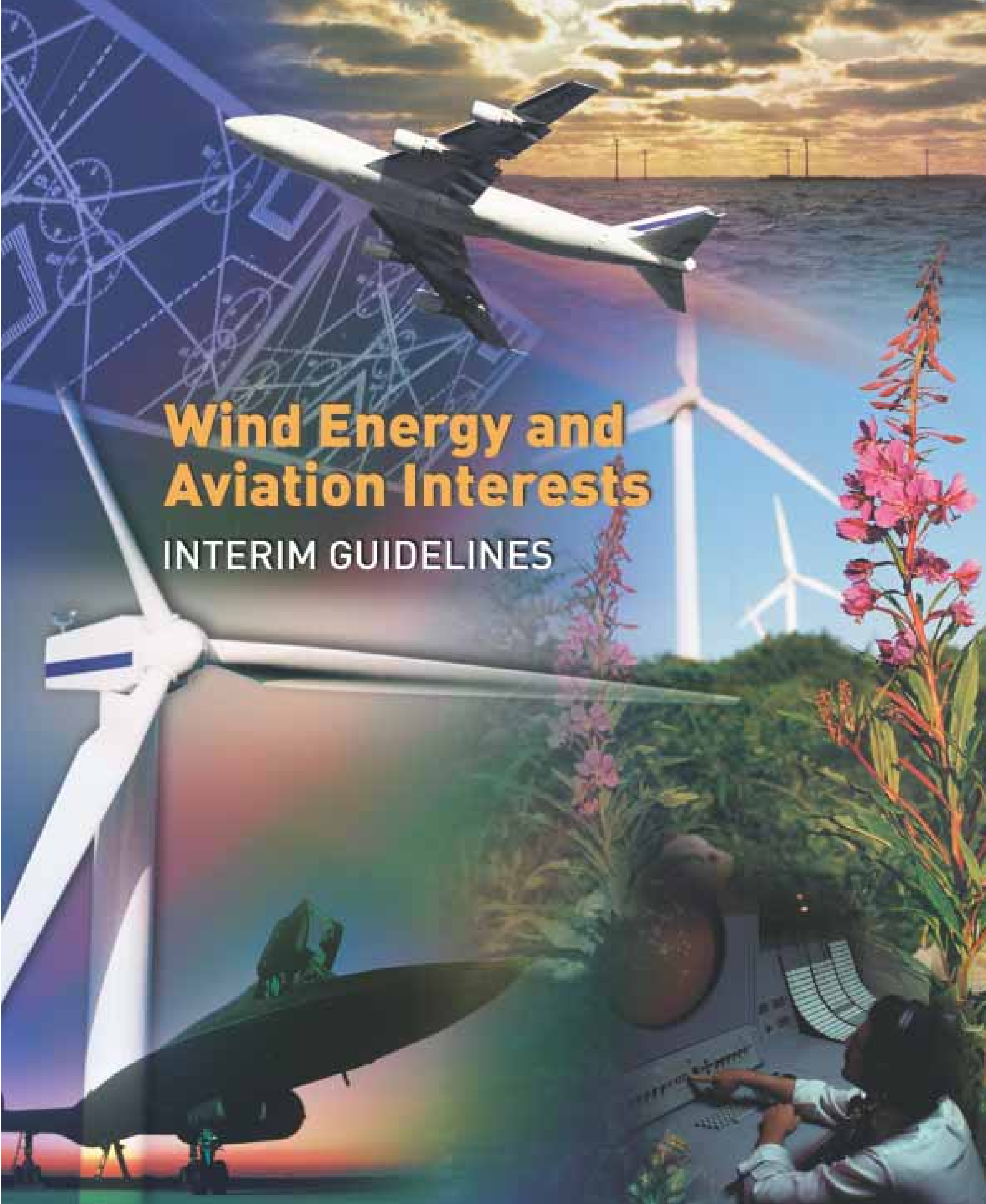

Wind Energy and Aviation Interests

INTERIM GUIDELINES

dti
Department of Trade and Industry

DTI Sustainable Energy Programme

Civil Aviation Authority

THE BRITISH WIND ENERGY ASSOCIATION

This document is designed to be read by the main stakeholder communities: the wind energy industry; and those responsible for aviation interests, broken down into safety of flight, air traffic management and air defence. Consequently, it is structured to allow readers to quickly identify information pertinent to each interest group.

ETSU W/14/00626/REP

WIND ENERGY AND AVIATION INTERESTS – INTERIM GUIDELINES

WIND ENERGY,
DEFENCE & CIVIL AVIATION
INTERESTS WORKING GROUP

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Foreword

FOREWORD BY BRIAN WILSON MP,

MINISTER FOR ENERGY AND CONSTRUCTION

DEPARTMENT OF TRADE AND INDUSTRY

dti
Department of Trade and Industry

Harnessing the UK's wind resources is crucially important in meeting the Government's targets for renewable energy and in tackling climate change. My Department is fully committed to encouraging the rapid development of the wind energy industry. However, such development must take place in a way which takes full account of national defence and air safety. It is important that the wind energy and aviation communities understand the needs of the other and the purpose of these guidelines is to foster a better informed dialogue. In particular the guidelines explain the potential impact of wind turbines on radar systems and the process for ensuring that wind farms are located where they do not give rise to insuperable difficulties. I very much welcome their publication and commend them to wind energy developers and others with an interest as essential reading.

FOREWORD BY Dr LEWIS MOONIE MP,

PARLIAMENTARY UNDER SECRETARY OF STATE

FOR DEFENCE AND MINISTER FOR VETERANS

The Government has a target to achieve 10 per cent of the United Kingdom's energy from green sources by 2010 which my Department fully supports, and makes every effort to assist in achieving this. It is true to say however, that the Ministry of Defence does have a number of safety concerns over the effects of wind turbines on radar and low flying. Whilst efforts must continue to maintain flight safety and optimum radar coverage throughout the United Kingdom, we await the findings of a number of studies into these problems, and Defence Estates will continue to assist developers by evaluating wind farm planning proposals on a case by case basis.

I believe these guidelines are a welcome addition to both setting out my Department's and the Government's position and will greatly assist all involved in the Wind Energy industry.

FOREWORD BY SIR ROY McNULTY, CHAIRMAN, CAA

The publication of this document is an important milestone in ensuring that all those involved in renewable energy and aviation have a better understanding of issues of mutual interest. It is vital that the many different parties involved work closely together to ensure that progress towards delivering national objectives can be achieved in a co-operative and consistent way. This publication is evidence of work towards this goal and our understanding will continue to evolve as the necessary research is completed. Safety cannot be compromised, but it is imperative that all the parties involved in these issues can participate in an informed process which seeks solutions rather than confrontation.

FOREWORD BY DAVID STILL, CHAIRMAN, BRITISH WIND ENERGY ASSOCIATION

The BWEA and its members consider safety of the utmost importance during the development and operation of wind farms. We work in partnership with Government and the aviation communities to ensure that the delivery of clean, green electricity does not cause any adverse effects to national defence or air safety. To achieve this, we all need to understand the issues and make informed decisions. These new guidelines are a significant step forward in ensuring that the best information is widely available. In working to these guidelines, we ensure that we will achieve renewable energy targets safely, speedily and to the highest possible standards.

Contents

1

1 Introduction

1.1 GENERAL

1.1.1 The wind is an increasingly important source of energy for the UK. It is exploited by the use of turbines to generate electricity. Many wind farms are already in operation and the number can be expected to increase sharply in the next few years. The advantage of wind energy is that, unlike fossil fuels, it will never be exhausted and it does not create damaging carbon emissions. Such renewable energy also contributes to the diversification of the UK's energy sources, an important factor in ensuring security of supply, as well as creating new jobs and export opportunities.

1.1.2 The role of authorities responsible for the regulation of aviation activity, both civil and military, is to ensure that flight safety is not compromised. Furthermore, the Ministry of Defence (MOD) has a need for access to and unimpeded surveillance of the air in the interests of national security.

1.1.3 Because of their physical size, in particular their height, wind farms can have an effect on the aviation domain. Additionally, rotating wind turbine blades may have an impact on certain aviation operations, particularly those involving radar. The aviation community has procedures in place which are designed to assess the potential effect of developments such as wind farms on its activities, and, where necessary, to identify mitigating measures.

1.1.4 This document has been commissioned by the Wind Energy, Defence and Civil Aviation Interests Working Group, comprising the Department of Trade and Industry (DTI), the Civil Aviation Authority (CAA), the Ministry of Defence, and the British Wind Energy Association (BWEA) to provide guidelines for all those involved in the consultation process for wind farms, including wind farm developers, local authorities and statutory consultees within the aviation community. In particular it offers guidance to developers on the issues to be taken into account in decisions on the siting of wind farms. The Terms of Reference of the Working Group are at Annex A. The assistance of STASYS Ltd in preparing these guidelines is gratefully acknowledged.

Picture credit: © Renewable Energy Systems Ltd

Hare Hill wind farm

1.1.5 Both wind energy and aviation are important to UK national interests. Furthermore, defence remains one of the prime responsibilities of any Government. All the communities involved in wind energy and aviation have legitimate interests that must be balanced to identify a way ahead that gives the best results, taking into account the overall national context. The purpose of this document is to facilitate an informed dialogue.

1.1.6 Neither aviation nor the wind industry is static and both can be expected to evolve in ways which will have an impact on the other. It is expected that these guidelines will be a "living" document, which will be updated and amended as changes to the subject matter it covers occur. Furthermore, it is intended that the document will be updated to reflect the outcome of research into the interaction between wind turbines and aviation (particularly radar).

1.2 AIM AND SCOPE

1.2.1 The primary goal of the guidelines is to facilitate the development of wind energy to meet UK Government targets, whilst ensuring that the interests of both civil and military aviation are recognised.

1

Picture credit: © Renewable Energy Systems Ltd

Dun Law
wind farm

In particular, they aim to:

(a) Provide a clear, readable, single source of information on all aspects of the impact of wind turbines on aviation, both civil and military.
(b) Identify the range of interactions between wind energy and aviation interests.
(c) Outline the measures adopted to address the issues which are likely to arise from such interactions.
(d) Identify the organisations involved in these processes.

1.2.2 The document has been written for a number of different audiences including wind farm developers, local authorities and statutory consultees, as well as others with an interest. Some sections will be more pertinent to certain stakeholders than others. Since the developer initiates the process to obtain planning consent emphasis is given to identifying his courses of action in each case.

1.2.3 The document does not contain in-depth technical analysis but where such analysis has been conducted elsewhere, it is identified and references given. Nor does it cover the issue of objections to wind farm proposals on economic grounds (such as future airport developments): such objections should be handled as part of the normal planning process.

1.2.4 The guidelines will not be able to solve all aviation-related problems but developers who follow the guidance will be in a position to establish a dialogue with the main interests concerned.

1.2.5 Further information on the background to the guidelines can be found at Annex A.

2 The Need for Wind Energy

Picture credit: © BWEA

Photomontage of an offshore wind farm

2.1 INTRODUCTION

2.1.1 This section outlines UK energy policy, both up to and beyond 2010, discusses the potential contribution of wind energy and examines current and future wind energy technologies. Its goal is to help those responsible for aviation interests to understand the Government's wind energy aims within a broader context.

2.2 UK ENERGY POLICY IN THE GLOBAL CONTEXT

2.2.1 Wind power is now a viable and well-established source of electricity generation, that creates no harmful emissions. As the UK is the windiest country in Europe[1], it is well placed to exploit this never-ending resource. Consequently, the Government believes that wind power will play a major role in meeting policy targets for renewable energy generation over the next decade and beyond.

2.2.2 In February 2000, the Government published its conclusions on policy for renewable energy, setting out targets for the amount of electricity to be generated from renewables in the near-term[2]. By 2010, 10% of UK electricity should be met from renewables, which is 33.6 Terawatt-hours (TWh) per year of electricity: a substantial proportion of the target is likely to be met by wind energy. It is conservatively estimated by the BWEA that this could represent around 4,000 turbines, in both onshore and offshore locations.

2.2.3 Government policy does not set targets for individual renewable energy sources, but wind energy is currently the most economically viable renewable energy

1 The UK has access to 40% of the total European resource.
2 New and Renewable Energy: Prospects for the 21st Century, DTI, 2000.

2

source and therefore may be expected to make the largest contribution.

2.3 THE RENEWABLES OBLIGATION

2.3.1 The Government has recently introduced the Renewables Obligation with the aim of increasing the amount of electricity generated in Great Britain from renewables sources, thus contributing to a reduction in greenhouse gas emissions. The Renewables Obligation (and the associated Renewables Obligation (Scotland)), which came into force on 1 April 2002 requires that suppliers derive a specified and increasing proportion of the electricity they supply to customers from eligible renewables. The Renewables Obligation will create extra demand for renewable energy worth £1 billion by 2010.

2.3.2 The initial proportion of electricity generated from renewables is proposed to be 3% in the first period (2002-3), rising annually to over 10% in 2010-11. The Obligation will then remain at least constant after 2010, but may well be increased. It will not be reduced.

2.4 THE POTENTIAL FOR RENEWABLE ENERGY

Table 1: Potential Renewable Electricity Generation in 2010 – High Estimate[7]

SOURCE	MW_e[4]	TWh	Proportion of RO[5]
Onshore wind	4542	11.9	37%
Offshore wind	1483	5.2	16%
Marine technology	72	0.2	1%
Landfill gas	615	4.8	15%
Biomass	874	6.5	20%
Anaerobic digestion	87	0.6	2%
Small hydro	111	0.4	1%
Photovoltaics	56	0.1	Less than 1%
Energy from biodegradable waste	329	2.4	8%
TOTAL[6]	**8170**	**32.3**	**100%**

Picture credit: © Vestas Wind Systems AS

2.4.1 A report commissioned by the DTI and the former Department of Transport, Local Government and the Regions (DTLR), and published in February 2002, examined regional assessments of the potential for renewable energy generation in 2010[3]. The report examined the proposed regional targets to find whether, in aggregate, they would meet the target set by the national government. It discovered that over half of the total of the regions' assessments consisted of wind power, both on- and offshore, and even this may be an underestimate. Table 1 gives an indication, from the OXERA Report, of how different renewables technologies might contribute to the Renewables Obligation. The figures given are indicative only and do not reflect official Government policy or forecasts.

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[3] A Report to the DTI and the DTLR: Regional Renewable Energy Assessments, OXERA Environmental, 2002.
[4] Megawatts of electricity.
[5] At 10% of forecast national energy requirements. To determine the overall contribution of each technology to meeting the UK's total energy needs, therefore, the figure should be divided by 10.
[6] Figures in the total line do not reflect the precise sum of their constituents due to rounding effects.
[7] The report gave a low estimate of 37% and a high estimate of 53% from the combination of both on- and offshore wind by 2010. The figures given here are for the high estimate.

Picture credit: © Powergen Renewables

2.4.2 The Scottish Executive Report "Scottish Renewable Resource 2001" identified that there is enough potential energy from onshore wind power alone to meet Scotland's peak winter demand for electricity twice over. In all, the total resource amounts to 75% of the total UK existing generating capacity. The study considered the potential availability of renewable resources out to 2020 and found that offshore wind and onshore wind could provide 80TWh and 45TWh respectively.

2.4.3 The next few years are likely to see large wind farm developments in the UK. So far as onshore wind farms are concerned, developers have plans for a number of large projects, predominantly in Scotland (including the islands) to take advantage of the windy conditions there. As for offshore wind, this is at an earlier stage of development in the UK but is now the focus of considerable attention by developers and may in due course overtake onshore wind in terms of its contribution to renewables targets. The country's first offshore turbines were installed off the coast of Blyth, Northumberland, in October 2000. Wind farms at 19 sites around the UK coast are now planned and statutory consents have already been given for 30-turbine projects on Scroby Sands off the coast of Great Yarmouth, Norfolk (April 2002) and at North Hoyle off the coast of North Wales (July 2002). Looking ahead, much larger offshore wind farm developments around the coast of the UK are in prospect.

2.4.4 Further information on wind turbines can be found in Annex B.

2.5 PROSPECTS FOR WIND ENERGY POST-2010

2.5.1 A report[8] by the Performance and Innovation Unit (PIU) in February 2002 made several recommendations for energy policy up to 2050. These include that the target set for the proportion of electricity generated from renewables should be increased to 20% by 2020, in part owing to the fact that the UK will be subject to increasingly demanding carbon reduction targets. This is in line with the report's recommendation that measures should be taken over the coming decades to ensure the UK energy system is environmentally

[8] The Energy Review, PIU, 2002.

sustainable and affords security of supply. A White Paper on Energy Policy will be produced at the turn of the year and will include a Government response to the PIU Report. Also, it is likely that the Scottish Executive will shortly issue a Consultation Paper on whether increased renewable energy generation targets should be set for the period beyond 2010.

2.5.2 There is a likelihood that more stringent greenhouse gas targets will be adopted in the future and this will justify giving environmental objectives high priority within future energy policy. Wind energy is the most mature and economically viable renewable energy source and thus it follows that the growing priority given to renewable electricity will mean growing priority given to wind farm development.

2.6 WIND ENERGY - CONCLUSION

2.6.1 In summary, the Government is committed to reducing greenhouse gas emissions within the UK and this, in turn, means a shift towards economically viable renewables. The impetus behind this shift can be expected to increase further after 2010, as the UK is likely to become subject to more stringent emission controls. It is important therefore that the aviation community recognises the increasing role which wind farms will play in the national economy and actively engages in the process of developing solutions to the conflicts of interest between wind energy and aviation operations.

