CHAPTER 12: AVIATION

INTRODUCTION

12.1 Wind turbines have the potential to interact with aviation interests in two key ways – physical obstruction of flying activity around airfields, and presence of returns from turbines on a radar screen. Physical obstruction issues generally impose constraints over a relatively small area around both military and civil airfields and airports. Wind farms however, are known to have effects on radar over larger areas. It is not unknown for the MOD to object to wind farm proposals up to 74 km from air defence radars. In the case of radar equipment at civil airports, objections to wind developments out to 20 km or 30 km from the airport are not unknown. Consultation with MOD, CAA and other aviation interests is therefore advisable at an early stage in site selection, and advice sought if appropriate.

12.2 This chapter provides an assessment of the possible effects of the proposed Heckington Fen Wind Park on aviation interests in the area. This study has included a review of the location, technical characteristics and operational activities of aviation facilities in the area and an examination of the potential impacts of the proposed development.

12.3 This chapter has been compiled by Ecotricity using research completed by QinetiQ, a consultancy specialising in assessing the impacts of wind energy developments on aviation, and by reference to relevant guidance and consultations to assess the potential impacts on aviation as a result of the proposed development.

12.4 The Heckington Fen Wind Park consists of up to 22 wind turbines, being 80m to the hub and 125m to the tip, situated approximately 1kM north of the A17 and the village of East Heckington.

METHODOLOGY

12.5 The effects of the proposal on air traffic control radar were evaluated by determining whether the turbines would be within line of sight of any such radar facilities and whether the development site is within an area of operational importance to those radars.

12.6 The potential impacts of turbines on radar diminish with distance, and hence there is a 15km consultation zone and a 30km or 32km advisory zone around civilian and military air traffic radar respectively (paragraph 94, Companion Guide to PPS22 (2004) page 181).

12.7 Potential effects on other aviation interests were evaluated by considering the consultation response from the CAA in the context of the likelihood of identified aviation operators using the airspace in the vicinity of Heckington Fen Wind Park, and the requirements for obstacle clearance.

12.8 Due to the complexities involved in assessing the potential effects of the development on aviation interests, it is not considered practicable to define criteria for establishing sensitivity and magnitude of change for the effect of the development on aviation facilities or operations. Current guidance and the outcome of consultations have therefore been used to establish whether any identified effects are significant in terms of the Environmental Impact Assessment (1999) Regulations and in accordance with the criteria set out in **Table 2.1** of this Environmental Statement.

Guidance

12.9 In conducting this assessment, use was made of the following guidance and industry standards on the potential effects of wind turbines on aviation:

- Wind Energy, Defence & Civil Aviation Interests Working Group, Wind Energy And Aviation Interests – Interim Guidelines, ETSU W/14/00626/REP, 2002;
- Office of the Deputy Prime Minister, Planning Policy Statement 22: Renewable Energy Developments, 2004;
- Office of the Deputy Prime Minister, Planning for Renewable Energy: A Companion Guide to PPS22, 2004.
- Civil Aviation Authority, Safety Regulation Group, CAP 764: CAA Policy and Guidelines on Wind Turbines, May 2010;
- Civil Aviation Authority, Safety Regulation Group, CAP 738: Safeguarding of Aerodromes, February 2003;
- Civil Aviation Authority, Safety Regulation Group, CAP 670: Air Traffic Services Safety Requirements, Part B, Section 4, June 2003;
- Civil Aviation Authority, CAP 168: Licensing of Aerodromes, February 2001;
- Office of the Deputy Prime Minister, Circular 1/2003: Safeguarding Aerodromes, Technical Sites and Military Explosive Storage Areas: The Town and Country Planning Direction 2002; and
- National Air Traffic Services safeguarding maps (via BWEA web site).

12.10 Taken collectively, these guidance sources establish that:

- Officially safeguarded aerodromes need to be consulted if the proposed wind turbines are within 30km;
- Consultation with the operators of officially safeguarded technical sites is required if the proposed wind turbines are within 10km;
- If the development is within potential line of sight of an air defence, military aerodrome or en-route radar an assessment of the effects is likely to be required;
- Further assessment and/or consultation will be required if turbines are planned within:

    17km of a licensed aerodrome within a runway of 1100m or more;

    5km of a licensed aerodrome with a runway of less than 1100m;

    4km of an unlicensed aerodrome with a runway of more than 800m;

    3km of an unlicensed aerodrome with a runway of less than 800m;

    3km of any other unlicensed aviation land use.

Consultations

12.11 Consultations have been conducted with the Civil Aviation Authority (CAA), National Air Traffic Service (NATS) and the Ministry of Defence (MoD). All the consultation response letters, including those relating to aviation operators, can be viewed within **Appendix 2.1**. A summary of their responses is set out in **Table 12.1** below.

Table 12.1: Summary of Consultations

Consultee	Date of response	Response
CAA	20 October 2010	The CAA had no specific observations regarding the development. They have requested suitable aviation lighting to be installed.
MoD (Defence Estates)	21 October 2009	A number of concerns were identified
NATS	15 November 2010	A holding objection was initially received on the 6th October 2010 subject to a more detailed assessment. The detailed assessment was completed in November 2010 and anticipated that the reflected power of the development would be sufficient to be detected by the radar at Claxby which is 51.3km from the site.

BASELINE

12.12 Identification of baseline aviation facilities was conducted using the following information sources, and responses from consultees:

- the UK Aeronautical Information Publication;
- the Ministry of Defence list of safeguarded sites;
- National Air Traffic Services safeguarding maps (via Renewable UK web site);
- Office of the Deputy Prime Minister Circular 1/2003, Safeguarding Aerodromes, Technical Sites and Military Explosives Storage Areas;

12.13 This identification process established that MOD has three installations that may be affected by the proposed development. These are operational airfields at Coningsby, Cranwell and Waddington.

12.14 The exercise also established that the turbines would be visible from the NATS radar installation at Claxby.

ASSESSMENT OF EFFECTS

12.15 Aviation may be affected by wind turbines in the following ways:

- wind turbines located in areas close to airfields, or where certain types of low flying training are carried out, may pose a vertical obstruction hazard to aircraft;
- wind turbines located within line of sight and operational range of air traffic control or air defence radar equipment can present a similar appearance to aircraft on the radar screen. There is also some potential for reduction of a radar's ability to detect and track aircraft in the area above and behind a wind farm;
- aeronautical radio navigation aids may be affected by wind turbines due to reflection or scattering of the signal by the blades and towers.

12.16 **Appendix 12.1** (CAP 764 Chapter 2) contains further information, prepared by the CAA, on the potential impacts of wind turbines on aviation.

Ministry of Defence (MoD)

12.17 The latest consultation with the Ministry of Defence is presented in the response dated 21 October 2009 (see **Appendix 2.1**). Subsequent to that meeting ecotricity and Qinetiq met with MOD representatives on the 27 July 2010 to discuss mitigation solutions which might address the concerns set out in the MOD consultation letter. Based on the outcome of that meeting Qinetiq was commissioned to develop a mitigation strategy which would be acceptable to MOD. During this development stage a dialogue was maintained with MOD. It is our understanding that the mitigation strategy prepared by Qinetiq and submitted to MOD will enable MOD to confirm to DECC that it has no objection to the development subject to conditions being imposed on any deemed consent which will ensure delivery of the mitigation measures prior to development of the turbines being commenced.

12.18 In their scoping response letter the MOD recommends that the turbines are fitted with low intensity lighting in the interests of air safety.

12.19 With the mitigation in place the impact on MOD operations will be insignificant.

NATS

12.20 NATS En Route Ltd (NERL) provides wind turbine safeguarding coverage maps, at different heights above ground level from 20m to 140m, on the British Wind Energy Association (BWEA) website. The 120m coverage map was consulted for the Heckington Fen area. This showed that the site is within an area where a wind turbine development could potentially interfere with NERL facilities.

12.21 In September 2010 Ecotricity made an application for pre-planning consultancy and requested a NATS Technical Assessment. NATS provide a report on this Technical Assessment in November 2010. This report (see **Appendix 2.1**) concluded that the proposed Heckington Fen Wind Park may conflict with NATS safeguarding criteria and the reflected power of the development would be sufficient to be detected by the radar at Claxby which is 51.3km from the site.

12.22 The conclusion is that the proposal conflicts with NATS (En Route) safeguarding criteria and on that basis NERL object to the development. NERL identified similar impacts on the infrastructure at Claxby in relation to an ecotricity proposal at Dalby in Leicestershire. NERL also identified that it was possible to mitigate those impacts by technical or operational measures and a condition requiring the delivery of those measures was imposed on the planning permission by the Local Planning Authority. Ecotricity is satisfied that such conditions identified in the planning statement supporting this EIA would be appropriate in this instance and would deliver the mitigation measures required to address NERL's objection.

12.23 The impact on NATS operations is therefore considered to be **insignificant** on the presumption that conditions as set out in the Planning Statement form part of any deemed consent issued by DECC.

MITIGATION

12.24 In the interests of air safety it is proposed that, if granted planning permission, the Heckington Fen Wind Park accommodates sufficient aviation lighting as required by the Ministry of Defence and the Civil Aviation Authority.

12.25 If DECC is minded to direct that deemed permission be granted then such permission should be subject to the conditions set out in the Planning Statement. This will ensure that the mitigation measures required by MOD and NERL are implemented prior to the development commencing.

RESIDUAL SIGNIFICANCE

12.26 There are predicted to be no aviation impacts from the development.

STATEMENT OF SIGNIFICANCE

12.27 This chapter has provided an assessment of the effects of the proposed Heckington Fen Wind Park on aviation. This study has included a review of the location, technical characteristics and operational activities of aviation facilities in the area and an examination of how these may be affected by the development. The assessment identified two potential aviation facilities (MoD and NERL) which might be affected by the development. It is predicted that the Heckington Fen Wind Park will have no effects considered significant under the terms of the EIA.

