on uncharted aerodromes must still be considered.

[34] Licensed in accordance with Part 27 of ANO (2009) as amended.

4.3. The figures above are for initial guidance purposes only and do not represent definitive ranges beyond which all wind turbine developments will be approved or within which they will always be objected to. These ranges are intended as a prompt for further discussion between developers and aviation stakeholders in the absence of any other published criteria.

4.4. Many modern gliders have a glide ratio of at least 50:1 and the most modern gliders can exceed that, with further progress expected in future. Developments of wind turbines within 10 km of a gliding site or where the maximum height of the structure is within a 50:1 angle of a gliding site will present additional considerations beyond those associated with powered aircraft. Therefore, notwithstanding the CAA recommended distances quoted above, the British Gliding Association (BGA) requests that relevant gliding sites and the BGA are consulted where proposed developments are within 10 km of any charted glider launch site.

4.5. Aerodrome operators should address physical safeguarding issues in accordance with the guidance contained within relevant EASA documentation, CAP 168 and CAP 738 as applicable. Operators of unlicensed aerodromes should refer to CAPs 793 and 738 as applicable and are strongly advised to engage with their LPA to ensure that their activities and requirements are well understood. At the very least, unlicensed aerodromes should subscribe to their LPA's Weekly Planning List, which will provide them with information on all planning applications – including wind turbines and anemometer masts – and therefore provide a mechanism for effective self-briefing for their associated pilots.

4.6. Non-aerodrome related activity. Developers should also consider the potential for wind turbines to impact upon known general aviation activity that are annotated on CAA-sponsored, NATS-produced VFR charts, but which are not related to a recognised or single aerodrome (for example, charted fee-fall parachute DZ and hang/ para-gliding winch launch sites). Typically, developers will need to engage direct with relevant aviation operators where a development would be within 3 km of any such site.

4.7. NATS. There may be issues related to en route CNS facilities. Accordingly, details of any proposal need to be considered by NATS. Developers need to undertake related consultation as appropriate as NATS will be consulted by the LPAs. NATS Windfarm web pages provide support.

4.8. Lighting and marking. There might be a need to install aviation warning lighting to some or all of the turbines if increased conspicuity is deemed necessary.

4.9. Charting. In terms of obstacle charting requirements in the UK, a threshold exists at 300 ft (91.4m)[35]

1. Structures with a maximum height of 300 ft (91.4m) above ground level or higher:

   a) There is an ICAO Annex 15 requirement for all obstacles (temporary or otherwise) over 300 ft (91.4m) AGL to be promulgated in the UK AIP and charted on civil aviation charts. Accordingly, any such structure is required to be notified to the Defence Geographic Centre (DGC) who provides the source of obstacle data, published in the UK AIP at ENR 5.4 no later than 10 weeks prior to construction. Information provided should include the type of structure and name of location, an accurate location of the structure(s) in WGS 84 latitude and longitude (degrees, minutes and 1/100 second), an accurate maximum height AMSL/AGL, the lighting status of the turbines and date for the completion of construction. In addition, the developer should also provide the maximum height of any construction equipment required to build the turbines. Removal of turbines is also required to be notified and expected date of removal. The DGC prefer notifications to be submitted electronically: mail to dvof@mod.uk.

   b) In order to ensure that aviation stakeholders are aware of the turbines while aviation charts are in the process of being updated, developments should also be notified through the means of a NOTAM. To arrange an associated NOTAM, a developer should contact CAA Airspace Regulation[36] (AROps@caa.co.uk / 0207 453 6599) no later than 14 days prior to the commencement of construction with the same information as required by the DGC. Of note, if the obstacle falls within an Aerodrome Traffic Zone or Military Aerodrome Traffic Zone, it is the responsibility of that aerodrome to issue the NOTAM.

2. Structures with a maximum height below 300 ft (91.4m) above ground level. In the interest of Aviation Safety, the CAA also requests that any feature/structure 70 ft (21.3m) in height, or greater, above ground level is also reported to the DGC. It should be noted that NOTAMs would not routinely be required for structures under 300 ft (91.4m) unless specifically requested by an aviation stakeholder.