3 Aviation Interests

3.1 GENERAL

3.1.1 Just as the wind industry is set to grow over the next decade and beyond, the demands placed on the civil aviation industry also continue to increase. The Department for Transport (DfT) estimates that UK air passenger traffic will increase three-fold by 2030. In July 2002 the Department published a series of consultation papers outlining options for expansion of existing airports and the construction of new airports in various regions of the UK to cope with this increased demand. A White Paper on air transport is planned for publication in Spring 2003 which will provide a policy framework for the long-term future of both civil aviation and airports in the UK[9].

3.1.2 The Safety Regulation Group of the CAA is responsible for the regulation of licensed aerodromes and air traffic services within the UK. The Directorate of Airspace Policy (DAP) within the CAA 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. UK airspace policy is set and maintained by the CAA in consultation with MOD, since the airspace is used for both civil and military purposes. The CAA will object to wind farms that they believe will compromise safety.

3.1.3 MOD needs access to UK airspace for two purposes: operations training and national defence. For the defence mission, the importance of which was starkly highlighted by the events of 11 September 2001, the MOD must be able to conduct surveillance of the airspace above and around the UK, and undertake military operations in this area.

3.1.4 It is therefore essential that the safety of UK aerodromes, aircraft and airspace continues to be guaranteed. As wind turbines increase in size and number their potential impact on aviation operations increases correspondingly. Interactions between wind turbines and aviation activity are potentially complex. The most effective way to ensure that the interests of all parties are balanced is through a process of informal pre-planning consultation (initiated using the proforma shown in Annex E) before the formal application for consents. This should help to identify (and remove) as many as possible of the stakeholders' concerns before the formal planning process commences; it can also help to avoid the cost and effort of nugatory work for both stakeholders and developers. These processes are described in Section 4.

3.2 SAFEGUARDING OF AVIATION INTERESTS

3.2.1 There are basically two ways in which the construction of a wind turbine or wind farm may impact upon aviation operations:

a) The physical obstruction caused by a tall structure; and
b) The effects that the supporting structure and rotating turbine blades can have on CNS systems (including radar) and other equipment, referred to as "technical sites". (Further information on the definition of a technical site is given at 3.5.1.1).

[9] Further information is available from the Department for Transport web site at www.dft.gov.uk/consult/airconsult/index.htm

3

3.2.2 The stakeholders in both civil and military aviation conduct a process known as "safeguarding"[10] to ensure that their interests are not compromised by development such as wind farms. The objectives of the safeguarding process are threefold:

a) to prevent the granting of planning permission for developments which would impact upon the safe use of aerodromes or CNS systems (including radar);
b) to ensure that the cumulative effects of previous and continuing developments are taken into account; and
c) to ensure that planning permission, where granted, is subject to appropriate conditions.

3.2.2.1 Safeguarding is the last stage at which proposals may be halted through objection from a stakeholder. The voluntary pre-planning consultation process (described in Section 4.1) is designed to uncover and address any conflicts between aviation interests and wind energy before this stage is reached. Should new objections arise at the formal safeguarding stage, it is highly unlikely that they will prove to be easily, and inexpensively, resolved. This is but one reason for recommending that developers establish an early dialogue with aviation stakeholders who may be affected by their plans.

3.2.2.2 The safeguarding process is always changing due to new technologies and changes in airspace structure and regulations, among other factors. The guidelines reflect current processes and procedures.

3.2.2.3 Requirements for safeguarding aerodromes and technical sites are set out in Government documentation[11]. The consultation requirements in the documentation apply to military as well as civil facilities. The process is based on safeguarding maps that are lodged with local planning authorities (LPAs).

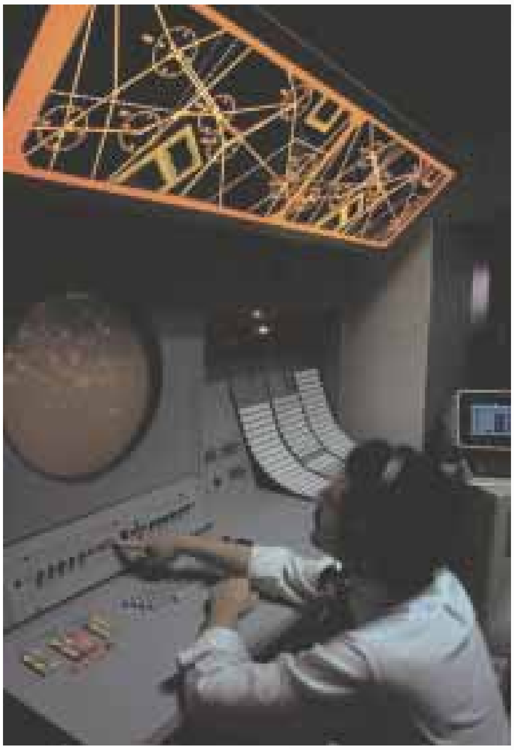
3.2.2.4 Under the current safeguarding process, LPAs consult the CAA about wind farm proposals that fall within areas covered by safeguarding maps. Owing to a change in the regulations[12], with effect from September 2002, planning authorities will be required to consult the relevant civil aerodrome representative directly[13]. This is a relatively minor change and should be transparent to wind farm developers.

3.2.3 Safeguarding and Wind Turbines

3.2.3.1 Vertical Obstruction Safeguarding. Owing to their size, wind turbines are assessed as a vertical obstruction, as would any other tall structure, such as a large building or mast. This is of particular relevance in the vicinity of aerodromes (see Section 3.3) and within the UK Low Flying System (UKLFS) (see Section 3.4).

3.2.3.2 Technical Site Safeguarding. Any tall structure can potentially interfere with certain electromagnetic transmissions;

10 The formal term Safeguarding in association with wind turbines is only used for civil purposes; military agencies do not have an equivalent formal term but follow effectively the same procedures. For simplicity, the term safeguarding in this document is used to refer to both civil and military processes.
11 Safeguarding Aerodromes, Technical Sites and Explosive Storage Areas: Town & Country Planning (Aerodromes and Technical Sites) Direction 1992 (England & Wales) and Scottish Development Department Circular 16/1982, Safeguarding Aerodromes, Technical Sites and Explosive Storage Areas. These documents are scheduled to be replaced in September 2002 by the Department for Transport document Safeguarding Aerodromes, Technical Sites and Military Explosives Storage Areas: the Town and Country Planning (Safeguarded Aerodromes, Technical Sites and Military Explosives Storage Areas) Direction 2001.
12 This will occur when Direction 2001 comes into effect; see footnote 11.
13 Military aerodromes may only be contacted through MOD and must under no circumstances be approached directly.



any aerodrome in the UK may wish to safeguard itself and therefore be consulted. In addition, certain military aerodromes are safeguarded, on the basis of their strategic importance, together with a large number of military technical sites (see Annex C for lists of safeguarded aerodromes).

3.3 VERTICAL OBSTRUCTIONS AND AERODROMES

3.3.1 Safeguarding Maps for Aerodromes

3.3.1.1 Each safeguarded aerodrome is issued with two safeguarding maps centred on the aerodrome. One map extends out to a radius of 15 km and is colour-coded to indicate the height above ground level for which any proposed developments must be consulted. These coloured areas are based loosely on a series of protected "surfaces" around the aerodrome[15]. The second map extends out to a radius of 30 km: the LPA is required to consult the relevant aerodrome regarding any wind turbine proposal within this radius. Figure 3-1 shows an example of an aerodrome safeguarding map.

3.3.1.2 It should be noted that this does not necessarily mean that an aerodrome will object to a proposal. Each proposal will be assessed against the relevant protected surface. Only in the event of a penetration of this surface will the aerodrome raise an objection. However, if a developer has consulted the aerodrome operator at the voluntary pre-planning consultation stage, such an issue should have already been resolved.

3.3.1.3 It is not easy to summarise the ideal positioning of wind turbines in relation to a generic 'airfield'. All aerodromes vary due to their size, their equipment fit and the nature of their operations, among other factors. As ever, early dialogue is the best way to resolve any conflicts.

3.3.1.4 Technical site safeguarding, including aerodromes, is covered in Section 3.5.

however, interactions are particularly complex in the case of rotating turbine blades. The impact on technical sites is assessed when a wind turbine or farm is proposed near an aerodrome that has a co-located technical site (for example, aerodrome approach radar); a stand-alone civil technical site (for example, a National Air Traffic Services (NATS) en route radar); or on a stand-alone military technical site (for example, an air defence radar). This is described further in Section 3.5.

3.2.3.3 Certain civil sites may contain a NATS en route radar (a technical site) and an aerodrome. If this is the case, separate safeguarding maps will exist; both must be consulted and individual consultations must take place with both NATS En-Route Limited[14] and the aerodrome operator. Where a military technical site is co-located with a military aerodrome that is subject to safeguarding, a single map exists.

3.2.3.4 There are currently 40 civil aerodromes and approximately 150 civil technical sites in the UK that are officially safeguarded as per the directions. However,

[14] National Air Traffic Services Ltd is the parent company for a number of subsidiary operating and service provision companies, including NATS En Route Ltd which is responsible for en-route radars.
[15] These are described and detailed in Civil Aviation Publication (CAP) 168 (Licensing of Aerodromes).

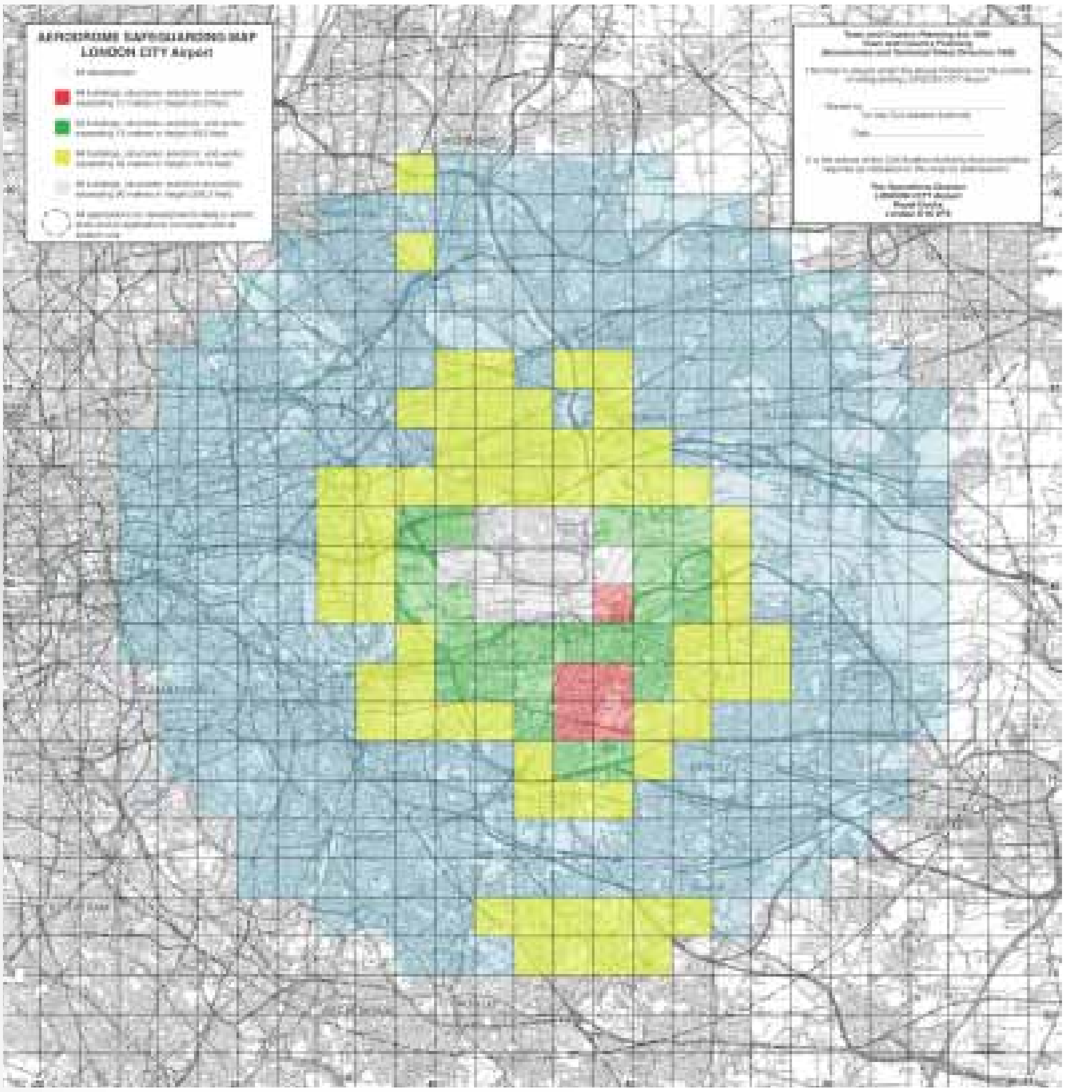


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Figure 3-1.
Example Aerodrome Safeguarding Map (Illustrative only)

3.4 VERTICAL OBSTRUCTIONS AND LOW FLYING

3.4.1 Introduction

3.4.1.1 In addition to the hazard posed to aircraft in approaching or departing from an airfield, wind turbines can also pose a potential danger to aircraft flying at low level for any other reason. In the UK, this is largely (although not entirely) restricted to military aircraft conducting low flying training.

3.4.2 The Need for Low Flying

3.4.2.1 Flying at medium or high level makes UK aircraft and their crews more vulnerable to enemy defences, thus necessitating low level flying and low level flying training. Helicopters also use very low altitudes to muffle noise and conceal their approach. For this reason helicopters can be permitted to train as low as ground level. Transport aircraft will use low level airspace either for concealment or, during humanitarian operations, when carrying out low-level airdrops. Flying must be second nature to aircrew and cannot be learned at short notice, hence the requirement for progressive and continuous low flying training.

3.4.3 The UK Low Flying System

3.4.3.1 The Low Flying System (LFS) employed in the UK is unique. It covers the whole of the open airspace of the UK and surrounding oversea areas up to 3 nautical miles offshore, from the surface to 2000 feet above ground or sea level. By contrast, in Germany aircraft may generally not fly below 1000 feet, well above the top of even the largest wind turbine[16]. Certain areas of the UK (airports, certain industrial sites etc) are excluded from the LFS for safety reasons and low flying over larger centres of population and some conservation areas is also avoided[17].

Picture credit: © BWEA

3.4.3.2 The majority of military fixed-wing aircraft are defined as low flying when operating within the LFS at less than 2000 feet minimum separation distance (msd) from any part of the ground, the sea, or any object[18]. Helicopters are defined as low flying when operating at less than 500 feet msd and may operate down to ground level.

3.4.3.3 The normal lower limit for low flying by fixed wing aircraft is 250 feet, which is within the area swept by a turbine with a rotor diameter of 80m. Some operational low flying training is permitted during the day between 100 and 250 feet in Tactical Training Areas (see below). A diagram illustrating low flying limits, scaled against a typical wind turbine, is at Figure 3-2.

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16 The air forces of other nations face the same need to hone their flying skills. In the case of Germany, much of this is done in Canada at considerable expense.

17 Further information on low flying can be found in General Aviation Safety Sense Leaflet 18A Military Low Flying published by the CAA.