APPENDIX 12.1: CAP 764

Directorate of Airspace Policy

CAP 764

CAA Policy and Guidelines on Wind Turbines

July 2011

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Enquiries regarding the content of this publication should be addressed to:
Surveillance and Spectrum Management, Directorate of Airspace Policy, Civil Aviation Authority, CAA House, 45-59 Kingsway, London, WC2B 6TE

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Contents

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[1], which provides amplifying information, and which will enable currency and relevancy to be maintained in between the bi-annual revisions of CAP 764.

1 http://www.caa.co.uk/default.aspx?catid=1959

Foreword

1 Introduction and Background

1.1 The DfT White paper "The Future of Air Transport", presented to Parliament in December 2003, recognised the value and importance of aviation to the UK in terms of its contribution to the national economy and in meeting social demands. The White Paper set out a strategic framework for the development of airport capacity in the United Kingdom over a 30-year period, against the background of wider developments in air transport. Links to current government legislation are available through the Civil Aviation Authority (CAA) Wind Energy web pages.

1.2 However, whilst recognising the need for further aviation capacity in the UK, the strategy is based on the requirement for a balanced approach, which also addresses the wider impacts and the need for sustainable development.

1.3 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. 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 20% of the UK's electricity supply should come from renewable sources by 2020; the Scottish parliament has adopted a more ambitious 80% by 2020.

1.4 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.

1.5 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 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.

1.6 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 and transport policies.

2 Aim of this Publication

2.1 Being a Civil Aviation Publication (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)[1], 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.

3 Scope

3.1 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.

3.2 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 Wind Energy web pages.

3.3 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).

4 Feedback

4.1 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 bi-annually and, due to the lengthy process that must be followed, minor amendments cannot be made. However, interim amendments and supplementary guidance will be published on the CAA Wind Energy web pages to maintain the currency and relevance of CAA guidance and policy.

5 Contact Details

5.1 Contact addresses, should you have any comments concerning the content of this document or wish to obtain subsequent amendments, are given on the inside cover of this publication.

1 The term 'LPA' throughout this document is used generically to refer to Planning Authorities within England, Scotland, Wales and Northern Ireland

Glossary

A list of specialised words or terms with their definitions follows:

ACP	Airspace Change Process
AD	Air Defence
AIP	Aeronautical Information Publication
ANO	Air Navigation Order
ANSP	Air Navigation Service Provider
AOA	Airport Operators Association
ASD	Aerodrome Standards Department (CAA)
ATC	Air Traffic Control
ATS	Air Traffic Service(s)
ATSD	Air Traffic Standards Division (CAA)
CAA	Civil Aviation Authority
CAS	Controlled Airspace
CAP	Civil Aviation Publication
CFAR	Constant False Alarm Rate
CNS	Communications, navigation and surveillance
DAP	Directorate of Airspace Policy (CAA)
DfT	Department for Transport
DIO	Defence Infrastructure Organisation (formerly Defence Estates)
DME	Distance Measuring Equipment
DTI	Department of Trade and Industry
DTM	Digital Terrain Mapping
DVOF	Defence Vertical Obstacle File
DZ	Dropping Zone
EM	Electromagnetic
FOD	Flight Operations Division (CAA)
ft	Feet
GA	General Aviation
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 miles
ODPM	Office of the Deputy Prime Minister
OLS	Obstacle Limitation Surface
PPG	Planning Policy Guidance Note
P-RNAV	Precision Area Navigation
PSNI	Planning Service of Northern Ireland
PSR	Primary Surveillance Radar
RAM	Radar Absorbent Material
RCS	Radar Cross-Section
RF	Radio Frequency
RNAV	Area Navigation
SID	Standard Instrument Departure
SMS	Safety Management Systems
SRG	Safety Regulation Group (CAA)
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

1 General

1.1 The CAA is responsible for safety regulation of civil aviation in the UK under the Civil Aviation Act 1982. The Safety Regulation Group (SRG) is responsible for the regulation of licensed aerodromes and Air Traffic Services (ATS) in the UK. The Directorate of Airspace Policy (DAP) is responsible for the planning and regulation of all UK airspace, including the communications, navigation and surveillance (CNS) infrastructure, to support safe and efficient operations by the appropriate aviation stakeholder. DAP also has the lead responsibility within the CAA for all wind turbine related issues.

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, National Air Traffic Services (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:

a) 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 of the air is paramount and will not be compromised. As the independent aviation regulator, the CAA is well placed to provide support to both the aviation industry and the wind energy industry;

b) 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;

c) 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;

d) Guidance is provided through the publication of this and associated official CAA and government documents, along with the CAA Wind Energy web pages.

2 Aerodrome and CNS Site Safeguarding[1]

2.1 In domestic legislation, many civil aerodromes are licensed in accordance with the Air Navigation Order (ANO) made under Section 60 of the Civil Aviation Act 1982. The CAA is responsible under the ANO (2009) for being satisfied that a licensed aerodrome is safe for use by aircraft, having regard in particular to the physical characteristics of the aerodrome and its surroundings. This is a continuing responsibility, which it discharges by means of: regular audits; by placing obligations on the licensee to inform it when material changes take place; and by ensuring that proposed developments are assessed. In addition, a requirement is placed on the licensee to take all reasonable steps to ensure that the aerodrome and its surrounding airspace is safe at all times for use by aircraft.

2.2 'Statutory' or 'official' safeguarding is a process of consultation between an LPA and consultees that is made obligatory by Statutory Direction and is designed to safeguard technical sites and certain aerodromes in the United Kingdom. However, the same process of consultation can take place for aerodromes and technical sites that are not given Statutory Protection; this process is known as unofficial safeguarding.

2.3 Certain civil licensed aerodromes (selected by Government on the basis of their importance to the national air transport system) are officially safeguarded[2]. 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, selected on the basis of their strategic importance.

2.4 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's Aerodrome Standards Department (ASD) regulates licensed aerodromes and applies safety standards equivalent to those in Annex 14 of the Chicago Convention. CAP 738 (Safeguarding of Aerodromes) provides generic safeguarding guidance whilst CAP 168 (Licensing of Aerodromes) lays down specific safeguarding criteria for licensed aerodromes, and CAP 793 (Safe Operating Procedures at Unlicensed Aerodromes) provides guidance for unlicensed aerodromes. Furthermore, 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.

2.5 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)[3] 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 Further information can be found in Joint ODPM, DfT, Planning Circular 1/2003 guidance on Safeguarding, Aerodromes, Technical Sites and Military Explosives Storage Areas http://www.dft.gov.uk/pgr/aviation/safety/safeguarding/safeguardingaerodromestechni2988 and associated Scottish and Welsh circulars available via the CAA Wind Energy web pages. Graphics of safeguarded technical sites can be found at http://www.nats.co.uk/environment/windfarms/nerl-self-assessment-maps/

2 Officially Safeguarded aerodromes are listed within national planning circulers available via the CAA Wind Energy web pages.

3 OLS is the hypothetical boundary which indicates the extent of a volume of airspace which must 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.

2.6 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."

2.7 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.

2.8 In all cases, regardless of the status of the aerodrome, any development that causes pilots to experience – or simply perceive – an increase in difficulty when using an aerodrome may lead to a loss of utility. The CAA considers that if the Aerodrome Manager (or equivalent) advises that the aerodrome's established amenity would be affected by a development, their advice can generally be considered as expert testimony. 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. It is accepted that an Aerodrome Manager is competent until proved otherwise, and that the CAA licensing process would prevent an incompetent person from managing a licensed aerodrome. Note that the CAA has no regulatory oversight of unlicensed aerodromes.

2.9 It is advised that the CAA (DAP) is informed when aerodrome operators have agreed unofficial safeguarding maps with LPAs, as this will enable DAP to issue better-informed guidance and advice to enquiries from wind energy developers and LPAs.

2.10 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.

3 Airspace Management

3.1 DAP, as the airspace approval and 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.

3.2 DAP is directed by the Secretaries of State for Transport and Defence 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 the 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.

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

4 Approvals for Equipment and Service Provision

4.1 In order to provide an ATS in the UK, a service provider must be granted an approval by the CAA. Article 205 of the ANO (2009), (concerning the suitability of the equipment to be used for the service), and Article 169 (concerning the suitability of the operation in general), apply. Those service providers that run mature Safety Management Systems (SMS) may have CAA-agreed standing ANO Article 205 and 169 Approvals.

4.2 Where service providers use a remote feed of radar data from a contracted source, they remain responsible for gaining the requisite approvals for the use of data as part of a radar service. Regardless of whether the service is approved under discrete Article 205 and 169 Approvals or via an SMS, service providers must be able to achieve the following in order to retain these approvals:

a) Safeguard their service through being able to recognise when wind turbine developments may affect their service, and by participating in planning activities;

b) 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);

c) 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.

4.3 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:

a) The service provider must perform a safety assessment on the change. This will either be in accordance with procedures documented as part of the SMS of the organisation, or be a standard safety assessment process (cognisant of European requirements[1]) such as that documented in CAP 760 (Guidance on the Conduct of Hazard Identification, Risk Assessment and the Production of Safety Cases: For Aerodrome Operators and Air Traffic Service Providers). The final safety assessment cannot be made until all changes have been implemented and wind turbine developments are operational;

b) 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;

c) Where considering mitigations to address the impact of the wind turbine development, service providers are advised to review the issues and limitations described in Chapter 4 of this CAP;

1 For example Commission Regulation (EC) No 2096/2005 – laying down common requirements for the provision of air navigation services

d) Where the service is approved under discrete Article 169 and 205 Approvals, then the service provider must notify their SRG Regional Inspector of the change and supply evidence that the change has been addressed in the appropriate safety case(s) for the service;

e) Where the service is part of a standing approval under an SMS regime, then the service provider must notify their SRG Regional Inspector of the change. The Regional Inspector will make a decision whether to request any further information (this will depend, in part, on the maturity of the SMS in the organisation and the significance of the change being made);

f) Licensed service providers that fail to properly address the effects of a wind turbine development on a service may have the existing Approval withdrawn by the CAA, which may result in the closure of that service.

