

Tall structures and their impact on broadcast and other wireless services

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Section 1

Foreword

1.1 Purpose of this document

Large building developments and structures such as wind turbines can affect reception of wireless services, including domestic television reception. This document is intended to provide an overview of the issues for developers and Local Planning Authorities and of the mitigation measures that might be taken by households affected. It also gives sources for further information and advice.

1.2 Ofcom's role and duties

Ofcom is a regulatory body that is independent from Government. We are given powers and duties by Acts of Parliament. Ofcom's primary duties are set out in the Communications Act 2003. These include ensuring optimal use of the electromagnetic spectrum (sometimes called the radio spectrum or 'the airwaves').

Under the Wireless Telegraphy Act 2006, Ofcom is also responsible for protecting the spectrum from interference or abuse, which may be either deliberately or unintentionally caused. We offer an interference investigation service with field officers that are able to look into complaints of interference to domestic TV and radio reception or business radio. We have legal powers to deal with interference where the cause is due to illegal or malfunctioning electrical equipment.

We do not have any powers or means of providing a remedy if the cause of the interference is due to generally poor signal levels in a particular area, or if it is due to a physical obstruction, or signal reflection, from such a large new building or wind turbine. Therefore we aim to provide information to developers and planners so that potential issues can be identified and appropriate remedies planned at an early stage of a project to minimise inconvenience and disruption later.

Ofcom gratefully acknowledges the assistance of the BBC in compiling this document.

Section 2

Introduction

2.1 The impact of new structures on reception of wireless services

Tall buildings and structures can disrupt wireless services. We recommend that consideration of the impact of a new development on wireless services is undertaken at the design and planning stages.

Developers can assess any consequential impact that their development may have on wireless services before the development takes place and allow for any mitigation measures at the planning stage. This should reduce the likelihood of unexpected problems arising during or after the development has taken place.

Local Planning Authorities can take into account the impact of a development on wireless services when considering planning applications and can choose to put proportionate conditions on developers to provide a remedy if appropriate[1].

Ofcom has produced this note to provide information to developers and local authority planners. It also outlines some of the mitigation measures that might be taken by households or communities affected by a development and gives sources of further information and advice.

2.2 Wireless services

'Wireless service' is a general term for any technology that sends signals from one device to another without the two being connected by wires. Instead, signals are transmitted in the radio spectrum using electromagnetic waves.

In this document we consider wireless services that might commonly be affected by building developments. These may be broadcast services for reception by members of the public (for example television), business radio (for example voice or data communications between commercial premises) or point to point microwave fixed links (for example the interconnecting infrastructure to mobile phone base stations).

[1] Under section 106 of the Town and Country Planning Act 1990 [in England and Wales], section 75 of the Town and Country Planning (Scotland) Act 1997 [in Scotland] or section 40 of the Planning (Northern Ireland) Order 1991 [in Northern Ireland].

Section 3

How structures affect wireless services

3.1 Background

In the majority of cases, new building developments such as housing, low-rise office developments and building extensions will have no significant effect upon wireless services.

Problems are more likely to occur if a building or structure is constructed which is significantly taller than those around it, or is on high ground. In general, wireless services work best if there is a clear path between the source of the signal (the transmitter) and its intended destination (the receiver). Large structures within, or near to, this path can affect the signals. This may lead to a degrading of the performance or even a complete loss of a wireless service.

There are two potential mechanisms that can cause problems to wireless services: physical blocking of the signal by the structure; and reflection from the sides of the structure.

3.2 Signal blocking

Wireless signals, especially those using relatively high frequencies such as television, behave much like light. Therefore it is desirable to have a clear line of sight path between the transmitter and a receiving aerial in order to achieve the most reliable reception. The presence of a tall structure between the transmitter and receiver will cause a 'shadow' to be cast behind the structure on the side opposite the transmitter. This effect is similar to the way that an obstruction between a lamp and an observer's eye blocks out the light.

