Chapter 15: Shadow flicker, aviation and communication

Introduction

15.1 SKM undertook a study to examine the potential effects of the proposals on:

- sensitive receptors that may be susceptible to shadow flicker from the turbines
- communication links that cross the site
- aviation.

15.2 This chapter presents the findings of these assessments.

Shadow flicker

15.3 Shadow flicker is defined by the Government planning portal as:

'*the on-and-off flickering effect of a shadow caused when the sun passes behind the rotors of a wind turbine*.'

15.4 It is an effect that occurs only under specific conditions (time of day, height of sun and geographic location of turbine) when the sun is low in the sky and the turning blades cast patches of shade that flick on and off through a narrow aperture such as window or door openings. Reflected light from the turbine blades may also cause a similar flickering effect.

Communication

15.5 Wind turbines can cause disruption to communication systems that rely on electromagnetic radiation (EMR). The size and nature of the rotating blades of the turbine structures can cause reflection and scattering of EMR. In addition, the electrical components of the turbine emit their own EMR that could interfere with signals and other equipment.

Aviation

15.6 There are a number of airports in the wider area that use the air space over the Isle of Wight. These include Southampton International Airport, Bournemouth International Airport, Bembridge Airport and Sandown Airport. This assessment examines the potential effects of the proposals on flight paths that may pass over the site.

15.7 Table 15.1 lists the data sources and references used in the assessment.

PPS 22 Planning Policy Guidance: Renewable Energy
PPS 22 Companion Guide
BWEA website www.bwea.com
Bacon D.F, 2002, Fixed link wind turbine exclusion zone, Ofcom
Clarke, A. D., October 1995. Assessment of Proposed Wind Energy Project at Meenacahan, Donegal, Ireland, for Shadow Flicker. Report for B9 Energy Services Ltd.
Table 15.1: data sources and references

Legislation and policy

15.8 The companion guide to PPS 22 considers the issue of shadow flicker and states that *'Only properties within 130º either side of north, relative to the turbines can be affected at these latitudes in the UK'* and that *'Flicker effects have been proven to occur only within ten rotor diameters of a turbine.'*

15.9 PPS 22 states that *'It is the responsibility of developers to address any potential impacts, taking account of Civil Aviation Authority, Ministry of Defence and Department for Transport in relation to radar and aviation...'*

Methodology

Shadow flicker

Methodology

15.10 A desk-based study was carried out to assess the potential effects of the proposal in relation to shadow flicker on sensitive receptors around the site.

15.11 Following the information in the companion guide to PPS22, a zone of influence was determined for each of the turbines, where its shadow is predicted to pass over the course of a year.

15.12 Once the zone of influence had been determined, receptors located within the zone were identified and characterised through the use of maps, aerial photographs and site visits.

15.13 The assessment of significance of potential effects (figure 5.1) has been derived from the receptor sensitivity and the magnitude of impact.

Assessment of significance

15.14 There are no known guidelines relating to the sensitivity of receptors, magnitude of impact or even the threshold at which shadow flicker is considered to be a nuisance.

15.15 Receptors such as schools, nurseries, hospitals and community facilities are attributed a high sensitivity as they might accommodate larger concentrations

of people. Individual dwellings located within the shadow sweep have been attributed a medium sensitivity.

15.16 The outer edge of the sweep of shadow flicker is based on a distance of 10 rotor lengths from the turbine (Clarke 1995), calculated as 820m for this site (figure 15.1). The accompanying guide to PPS 22 states that for potential shadow flicker, '*The further the observer is from the turbine the less pronounced the effect will be.*' The magnitude of change categorisation has therefore been related to the distance between the receptor and turbine. The shadow sweep is divided into three concentric zones. In the inner zone, closest to turbine, the magnitude of change is high; in the central zone a medium change is expected; and a small magnitude of change is given for receptors in the outer zone. Receptors outside the zone of influence are attributed negligible change.