5 Advice to Government

5.1 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 1.

Chapter 2 Impact of Wind Turbines on Aviation

1 Introduction

1.1 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 affects 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.

1.2 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 are best qualified to provide expert interpretation of what this impact will be and how it will affect the safety, efficiency and flexibility of their specific operations.

1.3 Appendix 2 refers to the complex subject of radar assessment and Line of Sight (LOS) methodology, and should be read in conjunction with Chapters 2 and 4 of this document.

2 PSR

2.1 In basic terms, PSR transmits a pulse of energy that is reflected back to the radar receiver by an object that is within Line of Sight (LOS) of the radar (note: this is different to optical LOS). The amount of reflected energy picked up by the receiver will depend upon factors such as the size, shape and orientation of the obstacle, as well as receiver sensitivity and weather. The amount of energy that an object reflects back is related to the object's Radar Cross Section (RCS). Generally, the larger a wind turbine is, the larger its RCS will be, which will result in more energy being reflected and an increased chance of it creating false returns (i.e. non aircraft), known as 'clutter'[1]; these issues are compounded by increasing numbers of wind turbines which cause greater areas and densities of clutter.

2.2 The closer a wind turbine is to a radar station, and while within the LOS of the radar, the greater the likelihood that 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 (terrain dependent). However, 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 will vary depending upon wind direction. Additionally, the orientation of the blade when reflecting the radar's energy pulse will determine the RCS of the turbine at that instant. Therefore it is not possible to generate a 'standard' RCS for modeling purposes. Given that aviation safety issues are involved, a conservative / worst case approach should generally be adopted.

1 Note that the term 'clutter' refers simply to unwanted false returns, and can be generated by means other than from wind turbine interference.

2.3 Wind turbine developments can have the following effects on PSR:

a) **False Radar Returns (Clutter)**

Moving targets impart a frequency shift in the reflected energy of the radar. The effect is known as Doppler shift. The Doppler shift induced by the rotation of the wind turbine blades can cause them to be misinterpreted as an aircraft once detected by the radar, as the radar uses the Doppler shift to distinguish between moving objects and stationary objects.

In order to address the issue of clutter, some radars use techniques such as Moving Target Indication (MTI) and Moving Target Detection (MTD) that employ filters to detect the Doppler shift, enabling discrimination of fast moving objects (assumed to be aircraft) from slow moving, or stationary objects (assumed to be clutter such as buildings or terrain); the slow moving or stationary objects can then be suppressed from display. The stationary parts of a wind turbine (nacelle and tower) can be filtered out using these techniques. However, the tips of the rotating turbine blades can move at similar speeds to aircraft such that the returns caused by the rotation of blades are not suppressed from output and may appear as aircraft on the display.

The position of the wind turbines within a development, and the rotation of turbine blades, can cause a 'twinkling' effect by illumination of fresh reflections from the turbine blades and fading the previous reflections, or even the formation of tracks, both of which can be very distracting for air traffic controllers, causing confusion when trying to distinguish between real aircraft and false returns. Additionally, the separation of other aircraft from these false returns may need to be maintained which can increase controller workload.

Additionally, high levels of clutter can obscure display symbology such as track labels making them difficult to read, and the real aircraft returns indistinguishable from other returns. Overall, false radar returns decrease the situational awareness of air traffic controllers, which could result in safety incidents.

The false plots caused by the wind turbine can also generate the effect known as 'track seduction' on radar screens. Track seduction is when the false plots generated by the wind turbine are selected as the updated plots and causes the effect of steering the true track away from the actual path of the aircraft. If on subsequent scans further 'alternative' plots are available to sustain the deviated path then the track is said to have been seduced. The criticality of such occurrence has to be taken into consideration depending on the density of traffic levels within the coverage and the false targets caused by the wind farm.

Furthermore, it may also be possible that the wind turbines may also increase the number of false targets by being in the path of radar signals and reflecting the radar signals such that the plot indicated to the controller by the received signal would not represent the true aircraft position;

b) **Loss of Receiver Sensitivity**

Wind turbines can cause conditions leading to the loss of sensitivity in detection to such an extent that the aircraft returns are completely lost.

Radars use an adaptive algorithm to detect target returns against a background of noise, clutter and interference also referred to as CFAR (Constant False Alarm Rate). The received echo at the radar receiver comprises the wanted echo signal from the aircraft and the unwanted power from internal receiver noise, as well as external clutter and interference. The role of this algorithm is to determine the power threshold above which any return can be considered to probably originate from a target. This threshold may rise and fall depending on the noise, clutter and interference present in various areas within coverage.

Clutter, including wind turbine clutter, can cause the threshold to rise resulting in complete loss of detection of lower energy targets. This can lead to a lowering of the probability of detection of aircraft in the region of the clutter.

This unwanted energy reflected back from the wind turbine will remain and affect the thresholds whether or not the turbines are rotating. Although the returns from the stationary parts of the wind turbine may be filtered out and prevented from being displayed by using the Doppler filtering techniques, the loss of detection capability due to the high receiver thresholds is difficult to prevent;

c) **Plot Extractor/Filter Memory Overload**

On radars fitted with a plot extractor, every target picked up by the radar is processed and filtered. Due to the constraints of memory size, there is a limit to the number of plots and tracks a system can handle. Therefore, if a particular radar has a high number of false plots, its memory capacity may be reached and subsequent problems arise. Where such concerns exist, the developer must take such issues into consideration, by consultation with the ANSP;

d) **Presenting an Obstruction (Shadow)**

In general, whether the blades are rotating or not, a wind turbine presents an obstruction to a radar signal in the same way as any other structure, e.g. a large building. The presence of a physical obstruction with a large RCS in the path of the radar beam is expected to create a region behind the turbine farm within which aircraft would be masked from detection, known as the shadow region.

This shadow region is believed to be a direct result of the interference of large physical objects (components of the wind turbine towers), with the propagation of the radar beam. It is believed to only occur in the region directly behind the wind turbines up to a maximum of a few km.

The effect on a wavefront partially obstructed by an obstacle is generally referred to as 'diffraction' and the effect causes a bending of the direction of propagation of the wavefront. The energy that has been blocked by the turbine is lost by reflection in other directions. The energy that partially fills the shadow region behind the turbine is taken from the energy that passes the turbine unobstructed, hence the field strength behind the turbine is diminished over a region that shrinks with range behind the turbine.

The proportion of the volume behind the turbines that is shadowed depends on a number of factors such as the number of turbines, size of the turbines and their geographical distribution with respect to the location of the radar. The operational effect of large structures in the coverage area of a radar are taken into consideration using current planning and assessment procedures, however the volume of the shadow region and its operational impact has to be given careful consideration in the planning process of a wind turbine implementation;

e) **Receiver Saturation**

Radar receivers require a large dynamic range in order to detect the reflected energy from both large and small aircraft. However, if an obstacle such as a wind turbine reflects a significant amount of power, the receiver can be pushed beyond its dynamic range and can become saturated. This effect is not limited to wind turbines and can be caused by any large obstacle; however, it is dependent upon the size and range of the obstacle from the receiver. It is acknowledged that the likelihood of wind turbine generated receiver saturation is low; however, any possibility of receiver saturation should be taken into consideration.

3 Secondary Surveillance Radar (SSR)

3.1 SSR does not rely on reflections from objects for detection. Instead, aircraft to be detected are required to carry a transponder, which replies (via the downlink) to radar interrogations (made via the uplink). Although clutter will not be generated, wind turbines can cause the following effects on SSR:

a) **False Targets Caused by SSR Signal Reflections**

Wind turbines, like any other large obstacle, can cause SSR reflections if they are sufficiently close to the SSR and are within radar LOS. In general terms, SSR energy may be reflected off the structures in both the uplink and downlink directions. This can result in an aircraft which is in a different direction to the way the radar is looking, replying through the reflected signal which results in the radar attributing that response to the original signal, and therefore outputting a false target in the direction where the radar is pointing i.e. at the obstruction. Traditional SSR (Mode A and C) is susceptible to this, but employs reflection processing and gain-time control (essentially speed/time calculations to confirm the validity of a response) to try to eliminate the reflections. However, these techniques are not always successful in eliminating high power reflections. Moreover, most reflection processing assumes a fixed-reflector orientation, which can be defeated by wind turbines due to the manner in which their orientation changes as the blades swing to face the wind. The selective and predictive tracking used by Mode Select (Mode S) radars makes them less susceptible to the effects of reflections (i.e. the reflection is not in the predicted location where the aircraft should be, so the selective interrogation will not be directed there); however, not all SSR radars are Mode S capable;

b) **Presenting an Obstruction**

If the wind turbines are within radar LOS and aircraft are required to be detected at longer range behind the wind turbines, then shadowing effects similar to those described above for PSR at paragraph 2.3d can occur.

3.2 Following discussion with service providers, and in the absence of recorded specific research, the CAA advises that 24 km (approx 15 NM) should be used as the trigger point for further discussions with the appropriate service provider who can make a more detailed, accurate assessment of the likely effect on their SSR. The majority of effects are likely to be within 10 km but, because the possibility exists for effects out to 24 km, the greater distance should be utilized for consultation. It must be noted that this is not intended as a range within which all turbines should be objected to.

4 Aeronautical Navigation Aids and Communication Systems

4.1 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. Further research is required to fully understand the potential issues; therefore, a cautious approach and case-by-case analysis is required.

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

5 Air Traffic Services

5.1 Where a service provider 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 service provider 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 service provider and/or wind energy developer to deal with the negative impact. The position of a service provider 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 service provider in order to deal with the harm that their development may cause, prior to making an application.