18 Not including other aircraft in the same formation.

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3.4.4 Low Flying Limits and Wind Turbines

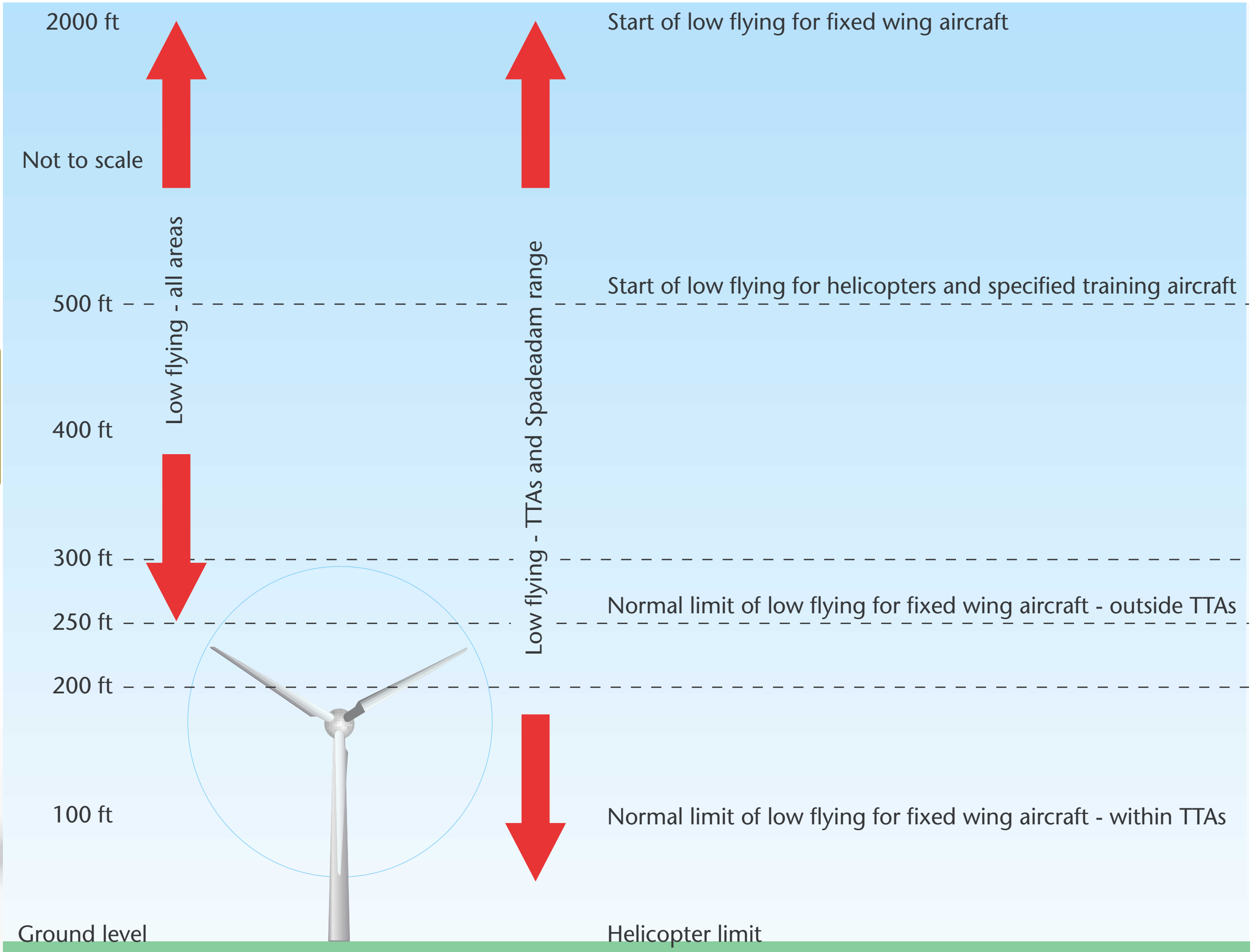

Figure 3-2. Comparison of Low Flying Limits with 80m Rotor Diameter Turbine

3.4.5 Tactical Training Areas

3.4.5.1 Fast jet aircraft may fly down to 100ft msd (150ft msd for Hercules transport aircraft) when undertaking Operational Low Flying (OLF) training in three Tactical Training Areas (TTAs) in the UK. The TTAs are located in northern Scotland, the Borders area of northern England/southern Scotland and in central Wales (see Figure 3-3). While some OLF training takes place and is practised outside the UK (largely in Canada and the USA) a proportion must be undertaken in the UK and this requirement will continue. When the areas are not being used for OLF, routine low flying is permitted down to the heights described previously.

3.4.5.2 There is no blanket ban on wind farm developments within TTAs (there are already developments in all three areas) but because of the height at which OLF takes place, proposals are subject to careful scrutiny. A proposal on the edge of a TTA has a greater chance of obtaining approval. Very large developments, the proliferation of developments, or developments at certain locations within the TTA may, for reasons of safety, result in a significant curtailment or displacement of training that would lead to the lodging of an objection by MOD.

3.4.6 Spadeadam Range

3.4.6.1 RAF Spadeadam is home to the Electronic Warfare Tactics Range (EWTR), a facility offering a range and quality of electronic warfare training unique in Europe. High energy and high speed tactical radar avoidance training involving simulated anti-aircraft missile firings, requiring the ability to undertake sudden evasive manoeuvres, take place down to 100ft msd in the training area associated with use of the Range. In addition, test and evaluation flying, specialised night flying and some OLF take place within the airspace, the majority of which falls within TTA No 20T (see Figure 3-3). Other NATO countries use the facilities at Spadeadam on a repayment basis.

3.4.6.2 The Secretary of State for Trade and Industry has previously denied permission for the construction of a wind farm within the range, reflecting the importance and unique nature of training that occurs there. There is no blanket ban on wind farms; each proposal will be considered on its own merits. However, it is likely that the MOD will object to a proposal to site a wind farm within the range. Developers considering locating a wind farm within the Spadeadam range are advised to enter into dialogue with the MOD, through Defence Estates, at the earliest opportunity.

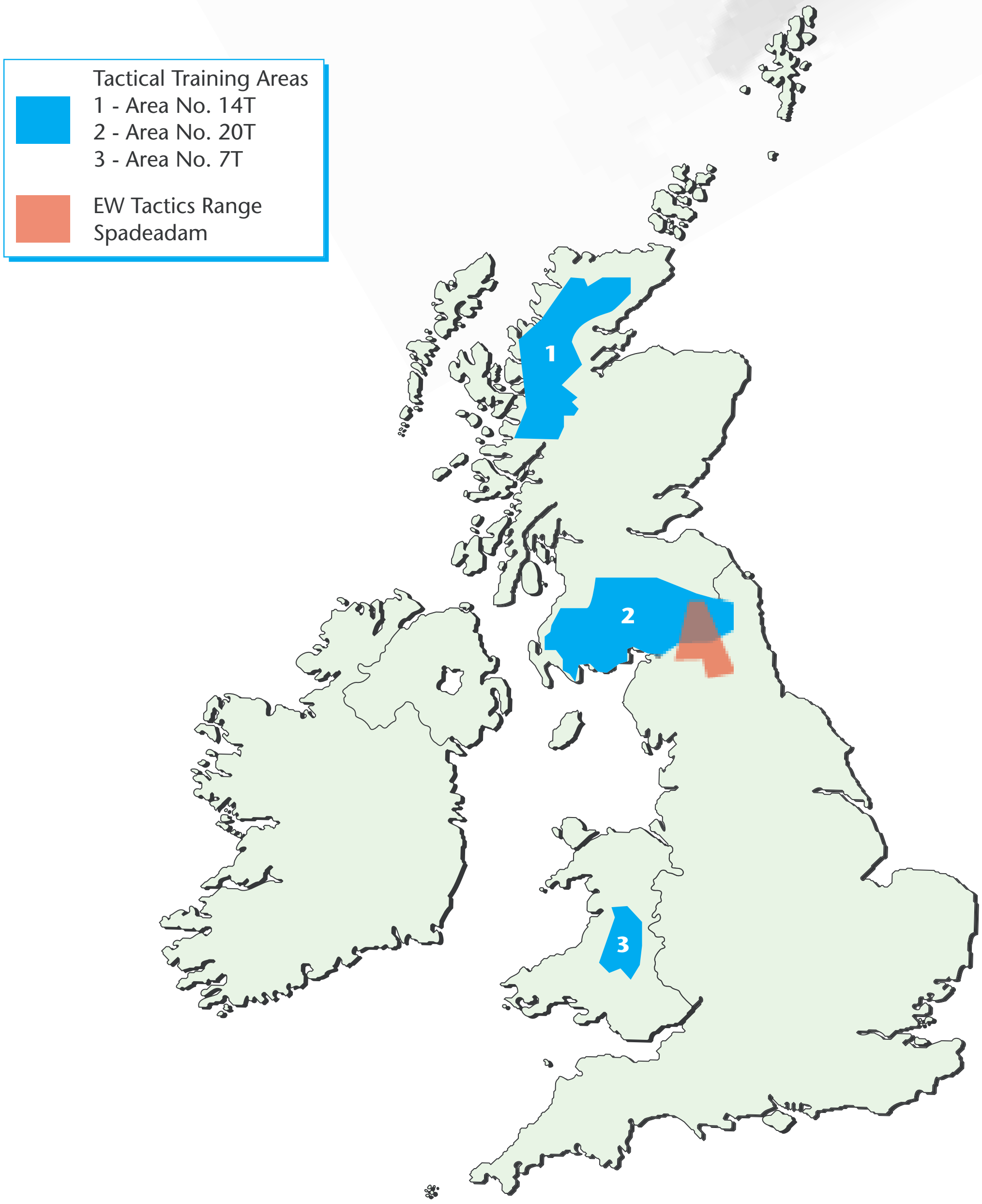

Figure 3-3. Tactical Training Areas and Spadeadam Range (Indicative only)

Picture credit: © GE Wind Energy

3.4.7 Low Flying Offshore

3.4.7.1 The LFS *per se* extends only 3 nautical miles out to sea; however, both military and civilian aircraft routinely fly down to low levels over the sea, including military fast jets conducting training, surveillance aircraft engaged in fisheries protection, or helicopters conducting search and rescue operations or en route to oilfields. Nevertheless, there is currently no formal low flying system over the sea which is likely affect wind turbine developments.

3.4.7.2 Offshore wind farms, especially developments of considerable size, may affect operations such as those described above. However, the potential for conflict is likely to be resolved by effective charting and appropriate lighting arrangements so that aviators can avoid the development[19].

3.4.7.3 Developers planning wind farms offshore are advised to follow the usual pre-planning consultation procedures (as described in Section 4.1) and address any potential conflicts with aviation stakeholders as soon as possible.

3.4.8 Conclusions

3.4.8.1 It is evident from existing wind farms that low flying aircraft and wind turbines can co-exist and new developments should not in principle give rise to objections on the ground that they represent a hazard to low flying aircraft. MOD will review all applications on a case by case basis, paying particular attention to cumulative effects. However, special considerations apply in TTAs and the Spadeadam Range. Developers who are considering siting turbines in these locations are strongly advised to discuss their plans with MOD, through Defence Estates, at the earliest opportunity.

3.5 SAFEGUARDING OF TECHNICAL SITES AND AERODROMES (INCLUDING RADAR)

3.5.1 General

3.5.1.1 The technical sites requiring safeguarding fall into three basic categories:

a) Sites engaged in or supporting airspace and air traffic management (both civil and military), including radars and navigation aids.
b) Sites engaged in or supporting the air defence of the UK, including radars.
c) Meteorological (Met) Office weather radars.

3.5.1.2 Consultation on safeguarding requirements for civil technical sites is required within a 30km radius centred on the aerodrome or technical site[20]. This is to reflect the fact that turbines can have effects on the electromagnetic spectrum in addition to their physical presence. This 30km radius is not a simple 'yes/no' line, however, but a working figure to signal that consultation is necessary. Depending upon the nature of the technical site in question, plus other factors such as terrain, proposals within 30km may well receive no objection whilst those a considerable distance from the site may sometimes prove more problematic. Again, cumulative effects will be taken into account.

3.5.1.3 The safeguarding of military technical sites will be conducted on a case by case basis, taking into account the individual circumstances of the application.

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19 Offshore wind farms must be marked with suitable Aircraft Warning Lights as described in 'Lighting of Wind Turbine Generators in United Kingdom Territorial Waters' and in consultation with the Directorate of Airspace Policy within the Civil Aviation Authority.

20 It should be noted that this figure applies to civil sites only. Separate arrangements apply to military sites, including radars.

This is another reason why it is advantageous for developers to enter consultation with aviation stakeholders at the earliest opportunity to improve the chances of resolving any issues raised.

3.5.2 Air Traffic Management Considerations

3.5.2.1 General

3.5.2.1.1 The potential impacts of wind farms on air traffic management include the cumulative effects on the UK airspace management and surveillance infrastructure and affect the following systems:

a) Primary Radar.
b) Secondary Surveillance Radar (SSR).
c) Microwave links associated with a) and b).
d) Navigation Aids (Navaids)[21].

Background information on how these systems work and are used, together with the effects of wind turbines and mitigation techniques, is at Annex D. The remainder of this section concentrates on how the systems above can be affected by wind turbines and identifies, where known, mitigating measures that can be taken from a developer's perspective. However, many of the precise effects of wind turbines on these systems are not yet fully understood[22] and the guidance issued in this section must therefore be considered as interim, based on the best knowledge currently available.

3.5.2.1.2 It should be borne in mind that it is not the effect that wind turbines have on technical systems in themselves that is important but the end effect that is caused to flight safety-critical air traffic management operations. Hence, if pragmatic solutions can be found (for example, by replacing the service provided by an affected SSR with a suitably located replacement SSR), these may offer a way forward. On the other hand, if an aerodrome approach radar must be situated in one particular location in order to ensure safety of departing and arriving aircraft, any proposal for wind turbines that will cause detrimental effects to the radar is unlikely to be acceptable. The stakeholders identified in Section 4 will be able to advise developers on such issues at a very early stage.

3.5.2.2 Primary Radar

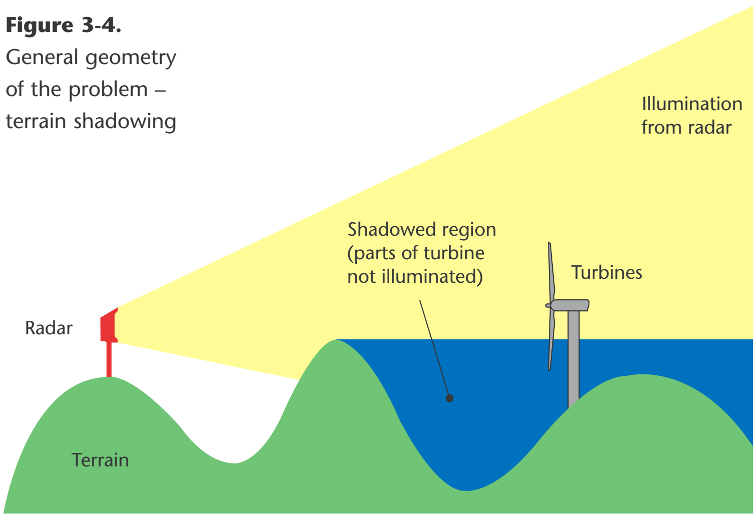
Picture credit: © JANES defence publications

Watchman (normal ATC) radar

3.5.2.2.1 There are two basic effects that can be caused to air traffic management radars by wind turbines: the presentation of false radar responses (known as returns), and the masking (shadowing) of genuine aircraft returns. Each causes different problems to the air traffic management systems, and air traffic controllers in particular, but both may be amenable to mitigation in similar ways.

3.5.2.2.2 Both the towers and the blades of wind turbines may be detected if they are in the line of sight of the radar[23]. This will cause the presentation of returns to the

Figure 3-4. General geometry of the problem – terrain shadowing



21 The effects of wind turbines on High Intensity Radio Transmission Areas (HIRTAs) have also been considered but are thought to be so minimal as not to be a safety issue and thus are not discussed here.

22 Studies into both the effects of wind turbines and possible technical mitigating measures are currently being undertaken. See Annex D, Section 5, for details.

23 The line of sight for a radar is usually equal to or greater than the optical line of sight. The radar line of sight is a complex function of the radar, the terrain and local weather conditions. A good approximation is that the radar line of sight is 33% greater than the optical line of sight. However, over the sea the difference can be much greater. Consultation with stakeholders can identify the actual line of sight for any particular radar.

radar users that, in principle, are the same as the returns of actual aircraft. It is normally possible to differentiate the towers from aircraft because they are stationary and, in this respect, they are no different from other objects that cause returns, such as buildings and radio masts.

3.5.2.2.3 The movement of the blades, however, makes differentiation more difficult. Each blade will only be seen when it is in a particular range of positions (say, for example, when any part of it is more than 120 feet above the ground) and the blades of a single turbine will always appear in the same place. However, when a number of turbines are present in a farm, the combination of blades from different turbines can give the appearance of a moving object. This may cause air traffic controllers to perceive this as an unidentified aircraft and to take action to ensure that other aircraft avoid it (which may, in itself, cause other safety problems).

3.5.2.2.4 The masking of real aircraft can happen in two ways: by reflecting or deflecting the radar such that aircraft flying in the “shadow” of the turbines are not detected, and by presenting such a large number of returns from the towers and the blades that the returns from actual aircraft are lost in the “clutter”. While shadowing will only affect returns from aircraft flying at low altitudes and will thus normally only have a small effect, the effects of radar clutter will have an impact on all aircraft flying at all altitudes over the area affected and is more critical. The effects of clutter on flight safety are always potentially extremely serious. In practice, the effects of clutter will impair the radars’ detection performance in certain sectors and it may be insidious in nature.

3.5.2.3 Mitigation Measures

3.5.2.3.1 The simplest mitigation measure that developers can take is to ensure that the wind farm is situated in an area where only limited aircraft traffic may be expected. For example, siting a wind farm 5 miles in direct line from the end of an airfield runway will almost certainly be unacceptable, whereas there may be other areas off to the side of the direction of the runways where the effects of turbines at similar distances may be tolerable.

3.5.2.3.2 As well as airfields, the airways structure must also be taken into account: locating a wind farm below the route of an airway may be acceptable provided that it is not in the line of sight of any air traffic radar and therefore cannot be the cause of clutter. Early consultation with the appropriate stakeholders can help to identify locations where effects may be unacceptable and, conversely, to identify locations where no intolerable effects are likely to be caused. The technical and procedural measures which the air traffic management system can take to mitigate the effects of wind turbines are described in Annex D.

3.5.2.4 Secondary Surveillance Radar

3.5.2.4.1 SSR relies on co-operative transmissions from aircraft carrying equipment known as transponders. For this reason, confusion between returns from aircraft and from other objects is highly unlikely and many of the effects caused to normal radars will not occur. However, reflection of transmissions could be caused by wind turbines in some circumstances. Both events could cause misidentification or mislocation of aircraft, which can have potential flight safety implications.

3.5.2.4.2 Although it is not yet possible to state the minimum safe distance from such installations to ensure that wind turbines will have no effect, developers should avoid planning wind farms in close proximity to ground-based SSR transmitters wherever possible. Early consultation with stakeholders is strongly recommended.

3.5.2.5 Navaids

3.5.2.5.1 Navaids could suffer from similar reflection and deflection effects as SSR, with similar flight safety implications. Such effects could have an effect on the safe operation of Navaids and, although it is not yet possible to state the minimum safe distance from such installations to ensure that wind turbines will have no effect, developers should avoid planning wind farms in close proximity to Navaids wherever possible. Again, early consultation is strongly recommended.