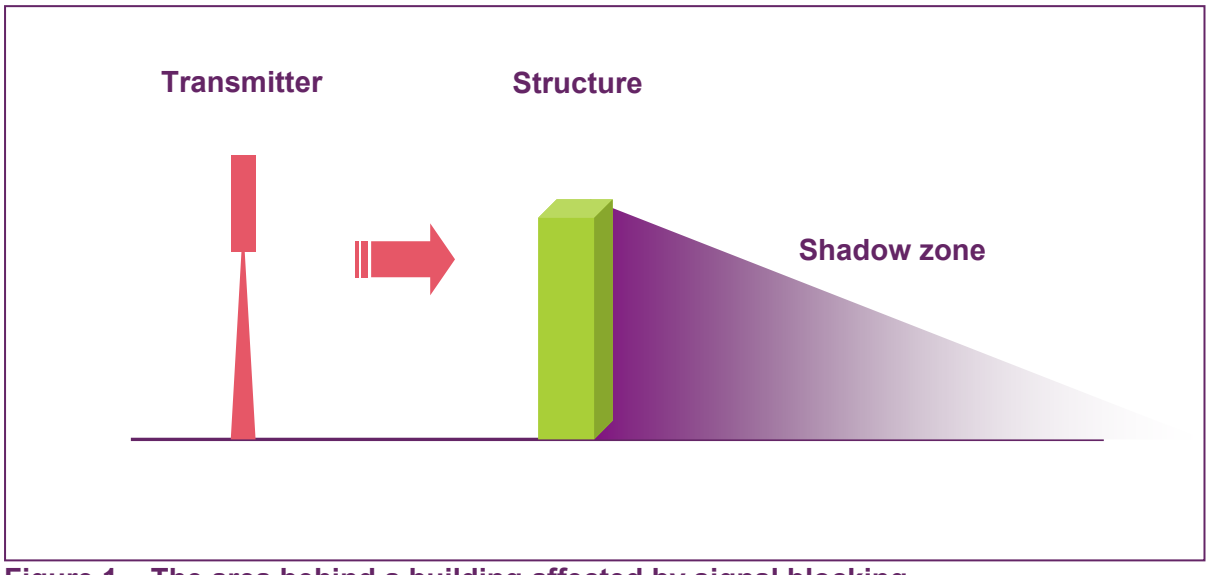


Figure 1 – The area behind a building affected by signal blocking

The shadow cast by a structure does not have hard edges though and does not usually extend indefinitely. While there would be a large reduction in signal levels immediately behind the structure, the blocking effect of the structure diminishes with distance because of diffraction. Diffraction is a process where signals appear to bend behind the structure and partially fill in the shadow.

In general, there will be three ‘zones’ behind the structure:

Zone A - close behind the structure (typically a few tens of metres) there may be a large reduction in signal level with a possible complete loss of reception

Zone B - further away (typically a few hundred metres) the signal reduction is less severe and the shadow will be smaller as diffraction effects partially fill in the shadow. Depending on the size of the structure, some locations could still lose reception completely

Zone C - some distance away (1-5km) the shadow will effectively have disappeared

The resulting shadow is therefore a triangular shape as shown in Figure 2.