4.10. Emergency ASUs. For completeness it would also be sensible to establish the related viewpoint of local emergency ASUs. This is because of the unique nature of their operations in respect of operating altitudes and potentially unusual

[35] The effective height of a Wind Turbine is the maximum height to blade tip.

[36] Previously named Airspace Utilisation with the email address AUSOps@caa.co.uk. The AROps email address should now be used for all correspondence and NOTAM requests.

landing sites. In addition, The MCA is responsible for the provision of SAR services onshore and offshore. It is recommended that the MCA is consulted on all offshore developments and one of the factors that it will consider is the implications of a development on SAR operations (with surface craft and helicopters). Further information is available in Chapter 2.

4.11. Cumulative effect. The growth in the number of wind turbine developments (either under consideration, in planning, under construction, or operational), is significant. It is possible that the cumulative effect of a number of wind turbine developments in any particular area might potentially result in difficulties for aviation that a single development would not have generated. See also Chapter 2.

4.12. Cross-boundary. In order to delineate responsibility for the provision of flight information services to aircraft, airspace is divided up into internationally recognised Flight Information Regions (FIRs). Airspace in the UK is divided into the London and Scottish FIRs which together form the UK FIR. Coordinates for these boundaries are listed in the UK Aeronautical Information Publication Section ENR 2.1. Offshore developments have the potential to straddle these boundaries, one example being the consented East Anglia ONE development, part of which is in the Dutch FIR. Airspace outside the UK FIR is the responsibility of other European aviation authorities, whose regulations may differ from those that apply in the UK. Accordingly, wind turbine developers should contact the CAA for specific guidance in all instances where developments are likely to approach the limits of the UK FIR.

Formal planning

4.13. Regardless of whether voluntary pre-planning has been undertaken, all proposals for wind turbine developments must eventually move into a formal approval process either through the Electricity Act 1989, the Planning Act 2008, or through the Town and Country Planning Acts[37] . The process is outlined in the subsequent paragraphs, although these guidelines do not purport to be a comprehensive guide to planning procedures.

England and Wales

4.14. In England, LPAs currently handle consent applications for land-based generating stations with a capacity up to 50 MW in accordance with the polices set out in the National Planning Policy Framework (NPPF) and following the procedure set out in the Town and Country Planning Act 1990. The Planning Act 2008 sets out thresholds above which certain types of infrastructure development

[37] Taken to include the Town and Country Planning Act 1990 and Town and Country Planning Act (Scotland) 1997.

are considered to be nationally significant. Currently, land-based electricity generating stations with a capacity over 50MW and offshore generating stations with a capacity above 100MW are classified as Nationally Significant Infrastructure Projects (NSIPs), however, it is the Government's published intention to amend legislation so that all applications for onshore wind energy developments are handled by local planning authorities[38]. Any developer wishing to construct an NSIP must first apply for a type of consent known as 'development consent'. For such projects, the Planning Inspectorate examines the application and will make a recommendation to the relevant Secretary of State, who will determine the application. In Wales, onshore applications over 50 MW and offshore applications over 100MW are currently decided by the relevant UK Secretary of State following the recommendation of the Planning Inspectorate. Applications for developments under 50 MW are dealt with by the relevant LPA under the Town and Country Planning Legislation (Wales). The Welsh Government has published planning advice on renewable energy in the form of Technical Advice Note (TAN) 8 and in the Planning (Wales) Act 2015. In addition, the UK Government has expressed the intent to devolve powers to Welsh Ministers for the consenting of energy schemes both onshore and offshore of up to 350 megawatts capacity[39].

Scotland

4.15. In Scotland, there is currently a similar division of responsibility. Applications for onshore stations of a capacity up to 50 MW are made to the relevant LPA under the Town and Country Planning Act (Scotland). Onshore developments with a capacity greater than 50 MW require consent from the Scottish Government. These applications are handled on behalf of the Scottish Ministers by the Energy Consents Unit (ECU) under Section 36 of the Electricity Act (1989). In Scotland, applications for marine energy (including offshore wind) are made to Marine Scotland.