3.5.3 Air Defence Considerations

3.5.3.1 Introduction

3.5.3.1.1 The main effects that wind turbines can have on air defence operations are upon the ability of the surveillance and command and control systems to detect and identify aircraft approaching, over-flying or leaving the UK and thence to produce a Recognised Air Picture (RAP). The system for achieving this task is known as the Air Surveillance and Control System (ASACS); the ASACS has three main elements:

a) Ground-based radars.
b) Airborne radars.
c) Command and Control systems.

3.5.3.1.2 Background information on how these systems work and are used (and how this differs from air traffic management) can be found at Annex D. As with air traffic management, an important point is that it is not the effect that wind turbines have on technical systems per se that is critical: it is the end effect on national security. It should be borne in mind also that the enhanced requirement for air surveillance and defence that has arisen since the terrorist attacks on the USA may lead to a greater need to protect the overall capability of the air defence system from interference than was previously the case.

3.5.3.1.3 The remainder of this section concentrates on how elements of the ASACS can be affected by wind turbines and identifies, where known, mitigating measures that can be taken from a developer's perspective.

3.5.3.2 Radars

3.5.3.2.1 Ground-Based Radars. The UK ASACS relies primarily for its information upon a network of ground-based air defence radars, augmented (under an agreement with NATS) by feeds from a number of civil air traffic control radars. At present, there are only 13 military ground-based air defence radar sites (their locations are shown in Annex C) and, consequently, much of the UK is unaffected. Apart from the radars belonging to the RAF's mobile air control unit (No 1 Air Control Centre), which contributes to the RAP when it is not deployed on overseas operations, all current ground-based sensors are static.

Picture credit: © JANES defence publications

Air defence radar

3.5.3.2.2 The performance of ground-based radars is likely to be affected by any wind turbine sited in their field of view. Air defence radars are typically more complex and capable than air traffic control radars and may be able to process out electronically some of the effects that might be caused by wind turbines. Research into this topic is underway but is not yet complete.

3.5.3.2.3 Implications. At present, MOD policy is to not accept any application within 74km of an air defence radar site unless developers can prove that it will have no impact on the radar concerned. Where the turbines are not in the field of view of the radar due to local topography, this will be straightforward to achieve[24]. Where the turbines are in the field of view, however, it will be more difficult. Nevertheless, MOD's position is, in part, an emergency reaction to the events of 11 September 2001 and it is currently being reviewed. It is hoped that this blanket constraint may be reduced in the comparatively near future, especially if effective technical mitigation measures are identified by current research.

3.5.3.2.4 Airborne Radars. The UK currently operates a fleet of E-3D Sentry airborne early warning aircraft which are able to pass radar information for use in

[24] For example, the radar at Portreath (near Newquay) in Cornwall is on the North coast. The Cornish landmass would prevent the radar seeing any turbines anywhere off the south coast, regardless of the distance.

compilation of the RAP. By their very nature, the E-3D's radar and other sensors are much less likely to be significantly affected by the presence of wind turbines. In the future, the RAF will bring the Airborne Stand-off Radar (ASTOR) airborne system into service, which will possess a sophisticated suite of sensors, primarily for land surveillance. At present, it is not possible to determine the potential effects a wind turbine could have on this system, nor how these might affect defence considerations. Other airborne radars, including those in fighter aircraft, can also see wind turbines but there is currently no firm evidence of their effects on either operational performance or flight safety[25].

3.5.3.3 Command and Control Systems

3.5.3.3.1 The radar sensors around the UK produce the raw data for compilation of the RAP; it is the role of the staff within the Command and Control system actually to produce the RAP and to direct responses to any activity which may warrant action. The equipment within the UK ASACS Command and Control centres consists of, inter alia, radar displays, tactical data link consoles and communications systems. Any detrimental effects produced by the presence of wind turbines upon the ASACS sensors will be highly likely to have an impact at the Command and Control centres. It is at this level, therefore, that the effects induced by wind turbines become critical. Developers (and others) conducting studies into the effects of wind turbines on air defence must therefore also consider the effects on the Command and Control system; simply considering the radar in isolation will not adequately address the issue. Indeed, it may be that some effects that the radar itself is unable to compensate for can be adequately handled by the processing elements of the Command and Control system.

3.5.3.3.2 In addition to production of the RAP, certain staff within the ASACS are responsible for the control of (primarily air defence) aircraft. The considerations for control of these aircraft are similar to those for air traffic management, as described in Section 3.5.2.

3.5.3.4 Mitigation Measures

3.5.3.4.1 Developers planning to locate a wind farm within the vicinity of ASACS radar installations are strongly advised to contact MOD as early as possible to discuss the implications of their proposals on air defence operations, including the Command and Control system, and to explore possibilities for mitigating the effects of turbines on the system. It is likely that both the impact of the turbines and the results of mitigation techniques will vary depending on the particular radar in question and the location and characteristics of the wind farm.

3.5.3.4.2 As the effects on air defence radar (and radar in general) are highly complex and are not yet completely understood developers are strongly advised to seek expert advice to inform their discussions with MOD. Early indications from current research (see Annex D for further information on current studies) are that a variety of mitigation techniques may be of use either individually or in combination. Possible mitigation measures include moving the location of the wind farm or adjusting the configuration of the turbines. For larger wind farms, as a last resort, it might be possible to overcome MOD objections by providing an alternative location for the affected radar or contributing to investment in additional or improved radar systems.

3.5.4 Met Office Radar Considerations

3.5.4.1 There are 12 weather radar stations in the UK (1 in Northern Ireland, 1 in Wales, 3 in Scotland and 7 in England) and they are used for monitoring weather conditions to assist in forecasting. A map of Met Office radar sites is at Figure 3-4. In simple terms, two types of radar are used: weather radar and wind profiling radar.

3.5.4.2 Weather radar is designed to look at a thin layer of the atmosphere, as close to the ground as possible, for accurate forecasting. For this reason, sites are situated on high ground and look out at a narrow band of airspace between 0 and 1°

[25] This situation may be clarified as experience of operating in the presence of wind farms increases.

Picture credit: © The Met Office

Typical Met Office radar

of elevation. Subsequently, there is potential for interference from wind turbines.

3.5.4.3 The easiest way to avoid disruption to weather radar is to ensure that the maximum height of the turbines (above mean sea level) is below the height of the radar. This will ensure that there is no interference. In addition, if terrain features lying between the turbine and the radar mask the turbines they will have no impact on the operation of the radar. Put simply, weather radar may still be able to operate with a few wind turbines within its line of sight (LOS), dependent upon range and other factors.

3.5.4.4 Accurate weather forecasting and reporting is highly important to aviation safety. One of the most important effects for aircraft is "wind shear", where the winds at different altitudes may vary greatly in both direction and speed. Wind profiling radars are susceptible to spurious reflections and, for this reason, developers should avoid planning wind farms in close proximity (currently assessed as 10 kilometres or less) to Met Office wind profiling radars.

3.5.4.5 As with all other issues, the key is to engage in dialogue with the Met Office (initially via Defence Estates, using the pre-planning process described in Section 4.1) as early as possible if it is anticipated that there may be a conflict.

Figure 3-4. Met Office Radar Sites (Indicative only)

3.6 AVIATION INTERESTS - CONCLUSION

3.6.1 Both civil and military aviation communities have legitimate interests that must be protected; this includes protection against the adverse effects of wind turbines. However, there is scope for flexibility throughout the process of considering wind farm applications. The effects of wind turbines on the physical element of the air domain (as obstructions) are well understood and the procedures for handling them are relatively straightforward. Certainly, a flexible approach to siting of turbines can be expected to pay dividends. Developers must, however, bear in mind that there are some locations in which the presence of turbines is unlikely ever to be tolerated.

3.6.2 The effects of wind turbines on electronic systems and the measures that can be taken to overcome these effects are less clear-cut. The siting of wind turbines will, potentially, affect the radar sensors belonging to both civil and military users in much the same ways, although the operational impact of these effects will probably not be the same. As further research is conducted and experience with existing (and currently approved) wind farms grows, all stakeholders will be able to determine more precisely what may be acceptable and what will not. No matter what, however, this is an area in which early dialogue with the relevant stakeholders is particularly recommended.

4 The Planning and Consultation Processes

4.1 THE PRE-PLANNING CONSULTATION PROCESS

4.1.1 It has been emphasised throughout the document that early consultation with aviation stakeholders is of vital importance to address any potential problems as soon in the development process as possible and to ensure that any objections are resolved by the time a development reaches the formal planning stage. To assist the process a consultation proforma has been drawn up and agreed between the BWEA and key aviation stakeholders (the MOD, CAA and NATS). A blank copy is enclosed at Annex E, along with an example of how the proforma should ideally be completed. The use of this process is voluntary, but developers who do not use it will likely be directed to the consultation proforma by one of the aviation stakeholders at a later stage of development, with subsequent delays.

4.1.2 It is recognised that all the information requested in the proforma might not be available in the early stages of planning a development; nevertheless, developers are urged to supply as much detail as possible and to double-check the information before submission. Of particular importance is the positional information supplied, preferably in both latitude and longitude and National Grid Reference (accurate to within 10 metres, where possible)[26] and maximum height above ground. Where the exact location of a wind farm is not yet finalised, boundary points for an area within which the farm is planned to be located are sufficient for initial analysis. Generally, it will be preferable to give stakeholders details of the largest case scenario as it allows for the consideration of smaller alternatives in the event of problems.

4.1.3 Developers are reminded that, following the submission of the form, responses from MOD, CAA, NATS and Aerodromes are valid for a period of 2 years, following which the form must be

resubmitted if the development has not gone ahead. In this case, it is advised that a proposal be resubmitted using a fresh copy of the proforma.

4.1.4 When submitted, the proforma is distributed by the MOD Defence Estates (DE) and the CAA Directorate of Airspace Policy (DAP) to relevant stakeholders, who will study the submission and assess the proposal's impact, if any, on their area of interest. The stakeholders, their concerns, and the mechanics of the process itself are described in the following paragraphs.

4.1.5 Should any of the MOD stakeholders have any concerns regarding the potential impact of a proposal upon their systems or operations, which they themselves cannot resolve, it is likely that they will, through Defence Estates, raise an initial objection. This by no means represents the end of the process, however. In many cases objections will be withdrawn if the developer provides more information and/or satisfactory discussions between the objector and the developer are held.

4.1.6 The Stakeholders

4.1.6.1 The primary aviation stakeholders, together with their main areas of interest, are shown in Table 2. Contact details for most of these are given in Annex H.

[26] For offshore developments, only latitude and longitude are required.

4

Table 2. Principal Stakeholders and their Areas of Interest

Department	Primary Area of Interest
Defence Estates, MOD	Facilitator and focal point for other MOD stakeholders
Property Services Department, Meteorological Office	Met Office weather radar network
MOD Defence Communications Systems Agency, Configuration Management Branch	Radar and communications links
Royal Air Force, Headquarters Strike Command, Operations Support (Air Traffic Control)	Military aerodromes
Royal Air Force, Headquarters 2 Group, Air Surveillance and Control Systems	Air defence radars and control systems
Royal Air Force, London Terminal Control Centre (Military) - Low Flying	UK Low Flying System (LFS), including Tactical Training Areas (TTAs)
Directorate of Flying, MOD (DPA)	Civil sites with defence contracts
CAA Directorate of Airspace Policy (DAP)	UK Airspace Policy, spectrum management policy and the impact on the communications, navigation and surveillance (CNS) infrastructure. Other Civil Aviation interests eg unlicensed airfields
CAA Safety Regulation Group, Air Traffic Services Standards Department (ATSSD); Aerodrome Standards Department	Civil licensed aerodromes
NATS En-Route Limited (NERL)	NATS-owned and operated en-route CNS facilities
Airport operators	Civil licensed aerodromes

4.1.7 MOD Policy - General

4.1.7.1 The MOD has issued the following policy statement:

"The MOD is well aware of and fully supports the Government's renewable energy policies and targets. We can and do adapt military training to take account of many interests, including of those seeking to develop wind farms in the UK. The MOD's low flying, air defence and communications experts must examine the potential impact of proposals to site wind farms on the safety of aircrew and the public, and on essential training and operations. To this end, each wind farm proposal seen by MOD is considered on its merits."[27]

4.1.7.2 As the statement makes clear, every proposal is individually assessed. For farms in the LFS in general, the MOD is unlikely to object unless a proposal is in a particularly busy or congested part of the LFS and would cause an unworkable hazard to aircraft in the vicinity. Proposals within TTAs present more danger to aircraft due to the lower altitudes at which fast jet aircraft must fly. Nevertheless, a wind farm on the edge of a TTA may well be approved if it presents little danger to training within the TTA, and several have been developed in the past.

4.1.8 Defence Estates

4.1.8.1 Defence Estates acts as the facilitator and focal point for other MOD stakeholders. It will therefore have an interest in all aspects of proposals to ensure that all MOD concerns (as described against the individual stakeholders) are addressed.

4.1.9 Defence Communications Systems Agency

4.1.9.1 The Defence Communications Systems Agency (DCSA) examines proposed developments to assess their impact on all military technical systems, such as microwave links and radar. It also, in turn, advises other defence interests of potential conflicts. Often, simple steps can be taken

[27] The Pattern of Military Low Flying Across the United Kingdom 2001/02, Ministry of Defence, Directorate of Air Staff.

to resolve objections raised by DCSA (for example, interference from wind turbines with microwave links supporting Command and Control of air defence operations can be resolved by relocating the relevant turbines by around 500m).

4.1.9.2 Owing to the number and variety of systems for which the agency is responsible, it is not possible to provide a list or map of DCSA sites of interest. Developers should await DCSA's initial response, via Defence Estates, and thereafter engage in dialogue at the earliest opportunity, as many of the Agency's objections can be easily resolved.

4.1.10 Headquarters Strike Command, RAF

4.1.10.1 The Headquarters Strike Command (HQSTC) Air Traffic Control (ATC) branch is responsible for the safe operation of military aerodromes in the UK, including Army Air Corps airfields and Royal Naval Air Stations. Its concerns have been discussed in sections 3.1 - 3.2. As these sections describe, in addition to the physical safeguarding of vertical obstructions, the effects of wind turbines on technical sites are also considered.

4.1.10.2 It should be noted that naval and other maritime issues are not within the remit of these guidelines. However, as stated above, all naval aviation and airfields are represented by Royal Air Force Strike Command, who will also assess the impact on army aviation and airspace above and around military firing ranges.

4.1.10.3 Military sites are distributed throughout the UK and HQSTC will consequently have an interest in all proposed developments, regardless of location.

4.1.11 Headquarters No. 2 Group, RAF

4.1.11.1 Headquarters No. 2 Group (HQ 2 Gp) Air Surveillance and Control Systems (ASACS) branch is concerned with the impact of wind turbines on the ASACS and, primarily, the effects on long-range ground-based air surveillance. Most of the radars concerned are currently located on the east coast of the UK[28]; the associated Command and Control centres are distributed around the UK but their position is not germane to the effects. With the change in the security climate following the terrorist attacks of 11 September 2001, the importance of the air picture provided by the system has increased dramatically.

4.1.11.2 Traditionally, the primary role of the ASACS has been to detect aircraft approaching the UK from overseas. However, equal, if not more, importance is now given to monitoring the airspace overland in the UK, to detect, track and respond to air traffic which is giving concern (for example, hijacked aircraft). In addition, the significance of the low-level cover provided by the ASACS has risen

[28] They were originally sited in this orientation due to Cold War concerns. However, the locations were also found to be generally the most suitable for routine air policing requirements and the support of training.

markedly. Consequently, and as described previously, the MOD will be extremely interested in any proposed wind turbine development that has an impact on the ASACS system (both radars and Command and Control), whether the wind farm is on- or offshore.

4.1.11.3 A map of UK ASACS radar sites is in Annex C (Figure C-2).

4.1.12 HQ Strike Command Detachment - London Terminal Control Centre

4.1.12.1 The London Terminal Control Centre (LTCC) is a joint military/civil Air Traffic Control Centre (ATCC) responsible for the safety of flying. The Low Flying (LF) section is a detachment of HQ Strike Command which lodges at LTCC and is responsible for protecting the interests of the UK Low Flying System (LFS), which was described in Section 3.4. Clearly, where aircraft are likely to fly at very low levels, any physical obstruction, such as a wind turbine, is a hazard to flight safety and for this reason, the LF section examines every wind energy proposal to assess its impact on low flying training.

4.1.13 Directorate of Flying, MOD

4.1.13.1 The Directorate of Flying (D Flying) is an office within the Defence Procurement Agency (DPA) concerned with civil sites with MOD contracts, and the impacts of wind turbines upon them. One example of such a site would be BAe SYSTEMS Warton, in Lancashire, where the Eurofighter project is based. Owing to the wide variety of sites and systems that fall within this remit, it is not possible to list the areas of interest here.

4.1.14 Civil Aviation Authority, Directorate of Airspace Policy

4.1.14.1 The Directorate of Airspace Policy, CAA, is responsible for all UK airspace policy and the requirements that it places on its supporting CNS Infrastructure. As such, it acts as the focal point for wind turbine activity, ensuring that all civil aviation interests are considered. In addition, through the formal Radio Site Clearance process, it handles the pre-planning enquiries and subsequent notification to aerodrome operators and, where appropriate service providers. Furthermore, DAP addresses the implications for CNS from an overall UK airspace perspective.