5.2 Where possible, it can be beneficial for the service provider 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.

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

a) Departure Routes including Standard Instrument Departures (SID);

b) Standard Instrument Arrival Routes (STAR);

c) Airways;

d) Area Navigation (RNAV) and Precision Air Navigation (P-RNAV) routes;

e) Sector Entry and Exit points;

f) Holding points (including the holding areas);

g) Missed Approach Routes;

h) Radar Vectoring Routes;

i) Final Approach Tracks;

j) Visual Reporting Points;

k) Published Instrument Flight Path (IFP) for the aerodrome;

l) Potential impact on navigation aids and voice communications;

m) Future airspace and operational requirements where aerodrome growth is anticipated (section 9 provides comment on future requirements).

5.4 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 affects; however, further discussion on this issue can be seen in Chapter 4, paragraph 2.

6 Offshore Helicopter Operations

6.1 Wind energy developments (including anemometer masts) within a 9 NM radius of an offshore helicopter destination, such as oil or gas platforms, could impact on the ability to safely conduct essential instrument flight procedures to such facilities in poor weather conditions.

6.2 As a result, there could be significant consequential economic impacts relating to the operation of the offshore platform. More importantly, because of the potential to restrict helicopter operations and affect the operator's safety case, wind energy developments within 9 NM may also threaten the integrity of offshore platform safety cases where emergency scenarios are based on the use of helicopters to evacuate the platform.

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

7 Cumulative Effects

7.1 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 service providers may lodge objections to subsequent developments in areas where they had previously been able to accommodate proposed wind turbine developments.

7.2 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 service provider.

7.3 For aerodrome operators or en route service providers, there is a difficulty in protecting aviation activity from these cumulative effects because planning applications (see Chapter 5) are generally dealt with on a 'first come, first served' basis. The use of suspensive conditions[1] significantly reduces the clarity of the planning situation. All approved applications must be taken into account when considering future applications – irrespective of the likelihood of a suitable technological mitigation being identified to enable aviation objections to be removed. This could lead to the situation whereby more viable applications are objected to on the grounds of cumulative effect as a result of less viable projects that have been previously approved through a suspensive condition.

1 Where planning approval is granted subject to final agreement from an aviation stakeholder once an appropriate technological mitigation has been agreed.

7.4 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 would be taken into consideration by an LPA, albeit without any direct legal standing.

7.5 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 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.

8 Turbulence

8.1 Turbulence is caused by the wake of the turbine which extends stream wise behind the blades and the tower, from a near to a far field. The dissipation of the wake intensity depends on the convection, the turbulence diffusion and the topology (obstacles, terrain etc.).

8.2 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 thorough literature survey would be necessary to establish the scale and the advances of the research findings.

8.3 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[1]. 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[2, 3]. Although models can be used to study the effects of the far wake, verification and validation processes of these models are still ongoing[4].

8.4 There are currently no Mandatory Occurrence Reports (MOR)[5] 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 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.

1 Wind turbine wake aerodynamics, L.J. Vermeer, J.N. Sorensen, A. Crespo, Progress in Aerospace Sciences, 39 (2003) 467-510.
2 Calculating the flow field in the wake of wind turbines, J.F. Ainslie, Journal of Wind Engineering and Industrial Aerodynamics, 27 (1988) 213-224.
3 Turbulence characteristics in wind-turbine wakes, A. Crespo, and J. Hern'andez, Journal of Wind Engineering and Industrial Aerodynamics, 61 (1996) 71-85.
4 Investigation and Validation of Wind Turbine Wake Models, A. Duckworth and R.J. Barthelmie, Wind Engineering, 32 (2008) 459-475.
5 CAP 382 – The Mandatory Occurrence Reporting Scheme.

8.5 The CAA is currently investigating the effects of wind turbine wakes on aircraft. 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.

8.6 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, are strongly encouraged to report this through the existing MOR scheme.

8.7 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.

8.8 In circumstances where wind turbines are planned to be developed in areas where aircraft will operate in close proximity to them, it is incumbent on the aerodrome operator (in collaboration with the developer) to ensure that safe operations are maintained. In the absence of further research, the assessment of obstacles within the Approach Surface and Take Off/Climb surface (as detailed in CAP 168) could be used for assessment of fixed wing activity, and the guidance is extant for unlicensed aerodromes.

8.9 Very light aircraft such as gliders, microlights, gyroplanes, hang-gliders, paragliders and paramotors are particularly susceptible to turbulence. In certain circumstances turbulence can cause loss of control that is impossible to recover from.

9 Economic Issues

9.1 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, en-route service provider 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.

10 En-Route Obstructions

10.1 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. An example of this is the current Manchester

Low Level VFR corridor where, in order to maintain clear of CAS, aircraft have to fly below 1250 ft and within a narrow corridor. Obviously, wind turbine developments in this area would have the potential to further restrict what is already narrow, congested airspace, which would be detrimental to flight safety.

10.2 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 and Lighting).

Figure 2.1 Difficulties in visually acquiring anemometer masts

10.3 Wind turbine developers should be aware that anemometer masts are often difficult for pilots to acquire visually (see Figure 2.1 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 to be lit, but the CAA would, if asked for comment, be likely to support reasonable requests for lighting/marking of anemometer masts sited in problematic locations. Where such obstacles affect operations on an aerodrome, it is the responsibility of the aerodrome operator to ensure appropriate publication in the AIP, and to ensure that they establish an effective working relationship with their LPA to ensure that they are consulted when appropriate. Further information is available in the AIC P 021/2011[1] and the CAA Policy Statements, Lighting of En-Route Obstacles and Onshore Wind Turbines[2] and The Lighting of Wind Turbine Generators in United Kingdom Territorial Waters[3].

1. http://www.nats-uk.ead-it.com/public/index.php%3Foption=com_content&task=blogcategory&id=161&Itemid=58.html
2. http://www.caa.co.uk/docs/7/20100401LightingOfEnRouteObstaclesAndOnshoreWindTurbinesFi%e2%80%a6.pdf
3. http://www.caa.co.uk/docs/7/20100728LightingOfOffshoreWindTurbinesWinchLightingIssueDate20100802.pdf

11 Air Support Units (ASU)

11.1 **Emergency Service ASUs** In recent years the number of police forces employing helicopters has increased dramatically, together with air ambulance operators and 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 there is a justifiable benefit. Chapter 5 refers.

12 Military Impact

12.1 Wind turbine developments can have a detrimental affect on military operations. Military aviation operations can differ markedly from civil operations, particularly with respect to operational low flying, and the sensitivity of military CNS facilities. DIO are to be consulted in all cases where a proposed wind turbine development may affect military operations.

Chapter 3 Safeguarding Considerations

1 General Considerations

1.1 There are a significant number of licensed aerodromes in the UK[1]. 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' operations managers about proposed developments that fall within the boundaries specified on the maps. The aerodrome then has 21 days within which to assess the impact of the development and to respond accordingly.

1.2 Those aerodromes and CNS sites that are not safeguarded by statutory process can be unofficially safeguarded by agreeing protection measures with their LPA. These unofficial safeguarding agreements can include both licensed and unlicensed aerodromes; in such cases the CAA does not certify any associated maps.

1.3 Further information about aerodrome safeguarding can be found in CAP 738 (Safeguarding of Aerodromes) and CAP 793 (Safe Operating Procedures at Unlicensed Aerodromes).

2 Safeguarding Maps

2.1 Maps of officially safeguarded aerodromes and en route CNS technical sites are endorsed by signature on behalf of the Head of Aerodrome Standards Department (ASD) before they are issued to the LPA. These signed maps denote that the CAA recognises them as being ones issued for the purposes of the Planning Circular[2] and confirms it is the map the service provider wishes to use.

2.2 Other aerodromes may produce a safeguarding map and request that their LPA recognise their wish to be included in consultation for planning purposes. However, these maps are not endorsed by ASD. It is the published advice of the Government[3] 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. Such unofficial Safeguarding maps remain with the relevant airport or LPA and are not held or validated by the CAA[4].

3 Wind Turbine Safeguarding Maps

3.1 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

1 Available at http://www.caa.co.uk/default.aspx?catid=375&pagetype=90&pageid=5373
2 DfT Circular 01/2003 and Scottish Planning Circular 2/2003
3 The Town and Country Planning (Safeguarded Aerodromes, Technical Sites and Military Explosives Storage Areas) Direction 2002
4 However, in the interest of ensuring that guidance given is up to date, DAP wish to be made aware when unofficial safeguarding maps are established

would be either undesirable, undesirable but possible, or acceptable (albeit potentially with constraints to address cumulative effects and proliferation issues). Other aerodromes have simply prepared radar consultation zone maps, given the dynamic nature of cumulative effects. The CAA encourages the production of such maps.

4 Safeguarding of Technical Sites

4.1 There is a statutory process to safeguard certain ATC 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[1]. 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. ICAO Eur Doc 015 and CAP 670 are sources of guidance to provide a basis for such discussion.

5 Obstructions, Lighting and Marking

5.1 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.

5.2 **Onshore Obstacle Lighting Requirement** ICAO regulations (Annex 14 Chapter 6) and Article 219 require that structures away from the immediate vicinity of an aerodrome, which have a height of 150 m or more Above Ground Level (AGL) are:

a) fitted with medium intensity steady red lights[2], positioned as close as possible to the top of the obstacle[3], 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;

b) illuminated at night, visible in all directions and any lighting failure is rectified as soon as is reasonably practicable;

c) 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.

5.3 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 high, which are outside the immediate vicinity of an aerodrome, are not routinely lit; unless the 'by virtue of its nature or location' argument holds fast. UK AIP ENR 1.1.5.4 refers.