Northern Ireland

4.16. Previously in Northern Ireland, the Planning Service (an Agency within the Department of the Environment), handled all proposals for land-based generating stations irrespective of capacity. From 1 April 2015, the responsibility for planning has been shared between 11 new councils and the Department of the Environment. Applications will be classified as either 'local', 'major' or being of 'regional significance'. Criteria for assessing the classification of developments are contained within The Planning (Development Management) Regulations (Northern Ireland) 2015. An application deemed to be of regional significance

[38] Dept of Communities and Local Government online guidance on Renewable and Low Carbon Energy dated 18 June 15.

[39] The Queens Speech 27 May 2015 - contained within the proposed Wales Bill.

must be made to, and will be determined by, the Department of the Environment. Councils will be responsible for determining major and local development applications. In Northern Ireland, offshore wind farm proposals are the responsibility of the Department of Enterprise, Trade and Investment.

Micro wind turbines

4.17. The legislation to allow permitted development rights for householders to install MWTs on their premises came into force on 1 December 2011. Details of the order can be found in Class H and I of Part 14 in Schedule 2 of The Town and Country Planning (General Permitted Development) (England) Order 2015. The same legislation came into force in Wales on 22 May 2012. The legislation applies to both building mounted and free standing turbines that do not exceed 15 metres and 11.1 metres above the ground respectively. The Planning Portal hosts the Domestic Wind Turbine Safeguarding Land Tool, which establishes whether or not a proposed wind turbine will be located on safeguarded land. If the proposed turbine is not on safeguarded land it has successfully met one of the requirements of being eligible for permitted development. All turbines that do not meet the above requirements are currently processed in a manner relevant to all other scales of wind turbine development.

CAA involvement

4.18. Currently, the CAA can provide the following input to formal planning submissions for wind turbine developments:

1. Identification of aviation stakeholders that would potentially be affected;
2. Reviewing the aviation section of the Environmental Statement for accuracy and completeness;
3. Consideration of regulatory requirements;
4. Consideration of whether all other aviation issues known to the CAA have been taken into account (including other potential developments).

4.19. It should be noted that the CAA is currently only a statutory consultee for onshore developments in excess of 50MW and for offshore developments in excess of 100MW. Responses to other planning submissions will be made, resource permitting.

Promulgation of wind turbine developments

4.20. The need to promulgate the existence of tall structures that might constitute a significant aviation obstruction is self-evident. LPAs routinely advise the DGC of also report such information to DGC. Through the updated promulgation of a database document, the SARG Aeronautical Charts and Data section is advised of all such developments and update aviation charts accordingly. All structures (including wind turbines and anemometer masts) in excess of 300 ft in height are depicted on charts and details of each wind turbine are promulgated in the UK AIP, ENR 5.4 (CAP 32) 9.2. By exception, structures less than 300 ft high may be promulgated for civil aviation en-route purposes if their presence is deemed to be of navigational significance.

Call-ins and inquiries

Call ins

4.21. Whilst the aviation industry has no powers of veto, there is a legal obligation placed upon LPAs to give warning if they are minded to grant planning permission against advice given by a statutory safeguarding consultee (ODPM/DfT/ NAFW Circular 1/2003 and Scottish Executive Circular 2/2003 refer). This process offers an opportunity for the CAA to establish whether a solution is apparent or, if it fails to resolve the issue, to refer the matter for a decision by central Government. This procedure is always a last resort, as it is anticipated that communication and cooperation can obviate the need for it.

Inquiries

4.22. In the event that a planning application is referred to a planning inquiry, the CAA may be requested by the LPA to provide expert witness evidence. This may be by providing written statements or by attendance at the Inquiry.

Consistency, accuracy and use of consultants

4.23. When aviation stakeholders are consulted over wind turbine developments, either at the pre-planning stage or once the formal planning application process has begun, it is critical that the responses made are consistent, factually accurate and cover all relevant aspects. It should be noted that these responses may be subject to challenge and CAA is often asked to provide an impartial regulatory perspective on what has been submitted.