4.1.15 Civil Aviation Authority, Safety Regulation Group

4.1.15.1 The Safety Regulation Group (SRG) of the CAA ensures that aerodromes are safe to use and that air traffic services and general aviation activities meet required safety standards. Therefore, the construction of wind turbines in the vicinity of a licensed aerodrome is of interest to the SRG and there are a number of criteria that the Group use to assess proposals. Chief among these are the guidance and requirements detailed in Civil Air Publication (CAP) 168 and 670.

4.1.15.2 If the proposed development is within 17km of an officially safeguarded aerodrome, its impact on the airfield's protected surfaces is assessed, as described under the safeguarding process; this addresses the issue of the turbine(s) as a physical obstruction. The Air Traffic Services Standards Department (ATSSD) within the SRG also assesses the impact of the proposal on any airfield technical facilities: if the development is within 30km of an airfield from where air traffic services (ATS) are provided (or 34km if an Instrument Landing System (ILS) may be affected), then the aerodrome should consider the impact. In some cases, NATS or another ATS Service Provider is contracted to provide the ATS; therefore, they will be asked to provide a technical safeguarding assessment. However, in all cases the aerodrome licensee or their nominated representative will be the point of contact for any liaison on physical and technical safeguarding issues. The onus is then on the aerodrome licensee and the developer to liaise in order to address any potential impacts.

4.1.15.3 A list and map of UK safeguarded civil aerodromes is in Annex C.

4.1.16 NATS En-Route Limited

4.1.16.1 NATS En-Route Limited (NERL) provides 'en route' air traffic control services to aircraft flying in UK airspace and over the northeastern Atlantic Ocean. NERL therefore has an interest in safeguarding CNS facilities located both at certain civil aerodromes and at stand-alone technical sites.

4.1.16.2 The criteria for consultation on a wind turbine proposal is whether or not it is within 30km of a facility; however, turbines farther away than 30km may be a factor if they are in the line of sight (LOS) of the facility in question. If the development is not within LOS of the facility, regardless of range (for example, shielded by terrain), then NERL is unlikely to object to the proposal. If the proposal is within LOS of a technical facility, then CAP 670 provides guidance material that can be applied to assess interference of physical obstructions against various types of technical equipment[29]. It is unlikely that turbines that infringe these criteria will be acceptable.

4.1.16.3 In summary, to avoid conflict with NERL facilities, wind turbines should ideally: not be within 30km of any radar, navigational aid or communications antennae; not be within LOS of any such facility at any range; and not infringe the CAP 670 criteria for all such facilities.

4.1.17 Aerodrome Operators (other than those covered in 4.1.14)

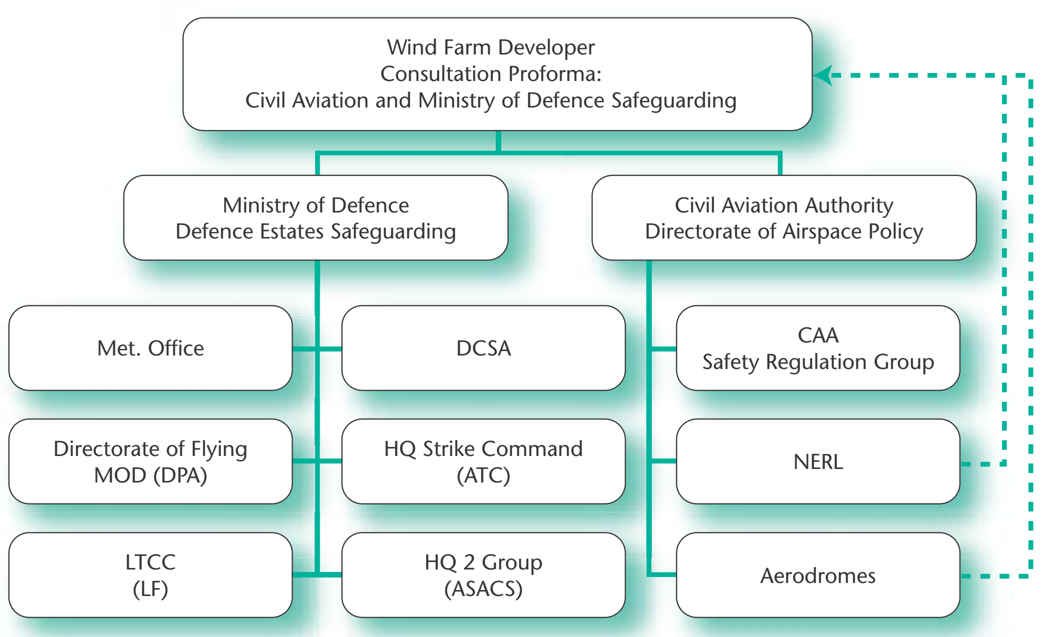
4.1.17.1 The aerodrome operators, whether part of a larger organisation or independent, will be concerned with all issues that might affect the safety of aircraft using their airfield. As the aerodrome licence holder, the operator is responsible for maintaining the safe operation of the aerodrome. They are, therefore, concerned with all aspects of any proposal that may have a detrimental impact upon the safety of the aerodrome. For any proposed wind turbine development that lies within 30km of the aerodrome they will determine whether the height of a proposed development infringes the protected surfaces around the aerodrome and in conjunction with their ATS provider will assess whether there is any impact upon the aerodrome's radar and the safe provision of air traffic control. Further information about aerodrome operators can be sought from The Airport Operators Association (address at Annex H).

4.1.18 The Stakeholder Contact Flow

4.1.18.1 A diagram of the pre-planning consultation process is shown in Figure 4-1; it should be noted that all connecting lines should represent a two-way dialogue process. Furthermore, this diagram should in no way be construed as precluding the developer from conducting a dialogue direct with any individual stakeholder. It is, however, recommended that initial contact be made via the route shown (the dotted lines on the right of the figure indicate a direct feedback path that is established after initial contact has been made).

[29] The gradients are: 1:200 for Secondary Surveillance Radar; 1:100 for Primary Radar; 1:50 for navigation aids and communications antennae. Wind turbines should not impinge on these safeguarding slopes.

Figure 4-1.
The Pre-Planning Consultation Process Flow



4.2 THE PLANNING PROCESS

4.2.1 Regardless of whether the voluntary pre-planning consultation process has been followed, all proposals for wind farms must eventually move into the formal planning process if the project is to come to fruition. The process is outlined in the subsequent paragraphs, although these guidelines do not purport to be a comprehensive guide to planning procedures.

4.2.2 Determination of Applications for Planning Approval

4.2.2.1 The organisation responsible for considering applications for consent for wind farms depends on the generating capacity of the development.

4.2.2.2 In England and Wales local planning authorities (LPAs) handle consent applications for onshore generating stations with a capacity up to and including 50MW under the general planning regime set out in the Town and Country Planning Act 1990. The Secretary of State for Trade and Industry considers applications for development consent under section 36 of the Electricity Act 1989 (see below) for onshore generating stations with a capacity greater than 50MW and offshore[30] generating stations with a capacity over 1MW.

4.2.2.3 In Scotland there is a similar division of responsibility. Onshore stations of a capacity up to and including 50MW are handled under the planning regime of the Town and Country Planning Act (Scotland) 1997. Similarly, onshore developments with a capacity greater than 50MW require a consent from the Scottish Executive under section 36. In Scotland, offshore developments are currently treated slightly differently from those in waters adjacent to England and Wales. As for onshore developments, only installations with a generating capacity greater than 50MW require a section 36 consent. However, an Order under the Electricity Act is currently being prepared to extend section 36 powers to offshore generating stations of capacity over 1MW, bringing Scottish legislation in line with England and Wales.

4.2.2.4 In Northern Ireland the Planning Service, an Agency within the Department of the Environment, handles all proposals for onshore generating stations irrespective of capacity under the general planning regime set out in the Planning (Northern Ireland) Order 1991. All proposals for generating stations with a capacity of 10MW and over must also obtain development consent from the Department of Enterprise, Trade and Investment in accordance with article 39 of the Electricity

30 Defined as between the low water mark and the seaward boundary of territorial waters, a distance of 12 nautical miles.

(Northern Ireland) Order 1992. The Electricity Act 1989 does not extend to Northern Ireland, although the procedures under the 1992 Order are broadly the same.

4.2.3 Guidance Available to Local Planning Authorities

4.2.3.1 It should be noted that the former DTLR has undertaken a major review of the planning system and published proposals in a Green Paper in December 2001[31] for speeding up the determination of planning applications. In July 2002 the Office of the Deputy Prime Minister (ODPM) issued a planning policy statement "Sustainable Communities - Delivering through Planning" which sets out the Government's plans for reform of the planning system[32].

4.2.3.2 Guidance on Renewable Energy Projects

4.2.3.2.1 In England Planning Policy Guidance Note 22 (PPG22) (1993) promotes the environmental benefits of increasing renewable energy generation and includes an annex on the implications of wind energy. The ODPM has given a commitment to revise this document. In Wales, more general guidance is given in Planning Policy Wales (PPW) (republished March 2002), with detailed guidance relating to wind energy in Technical Advice Note 8 (TAN8) (1996). A review of TAN8 is currently underway, with a draft consultation due at the end of 2002 or early 2003. PPW and TANs, together with Welsh Office circulars, together comprise Welsh national planning policy.

4.2.3.2.2 It should be noted that regional-level energy strategies are being developed, which are designed to engender a positive approach to renewables planning.

4.2.3.2.3 In Scotland National Planning Policy Guideline 6 (NPPG6) (revised January 2000) sets wide objectives for renewable energy development within the context of the national target. More information on the implications on the different renewable technologies is given in Planning Advice Note (PAN) 45; this includes a detailed section on wind power and was revised in January 2002.

4.2.3.2.4 In Northern Ireland the Regional Development Strategy 2025 promotes the use of renewable sources of energy and alternative energy technologies. Specific policy guidance for renewable technologies is given in Policy PSU 12 of the Planning Strategy for Rural Northern Ireland (1993).

31 Planning: Delivering a Fundamental Change, DTLR, December 2001.

32 Further details are available on ODPM's website at: www.planning.odpm.gov.uk/consult/greenpap/makebett/index.htm

4.2.3.3 Guidance on Aviation-related Issues

4.2.3.3.1 In considering aviation-related aspects of applications for planning approval LPAs will follow the processes and the guidance outlined in section 3.2 above on the Safeguarding of Aviation Interests.

4.2.3.4 Section 36 of the Electricity Act 1989

4.2.3.4.1 As described above, certain wind farm proposals in England, Wales and Scotland are subject to consent under section 36 of the Electricity Act 1989. Under section 36, the Secretary of State for Trade & Industry considers applications for generating stations in England and Wales; the DTI consults the Welsh Assembly Government on the latter. As section 36 powers have been devolved, Scottish Executive Ministers make decisions on relevant proposals in Scotland. The legislation is constructed to enable Government Ministers to make a decision within the broader context of energy policy, whilst recognising the interests of the LPA in which the development is planned to be located.

4.2.3.4.2 While consent ultimately rests with the relevant Minister, LPAs also receive a copy of the application. The planning authority will follow the relevant aviation guidance (as described above) and may raise an objection. If this objection is sustained and cannot be addressed by modification to the project, then a public enquiry will be held. The Government Minister(s) will take the outcome of the public enquiry into account when making a final decision.

4.2.3.4.3 At the same time, the DTI or Scottish Executive will be carrying out their own consultations. While not statutory consultees in the section 36 process, the views of the CAA and MOD will be sought as a matter of course. At any stage, the Ministers concerned have the right to call a public enquiry in the light of the objections they receive, and the outcome will be taken into account in their final decision.

4.2.3.4.4 Other consents are also required for offshore wind farms, but these are not related to aviation and, thus, are not described here[33]. The question of how renewables projects outside territorial waters might receive consent will be addressed in a consultation document on a future strategy for wind farms to be issued by the DTI in autumn 2002.

4.2.3.5 The Transport and Works Act 1992

4.2.3.5.1 If a development is likely to interfere with rights of navigation in English & Welsh territorial waters, developers may apply for approval under the Transport and Works Act 1992 as an alternative to section 36 consent. When developers follow this route, the Secretary of State for Trade and Industry (in England) or the Welsh Assembly Government will consider applications. They will consult with the LPA before making a decision on development approval.

[33] Specifically, a licence from the DfT under Section 34 of the Coastal Protection Act 1949 and a licence from DEFRA under Section 5 of the Food and Environment Protection Act 1985. Applications for these separate licences are submitted to the DTI which works with other relevant Government Departments to co-ordinate the administrative processes and produce a more streamlined system; see Guidance Notes: Offshore Wind Farm Consents Process, DTI, due Autumn 2002.

5 Conclusion

5.1 All parties should recognise the needs of others involved in the process. Wind farm developers should understand the legitimate concerns of the aviation and defence communities; aviation and defence stakeholders should bear in mind the importance of wind farms in meeting national energy needs. The key is early dialogue between all stakeholders with an interest. Early consultation can help to identify non-viable proposals and so keep wasted resources to a minimum. Alternative possibilities may emerge from the dialogue and wind farm developers should gain a better understanding of the concerns of aviation stakeholders and how individual applications are assessed. Once established, the dialogue needs to be maintained. As proposals for developments become more detailed their likely effects on aviation interests can be assessed in greater depth.

5.2 There is no doubt that certain interactions between wind farms and aviation have, in the past, appeared intractable. Wind turbines do have effects on both civil and military aviation. In fact, many issues can be resolved based upon the guidance in this document. Others, such as the effects of turbines on radar installations, will still have to be considered on a detailed case-by-case basis and not all the information that may be necessary to reassure stakeholders fully in this area may yet be available. There is, nevertheless, good reason for optimism that these issues may be resolved both in general and specific cases.

5.3 This edition of the guidelines provides interim guidance. It is a living document and the intention is to update it in the light of the findings from research currently under way and to incorporate feedback from all stakeholders (which is welcomed via the feedback form at Annex I). In the meantime it is clear that early and regular consultation with all the relevant stakeholders can make the planning process much easier for the developer.

Picture credit: © Paul Carter/Wind Prospect

6 Annexes

A. BACKGROUND TO THE GUIDELINES
B. WIND POWER
C. SAFEGUARDED SITES - LISTS AND MAPS
D. RADAR SYSTEMS AND THE EFFECTS OF WIND TURBINES
E. PRE-PLANNING CONSULTATION FORM
F. GLOSSARY
G. LIST OF ACRONYMS
H. CONTACT ADDRESSES
I. FEEDBACK PROFORMA

ANNEX A
Background to the Guidelines

A1 The Wind Energy, Defence and Civil Aviation Interests Working Group was formed as a result of an initiative by the Department of Trade and Industry (DTI) in early 2001 to review the issues surrounding wind energy development and civil and military aviation activities. The Group comprises a cross-section of stakeholders, including representatives from the British Wind Energy Association (BWEA) on behalf of the wind energy industry, the Ministry of Defence (MOD), the DTI, the Civil Aviation Authority (CAA), and National Air Traffic Services (NATS). The Scottish Executive provides guidance on Scottish issues. The Working Group commissioned the guidelines, has overseen their development and will be responsible for their updating.

A2 In addition to the guidelines three other studies have been commissioned as a result of the Group's work. Their respective objectives are:

- To develop a model to predict the effects of wind turbines on radar installations.
- To investigate mitigation measures to reduce the potential effects of wind turbines on radar installations.
- To review European experiences in the process of balancing the interests of wind farm development, aviation safety, and air defences.

Further details of these studies are provided at Annex D.

A3 These studies are expected to provide a substantial input to the understanding of many of the effects of wind turbines on aviation. Their full findings are not yet available but they will be incorporated into subsequent versions of this document. For the present the guidelines seek to clarify issues of concern to the wind industry and aviators regarding each other's interests and, in particular, to offer guidance to developers as to the areas of concern of stakeholders within both civil and military aviation.

A4 Terms of reference for the Aviation Working Group follow.

TERMS OF REFERENCE OF THE WIND ENERGY, DEFENCE AND CIVIL AVIATION INTERESTS WORKING GROUP

AIM

To produce public domain guidance on the appropriate siting of both onshore and offshore wind turbines, with respect to their likely effects on defence and civil aviation interests.

OBJECTIVES

To share information concerning the effects of wind turbines on defence and civil aviation interests.

- To streamline and formalise the wind farm development application process.
- To identify the issues associated with defence and civil aviation interests, which may effect the development of wind energy in the UK.
- To develop a programme of work to both evaluate the issues identified and subsequently to generate appropriate solutions or mitigation measures to any problems identified.
- To generate guidance acceptable to all stakeholders.
- To encourage the widespread adoption of the guidance.

ANNEX B
Wind Power

B1 INTRODUCTION

B1.1 The amount of electricity generated by wind turbines depends on two key factors - the wind resource and the swept area of the wind turbine rotor. Thus the energy produced is highly dependent upon the average wind speed at the chosen site and the size of the turbine.

B1.2 This said, however, relatively small increases in wind speed and blade size can result in large increases in the amount of electricity generated. This is for the following reasons:

- Wind speed: the power available increases with the cube of the wind speed - for example a machine on a site with a mean wind speed of 5 metres per second (m/s) will produce less than half the electricity of the same size turbine on a site with a mean wind speed of 7m/s.
- Blade size: the area swept by the rotor increases by the square of the rotor diameter, so doubling the length of a turbine’s blades actually quadruples the amount of energy produced.