1 ICAO EUR DOC 015 recommends safeguarding zones for VORs.
2 '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.
3 In relationship to wind turbines, the requirement to fit aviation obstruction lighting 'as close as possible to the top of the obstacle', is translated to mean the fitting of lights on the top of the supporting structure (the nacelle) rather than the blade tips.

5.4 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 an any aerodrome or it/they were of a height that was unlikely to affect even military low flying), the Authority 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.

5.5 All parties should be aware that, in any case where a wind turbine development lies (or would lay) outside any aerodrome safeguarding limits and the turbine height was less than 150 m (and therefore the provisions of ANO Article 219 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.

5.6 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. Chapter 2 paragraph 10 refers.

5.7 **Offshore Obstacle Lighting Requirement**

Legislation requires the fitting of obstacle lighting, primarily for night-time use, on offshore wind turbines with a height of 60 m or more above the highest astronomical tide. Whilst Article 220 of ANO (2009) refers, in general, offshore wind turbines of 60 m and higher are required to be fitted with aviation obstruction lighting as follows:

a) At least one medium intensity steady red light positioned as close as possible to the top of the fixed structure;

b) Where four or more wind turbines are located together in the same group, with the permission of the CAA only those on the periphery of the group need be fitted with obstruction lighting;

c) The downward spread of light is restricted as far as possible to minimize any potential confusion with maritime lighting whilst maintaining flight safety.

5.8 When considering offshore lighting requirements for wind turbines, the Maritime and Coastguard Agency should also be consulted. Currently there are disparities between the maritime and aviation requirements for offshore lighting. Until such time that these have been resolved, Article 220 remains extant as the aviation requirement. A related policy statement, The Lighting of Wind Turbine Generators in UK Territorial Waters[1] provides the most current advice.

5.9 CAP 437 (Offshore Helicopter Landing Areas) gives guidance on lighting requirement for helicopter winching operations onto offshore wind turbines.

1 http://www.caa.co.uk/docs/7/20100728LightingOfOffshoreWindTurbinesWinchLightingIssueDate20100802.pdf

5.10 As offshore wind farms are developed, a number of meteorological masts are planned to 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 above sea level should be fitted with one medium intensity steady red light positioned as close as possible to the top of the obstacle.

5.11 **Military Requirement for Infra-Red (IR) Lighting**

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 to 100 ft during training sorties in all areas. All night time flying by MoD craft is undertaken by crews equipped with Night Vision Goggles (NVGs); therefore infra red (IR) vertical obstruction lights will be suitable in most occasions.

5.12 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.

5.13 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.

5.14 It must be noted that the adoption of IR lights is for onshore turbines, where turbines are generally less than the 150 m height which would trigger aviation lighting under ANO (2009) (see paragraph 5.3). The requirement for lighting of offshore structures (including wind turbines) extends to obstacles with a height greater than 60 m.

5.15 Requests for clarification should be addressed to Officer Commanding Low Flying Ops Squadron on cas-aslfosoc@wittering.raf.mod.uk.

6 Obstacle-Free Zones Around Offshore Helicopter Platforms

6.1 The CAA has, for some years, indicated the need to maintain a 6 NM obstacle-free zone around offshore helicopter destinations to allow for the safe operation of associated instrument approaches in poor weather conditions. As a result of adapting such approaches in light of operational experience and the increasing height of structures such as wind turbines, this obstacle-free zone should now be considered to reach out to 9 NM. This is not a prohibition on development within a 9 NM radius of offshore operations, but a trigger for consultation with offshore helicopter operators and the operators of oil and gas installations. This consultation should be regarded as essential in respect of oil and gas developments already consented. However, wind energy developers are also advised to discuss their development plans with the holders of relevant petroleum licences, to minimise the risks of unanticipated conflict at a later date.

6.2 The following paragraphs provide, in lay-terms, an explanation of the reasoning behind the need for these 9 NM clear zones. While procedures will differ depending upon the platform, operator and aircraft type involved, the following notes are based upon JAR-OPS, future European flight rules and improved flight procedure documentation, and the practical application of such requirements:

a) **Basic Requirement**. The 9 NM zone aims to provide a volume of airspace within which an instrument 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;

b) **Approach**. Routinely, helicopters making pilot-interpreted radar/GPS approaches (and, in the future, more automatically controlled approaches), to offshore destinations will commence the approach from not below 1500 ft or 1000 ft above obstacles. As helicopters approaching offshore platforms must make the approach substantially into wind with little or no crosswind component, the approach could be from any direction. The obstacle-free zone must, therefore, extend throughout 360° around the destination helideck to prevent restrictions being placed on the direction of instrument 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 landing platform and the final approach starts at around 5-6 NM and 1000-1500 ft. The helicopter descends to a minimum descent height (normally 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. As the helicopter approaches this point, approximately 0.75 NM from the offshore destination, the pilot must decide whether or not he has the required visual references to proceed to land or if not conduct a Missed Approach Procedure (MAP) and go-around;

c) **MAP**. On initiating an MAP, 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, an MAP involving a climb from 200 ft needs to be conducted in an area free of obstructions as this procedure assures safe avoidance of the destination structure.

6.3 In summary, wind turbines within 9 NM of an offshore destination would potentially impact upon the feasibility to conduct some helicopter operations (namely, instrument 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 very 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). Moreover wind turbines within 9 NM of an offshore platform may breach the integrity of the obstruction free status of the area in which a missed approach is carried out. If approaches to the helideck are restricted, there could be a significant consequential economic impact relating to the operation of the offshore platform. More importantly, the integrity of offshore platform safety cases where emergency scenarios are based on the use of helicopters to evacuate the platform could be threatened.

7 Helicopter Main Routes (HMRs)

7.1 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 0° isotherm was at 2000 ft or below.

7.2 From a regulatory perspective, whilst in an ideal world the area 2 NM either side of a HMR should be obstacle free, providing one side of the route was obstacle free, some wind turbine development within 2 NM could be manageable. 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. Additionally, helicopters (like all aircraft), are required by the ANO (2009) (Rules of the Air Schedule 1, Section 3) 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.

7.3 Notwithstanding the above, low level coverage is of particular importance in the provision of full ATC services to offshore helicopter operators, and ANSPs will need to give careful consideration to any proposed development that impacts on the supporting PSR. 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 DAP.

8 Facilitation of Helicopter Support to Off Shore Installations

8.1 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 lay out plans. Such corridors should be oriented in line with the prevailing wind direction, and their width should be designed in consultation with the helicopter operators, given that it will be governed by the VFR performance of the aircraft in use.

9 Parachute Drop Zones

9.1 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/2.4 km radius from the centre of the Parachute Landing Area (PLA).

9.2 Hazards to PLAs are categorized as:

a) **Special Hazard.** A hazard which could constitute a special risk to parachutists e.g. stretches of open water, deep rivers, electricity power lines, densely built up areas, cliffs and quarries;

b) **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.;

c) **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.).

CAP 660[1] (Parachuting) refers.

9.3 Wind turbines pose a special risk to parachutists; 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.

9.4 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.

9.5 Wind turbines over 15 m high are considered a rotating special hazard and as such if located within 1200 m of the PLA/DZ centre, would likely result in restrictions being placed upon any parachute activity within that DZ.

9.6 It is worthy of note that any obstacle over 300 ft 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. If a wind turbine exceeding 300 ft was located within a DZ, restrictions may well be imposed upon parachuting within that DZ.

10 Very Light Aircraft

10.1 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 is likely to exceed the aircraft's operating limits.

1 www.caa.co.uk/CAP670

Chapter 4 Potential Mitigation Measures

1 Introduction

1.1 The following paragraphs give an explanation of some of the mitigation methods that are available to help counter the effects of wind turbines, primarily on PSR and SSR related issues. 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 dependent upon many factors such as the nature of the ATS being provided and the type and density of the airspace affected.

1.2 It must be noted that effects on navigation aids may be mitigated by bespoke operational mitigation, but that this can only be achieved through specific case by case assessment. In addition, given that the potential for wind turbine interference to affect voice communications is not yet understood, mitigation measures – if required – cannot yet be identified.

1.3 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 service provider who, in turn, would need to demonstrate that the system is safe in order to gain CAA (SRG) approval (where applicable).

1.4 Where a wind turbine development is likely to impact upon the provision of an ATS, then the developer and service provider should co-operate to mitigate such impacts wherever possible.

2 Mitigation Through Modification of Development Plan

2.1 Often re-siting of wind turbine locations will mitigate their effects on aviation interests, through the use of terrain shielding to provide natural cover from exposure to LOS. Similarly, changing the number or size (height) of wind turbine developments can often enable aviation objections to be removed.

2.2 It is vital that early and thorough consideration is made by wind turbine developers as to the potential for modifying development plans.

3 Operational Mitigation

3.1 **Re-Routing Air Traffic.** Subject to existing airspace restrictions (including environmental constraints), air traffic controllers may be able to tactically re-route aircraft to avoid overflight of wind turbine clutter (see chapter 2 paragraph 2.3), thereby maintaining aircraft identity at all time and enabling safe ATS provision. However, re-routing aircraft has the potential to: impair service provision; reduce efficient airspace use; create 'choke points' of high intensity use within unregulated Class G airspace; increase controller workload; and increase both fuel burn and emission levels. If permanent re-routing measures are considered, service providers (in consultation with wind energy developers) must fully adhere to CAP 725 (Airspace Change Process (ACP)) where required. The ACP is a lengthy and complex process, giving full consideration to all airspace users, so early consultation with the ACP sponsors (DAP) is essential to ensure a smooth process.

3.2 **Tolerating Clutter.** Radar clutter can be created by a large number of sources, not just by wind turbines and, in some circumstances, its effects can be tolerated. Consequently, guidance on how air traffic controllers should or should not apply radar services in proximity to clutter is generic and is covered in CAP 493 (Manual of Air Traffic Services (MATS) Part 1) section 1 chapter 5 paragraph 18 and in unit-specific MATS Part 2 documents.