15.17 While shadow flicker effects may increase with the numbers of turbines casting the shadow, this is difficult to quantify and such considerations have been excluded from the methodology. Other aspects of relationships between the turbine and receptors may be used to modify the magnitude of effect, such as:

- aperture of windows and angle of view
- number and nature of windows (room type, for example)
- orientation of the residence relative to the turbine
- presence of intervening topography, buildings or vegetation
- turbine hub-height and rotor diameter
- frequency of bright sunshine and cloudless skies
- prevailing wind direction and hence usual rotor orientation
- colour and finish of the turbine blades
- actual sensitivity of receptor in affected room.

Communication and aviation

Methodology

15.18 The potential effects of the proposals on communication systems have been assessed through consultation with stakeholders. Their responses highlight the degree to which the presence of the proposals will affect communication signals carried by their infrastructure and equipment. The following were consulted:

- Civil Aviation Authority (CAA)
- National Air Traffic Services (NATS)
- Southampton International Airport
- Bournemouth International Airport
- Bembridge Airport
- Ofcom
- T-Mobile
- BT
- Orange
- Cable and Wireless

- National Grid Wireless (formerly Crown Castle)
- BBC
- Arqiva
- MoD (Defence estates)
- Southampton Harbour Master.

Assessment of significance

15.19 The communication systems impact assessment is based on the results of this consultation. Where communication systems owners and operators advise that they have no objection to the proposed development, it is considered that there would be a negligible significance of effect. Where a holding objection is made until further investigation is carried out, it is considered that there will be a moderate significance of effect. A firm objection is considered to be a high significance of effect.

Baseline

Shadow flicker

15.20 Figure 15.1 shows that two dwellings are located within or on the outer edge of the zone of influence and susceptible to shadow flicker.

15.21 Dog Kennel Cottage falls within the outer sector of the shadow flicker zone of the westernmost turbine (T1), but is unaffected by the other turbines. The property overlooks the site, but is situated in a slight hollow, with a number of hedgerows between it and the site.

15.22 Hartshole Cottage to the north of the site is on the outer limit of the zone of influence. This cottage is orientated north-east/south-west front/back, with no upper floor windows and two lower windows on the back of the property. The south-eastern side has two upper and two lower floor windows. The property is surrounded by a 2-metre high hedge, which is close to the house.

Aviation and communication

15.23 Responses from consultees listed at the beginning of this chapter are shown in table 15.2, and highlight any concerns arising over the proposed development in relation to aviation activities and communication operations.

15.24 National Air Traffic Services (NATS) has confirmed that a number of local and national aviation operations have flight paths and radar crossing the Hampshire and Isle of Wight region.

15.25 Some communication links pass through the site. Figure 15.2 shows the location of these corridors in relation to the turbines. The buffer shown is 150 metres.

Potential effects

Shadow flicker

15.26 Residential properties have been identified as being of medium sensitivity. The magnitude of change experienced at properties is assessed individually. The siting of the properties, their alignment, and location in relation to topography, coupled with existing screening vegetation, will also influence the degree of shadow flicker experienced and hence the significance of any effect.

15.27 Dog Kennel Cottage lies in the outer zone of potential interference with a potential small magnitude of change. This, combined with the medium sensitivity of the receptor, means there is the potential for an impact of moderate significance. However, given the orientation of the cottage and the topographical characteristics described, the significance of effect is likely to be less, and probably not significant.

15.28 Heartshole Cottage lies on the outer limit of the zone of shadow flicker. The potential effect on this sensitive receptor is predicted to be of moderate significance, given that it falls just within the outer zone of influence (small magnitude) and it is a residential dwelling (medium sensitivity). However, this is considered a worst-case assessment; as the property is on the very limit of the shadow flicker zone and is surrounded by a hedge, the effects of shadow flicker will be further reduced, and will probably not be significant.

Aviation and communication

15.29 Responses from consultees listed at the beginning of this chapter are shown in table 15.2. These highlight any concerns arising over the proposed development in relation to aviation activities and communication operations.

15.30 After following the online screening tool as indicated by the National Air Traffic Services (NATS) the results showed that the proposal will have no effect on its infrastructure.

15.31 Arqiva suggests that the proposals may affect the quality of television broadcasts received by some local properties from the Rowridge TV transmitter. The likelihood of broadcasting interference requires property-specific investigation during commissioning and operation of the wind farm. Complete mitigation is possible through measures that can be put in place, and can be addressed in planning conditions.