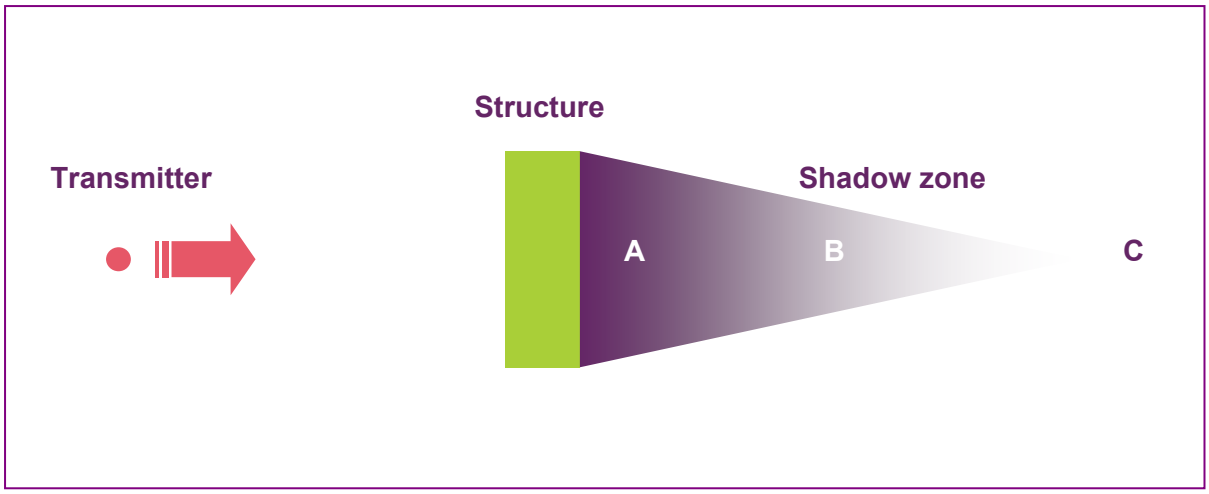


Figure 2 – Plan view of a structure’s shadow

It should be noted that the severity of the reduction and the actual size of the shadow will depend upon many factors including the construction of the structure and its height - the distances given above are for guidance only.

3.3 Signal reflection

Like light, wireless signals can also be reflected from the sides of structures. Signal reflections are commonplace - houses, roads and even natural features such as hills and trees can reflect signals. In many cases, these surfaces are not very good reflectors, so the reflected signals are relatively weak. However, if a building is clad in a reflective material (like metal sheeting) or has a steel frame or reinforcing (which is common in large buildings), the reflections can be quite strong.

Furthermore, if the structure is moving, as in the case of a wind turbine’s rotating blades, the reflections will fluctuate and be quite complex. The nature of the reflections will largely depend upon the rotational speed of the blades, and upon the varying angle of the blades to the source of the signal and the receiver.

Reflections can sometimes cause reception problems. Difficulties are usually, though not exclusively, evident on analogue wireless systems (digital systems are usually much more resistant to the effects of reflections). The effect is caused when the aerial receiving a signal from a transmitter also picks up a signal that has been reflected from a structure. The reflected signal takes a longer path and therefore arrives at the receiver later than the direct signal. If the reflected signals are quite strong, reception of some wireless services can be affected, even at locations that are not in the shadow of the structure.