4 Equipment Mitigation

4.1 Note that the majority of technological mitigations that follow pertain to PSR, and not to the potential effects on other CNS.

4.2 **PSR Blanking.** PSR blanking is the means of ensuring that clutter caused by a wind turbine development is not presented to the controller by deliberately masking fixed areas on the radar display.

4.3 **Effect of PSR Blanking on ATS Provision.** Regardless of the means of enabling PSR blanking, it is important to note that all radar returns – i.e. legitimate aircraft as well as wind turbine clutter – are prevented from being presented to the air traffic controller. Therefore, this mitigation can only be used in areas in which the ATS provider or ANSP deems a total loss of data to be acceptable. As a result, the decision on where and when PSR blanking is appropriate is dependent on case-by-case analysis and is the prerogative of the ATS provider or ANSP.

4.4 **In-Fill Radar.** Where PSR is blanked to avoid presentation of clutter to the air traffic controller, it is sometimes possible to enable the continued provision of radar coverage in the affected area by overlaying the returns from an unaffected alternative radar. The unaffected radar (for reasons such as terrain or distance) is known as the 'in-fill' radar, and the process is sometimes referred to as data-fusion or mosaicing. The process is reliant upon the capability of the ATC system to: blank specific areas[1]; receive data from an additional source; and fuse the data together and to display it to the controller in a usable format.

4.5 **Effect of In-Fill on ATS Provision.** In-fill as a mitigation is effective, but often problematic due to the following considerations:

a) Data fusion is technically difficult and the service provider must be content that the risks are mitigated effectively;

b) Service providers are understandably reluctant to rely on an in-fill radar that is not fully under their control, and so in-fill from external data sources will often require some form of guarantee to maintain the integrity of data for all but unforeseen, short-notice outages;

c) In-fill mitigations based on the provision of new radars will be subject to the availability of appropriate operating frequencies, which are scarce, and may be subject to an Administered Incentive Pricing Scheme in the future, which will add to the financial considerations of the viability of this form of mitigation;

d) Where the performance of an aeronautical radar station is affected by many wind turbine developments within its coverage, several in-fill radars may be required to cover the affected coverage areas, which could be costly and technically very complex.

4.6 **Shielding.** Where low-level radar coverage in the area of the wind turbine development is not required, it may be possible to use either terrain or a man-made object to prevent a radar from 'seeing' the wind turbines. The use of terrain may involve moving the turbines or radar (although the latter is likely to be far more

1 May be achieved at the affected radar head or the display.

problematic) to a suitable alternative location, where the physical characteristics ensure that the radar and the wind turbines are no longer in radar LOS. A man-made object could also be used (potentially constructed of Radar Absorbent Materials (RAM)) to create an artificial radar horizon. In either case, a detailed study of the radar performance requirements would be required.

4.7 **Effect of Shielding on ATS Provision.** Shielding is only viable when the operational use of the radar is such that completely removing all radar coverage on specified radials at certain levels is deemed acceptable, i.e. where low level coverage in the vicinity of the wind turbine development is not required.

4.8 **Use of Alternate Surveillance Techniques.** It is generally accepted that alternate surveillance techniques (such as Multilateration, Automatic Dependant Surveillance and Multistatic PSR) are less susceptible to effects induced by wind turbine developments. However the implementation of such systems should be considered with respect to their capability to deliver the required performance for the provision of a particular ATS, and the proportion of co-operative/non co-operative targets present in a particular operational environment where the service is being provided.

4.9 **Multilateration.** Multilateration is a form of co-operative and independent surveillance system which makes use of signals routinely transmitted by an aircraft to calculate the aircraft's position. Generally a multilateration system consists of a number of antennas receiving a signal from an aircraft and a central processing unit calculating the aircraft's position from the time difference of arrival of the signal at the different antennas. Active multilateration systems can also prompt replies from aircraft by interrogating the aircraft transponders, which includes transmitters as well as receivers.

4.10 **Automatic Dependant Surveillance (ADS).** ADS is also a co-operative system that uses data gained from the aircraft's own systems (derived from sensors such as GPS etc.) and then transmits information to interested parties using datalink technology. ADS may be used across a range of applications from local airfield monitoring (ADS works down to low level) to long range airspace coverage.

4.11 **Multistatic Primary Radar (MSPSR).** The term MSPSR refers to a sparse network of transmitters and either a single receiver or a network of receiver ground stations using static (i.e. non-rotating) antennas. These units receive signals reflected from the aircraft and prepare them for onward transmission to the centralized processing unit. The signal received via the reflected path is cross correlated with the direct signal from the transmitter(s) in order to locate the position of the target reflecting the signals.

4.12 **Non Auto-Initiation Zones (NAIZ).** Some plot extracted PSR systems[1] have the ability to create NAIZ, which are defined zones within which plot extracted tracks are prevented from initiating, whilst mature tracks are maintained and updated. NAIZ placed over the location of a wind turbine development ensure that turbine blades do not create false tracks, but established aircraft tracks entering the location continue to be updated.

4.13 **Effect of NAIZ on ATS Provision.** Despite wind turbine blade returns being inhibited from processing and displaying, if the return signal strength of the wind turbine blades is equivalent to or greater than an established aircraft track, there is potential for ATC

1 Received radar signals are displayed on ATC displays that, in their simplest form, are direct representations of the target's range, bearing and strength (known as video). By utilising advanced Digital Signal Processing techniques some radars analyse signals and provide them in the form of data messages instead (known as plot extraction). Amongst the many advantages of plot extraction is the ability to manipulate data from different systems in a Surveillance Data Processing system, however, significant difficulties may be encountered when combining information from plot extracted and video radars.

system processing to confuse the two returns, and switch the association of the established aircraft track from its real radar response to that of the wind turbine blade response. Switching of track association presents false information to the operator and may cause risk to flight safety. Moreover, NAIZ cannot identify the source of new potential tracks within the zone, and so will not enable initiation of a track on a radar response caused by an actual aircraft whose radar responses have only just begun to be received by the radar (i.e. climbing out of low level) before it enters the wind turbine development area. Therefore, the use of NAIZ are discouraged. When appropriate, their sizes must be minimal and proliferation avoided.

4.14 **Advanced Tracking Algorithms.** Advanced Tracking Algorithms are classified as non-traditional tracking methods that make use of high capacity and high speed processing systems to perform multiple calculations to determine the most probable target positions. These non-deterministic approaches to target detection and tracking have yet to be fully accepted in the UK civil radar arena, where more traditional deterministic tracking methods are utilized.

4.15 **Effect of Advanced Tracking Algorithms on ATS Provision.** Advanced tracking algorithms are non-deterministic. A radar may not have a solid detection of where an aircraft is and, to overcome this, tracking algorithms will predict (by extrapolation) the position of the aircraft based on the last known movement of the aircraft. The use of such advanced tracking algorithms to process plots over a wind turbine development affected area has to be given careful consideration as this process could associate false wind farm plots, generating false or diverted tracks. As such, it may be difficult for any service provider to provide a robust safety assessment, including necessary verification evidence, for systems using advanced tracking algorithms. Nevertheless, this does not mean that it may not be possible in the future.

4.16 **Use of SSR Only.** There may be instances whereby sole reliance on SSR is acceptable to the safe provision of an ATS; however, this can only be assessed on a case-by-case basis. It should also be noted that SSR is not the only co-operative surveillance technique (i.e. one that requires aircraft to be equipped with a transponder) available, hence techniques such as ADS-B and multilateration can also be used in situations where the sole use of a co-operative techniques is deemed acceptable.

4.17 **Effect of SSR Only on ATS Provision.** The use of SSR only in the busy Approach environment (Terminal Control Areas) is not approved in the UK, as it is deemed unacceptable for an aircraft transponder to be a single point of failure, and the subsequent increased risk of conflictions with non-transponding[1] – and therefore undetectable – aircraft. However, it may be justifiable to use SSR-only to maintain the identity of an aircraft transiting through small areas of airspace affected by the clutter caused by wind turbine developments. The use of SSR-only in the en route environment is more common; however, the same risks posed by non-transponding aircraft still exist but to a lesser extent and approval is still required from the CAA. Provision of surveillance systems according to airspace and ATS is described in CAP 670.

4.18 **Transponder Mandatory Zones (TMZ).** Transponder carriage requirements within UK airspace are changing to maximise the benefits offered by Mode S. However, under current regulations or proposals, not all UK airspace requires aircraft to be equipped with transponders, thus leaving large areas where transponders will not be mandatory. Nevertheless, it is recognised that, under certain circumstances and in certain areas, mandatory transponder carriage can provide significant safety benefits. Consequently, the CAA has the regulatory power to create TMZs. External bodies can also request TMZs; however, the ACP (CAP 725) must be followed. The ACP ensures

1 Either as a result of unserviceability or lack of equipment

that the requirement for a TMZ is fully justified and that the effect upon all airspace users is fully consulted and assessed. The responsibility for completing this assessment would not necessarily fall to the aviation stakeholder. Consideration of the feasibility of a TMZ as mitigation 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.

4.19 **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.

4.20 **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.

4.21 **Mechanical Beam Tilting.** To reduce the effects of clutter on radar it is possible to mechanically raise the radar beam so that it passes over the wind turbine development.

4.22 **Effect of Mechanical Beam Tilting on ATS Provision.** Beam tilting results in a significant reduction in low-level radar coverage and so can only be viable in areas where low level coverage is not required for ATS provision.

4.23 **Electronic Beam Switching.** This achieves an effect similar to that of mechanical beam tilting, with the same resulting issue.

4.24 **RAM.** RAM can significantly reduce an object's RCS in specific radar frequencies. The absorbed EM energy is dissipated as heat and very little energy is reflected. The use of RAM on wind turbines (referred to as 'stealth blades') to minimise their RCS is being developed and researched by many developers around the world and it could offer potential mitigation solutions in future.