15.32 T-Mobile has objected to the proposals because turbine T1 is 108 m from T-mobile link ML1181. The separation distance between communication links and wind turbines recommended by the Radio Communications Agency is the calculated as the 2nd Fresnel Zone, which is 67m in the case of Turbine 1. T-Mobile's company policy states that proposed wind turbines or wind farm site boundaries should be at least 250 m from the line of sight of a planned or installed radio link. The effect is potentially of high significance. However, the analysis for this assessment by SKM suggests that the T-Mobile distances are

over-precautionary (and in excess of the more usual standards) and a significant effect is not predicted (see appendix at the end of this chapter).

15.33 The Civil Aviation Authority has raised concerns over the possible effects of the proposal on operations at Bournemouth and Southampton Airports. The Pre-Planning Consultation Form has been completed and response awaited.

Consultee	Response	Comment
NATS	No objection	
CAA	Awaiting response	Informal suggestion of adverse effects on Bournemouth and Southampton Airports, awaiting consultation response.
Southampton Airport	No response	
Bournemouth International Airport	No response	
Bembridge Airport	No response	
Sandown Airport	No response	
Ofcom	No objection	
T-mobile	Objection	Turbine T1 is 108 m from T-Mobile link ML1181. The company states that proposed wind turbines or wind farm site boundaries should be at least 250 m from the line of sight of a planned or installed radio link.
BT	No objection	
Orange	No objection	
Cable and Wireless	No objection	
National Grid Wireless	No objection	Note: A 50m buffer must be maintained around transmitter LOS. T1 is only 90m from link path, and must not move significantly north.
BBC	No response	
Arqive	Objection	A large number of viewers may be affected by interference with transmissions.
CSS Spectrum Management	No response	
Joint Radio Company	No objection	
Defence Communication Systems	No response	
Southampton Harbour Master	No response	

Table 15.2: Consultee responses

Mitigation

15.34 Two properties could be marginally affected by shadow flicker. The use of a grey finish on turbine towers and a grey semi-matt finish on the turbine blades will minimise the effects of reflected light. If shown to be necessary, any turbine shown to be responsible for shadow flicker can be programmed to shut down automatically for a short period until the sun has moved, thereby eliminating the problem completely.

15.35 Mitigation measures to reduce the impact on some communication systems are considered necessary. A pre-construction and post-construction television signal reception survey will be carried out to quantify the level and extent of interference and assess the appropriateness of mitigation measures. Mitigation will vary according to individual situations, but may include:

- re-orientation of existing aerials to an alternative transmitter
- installation of directional aerials to mildly affected properties
- supplying cable or satellite television services (subject to parallel broadcast of terrestrial channels)
- installation of a new repeater station in a location where interference can be avoided (this is more complex for digital but also less likely to be required for digital viewers)
- switching from analogue to digital television broadcasts where available through the installation of 'free view' type digital receiver boxes.

Residual effects

15.36 No residual effects are predicted from this assessment.

Appendix to Chapter 15

15A 1 This appendix provides background information relating to chapter 15, shadow flicker, aviation and communication.

Sources and nature of communication system interference

15A 2 Large structures, such as wind turbines (stationary and moving), in the vicinity of the beam path or line of sight (LOS) between a transmitter and receiver of electromagnetic signals, can interfere with the signal and degrade the performance of the communication system. Wind turbines may also passively reflect a transmitted signal, causing multi-path transmission (the Doppler interference effect).

15A 3 The extent to which interference may be caused is dependent on the following parameters:

- location of turbine in relation to LOS
- type of wind turbine (the physical and electrical characteristics of the blades and tower)
- signal frequency and modulation
- receiver antenna characteristics
- communication signal wave propagation in the local atmosphere

15A 4 A wind turbine may degrade the performance of fixed microwave links that rely on an antenna that directs a narrow beam of radio waves to a specific receiver. A direct LOS is required and turbines blocking this may result in the loss of the link

15A 5 A wind turbine may also degrade the performance of a fixed link if it is within a certain lateral distance of the link, known as the Fresnel Zone, which is described by the US National Communication System Technology & Standards Division as:

'Fresnel Zone: In radio communications, one of a (theoretically infinite) number of concentric ellipsoids of revolution which define volumes in the radiation pattern of a (usually) circular aperture. Note: The cross section of the first Fresnal Zone is circular. Subsequent Fresnel Zones are annular in cross section, and concentric with the first.'