B1.3 Developers can assess wind speed by correlating historical data available from the Met Office with information derived from on site wind measurements. Wind masts are typically located on a site for a period of 12 months. While wind speed is vital, there is a range of other technical and environmental factors that must be considered when choosing sites suitable for wind farm development.

B2 GENERIC SITE REQUIREMENTS FOR WIND ENERGY

B2.1 Ideal wind farm sites are to be found on high, exposed land, which can cause conflict with aviation interests such as low flying or radar siting. In order to export the power generated the chosen site must have a technically and commercially feasible connection to the electricity distribution system as well as suitable access for vehicles, including large articulated vehicles during the construction phase.

B2.2 ENVIRONMENTAL FACTORS

B2.2.1 A key consideration is the effect of the development on landscape and visual interests. Therefore, opportunities for schemes in national designations such as National Parks or Areas of Outstanding Natural Beauty are generally limited and even outside these areas careful consideration of local designations and general landscape issues such as views from key public viewpoints must be considered.

B2.2.2 Wind farms should not be so close to domestic dwellings that they affect them by noise, shadow flicker, visual domination or reflected light. Consideration should be given to ecological designations and whether protected species are found at a proposed site. Listed buildings, Conservation Areas and archaeological sites may all influence the acceptability of a wind farm site.

B2.2.3 In finding an appropriate site a developer must therefore consider a range of factors and commit considerable time and resources in advance of moving forward with a planning application and full environmental assessment.

B3 WIND TURBINE CHARACTERISTICS

B3.1 Almost all wind turbines producing electricity for the electricity grid consist of a 3-bladed rotor that rotates around a horizontal hub. The hub is connected to a gearbox and generator, which are located inside the nacelle. The nacelle houses the electrical components and is mounted at the top of the tower. This is illustrated in Figure B-1.

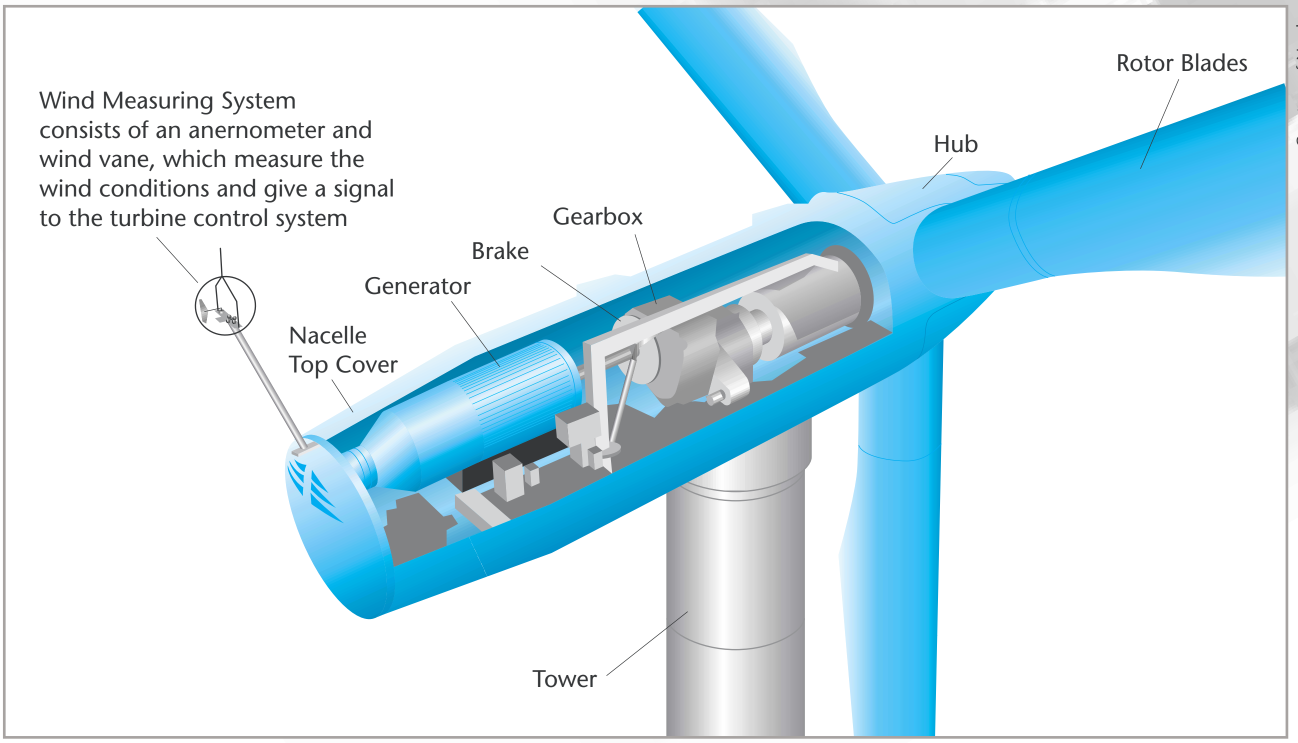


Figure B-1. A Typical Wind Turbine

B3.2 As mentioned previously, the swept area covered by the rotor determines how much energy a turbine can generate. Rotor diameters currently range up to 80 metres (2MW turbine), but smaller machines may be around 30 metres (225kW). The most popular turbines at present are around the 1300kW size and will typically have a rotor diameter of around 56 metres. Larger machines are generally able to deliver electricity more cheaply than smaller machines as infrastructure costs are similar (this is particularly the case for offshore installations).

B3.3 Turbines normally have a tubular tower mounted on a concrete foundation. The gearbox and generator are located in the nacelle at hub height. The blades are manufactured from glass fibre or wood epoxy.

B4 FUTURE TECHNOLOGICAL DEVELOPMENTS

B4.1 Wind turbine technology has advanced rapidly over the last 10 years. The average turbine size was around 400kW in 1992 and today is around 1.5MW. The requirements of offshore wind energy schemes are driving the development of still larger turbines, with prototypes as large as 4.5MW and with rotor diameters in excess of 100 metres currently being tested by manufacturers.

B4.2 It is likely, simply due to the physical constraints of transporting equipment on land, that a split will occur in the near future between the size of onshore and offshore turbines. This is not to say that sites for multi-megawatt turbines onshore will not be developed, but that constraints will exist that may restrict turbines to rotor diameters of perhaps around 60 to 80m. There is an element of flexibility in the size of towers, which is generally a compromise between planning constraints and wind speed (generally, the higher you go the more wind there is).

B4.3 There is little evidence that radical changes in the type of turbines on the market are likely in the short to medium term. The three bladed turbine with a tubular steel tower is likely to be the norm for the foreseeable future.

B4.4 Whilst turbines continue to look roughly the same, major changes in the technology are taking place beneath the surface such as the shift from single speed

B

machines to variable speed turbines which capture the wind more efficiently by speeding up and slowing down depending on the wind speed. Rotational speeds are in the order of 10-20rpm (compared with over 30rpm 10 years ago).

B4.5 The control systems continue to advance with turbines having ever more sophisticated software and hardware systems for monitoring and controlling their operation. Turbines have always required low maintenance but the particularly harsh operating environments of offshore wind farms will require the development of new systems to ensure that the high levels of availability seen for onshore turbines (98%+) can be maintained in the offshore environment where access for servicing is a key issue.

B4.6 Offshore schemes are likely to consist of farms of at least 30 turbines per site and possibly several hundred turbines. Onshore schemes of all sizes from individual turbines serving local communities or industry to large projects in excess of 30 turbines are likely to come forward in order to meet the Government target of 10% of electricity from renewables by 2010.

B5 WIND FARMS IN THE UNITED KINGDOM

B5.1 Indicative maps of the locations of operational wind farms and planned offshore wind farms are in Figures B-2 and B-3 respectively.

Figure B-2.
Operational Wind Farm Locations, August 2002
© BWEA

Figure B-3. Planned Offshore Wind Farm Locations © BWEA

NB There are also plans for a wind farm on the Tunes Plateau off the coast of Northern Ireland.

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B6 EXAMPLE OF A WIND TURBINE RADAR SIGNAL

B6.1 The radar modelling study mentioned in section A2 and described in section D5.3 includes some field measurements which will be used to validate the model. Figure B-4 shows some data from these trials. It shows the Doppler signal against time recorded by a radar array from a single 1.5MW turbine. The turbine rotor was at an angle of 30° to the radar direction, with a rotor speed of 20.3rpm.

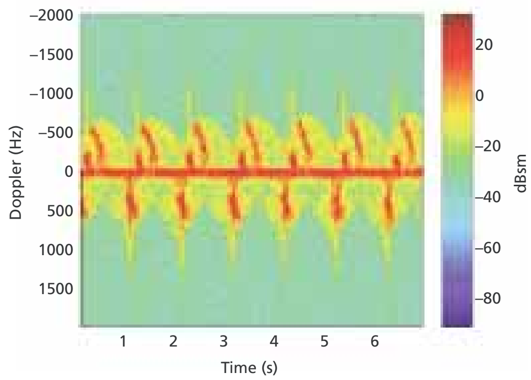

Figure B-4. Doppler radar signal from a single wind turbine.

ANNEX C
Safeguarded Sites - Lists and Maps[34]

C1 OFFICIALLY SAFEGUARDED AERODROMES IN THE UK

C1.1 CIVIL AERODROMES

C1.1.1 England (26)

The numbers given below relate only to Figure C-1.

1. Biggin Hill
2. Birmingham
3. Blackpool
4. Bournemouth
5. Bristol
6. Carlisle
7. Coventry
8. East Midlands
9. Exeter
10. Humberside
11. Leeds Bradford
12. Liverpool
13. London City
14. London Gatwick
15. London Heathrow
16. London Stansted
17. Luton
18. Manchester
19. Newcastle
20. Norwich
21. Oxford
22. Penzance
23. Plymouth
24. Southampton
25. Southend
26. Teesside

C1.1.2 Scotland (12)

27. Aberdeen
28. Benbecula
29. Edinburgh
30. Glasgow
31. Inverness
32. Islay
33. Kirkwall
34. Prestwick
35. Stornoway
36. Sumburgh
37. Tiree
38. Wick

C1.1.3 Wales (1)

39. Cardiff

C1.1.4 N. Ireland (1)

40. Belfast International

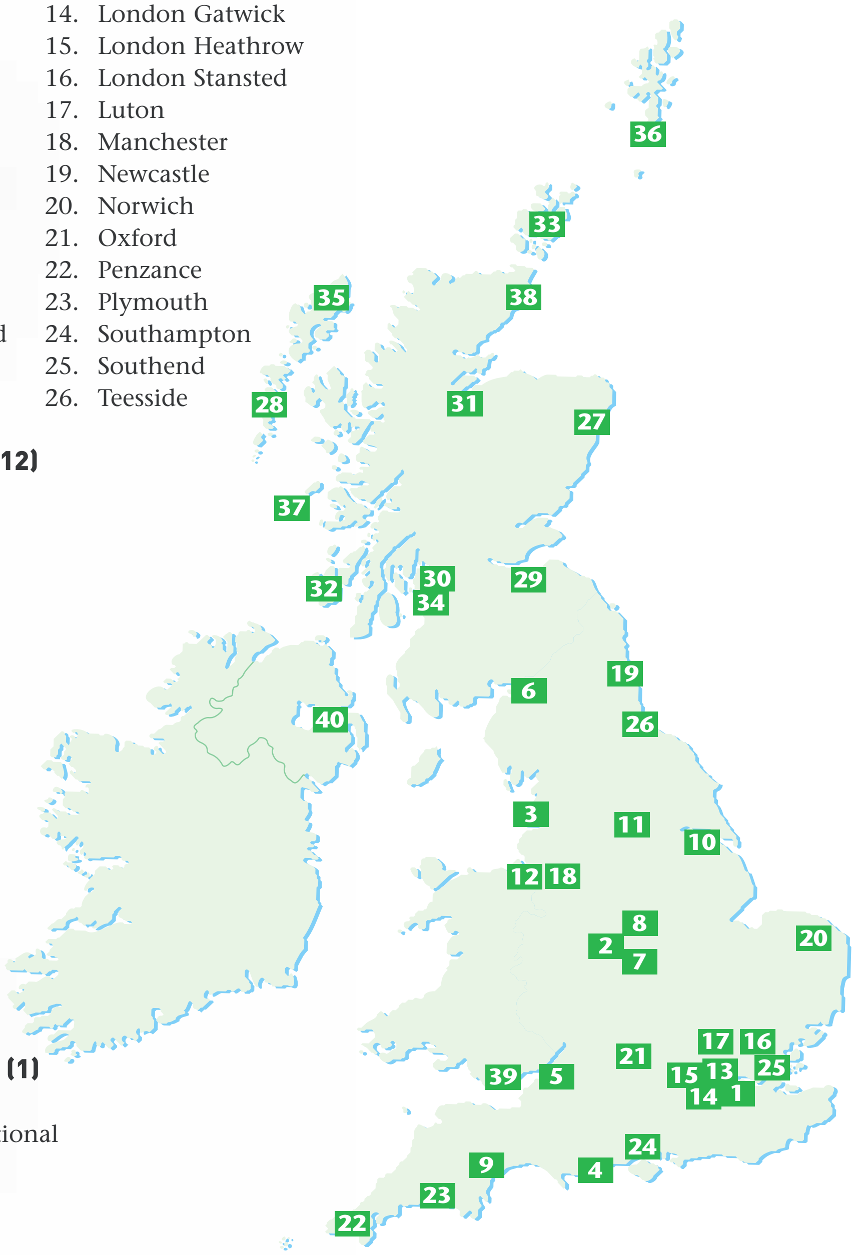

Figure C-1. Safeguarded Civil Aerodromes (Indicative only)

[34] It must be noted that all maps included in this document are indicative and for illustrative purposes only. They must not be used as a formal source for the location of any site or facility.

C2 TECHNICAL SITES

C2.1 CIVIL TECHNICAL SITES

C2.1.1 The list of NERL sites is a living document and, as such, it is not possible to include an up-to-date list in a document such as this. Details of sites should be sought from NERL.

C2.2 MILITARY TECHNICAL SITES

C2.2.1 Owing to the large number and variety of sites that are safeguarded by the MOD, it is not practical to include a list here (with the exception of a map of the ASACS radar sites below). Details of all military technical sites can be obtained from Safeguarding, Defence Estates (address at Annex H).

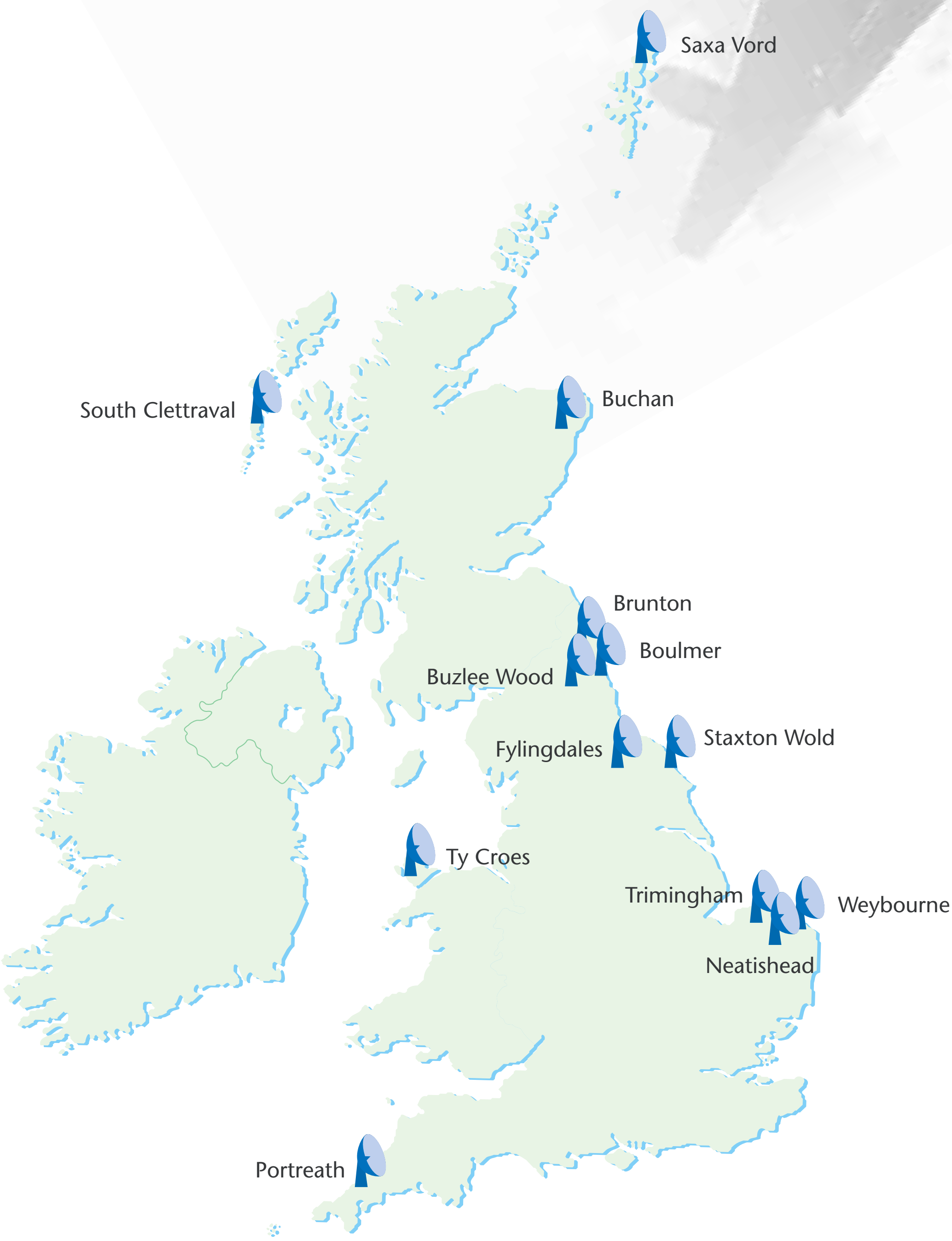

Figure C-2.
UK ASACS Radar Sites
(Indicative only)

ANNEX D
Radar Systems and the Effects of Wind Turbines

D1 GENERAL

D1.1 There are two types of radar used for air traffic control and air defence control and surveillance: primary radar and secondary surveillance radar (SSR).