4.25 **Other Developments.** The provision of technical mitigation solutions is an area of considerable interest to the aviation and wind industries, and is attracting a significant amount of commercial and technical involvement. Technologies are at different stages of maturity and viability. Details of significant advances will be included on the CAA Wind Energy web pages.

5 Risk Assessment and Mitigation of Possible Hazards Introduced By Wind Turbines

5.1 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 Unit SMS Risk Assessment and Mitigation process. Ultimately, failure to address such issues may result in withdrawal or variation of the Article 169/205 Approval/Certification thereby preventing the provision of the air navigation service.

5.2 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 aviation stakeholder. However its completion should be a co-operative effort between the developer and the aviation stakeholder with any necessary commercial considerations subject to agreement between the two.

Chapter 5 Wind Turbine Development Planning Process

1 Pre-Planning and Consultation

1.1 The weight of relevant knowledge accrued by wind turbine developers and service providers over the past decade has been substantial: issues are better understood, and proper procedures for effective consultation are in place. At the same time, the amount of sites for assessment as potential wind turbine developments rose substantially and the pre-planning service that the CAA provided became unsustainable. As a result – and following confirmation from the renewable energy stakeholders that the withdrawal of the CAA involvement within the pre-planning process would not be detrimental to future planning processes – the CAA involvement in the Windfarm Pre-Planning Consultation Process ceased on 25 December 2010. Since then, developers are required to undertake their own pre-planning assessment of potential civil aviation related issues. Table 1 provides an overview of considerations, and the following paragraphs detail what developers will need to consider, conducting associated consulted as appropriate.

Table 1

	CNS Facilities	Obstacle Considerations
Aerodrome	Safeguard PSR and SSR Safeguard Approach Aids Safeguard Navigation Beacons Safeguard VHF (Consultation required with aerodrome licensee/manager)	OLS Impact on procedures Need for lighting to aid night time conspicuity Anemometer masts. (Consultation required with aerodrome licensee/manager)
En Route	Safeguard PSR and SSR Safeguard Navigation Beacons Safeguard VHF (Consultation required with NERL)	>300 ft/91 m Chart and entry to AIP >150 m 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
Offshore	Safeguard PSR and SSR Safeguard Navigation Beacons Safeguard VHF (Consultation required with NERL)	Offshore Lighting in accordance with Article 220 of ANO (2009) DAP guidance on offshore lighting HMR Operations around oil and gas platforms Anemometer masts

1.2 **Aerodromes.** Whilst not definitive, it should be anticipated that any wind turbine development within the following criteria[1] might have an impact upon civil aerodrome[2]- related operations:

a) 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;

b) Within **airspace coincidental with any published Instrument Flight Procedure** to take into account the aerodrome's requirement to protect its IFPs;

c) Within 17 km of a **non-radar equipped licensed[3] aerodrome with a runway of 1100 m or more**;

d) Within 5 km of a non-radar equipped **licensed aerodrome with a runway of less than 1100 m**;

e) Within 4 km of a **non-radar equipped unlicensed aerodrome with a runway of more than 800 m**;

f) Within 3 km of a **non-radar equipped unlicensed aerodrome with a runway of less than 800 m**.

1.3 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.

1.4 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 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.

1.5 Aerodrome licensees should address physical safeguarding issues in accordance with the guidance contained within CAPs 168 and 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.

1 Aerodrome criteria is generically based upon the safeguarding requirements and guidance contained in 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.

2 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.

3 Licensed in accordance with Part 27 of ANO (2009).

1.6 **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.

1.7 **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[1] provide support.

1.8 **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.

1.9 **Charting.** There is a civil aviation requirement in the UK for all structures over 300 ft high to be charted on civil aviation maps (the MoD uses a lower threshold height). Should any proposed development progress and the 300 ft height be breached, developers will need to provide details of the development to the Defence Geographic Centre (DGC). In particular it is advisable to update the DGC if there are any variations to the construction schedule. Furthermore, it may be wise to actively notify local stakeholders of any delays to construction.

1.10 **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 landing sites.

1.11 **Proliferation.** 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 proliferation of wind turbines in any particular area might potentially result in difficulties for aviation that a single development would not have generated. Therefore, it is not necessarily the case that, because a generic area was not objected to by the aviation industry, future, similarly located potential developments would receive the same positive response.

1.12 **Cross-Boundary.** Cross-boundary consultation may be required for later rounds of offshore development. Wind turbine developers should contact the CAA for specific guidance in all instances where developments are likely to approach the limits of the UK Flight Information Region (details in AIP).

2 Formal Planning

2.1 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, the Planning Act, or through the Town and Country Planning Acts. The process is outlined in the subsequent paragraphs, although these guidelines do not purport to be a comprehensive guide to planning procedures.

2.2 **In England and Wales** LPAs handle consent applications for land-based generating stations with a capacity up to 50 MW under the general planning regime set out in the Town and Country Planning Act. The Infrastructure Planning Commission considers applications for development consent under Section 36 of the Electricity Act 1989[2] for land-based generating stations with a capacity greater than 50 MW and offshore[3] generating stations with a capacity over 1 MW; this responsibility is anticipated to be the responsibility of the Major Infrastructure Planning Unit from 2012.

1 http://www.nats.co.uk/env/windfarms/
2 The act can be found at http://www.opsi.gov.uk/acts/acts1989/Ukpga_19890029_en_1.htm
3 Statutory Instruction 2001 No 3642 refers and can be found at http://www.opsi.gov.uk/si/si2001/20013642.htm.

2.3 **In Scotland**, there is a similar division of responsibility. Onshore stations of a capacity up to 50 MW are handled under the planning regime of the Town and Country Planning Act (Scotland). Similarly, onshore developments with a capacity greater than 50 MW require consent from the Scottish Government under Section 36 of the Electricity Act. In Scotland, offshore developments are currently treated similarly to those in waters adjacent to England and Wales[1].

2.4 **In Northern Ireland** the Planning Service (an Agency within the Department of the Environment), handles all proposals for land-based generating stations irrespective of capacity under the general planning regime set out in the Planning (Northern Ireland) Order 1991. All proposals for land-based generating stations with a capacity of 10 MW and over, and offshore developments with a capacity of 1MW and over, must also obtain development consent from the Department of Enterprise, Trade and Investment in accordance with Article 39(2) of the Electricity (Northern Ireland) Order 1992[2]. The Electricity Act 1989 does not extend to Northern Ireland, although the procedures under the 1992 Order are broadly the same.

2.5 **MWT.** Current legislation makes no distinction in the planning process for MWT, and they are processed according to their MW capacity. However, the English government has begun to establish separate General Permitted Development Orders (GPDO) for MWT and other renewable energy technologies, which would enable MWT fulfilling the required criteria to be installed without undergoing the standard planning application process. The methods of establishing GDPO and, importantly, the parameters of MWT that will enjoy Permitted Development Rights (PDR) have not yet been finalized. It is hoped that the other devolved governments will adopt the same parameters and procedures for PDR within their jurisdiction. Further information on current government legislation is available via the CAA Wind Energy web pages.

2.6 **CAA Involvement.** Currently, the CAA provides the following input to all formal planning submissions for wind turbine developments:

a) Identification of aviation stakeholders that would potentially be affected, using the criteria at paragraph 1.2;

b) Reviewing the aviation section of the Environmental Statement for accuracy and completeness;

c) Consideration of regulatory requirements;

d) Consideration of whether all other known aviation issues have been taken into account (including other potential developments);

e) Consideration of the appropriateness of comments or statements provided by aviation stakeholders in any aviation based objections.

NOTE: Note that the CAA is only a statutory consultee for onshore developments in excess of 50MW and for offshore developments in excess of 100MW. Responsees to other planning submissions will be made, resource permitting.

1 Scottish Statutory Instruction 2002 No 407 refers: http://www.opsi.gov.uk/legislation/scotland/ssi2–2/ssi_20020407_en.pdf
2 http://www.legislation.gov.uk/nisi/1992/231/contents/made

3 Promulgation of Wind Turbine Developments

3.1 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 all proposed developments. Notwithstanding this LPA role, developers should also report such information to DGC. Through the updated promulgation of a database document, the DAP Aeronautical Charts and Data section is advised of all such developments and update aviation charts accordingly. All structures (including wind turbines) 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. AIC P021/2011 refers[1].

4 Call-Ins and Inquiries

4.1 **Call-Ins.** 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 co-operation can obviate the need for it.

4.2 **Inquiries.** 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. Given the large number of inquiries resulting from a variety of issues, LPAs are encouraged to draw the CAA's attention to matters requiring aviation input.

5 Consistency, Accuracy and Use of Consultants

5.1 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.

5.2 In submitting a wind turbine development proposal, developers will regularly use consultants to prepare reports to counter any issues raised by aviation stakeholders if the proposal is objected to. 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.

1 http://www.nats-uk.ead-it.com/aip/current/aic/EG_Circ_2011_P_021_en.pdf

6 CAA Provision of Advice

6.1 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.

6.2 Of further note is that as a civil organisation, the CAA will not 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).

6.3 As already stated, DAP have the lead on wind turbine related issues for the CAA; however, through appropriate internal consultation the view stated by DAP can be taken to be the view of the CAA as a whole. Wind turbine related enquires should be directed to:

Renewable Energy Project Officer

Surveillance and Spectrum Management Directorate of Airspace Policy
Civil Aviation Authority
CAA House
45-59 Kingsway
London
WC2B 6TE

e-mail: windfarms@caa.co.uk

Appendix 1 DECC Governance and Meeting Structure

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 co-ordinated 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.

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.

The governance of the Aviation Plan is the responsibility of an Aviation Management Board, 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 Finance Management Board. All meetings sit quarterly.