15A 6 The degradation mechanism of these fixed radio links is similar to that for television reception (diffraction, reflection and or scattering), where if the reflected part of the signal enters the receiver at a strong enough level when compared to the primary or required signal, the combination of the signals and the time delay (phase shift) may degrade performance.

15A 7 The criteria for avoiding diffraction effects is typically to apply an exclusion zone around a fixed link ray line equivalent to 0.6 of the first Fresnel Zone radius (however, this depends strongly on the

characteristics of the receiving antenna). Approximately 90% of the energy arriving at a receiver from a transmitter is contained within the first 0.6 of the Fresnel Zone radius. This is typically applicable to large static obstructions and terrain.

15A 8 Various clearance distances from the first Fresnel Zone to three times its width have been proposed for wind turbines to ensure immunity from interference. Although clearance zones are applied in 3-dimensional space, turbine layouts and mapping is usually carried out in the 2 – dimensions.

15A 9 A near-field clearance zone also exists around a transmitter and receiver where local inductive fields are significant and an object placed in the near-field will degrade the performance of the link. However, the near-field zone clearance zone is typically of the order of tens of metres and appropriate positioning of turbines can avoid causing degradation due to near-field effects.

15A 10 Additionally, the size of the reflection/scattering clearance zone is required to ensure that any multi-path effects caused by the wind turbines are negligible. This clearance zone applies closer to transmitter and receiver.

15A 11 Microwave fixed link exclusion zones for wind turbines can be calculated accurately based on Fresnel Zones around the LOS between two antennae, each Fresnel Zone representing an increased distance from the link. Guidance is available in a Radio Communications Agency Paper (Bacon DF, 2002) which suggests that, to avoid impact, a wind turbine exclusion zone be equal to the complete 2nd Fresnel Zone. The separation distance between the wind turbine blade and the microwave fixed link (at its shortest distance) should therefore equal the 2nd Fresnel Zone.

15A 12 Table 15A.1 presents preliminary calculations of the 2nd Fresnel Zone radius in relation to the T-Mobile and National Grid Wireless Telecom links in the proximity of Turbine 1, and identifies the actual separation distance from Turbine 1 to the link.

15A 13 On the basis of the calculated 2nd Fresnel Zone radius, Turbine 1 is compliant with the Radio Communications Agency recommendations. There will therefore be no impact on mobile communications network operators.

Turbine reference	Link operator	Separation distance between antennae (km)	Distance from closest antennae to turbine (km)	Link frequency (GHz)	Calculated 2nd Fresnel Zone radius (m)	Current distance from blade tip to link (m)	Actual separation distance greater than preliminary calculated separation distance
T1	T-mobile	41	7	7.7	<25	67	Yes
T1	National Grid Wireless	41	7	7.4	<25	67	Yes

Photosensitive epilepsy

15A 14 Photosensitive epilepsy is a condition brought on by strong flashing or flickering of lights or images. Epilepsy affects only 0.005% of the general population Photosensitive epilepsy is a condition that affects only 3-5% of those who suffer from some form of epilepsy.

15A 15 The factors influencing the onset of a seizure include the frequency and intensity of flickering, and the proportion of the field of view exposed. The frequency required to trigger seizures varies from one individual to another, but is generally between 5 to 30 Hz. Whilst some people are sensitive to higher frequencies, it is relatively unusual for people to be sensitive to frequencies below 5 Hz. Less than 5% of photo-sensitive epileptics are sensitive to the lowest frequencies of 2.5 to 3 Hz.

15A 16 The Vestas V82 turbine under consideration for this proposal has operating speeds of approximately 15 rpm. On this basis, and because the turbine is three bladed, the flickering frequency will be equivalent to three times the wind turbine's operating speed, or approximately 0.75 Hz. The proposed development will therefore not be operating within the frequency range that could trigger a photosensitive epileptic seizure