D1.2 Primary radar operates by radiating electromagnetic energy and detecting the presence and character of the echo returned from reflecting objects. Comparison of the returned signal with that transmitted yields information about the target, such as location, size and whether it is in motion relative to the radar.

D1.3 Primary radar cannot differentiate between types of object; its energy will bounce off any reflective surface in its path. Moreover, air traffic control primary radar has no means of determining the height of an object, whereas modern air defence radars do possess this capability, using electronic beam control techniques.

D1.4 For SSR, the ground station emits 'interrogation' pulses of RF energy via the directional beam of a rotating antenna system. When the antenna beam is pointing in the direction of an aircraft, airborne equipment, known as a transponder, transmits a reply to the interrogation. The reply is detected by the ground station and processed by a plot extractor. The plot extractor measures the range and bearing of the aircraft and decodes the aircraft replies to determine the aircraft's flight level and identity (Mode C operation).

D1.5 In the UK, all aircraft flying above 10,000 feet or in controlled airspace must carry a SSR transponder. Some light aircraft do not, and aircraft that do carry them may not have them switched on, in which case they will not be visible to SSR. Most ATC units are equipped with both primary and SSR, but, increasingly, radar services are provided using SSR only, especially at levels above 24,500 feet.

D1.6 From 2005 onwards, a new type of SSR called 'Mode S' will begin to be introduced in UK airspace. Mode S is a development of classical SSR that overcomes many of the current limitations of the SSR system. It is proposed, subject to formal consultation, to introduce Mode S initially in 2005 with a second phase of regulatory changes in 2008. In addition, it is proposed that the requirements for the carriage and operation of transponders will be significantly extended in conjunction with the Mode S plans for 2008.

D2 RADAR FUNCTIONS

D2.1 AIR TRAFFIC CONTROL (ATC)

D2.1.1 Radar performs two functions for air traffic control:

a) Aerodrome surveillance radar allows air traffic controllers to provide air traffic services to aircraft in the vicinity of an airport. This service may include vectoring aircraft to land, providing a radar service to departing aircraft or providing a service to aircraft either transiting through the area or in the airfield circuit.
b) En route (or area) radars (which in the UK are all operated by NATS) are used to provide services to traffic in transit. This includes commercial airliners and military traffic. Area radars have a longer range than aerodrome radars, particularly at high altitudes.

D2.2 AIR DEFENCE

D2.2.1 Air Defence radars are used in two ways. On the one hand, they perform a similar function to their ATC counterparts, in that they are used by air defence controllers to provide control services to military (usually air defence) traffic. However, they are also used to monitor all air traffic activity within the UK and its approaches in order that a Recognised Air Picture (RAP) can be produced, with the aim of preserving the integrity of UK airspace through air policing. The RAP is produced by allocating Track Identities to each radar return (or "plot") of interest. Often, a radar plot can fade from a radar display for a period of time due to a number of factors, but the Track Identity will remain, indicating that the associated plot is still actually present.

D2.3 METEOROLOGICAL RADARS

D2.3.1 Met Office weather radars use EM energy to monitor weather conditions (predominantly cloud and precipitation) at low altitudes, in order to assist weather forecasting. Wind profiling radars are used to measure wind speed at different altitudes.

D3 THE NATURE OF THE IMPACTS OF WIND TURBINES

D3.1 MASKING

D3.1.1 This is the main anticipated effect on air defence surveillance radars. Such radars work at high radio frequencies and therefore depend on a clear "line of sight" to the target object for successful detection. It follows that any geographical feature or structure which lies between the radar and the target will cause a shadowing or masking effect; indeed this phenomenon is readily exploited by military aircraft wishing to avoid detection. It is possible that, depending on their size, wind turbines may cause shadowing effects. Such effects may be expected to vary, depending upon the turbine dimensions, the type of transmitting radar and the aspect of the turbine relative to it.

D3.1.2 The Met Office is also concerned with the effect of masking on their sensors. Met Office radars look at a relatively narrow altitude band, as near to the earth's surface as possible. Due to the sensitivity of the radars, wind turbines, if they are poorly sited, have the potential to significantly reduce weather radar performance.

D3.2 RADAR RETURNS/RADAR CLUTTER

D3.2.1 Radar returns may be received from any radar-reflective surface. In certain geographical areas, or under particular meteorological conditions, radar performance may be adversely affected by unwanted returns, which may mask those of interest. Such unwanted returns are known as radar clutter. Clutter is displayed to a controller as "interference" and is of concern primarily to ASACS and aerodrome radar operators, because it occurs more often at lower altitudes.

D3.2.2 For an aerodrome radar operator, a wind turbine or turbines in the vicinity of his airfield can present operational problems. If the turbine generates a return on his radar screen and the controller recognises it as such, he may choose to ignore it (as is the case, for example, at RAF Marham). However, such unwanted returns may obscure others that genuinely represent aircraft, thereby creating a potential hazard to flight safety. This may be of particular concern in poor weather.

D3.2.3 A structure which permanently paints on the radar in the same position is preferable to one that only presents an intermittent return. This is because an intermittent return is more likely to represent a manoeuvring or unknown aircraft, obliging the controller to act accordingly. With this in mind, it is possible that aviators and radar operators could work safely with one or perhaps two turbines in the vicinity of an aerodrome. Of greater concern is the prospect of a proliferation of turbines, which could potentially saturate an airfield radar picture, making safe flying operations difficult to guarantee.

D3.2.4 Several turbines in close proximity to each other, painting on radar, can present particular difficulties for long-range air surveillance radars. A rotating wind turbine is likely to appear on a radar display intermittently (studies suggest a working figure to be one paint every six sweeps). Multiple turbines, in proximity to each other, will present several returns during every radar sweep, causing a 'twinkling' effect. As these will appear at slightly different points in space, the radar system may interpret them as being one or more moving objects and a surveillance radar will then initiate a 'track' on the returns. This can confuse the system and may eventually overload it with too many tracks. Measures can be taken to mitigate this problem and they are amplified in Section D4, but these too have their drawbacks.

D3.3 'SCATTERING', 'REFRACTION' AND/OR 'FALSE RETURNS'

D3.3.1 Scattering occurs when the rotating wind turbine blades reflect, or refract radar waves in the atmosphere. These are then subsequently absorbed either by the source radar system or another system and can then give false information to that system. It may affect both primary and SSR radars. This effect is as yet unquantified but is certainly possible - it has, for example, been witnessed at Copenhagen airport as a result of the Middelgrunden offshore wind farm.

D3.3.2 The possible effects are:

a) Multiple, false radar returns being displayed to the radar operator: blade reflections may be displayed at the controller's console as spurious radar contacts.
b) Radar returns from genuine aircraft being displayed, but in an incorrect location (range, azimuth or both).
c) Garbling or loss of SSR information. The SSR code allocated to an aircraft may not be received correctly at the radar installation because of attenuation, scattering or refraction effects. Moreover, it is possible that displayed aircraft altitude information derived from Mode 'C' (described in Section D1.4) may also be lost or degraded.

D4 POTENTIAL MITIGATING MEASURES

D4.1 TECHNICAL MEASURES

D4.1.1 Moving Target Indicator Processing

D4.1.1.1 Objects that are moving cause a shift in the frequency of the returned EM energy to the radar receiver; this is known as Doppler shift. Moving Target Indicator (MTI) processing removes from the display any returned pulses which indicate no movement or are within a specified range of Doppler shift. This removes unnecessary clutter, eliminates unwanted moving targets (such as road traffic) and makes moving targets above a certain velocity more visible.

D4.1.1.2 Rotating wind turbine blades can impart Doppler shift to EM energy reflecting off the blades. Depending on the MTI thresholds set in the radar processor, this may be displayed as a moving target. Changes in wind direction at the turbine, the position of the blade in its rotation, the blade pitch, plus other factors, may cause the amount of energy returned to the radar on different sweeps to vary. At single-turbine sites, a radar return will be repeatedly displayed in the same position and MTI processing can be deployed. However, multiple-turbine sites cause a different effect and MTI processing is much more difficult. On one return, blades from one (or more) turbine(s) may paint on the radar; on the next sweep, the blades of a different turbine may paint. This can create the appearance of radar returns moving around within the area of the wind farm.

D4.1.1.3 On both aerodrome and air defence radar this can appear (depending on the type of radar and the processing thresholds in effect) as unknown aircraft manoeuvring unpredictably. On air defence radars such as those used in the UK ASACS, the overall system may well interpret the activity as an aircraft and automatically start tracking the activity.

D4.1.2 Filters

D4.1.2.1 It is technically possible with many radars to filter out returns from a given area to ensure they are not presented on operational displays. However, this is at the expense of detecting actual aircraft in the area concerned. In the case of radars that have the ability to discriminate returns in height, it may be possible to filter out only the affected height band. On other radars, all returns in the given area will be lost and, in effect, no overall operational benefit is gained.

D4.1.3 Non-Automatic Initiation

D4.1.3.1 A measure that can be taken within the Command and Control system to mitigate the effects of spurious radar returns is to establish what is known as a Non-Automatic Initiation (NAI) area. Within this area the system does not perform its normal function of automatic track association and correlation. This would prevent the system attempting to correlate the returns from a large number of turbines in order to form what it perceives to be aircraft tracks. Instead, a human operator monitors the affected area to manually detect genuine aircraft tracks. Whilst this technique can help to avoid the problems both for surveillance and control of spurious tracks, it can be manpower-intensive and requires operator expertise. Furthermore, it can not help to overcome the effect on safety of clutter. Indeed, the use of clutter filters and NAIs may be operationally mutually exclusive.

D4.2 OPERATIONAL MEASURES

D4.2.1 The type of operations being conducted and the type of airspace within which a controller is operating are both relevant factors if radar clutter is being experienced.

D4.2.2 Controlled Airspace. Within controlled airspace, flight is only possible if approved by an ATC authority. Therefore, controllers should know of all aircraft within that controlled airspace. In this case, if radar clutter is experienced, whether from a wind turbine or other obstacle, the controller may assume that the return is not from an unknown aircraft and will not need to take any action. (There are exceptions to this rule, which need not be explored here.)

D4.2.3 Outside Controlled Airspace. Outside controlled airspace (in the UK, categorised as ‘Class G’ airspace), clutter and unknown radar returns present more of a problem. In such airspace, the radar returns of aircraft are the primary means on which the separation of aircraft is based; therefore, clutter must be avoided, as it is the only way of ensuring separation from unknown aircraft.

D4.2.4 What may occur is that radar clutter from a wind turbine may be interpreted as being a return from an aircraft; or the clutter may be obscuring a genuine radar return from an actual aircraft operating in the vicinity of that clutter.

D4.2.5 There are two ways a controller can deal with this problem; the safest option is to simply avoid the area of clutter, usually by a range of 5 nautical miles. Naturally, this is not always possible. Alternatively, the controller may ‘limit’ his radar service, whereby he informs the aircraft receiving the service that, due to being in an area of clutter, the pilot may receive late or no warning of other aircraft.

D4.2.6 Controllers use both methods but each presents its own problem. The cumulative effects of clutter make vectoring to avoid clutter harder and harder. Controllers may be able to cope with one or two areas of clutter, but there is a difficult judgement as to how much proliferation is acceptable. Alternatively, limiting the service is often a last resort, and to admit that clutter may well be obscuring returns from genuine aircraft is a clear indication that flight safety may be compromised.

D4.2.7 The significance of unwanted radar returns from wind turbines will depend not only on what type of airspace they are in or underneath, but also on their proximity to traffic patterns and routes. Wind turbines on an extended centreline of a runway are more likely to present a significant problem to controllers at longer ranges due to aircraft lining up for approaches and on departure. Similarly, aerodromes have Standard Arrival Routes (STAR) and Standard Instrument Departure (SID) routes, which may also be considered problematic.

D5 FUTURE DEVELOPMENTS

D5.1 All radars are different (even if only due to the physical impacts of their operating locations) and creating a ‘rule of thumb' for wind farm developments near all systems would require such a level of generalisation as to make it probably worthless. Therefore, in considering the effect of wind turbines on radar, developers need to focus on individual radars in the vicinity of their planned development. It is important also that developers appreciate the nature and extent of any problem. For example, studies into air defence radars that take no account of the associated Command and Control systems may be of very limited value.

D5.2 There is a lack of consensus on the precise nature of the effects of wind turbines on radar, and in the current security climate MOD is unwilling to diminish its air surveillance capability, particularly at low altitudes. For these reasons, a number of studies are underway which will enlighten the current debate. Three studies have been commissioned by the Wind Energy, Defence and Civil Aviation Interests Working Group which should go some way towards improving understanding of key questions.

D5.3 The first is a study by QinetiQ, which will produce a model that will be used for predicting the impact of wind turbines on radar systems. This tool will be used to predict the effect a proposed wind farm will have on a specific radar system, and will therefore be of use to both developers and radar users when assessing such issues. It is expected that the results of this study will be published in December 2002 as report ETSU W/14/00614/REP.

D5.4 The second study is being carried out by AMS (Contract Number W/14/00623). This is investigating the different technical approaches which could reduce the effect of wind turbines on radar function. This will look at technical feasibility and the practical issues. It will include a first look at the possible cost of implementing any feasible approaches. It is expected that the results of this study will be published in December 2002 as report ETSU W/14/00623/REP.

D5.5 Another DTI funded study examining European experience and practice is also ongoing. It is expected that this will identify a significant body of relevant work in mainland Europe (where Governments currently find themselves facing similar issues). The study could provide important information to the UK wind and aviation industries. It is expected that the results will be published in October 2002 as report ETSU W/14/00624/REP.

D5.6 All these reports will be available from the DTI's Renewable Energy Helpline - see Annex H for contact details.

D6 BIBLIOGRAPHY

D6.1 'Potential Effects of Wind Turbines on Navigational Systems', A. Knill (CAA), July 2002, available from BWEA Web site.

D6.2 'Wind Turbines and Radar: Operational Experience and Mitigation Measures', BWEA, December 2001, available from BWEA Web site.

D6.3 'Information Paper - Radar Mitigations', R. Lewis (CAA), March 2001, available from CAA SRG.

D6.4 'The Operational Effects of Wind Farm Developments on ATC Procedures for Glasgow Prestwick International Airport', E. Summers, January 2001, available from BWEA Web site.

D6.5 'The Provision Of Guidelines For The Installation Of Wind Turbines Near Aeronautical Radio Stations', Dr H. Dabis, Dr R. Chignell (for CAA), April 1999, available from CAA SRG.

D6.6 All relevant addresses are at Annex H.

D6.7 These studies represent a cross-section of the work that has thus far been carried out in the UK on the topic of wind turbines and their effects upon aviation systems, with much of the focus on radar. It is by no means exhaustive and more work should become available.

ANNEX E
Pre-planning Consultation Form

E1 BLANK PROFORMA

E1.1 This proforma can be downloaded from the BWEA Web site or obtained by post; addresses are at Annex H.

WIND FARM DEVELOPERS APPLICATION PROFORMA:

Civil Aviation & Ministry of Defence Safeguarding

NOTICE TO WIND FARM DEVELOPERS
Please submit a completed application form for all new or revised onshore and offshore wind farm plans. This form has been compiled in consultation with the British Wind Energy Association. Its purpose is to standardise the information provided and to expedite the assessment of your proposed wind farm development. Assessment is made against air safety and defence interests, through evaluation of the possible effects on air traffic systems, defence systems and low flying needs.

NOTICE TO PLANNING AUTHORITIES
This form has been compiled with the assistance of the Civil Aviation Authority (CAA), the Ministry of Defence (MOD), the National Air Traffic Service (NATS) and the British Wind Energy Association (BWEA), to assist in the processing and assessment of wind farm applications. It is important that copies of this form are forwarded within the planning consultation process. This will help these organisations trace their records of any earlier consultations, as well as provide them with the relevant information for their assessments.

WHAT TO DO WITH THIS FORM
Please provide as much detail as possible by **filling in the shaded areas**. If the specific turbine and/or exact positions have yet to be established then fill in the likely turbine size (hub height, rotor diameter) and boundary points as a minimum. On completion send copies to both the following addresses.

Safeguarding Defence Estates Blakemore Drive Sutton Coldfield B75 7RL	Directorate of Airspace Policy K6 Gate 3 CAA House 45-49 Kingsway London, WC2B 6TE

It is important that a copy of this form is retained for inclusion with subsequent planning applications at the same site. If no application has been made prior to a planning application, please include a completed form in your planning application.