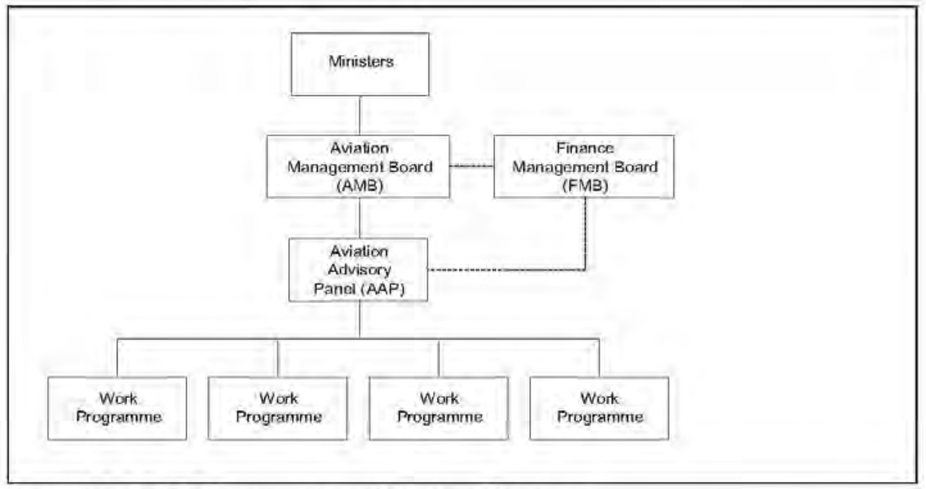

Figure 1.1 DECC Governance and Meeting Structure

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[1] 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.

1 The original Memorandum of Understanding can be found at http://www.berr.gov.uk/files/file46583.pdf The second Memorandum of Understanding will be promulgated via the CAA Wind Energy Web Pages once extant

Appendix 2 Radar Assessment Methodology

In view of the complex issues surrounding wind farm development, it is necessary to accurately assess whether a proposed development is likely to affect the operational performance of an aeronautical radar station. Prediction of the affect on a particular radar site by a proposed wind turbine development is a complex task as this depends on many factors including terrain, weather, maximum heights of the radar and the wind turbines, LOS, the operational range of affected radars, diffraction, antenna beam tilt, radio propagation characteristics, curvature of the earth etc. However, assessing whether the wind turbines are within the radar's LOS is a useful basic indication of whether the wind turbine could have potential impacts on the radar performance or not.

A simple LOS analysis method can be found on the CAA Wind Energy web pages. However, it must be noted that the result obtained by performing this analysis is solely based on the geometric location of the wind turbine and the radars, heights and local terrain only; as such, no guaranteed conclusions shall be made purely based on this assessment. It is possible that the result may change when a complete analysis is performed taking all other factors into consideration. Should the initial LOS analysis indicate that the proposed turbines were not within the LOS of the radar, there would be a possibility that no issues would arise. However, as stated above, given the characteristics of radio propagation, it can never be wholly discounted from a simple LOS assessment that the radar will not detect the wind turbines. If the analysis indicated that the wind turbine is within the radar's LOS or it is not within the simple LOS but occupies critical airspace, an accurate conclusion can only be drawn once a detailed analysis has been performed taking to account the other factors. It may be that the wind farm has no affect on the radar, depending on the beam patterns and the propagation characteristics.

Therefore, the LOS method provided in the CAA Wind Energy web pages is intended purely to give non-specialists the means to undertake a procedure that provides a general indication of the likelihood of affects on a radar; the outcome of this procedure should be used only to inform the decision as to whether to undergo further, detailed assessment with an appropriate radar assessment model. Further information is also provided as to what considerations and aspects should be addressed within detailed radar models.

There are a number of mathematical, or similar, 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 in the unpredictability of both 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 where aviation safety is an issue, safety consideration should always be applied in a conservative manner.

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. Therefore, it is strongly suggested that developers engage with the appropriate service provider prior to commissioning a propagation assessment, in order to ensure that the proposed model to determine suitability is based on an appropriate RCS and is acceptable to the service provider. Failure to do this could result in later disagreement and conflict once results are released. Service providers are encouraged to consider publishing clear guidance as to which radar models they would consider acceptable to their requirements.

Eurocontrol has provided international guidelines on how to assess the effects of wind turbines on radar: http://www.eurocontrol.int/corporate/public/event100429_wind_turbine_radar.html. 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.

If the radar station likely to be affected by a proposed wind turbine development belongs to NATS, useful self assessment guidance and a methodology which uses the maps of NATS surveillance radar infrastructure is available at: http://www.nats.co.uk/environment/windfarms/nerl-self-assessment-maps/. Note that the basic assessment methodology provided in the CAA Wind Energy Web Pages would be unnecessary for these radars, as the results indicated by NATS with respect to their radars are based on more detailed analysis.

Appendix 3 References[1]

CAP 32 (United Kingdom Integrated Aeronautical Information Package)

CAP 168 (Licensing of Aerodromes)

CAP 393 (Air Navigation Order)

CAP 493 (Manual of Air Traffic Services Part 1)

CAP 660 (Parachuting)

CAP 670 (ATS Safety Requirements)

CAP 725 (Airspace Change Process Guidance Document)

CAP 738 (Safeguarding of aerodromes)

CAP 760 (Guidance on the Conduct of Hazard Identification, Risk Assessment and the Production of Safety Cases)

CAP 793 (Safe Operating Procedures at Unlicensed Aerodromes)

Wind Energy and Aviation Interest Interim Guidelines

CAA, AOA & GACC advice note on the Safeguarding of aerodromes

Joint ODPM, DfT, NAFW Planning Circular 1/2003 guidance on Safeguarding Aerodromes, Technical Sites and Military Explosives Storage Areas

Scottish Planning Circular 2/2003 Arrangements for Safeguarding Aerodromes, Technical Sites and Military Explosives Storage Areas

CM 6046 (Department for Transport, The Future of Air Transport) – also known as the air Transport White Paper

White Paper from May 2007 – Meeting the Energy Challenge

CAA Policy Statement on Offshore Lighting Requirements

CAA Policy Statement on Lighting of En Route Obstacles

ICAO EUR DOC 015

Eurocontrol Guidelines on How to Assess the Potential Impact of Wind Turbines on Surveillance Sensors[2]

1. In all cases please refer to the latest edition
2. Note that national planning constraints take primacy.

Appendix 4 Contact Information

CAA Contacts

Directorate of Airspace Policy
Policy lead for CAA on wind turbine issues affecting aviation.

Civil Aviation Authority
Directorate of Airspace Policy
CAA House
45-59 Kingsway
London
WC2B 6TE

Contact: Renewable Energy Project Officer
Tel: 020 7453 6529

www.caa.co.uk/windfarms
windfarms@caa.co.uk

Safety Regulation Group – Aerodrome Standards
For information on aerodrome licensing criteria, obstacle limitation surfaces and call-in procedures, contact:

Civil Aviation Authority
Aerodrome Standards
Safety Regulation Group
Aviation House
Gatwick Airport South
West Sussex
RH6 0YR

www.caa.co.uk/srg
aerodromes@caa.co.uk

Safety Regulation Group – 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 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')

Southern Regional Office (Gatwick)

By post:

Regional Manager ATS Safety Regulation
(Southern Region)
Air Traffic Standards Division
Safety 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

Central Regional Office (Manchester)

By post:

Regional Manager ATS Safety Regulation
(Central Region)
Air Traffic Standards Division
Safety Regulation Group
Civil Aviation Authority
First Floor, Atlantic House
Atlas Business Park
Simonsway
Wythenshawe
Manchester
M22 5PR

Tel: (+44)(0)161 216 4500
Fax:(+44) (0) 161 216 4549

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

Northern Regional Office (Stirling)

By post:

Regional Manager ATS Safety Regulation
(Northern Region)
Air Traffic Standards Division
Safety Regulation Group
Civil Aviation Authority
First Floor, Kings Park House
Laurelhill Business Park
Stirling
Scotland
FK8 9JQ

Tel: (+44) (0) 1786 457400
Fax :(+44) (0) 1786 457440

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 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

Department for Transport

Great Minster House 76 Marsham Street London SW1P 4DR	www.dft.gov.uk/stellent/groups/dft_aviation/documents/sectionhomepage/dft_aviation_page.hcsp

Maritime and Coastguard Agency

For General enquiries:	Tel: (023) 8032 9332 Fax: (023) 8032 9488
SAR Operations Officer HM Coastguard Maritime and Coastguard Agency Southampton UK	Roly.McKie@mcga.gov.uk
For Maritime lighting requirements:	Tel: (023) 8032 9523 Fax: (023) 8032 9488
MCA Navigation Safety Branch, HM Coastguard Maritime and Coastguard Agency Southampton UK	

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

Kingston Road Sutton Coldfield West Midlands B75 7RL	David Naylor-Gray Tel: 0121 311 3810 david.naylor-gray@de.mod.uk www.mod.uk/DIO

NATS Safeguarding

NATS Corporate and Technical Centre 4000-4200 Parkway Whiteley Hants PO15 7FL	NATSSafeguarding@nats.co.uk www.nats.co.uk

National Assembly for Wales

Planning Division Cathays Park Cardiff CF10 3NQ	www.wales.gov.uk/subiplanning/index.htm

Northern Ireland Planning Service Headquarters

Millennium House 19-25 Great Victoria Street Belfast BT2 7BN	www.planningni.gov.uk

Department for Communities and Local Government

Eland House Bressenden Place London SW1E 5DU	www.communities.gov.uk

Office of Gas and Electricity Markets (OFGEM)

9 Millbank London SW1P 3GE	www.ofgem.gov.uk
70 West Regent Street Regents Court Glasgow G2 2QZ	

RenewableUK (formerly British Wind Energy Association)

Greencote House Francis Street London SW1P 1DH	www.bwea.com

Scottish Executive

Planning and Consents 4th Floor 5 Atlantic Quay 150 Broomielaw Glasgow G2 8LU	www.scotland.gov.uk/planning