4.24. In submitting a wind turbine development proposal, developers will regularly employ subject matter experts in the form of consultants to prepare reports to identify potential issues and address any issues raised by aviation stakeholders. This may be in the pre-application stage or to seek to address aviation concerns following aviation objections. In addition, as part of the formal process, developers are often required to submit an Environmental Impact Assessment which will include an assessment of aviation issues and mitigations, often based on supporting reports commissioned by the developers. If asked for comment, CAA will request that LPAs pursue any assertions or statements made in respect of aviation with the appropriate aviation stakeholder, developer or consultant.

CAA provision of advice

4.25. The CAA is often approached for comment and advice concerning the validity of objections raised or the suitability of mitigations proposed. However, it is incumbent upon the developer to liaise with the appropriate aviation stakeholder to discuss – and hopefully resolve or mitigate – aviation related concerns without requiring further CAA input. However, if these discussions break down or an impasse is reached, the CAA can be asked to provide objective comment. It must be remembered that the CAA has no powers to either prevent wind turbine developments going ahead or to require that an aviation stakeholder remove their objection. Nevertheless, by involving the CAA at an appropriate stage, it is hoped that some form of agreement can be reached that prevents the need for costly Planning Inquiries that feature aviation as a key issue.

4.26. Of further note is that as the UK's independent civil aviation regulator of, the CAA will not typically provide comment on MoD objections or arguments unless such comments have been requested by the MoD. However, in circumstances where there is a mixture of civil and military objections and where it is appropriate to do so, the CAA could facilitate discussions between all the parties (including the MoD).

APPENDIX A

DECC Governance and meeting structure

A1 In addition to work to improve the processes of consultation and assessment, there is a substantial amount of other activity going on to identify, develop and implement solutions to the potential impacts that wind turbines can have on radar systems. It was recognised that it would be beneficial to draw this work together within a single plan in order to have a coordinated approach to finding solutions to the wind turbine – radar issue. Therefore, together with stakeholders in the aviation and wind development sectors, DECC and several partners jointly developed an Aviation Plan to move work forward so that wind turbine developments could be developed while, at the same time, the maintenance of national security and the continued safe operation of our aviation environment were ensured. The structure and principles of the Aviation Plan were endorsed by the Wind Energy, Defence and Civil Aviation Interests Working Group in March 2008.

A2 The overall aim of the Aviation Plan is to provide an evolving suite of generic mitigation solutions to which wind turbine developers and their aviation stakeholders can turn when discussing the best potential solutions for any particular wind proposal. The development of this suite of generic solutions is an on-going process and builds on a number of solutions that are already available to wind turbine developers.

A3 The governance of the Aviation Plan is the responsibility of an Aviation Management Board (AMB), which in turn is supported by a technical-level Aviation Advisory Panel (AAP). RenewableUK have taken on the responsibility of establishing an industry funding mechanism that will part- support, financially, the work-streams within the Plan, which is managed by the Fund Management Board. All meetings sit quarterly.