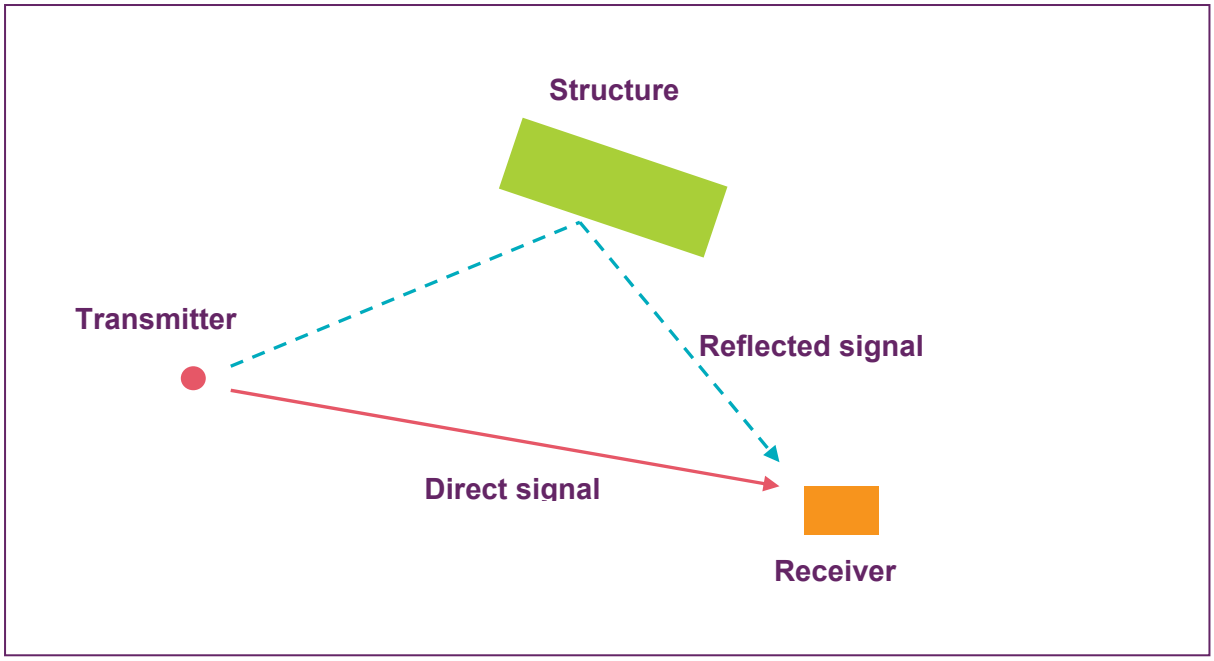


Figure 3 – Direct and reflected signals

Reflections potentially affect receivers all around a structure and the reflection zone can thought of as a circle with the structure in the middle. Where the receiver uses an aerial that is designed to receive signals better in some directions than others (known as a directional aerial) the shape of the zone within which reception might be affected becomes a 'keyhole' shape as illustrated in Figure 4. Most domestic television aerials are directional.

The radius of the hole around the structure is usually limited to less than a few tens of metres, perhaps extending to a few hundred metres for a very tall and reflective structure. The 'slot' part of the keyhole may extend for some kilometres, but typically for no more than 5km. The zone may be larger, particularly if the development is sited on much higher ground than the surrounding areas, as may happen with a wind farm. Reports have been received of reflection effects affecting broadcast television up to 20km from the structure, although this has only occurred in exceptional circumstances.

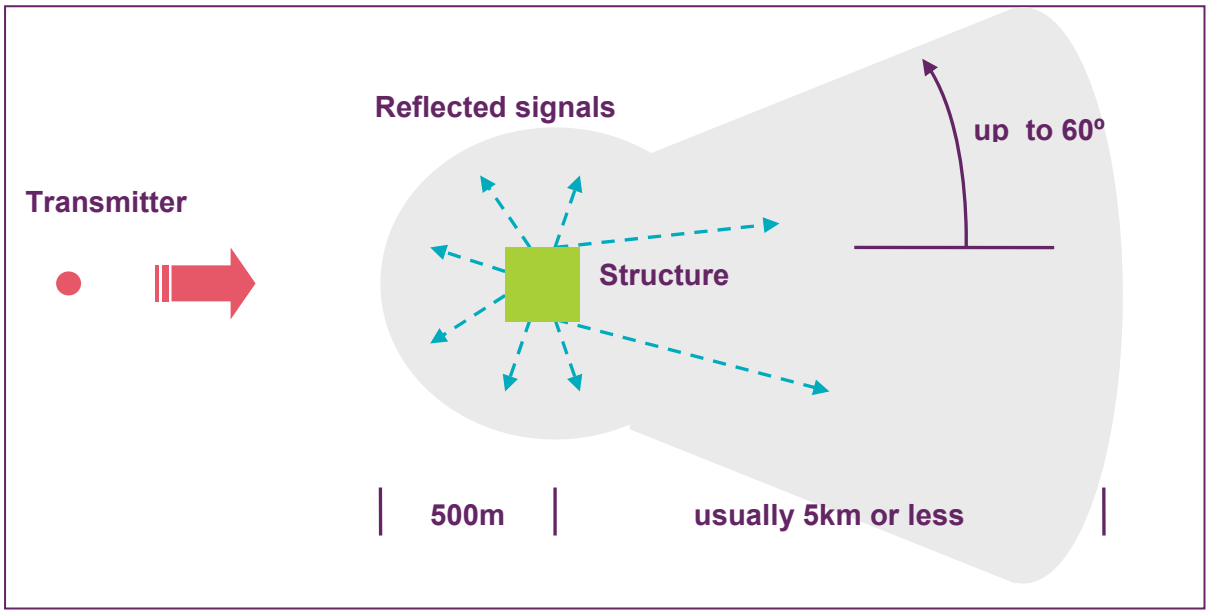


Figure 4 – Plan view of the area potentially affected by signals reflected by a structure