Wind Farm Name

Developer's reference	
Application identification No.	
Related/previous applications (at or near this site): Provide reference names or numbers	

Developer Information

Company name:	
Address:	
Contact:	
Telephone:	
Facsimile:	
e-mail:	

Relevant Wind Turbine Details

Wind turbine manufacturer:			
Wind turbine model:			
Wind farm generation capacity (MW)		**Number of turbines**	
Blade manufacturer			
Number of blades			
Rotor diameter			Metres
Rotation speed (or range)			Rpm
Blade material including lightning conductors			
Wind turbine hub height			Metres
Tower design (*delete as required)	* Tubular		* Lattice
Tower base diameter/dimensions			Metres
Tower top diameter/dimensions			Metres

Comments
Are there any details or uncertainties that may be helpful to add?

Turbine Locations

Please provide as much information as you can. The position and height above sea level of every machine if available, the site boundary if not. The height above sea level is the above ordinance datum (AOD) used to specify all heights on OS maps.

An Ordinance Survey (OS) map, or maritime chart, should be submitted with this pro-forma, showing locations of proposed turbine/turbines or scheme boundaries. Please number the turbines or boundary points on the map, to correlate with the information provided below.

Copy this page as necessary to account for all turbines or boundary points

Wind farm Name & Address:	

Turbine no.		**Height** AOD (m) of tower base					
Grid Reference			100 km square letter(s) identifier				
Easting (10 m)				Northing (10 m)			
	Degrees		Minutes	Seconds			
Latitude							
Longitude							

Turbine no.		**Height** AOD (m) of tower base					
Grid Reference			100 km square letter(s) identifier				
Easting (10 m)				Northing (10 m)			
	Degrees		Minutes	Seconds			
Latitude							
Longitude							

Turbine no.		**Height** AOD (m) of tower base					
Grid Reference			100 km square letter(s) identifier				
Easting (10 m)				Northing (10 m)			
	Degrees		Minutes	Seconds			
Latitude							
Longitude							

Turbine no.		**Height** AOD (m) of tower base					
Grid Reference			100 km square letter(s) identifier				
Easting (10 m)				Northing (10 m)			
	Degrees		Minutes	Seconds			
Latitude							
Longitude							

E2 EXAMPLE COMPLETED PROFORMA

Wind Farm Name

WILSON FARM

Developer's reference	0001
Application identification No.	1
Related/previous applications (at or near this site): Provide reference names or numbers	PENTLAND FARM DATED 01/02/01 OUR REF:- 0002/01

Developer Information

Company name:	MARK PICKETT WIND ENERGY
Address:	BLAKEMORE DRIVE SUTTON COLDFIELD WEST MIDLANDS, B75 7RL
Contact:	MARK PICKETT
Telephone:	0121 333 3642
Facsimile:	0121 333 2258
e-mail:	Mark.pickett@de.mod.uk

Relevant Wind Turbine Details

Wind turbine manufacturer:	ENERCON		
Wind turbine model:	E-66		
Wind farm generation capacity (MW) 5.4		**Number of turbines**	3
Blade manufacturer	ENERCON		
Number of blades	3		
Rotor diameter	70	Metres	
Rotation speed (or range)	10-22	Rpm	
Blade material including lightning conductors	FIBREGLASS EPOXY RESIN		
Wind turbine hub height	85	Metres	
Tower design (*delete as required)	* Tubular	~~* Lattice~~	
Tower base diameter/dimensions	4.3	Metres	
Tower top diameter/dimensions	2.7	Metres	

Comments
Are there any details or uncertainties that may be helpful to add?

Turbine Locations

Please provide as much information as you can. The position and height above sea level of every machine if available, the site boundary if not. The height above sea level is the above ordinance datum (AOD) used to specify all heights on OS maps.

An Ordinance Survey (OS) map, or maritime chart, should be submitted with this pro-forma, showing locations of proposed turbine/turbines or scheme boundaries. Please number the turbines or boundary points on the map, to correlate with the information provided below.

Copy this page as necessary to account for all turbines or boundary points

Wind farm Name & Address:	PENTLAND FARM LONG EATON, NR NOTTINGHAM

Turbine no.	1		**Height** AOD (m) of tower base	170				
Grid Reference				100 km square letter(s) identifier	ST			
Easting (10 m)	1	1	0	0	Northing (10 m)	8	2	0	0
	Degrees		Minutes	Seconds				
Latitude	N51		31	48				
Longitude	W3		17	4				

Turbine no.	2		**Height** AOD (m) of tower base	75					
Grid Reference				100 km square letter(s) identifier	ST				
Easting (10 m)	1	1	7	0	Northing (10 m)	8	1	3	0
	Degrees		Minutes	Seconds					
Latitude	N51		31	25					
Longitude	W3		16	27					

Turbine no.	3		**Height** AOD (m) of tower base	80					
Grid Reference				100 km square letter(s) identifier	ST				
Easting (10 m)	1	1	3	0	Northing (10 m)	8	1	2	0
	Degrees		Minutes	Seconds					
Latitude	N51		31	22					
Longitude	W3		16	48					

Turbine no.			**Height** AOD (m) of tower base						
Grid Reference				100 km square letter(s) identifier					
Easting (10 m)					Northing (10 m)				
	Degrees		Minutes	Seconds					
Latitude									
Longitude									

ANNEX F
Glossary

Airborne Stand-Off Radar
The Airborne STand-Off Radar (ASTOR) is a UK military airborne ground surveillance system designed to provide information regarding the deployment and movement of enemy forces. It will use radar technology to obtain high-resolution imagery of static features and will also identify and track moving vehicles. A number of Global Express commercial business jet aircraft, able to operate above 40,000 ft and which have an endurance in excess of nine hours, will be modified to carry the radar, air-to-ground data links and defensive aids equipment. Imagery gathered will be transmitted in near-real-time to a network of distributed Ground Stations deployed with front-line forces. Images will be displayed and analysed within the Ground Stations, ensuring that tactical commanders are aware of the latest developments on the ground. The In Service Date will be 2005.

CAP 168
Civil Aviation Publication 168 "Licensing of Aerodromes". Contact CAA Safety Regulation Group for further information.

CAP 670
Civil Aviation Publication 670 "Air Traffic Services Safety Requirements". Contact CAA Directorate of Airspace Policy for further information. Also available from www.caa.co.uk/docs/33/CAP670_A05.pdf

Doppler Shift
When an object is moving radially (that is towards or away from a transmitter), the frequency of the returned echo is shifted from the original frequency by an amount dependent on the radial velocity of the target. This change in frequency is called the Doppler Frequency or Doppler Shift.

Garbling
False codes displayed when aircraft are close enough for their SSR responses to overlap.

Greenhouse Gas
Greenhouse gases include any gas in the atmosphere that is capable, as a result of its particular molecular structure, of absorbing infrared radiation or heat. They are called greenhouse gases because they behave like glass in a greenhouse, allowing sunlight to pass through but trapping the heat formed and preventing it from escaping, thereby causing a rise in temperature. Natural greenhouse gases include water vapour or moisture, carbon dioxide, methane, nitrous oxide and ozone. The amounts of all these gases in the atmosphere are now increasing as a result of man-made processes, such as burning fossil fuels and deforestation.

High Intensity Radio Transmission Areas
High Intensity Radio Transmission Areas (HIRTAs) are established to warn aircraft of the presence of high power radio transmissions, which could seriously interfere with on-board systems. Their dimensions are determined by calculating the radio propagation paths and intensities.

Height A number of different terms are used to denote the height of an aircraft. All are based on vertical distance from a given datum: either the ground, sea level or an agreed reference. The normal measure used is feet. Whilst an aircraft's height may therefore be expressed in different ways, it is its height relative to the height of a wind turbine above the ground (or sea) that is important in the context of this document.

Navigation Aids Systems which aid aeronautical navigation.

Radar Radio Detection and Ranging. A system for detecting the presence or position or movement of objects by transmitting radio waves, which are reflected back to a receiver.

Radar Clutter Radar returns (echoes) from objects (targets) considered irrelevant to the purpose of the radar.

Radar Masking The masking of aircraft by reflecting or deflecting the radar echoes such that aircraft flying in the "shadow" of an object are not detected.

Radar Echo When the radio wave transmitted by a radar is interrupted by an object part of the energy is reflected back to a radio receiver located near the transmitter. This reflection is called an echo and the object reflecting it is called the target.

Recognised Air Picture The fullest achievable agreed level of identification and tracking of all airborne contacts in the area of interest.

Safeguarding Process The stakeholders in both civil and military aviation conduct a process aimed to ensure that their needs are not compromised that is termed "safeguarding". The formal term "Safeguarding" in association with wind turbines is only used for civil purposes; military agencies do not have an equivalent formal term but follow effectively the same procedures. For simplicity, the term "safeguarding" in this document is used to refer to both civil and military processes.

Secondary Surveillance Radar A radar system comprising a ground-based transmitter/receiver which interrogates a compatible unit in an aircraft (transponder), providing an instant and automatic radar identification without having to manoeuvre.

Surveillance The systematic observation of aerospace, surface or sub-surface areas, places, persons or things, by visual, aural, electronic, photographic or other means.

Tactical Data Link Means of communication, used primarily by the military, for transmission and receipt of a data messages.

Tactical Training Areas Tactical Training Areas (TTAs) are military training areas where Operational Low Flying at altitudes below 250 feet minimum separation distance (msd) is permitted. Within these areas, fast jet aircraft are permitted to fly as low as 100 feet msd. The TTAs are located in: northern Scotland, the border areas of northern England/southern Scotland, and in central Wales.

Transponder

The airborne receiver/transmitter portion of the SSR system, which receives the interrogation signal from the ground and automatically replies according to mode and code selected. Modes A and B are used for identification, using a four-digit number allocated by air traffic control. Mode C gives automatic altitude readout from an encoding altimeter.

UK Air Surveillance and Control System

The UK Air Surveillance and Control System (ASACS) comprises the surveillance and command and control systems which are used to detect and identify aircraft approaching, over-flying or leaving the UK and thence to produce a Recognised Air Picture (RAP). The ASACS has three main elements:

– Ground-based radars.
– Airborne radars.
– Command and Control systems (These systems are used to provide a composite picture of air activity (the RAP) and to direct responses to any activity that may warrant action).

UK Airspace

UK Airspace is divided into 2 main areas, known as Flight Information Regions, or FIRs, the Scottish FIR, and the London FIR. The responsibility for these lies with three centres: the London Area and Terminal Control Centre (LATCC) situated at Swanwick, the Scottish Oceanic and Area Control Centre at Prestwick, and the Manchester Area Control Centre (MACC), at Manchester Airport.

LATCC covers all airspace over England, Wales and Scotland up to 55 degrees North. The region North of this is covered by Scottish FIR. Manchester covers an area from surface to Flight Level 195 (Approx. 19,500 feet) in the Manchester area, extending West towards Dublin, East to Humberside, South to Birmingham and North to the Scottish Border. Manchester also has an extra area which covers ‘open’ airspace over the Yorkshire area designated ‘Pennine Radar’

For the purposes of controlling Air Traffic in manageable areas, each FIR is further split into ‘sectors’ for which a controller has responsibility.

UK Low Flying System

A system designed to allow the management of military low flying overland and surrounding overseas areas (extending out to 3nm from the land). It covers the whole of the open airspace of the UK and surrounding overseas areas from the surface to 2000 feet above ground or sea level.

Wind Farm

A collection of wind turbines designed to generate electricity, which is often fed into a grid distribution system.

Wind Turbine

A machine for generating electricity from the wind.

ANNEX G
List of Acronyms

AOD	Above Ordnance Datum
ASACS	Air Surveillance And Control System
ASTOR	Airborne Stand-Off Radar
ATC	Air Traffic Control
ATS	Air Traffic Services
ATSSD	Air Traffic Services Standards Department
BWEA	British Wind Energy Association
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
CNS	Communications, navigation and surveillance
D Flying MOD	Directorate of Flying, Ministry of Defence
DAP (CAA)	Directorate of Airspace Policy (Civil Aviation Authority)
DCSA	Defence Communications Systems Agency
DE	Defence Estates
DEFRA	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DPA	Defence Procurement Agency
DTI	Department of Trade and Industry
DTLR	Department of Transport, Local Government and the Regions
EM	Electromagnetic
EWTR	Electronic Warfare Tactics Range
HIRTA	High Intensity Radio Transmission Area
HQ 2 Gp MOD	Headquarters No. 2 Group, Ministry of Defence
HQSTC MOD	Headquarters Strike Command, Ministry of Defence
ILS	Instrument Landing System
LF	Low Flying
LFS	Low Flying System
LOS	Line of Sight
LPA	Local Planning Authority
LTCC	London Terminal Control Centre
m	Metre(s)
m/s	Metres per second
Met	Meteorological
MOD	Ministry Of Defence

msd	Minimum Separation Distance
MTI	Moving Target Indicator
MW	Megawatt
NAI	Non-Automatic Initiation
NATS	National Air Traffic Services
Navaids	Navigation Aids
NFFO	Non-Fossil Fuel Obligation
nm	Nautical mile(s)
NPPG6	National Planning Policy Guideline 6
ODPM	Office of the Deputy Prime Minister
OFGEM	Office of Gas and Electricity Markets
OS	Ordnance Survey
PAN	Planning Advice Note
PIU	Performance and Innovation Unit
PPG22	Planning Policy Guidance Note 22
PPW	Planning Policy Wales
RAP	Recognised Air Picture
RO	Renewables Obligation
rpm	Revolutions per minute
SRG	Safety Regulation Group
SSR	Secondary Surveillance Radar
STAR	Standard Arrival
SID	Standard Instrument Departure
TTA	Tactical Training Area
TAN8	Technical Advice Note 8
TWh	Terawatt-hours

ANNEX H
Contact Addresses

The Airport Operators' Association
Birdcage Walk
London
SW1H 9JJ
www.aoa.org.uk

British Wind Energy Association
Renewable Energy House
1 Aztec Row
Berners Road
London
N1 0PW
Telephone 020 7689 1960
e-mail info@bwea.com
www.britishwindenergy.co.uk

Civil Aviation Authority
Directorate of Airspace Policy
CAA House
45-59 Kingsway
London
WC2B 6TE
Andy Knill (Telephone 020 7453 6530;
e-mail: Andrew.Knill@dap.caa.co.uk)
www.caa.co.uk/dap

Civil Aviation Authority
Safety Regulation Group
Aviation House
Gatwick Airport South
West Sussex
RH6 0YR
Andy Sneddon (Telephone 01293 573432;
e-mail Andy.Sneddon@srg.caa.co.uk)
Enquiries 01293 567171
www.caa.co.uk/srg

Department for Environment, Food and Rural Affairs
Nobel House
17 Smith Square
London
SW1P 3JR
www.defra.gov.uk

Department of Trade and Industry
1 Victoria Street
London
SW1H 0ET
Robert Lilly (Telephone 020 7215 6122;
e-mail Robert.Lilly@dti.gsi.gov.uk)
Keith Welford (Telephone 020 7215 0478;
e-mail Keith.Welford@dti.gsi.gov.uk)
www.dti.gov.uk/energy/leg_and_reg/consents/index.shtml

DTI's Renewable Energy Helpline
B329 Harwell
Oxon
OX11 0QJ
Tel: 01235 432450
e-mail: NRE-enquiry@aeat.co.uk
www.dti.gov.uk/renewable/index.html

Department for Transport
Great Minster House
76 Marsham Street
London
SW1P 4DR
www.aviation/dft.gov.uk

Ministry of Defence (Defence Estates)
Blakemore Drive
Sutton Coldfield
West Midlands
B75 7RL
Mark Pickett (Telephone 0121 311 3847;
e-mail: Mark.Pickett@de.mod.uk)
www.defence-estates.mod.uk

National Air Traffic Services
1 Kemble Street
London
WC2B 4AP
www.nats.co.uk

NATS En-Route Limited
Nav, Spectrum & Surveillance
Spectrum House
Gatwick Airport South
Gatwick
West Sussex
RH6 0LG

NATS (Services) Limited
Technical Safeguarding
Room 101
Control Tower Building
Heathrow Airport
Hounslow
Middlesex
TW6 1JJ

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

Northern Ireland Planning Service Agency
Clarence Court
Adelaide Street
Belfast
BT2 8GB
www.doeni.gov.uk/planning

Office of the Deputy Prime Minister
Eland House
Bressenden Place
London
SW1E 5DUOf
www.planning.odpm.gov.uk

Office of Gas and Electricity Markets
(OFGEM)

9 Millbank
London
SW1P 3GE

Regents Court
70 West Regent Street
Glasgow
G2 2QZ

www.ofgem.gov.uk

Performance and Innovation Unit
4th Floor
Admiralty Arch
The Mall
London
SW1A 2WH
www.piu.gov.uk

Scottish Executive
Enterprise and Lifelong Learning Dept
Energy Division
Meridian Court
Cadogan Street
Glasgow
G2 6AT
www.scotland.gov.uk/planning

Scottish Executive
Development Department
Planning and Building Standards
Victoria Quay
Edinburgh
EH6 6QQ
www.scotland.gov.uk/planning

H

ANNEX I
Stakeholder Feedback Proforma

Name, organisation and contact details	Comment (including section number commented on, where appropriate)

When completed, this form should be sent to:

Fiona Brocklehurst
Future Energy Solutions
AEA Technology plc
Harwell
Didcot
Oxfordshire
OX11 0QJ

Or alternatively, send an e-mail titled ‘Feedback on wind energy and aviation interests - interim guidelines’ and containing your name, organisation and contact details to:

Fiona.Brocklehurst@aeat.co.uk

Department of Trade and Industry

DTI/Pub URN 02/1287