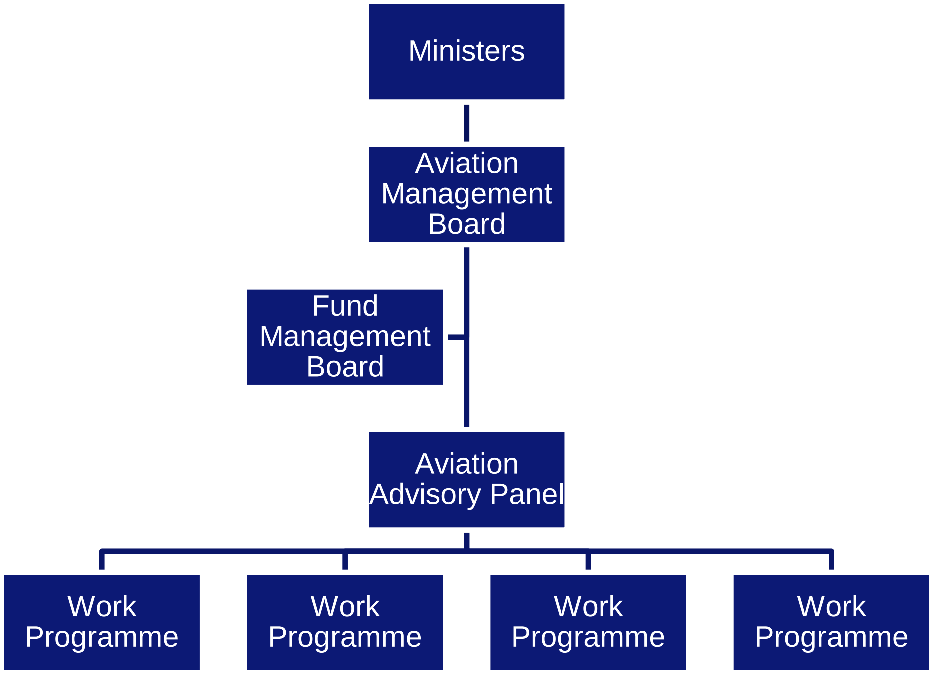

Figure A-1: AMB Governance

A4 The value of the Aviation Plan as a tool for enabling the development of mitigation solutions has been recognised by key stakeholders that have an interest in radar systems and wind turbine developments. To ensure the success of the plan, a number of these have agreed to sign off a second Memorandum of Understanding[40] to commit to the full implementation of the Aviation Plan and its approach to ensuring the timely and effective delivery of solutions to reduce the effect of wind turbines on aviation interests.

[40] https://www.gov.uk/government/publications/wind-turbines-and-aviation-radar-mitigation-issues-memorandum-of-understanding-2011-update

APPENDIX B

Contact Information

CAA Contacts

CAA Windfarms

Windfarms

Infrastructure

Safety and Airspace Regulation Group

CAA House

45-59 Kingsway

London

WC2B 6TE

Tel: 020 7453 6534

http://www.caa.co.uk/Safety-Initiatives-and-Resources/Safety-projects/Windfarms/Windfarms/

windfarms@caa.co.uk

CAA Aerodromes

For information on aerodrome licensing criteria, obstacle limitation surfaces and call-in procedures, contact:

Civil Aviation Authority

Aerodromes Standards Department

Safety and Airspace Regulation Group

Aviation House

Gatwick Airport South

West Sussex

RH6 0YR

CAAAerodromeStandardsDepartment@caa.co.uk

CAA Air Traffic Standards

Where a service provider has to update the safety documentation for a service as a result of a wind turbine development, then they should follow standard practice and contact their regional inspector for approval as necessary. Contact details are below:

CAA En-Route Regulation

Safety and Airspace Regulation Group Aviation House – 2W

Gatwick Airport South

West Sussex

RH6 0YR

Tel: (+44) (0)1293 573060, Fax: (+44) (0)1293 573974

ats.enquiries@caa.co.uk (mark to 'En-Route Regulation')

CAA Southern Regional Office (Gatwick)

Regional Manager ATS Safety Regulation (Southern Region)

Air Traffic Standards Division

Safety and Airspace Regulation Group

Civil Aviation Authority

Aviation House

Gatwick Airport South

West Sussex

RH6 0YR

Tel (+44) (0) 1293 573330, Fax: (+44) (0) 1293 573974

ats.southern.regional.office@caa.co.uk

CAA Northern Regional Office (Stirling)

Regional Manager ATS Safety Regulation (Northern Region)

Air Traffic Standards Division

Safety and Airspace Regulation Group

Civil Aviation Authority

First Floor, Kings Park House

Laurelhill Business Park

Stirling

Scotland

FK8 9JQ

Tel: (+44) (0) 1786 457400

ats.northern.regional.office@caa.co.uk

ATCO Training and Area Control Centres

Enquiries about ATS at Area Control Centres and air traffic controller training establishments should be addressed to:

En Route and College Regulation

Air Traffic Standards

Civil Aviation Authority

Safety and Airspace Regulation Group

Civil Aviation Authority

Aviation House

Gatwick Airport South

West Sussex

RH6 0YR

Tel: (+44) (0) 1293 573259

Fax: (+44) (0) 1293 573974

Other Contacts

The Airport Operators' Association

3 Birdcage Walk

London SW1H 9JJ

www.aoa.org.uk

Tel: (+44) (0) 20 7799 3171

General Aviation Awareness Council

RAeS House

4 Hamilton Place

London

W1J 7BQ

www.gaac.org.uk

Tel: 020 7670 4501

Fax: 020 7670 4309

British Gliding Association Limited

8 Merus Court

Meridian Business Park

Leicester

LE19 1RJ

Tel: +44 (0) 116 289 2956

Fax: +44 (0) 116 289 5025

office@gliding.co.uk

British Parachuting Association

Wharf Way

Glen Parva

Leicester

LE2 9TF

www.bpa.org.uk

Tel: +44 (0)116 278 5271

Fax: +44 (0)116 247 7662

skydive@bpa.org.uk

Defence Geographic Centre

UK DVOF & Powerlines

Air Information Section

Defence Geographic Centre

Elmwood Avenue

Feltham

Middlesex

TW13 7AH

Tel: (+44) (0) 208 818 2702

DVOF@mod.uk

Department for Environment, Food and Rural Affairs

Nobel House

17 Smith Square

London

SW1P 3JR

https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs

Department of Energy and Climate Change

Kieran Power

3 Whitehall Place

London

SW1A 2AW

Tel: 0300 068 6189

www.decc.gov.uk

kieran.power@decc.gsi.gov.uk

Department for Transport

Great Minster House

76 Marsham Street

London

SW1P 4DR

https://www.gov.uk/government/organisations/department-for-transport

Maritime and Coastguard Agency

For general enquiries:

SAR Operations Officer

HM Coastguard

Maritime and Coastguard Agency

Southampton

UK

Tel: (023) 8032 9332

Fax: (023) 8032 9488

https://www.gov.uk/government/organisations/maritime-and-coastguard-agency

Roly.McKie@mcga.gov.uk

For Maritime lighting requirements:

MCA Navigation Safety Branch,

HM Coastguard

Maritime and Coastguard Agency

Southampton

UK

Tel: (023) 8032 9523

Fax: (023) 8032 9488

National Police Air Service (England and Wales)

NPAS HQ

Head of Estates and Infrastructure

West Yorkshire Police

Laburnum Road

Wakefield

West Yorkshire

WF1 3QP

Tel: 01924 292520

npas.obstructions@npas.pnn.police.uk

http://www.npas.police.uk/

Ministry of Defence – Defence Infrastructure Organisation (formerly Defence Estates)

Kingston Road

Sutton Coldfield

West Midlands

B75 7RL

0121 311 3847

dio-safeguarding-wind@mod.uk

www.mod.uk/DIO

NATS Safeguarding

NATS Corporate and Technical Centre

4000-4200 Parkway

Whiteley

Hants

PO15 7FL

NATSSafeguarding@nats.co.uk

National Assembly for Wales

Planning Division

Cathays Park

Cardiff

CF10 3NQ

0300 0603300 or 0845 010 3300

Planning.division@wales.gsi.gov.uk

http://gov.wales/topics/planning/?lang=en

DOE Northern Ireland Planning

DOE Planning

Causeway Exchange

1-7 Bedford Street

19-25 Great Victoria Street

Belfast

BT2 7EG

www.planningni.gov.uk

Department for Communities and Local Government

Eland House

Bressenden Place

London

SW1E 5DU

https://www.gov.uk/government/organisations/department-for-communities-and-local-governmentw

Office of Gas and Electricity Markets (OFGEM)

9 Millbank

London

SW1P 3GE

70 West Regent Street

Regents Court

Glasgow

G2 2QZ

https://www.ofgem.gov.uk/

RenewableUK

Greencoat House

Francis Street

London

SW1P 1DH

http://www.renewableuk.com/

Scottish Executive

Energy Consents Unit

4th Floor

5 Atlantic Quay

150 Broomielaw

Glasgow

G2 8LU

econsentsadmin@scotland.gsi.gov.uk

http://www.energyconsents.scot/