3.4 Effect on broadcast television services

Technologies such as analogue television are quite seriously affected by signal reflections, which can give rise to an effect known as 'ghosting'. Ghosting (or delayed image interference) is where a pale shadow or shadows appear to the right of the main picture on viewers' television screens. The reception of teletext on analogue TV can also be affected with an increase in the number corrupted characters displayed. Analogue terrestrial television will be phased out in the UK as digital TV switchover progresses. Switchover will be complete, and no analogue TV transmissions will remain, by the end of 2012.

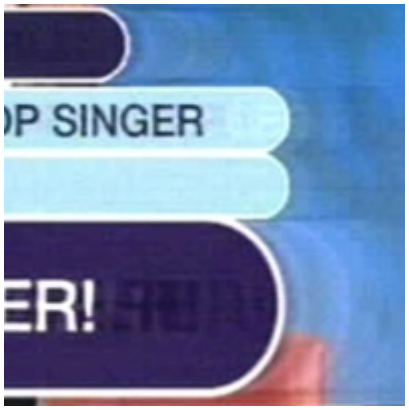


Figure 5 – 'Ghosting' on an analogue television picture

Digital television signals are much better at coping with signal reflections, and digital television pictures do not suffer from ghosting. However a digital receiver that has to deal with reflections needs a somewhat higher signal level than one that has to deal with the direct path only. This can mean that viewers in areas where digital signals are fairly weak can experience interruptions to their reception should new reflections appear. Over time, this problem is expected to diminish as the power of transmitters is increased as digital switchover continues across the UK. However, higher transmitter powers will not be a solution in all situations which means that reflections may still affect digital television reception in some areas, although the extent of the problem should be far less than for analogue television.

3.5 Impact on other terrestrial broadcasts

Although reports of new structures causing problems to radio reception are rare, the possibility of difficulties cannot be ruled out entirely. Broadcast radio (FM, AM and DAB digital radio) are transmitted on lower frequencies than those used by terrestrial TV signals. Lower frequency signals tend to pass through obstructions more easily than the higher-frequency TV signals, and diffraction effects also become more significant at lower frequencies. Both these factors will tend to lessen the impact of new structures on radio reception.

Strong signal reflections will reduce the quality of FM reception leading to fluttering noises or sound distortion. In contrast, the signal format used for DAB digital radio is designed to offer high levels of robustness in difficult conditions and it is not materially affected by reflections. FM and DAB reception can be affected where a structure blocks signals and both may cease to function if signals are reduced below a certain threshold.

3.6 Satellite television reception

Satellite TV reception is not generally affected by new structures unless the development blocks the 'line-of-sight' between a dish antenna and the satellite in the sky. While terrestrial TV aerials are generally mounted to receive signals in line with the horizon, and are therefore liable to be blocked by taller structures, satellite signals are received from a much higher elevation. This means that disruption to satellite reception is usually limited only to cases where a tall building is erected very close to an existing building.

The line of sight path from a dish to a satellite will depend on the location in the UK. For the Astra satellites at 28.2ºE, the dish elevation will vary between about 26º and 24º in the very south of England, reducing to around 17º in the far north of Scotland. If the new structure does not obstruct this angle to dishes on adjacent buildings, it is unlikely to cause a problem to reception of the most commonly used satellites. Switching to digital satellite reception may therefore be a solution in cases where terrestrial reception is blocked by a new structure.

In Figure 5 a tall structure blocks the path between the terrestrial transmitter and a viewer's property. However, the angle of elevation of the satellite (**β**) is greater than the angle (**α**) from the top of the structure to the viewer's house and satellite reception is therefore not affected by the structure.

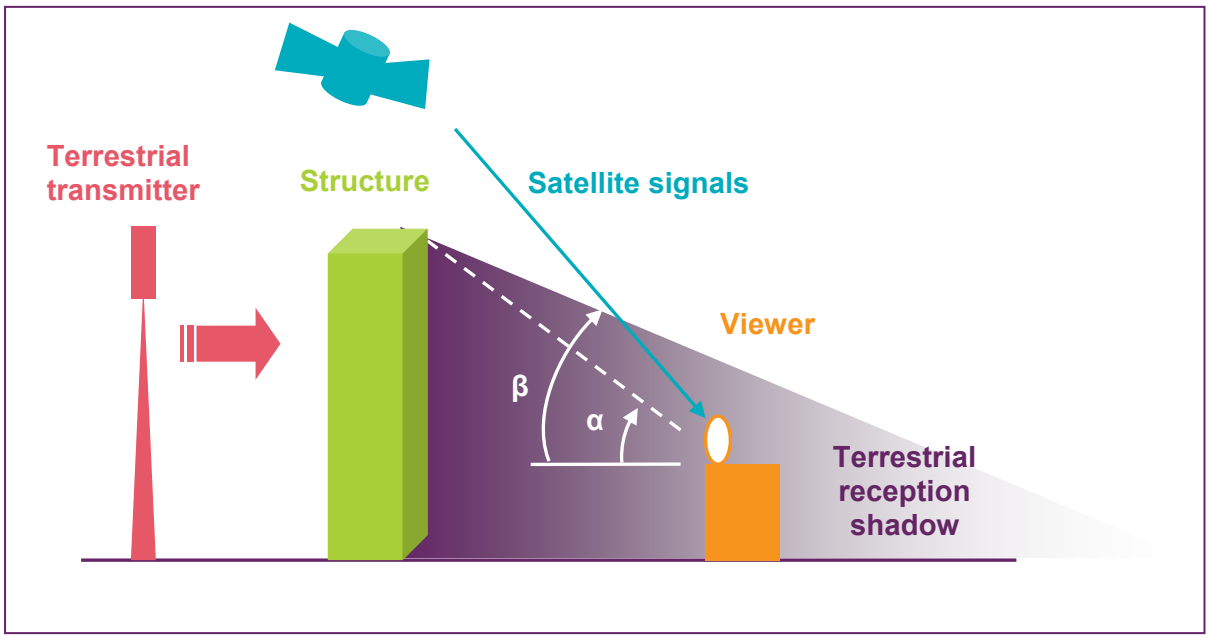


Figure 5 – Satellite reception not affected by a new structure

3.7 Fixed links

Ofcom licenses a large number of fixed wireless services over a wide range of frequencies. These are known as fixed links and are used by licensees for a number of uses; example uses are remote monitoring of unattended equipment (scanning telemetry), data transfer between business premises and voice communication. Because of the wide range of frequencies and distances involved, it is difficult to generalise on the impact that a development may have. Those links that use higher frequencies in the gigahertz range (such as microwave links) are mostly affected by physical blocking. Some links use lower frequencies and these can also be affected by reflections. Further information is available in section 4 of this document.

Section 4

Assessment of impact

4.1 Broadcast reception

Rooftop test

In the case of new building developments, a simple rule of thumb that can be used as an initial assessment of whether a new development might cause a reception problem is the 'rooftop test'. In simple terms, if the proposed development is of a similar height to the surrounding buildings it is unlikely to have any effect upon signals in the neighbourhood.

Even where a building is somewhat taller than those in the surrounding area, it will not necessarily lead to reception difficulties. Much will depend upon local signal strengths, the location of the transmitter(s) serving the area, the type of aerials used by householders and the direction they are pointing in relation to the new structure.

Commissioning a desktop assessment

Developers wishing to investigate the possible impact of a development can commission an assessment on a private basis from a suitably competent consultant organisation. Organisations offering wireless network planning or spectrum planning services are often suitably equipped to carry out such an assessment. Desktop assessments vary in complexity, but generally take into account transmitter and proposed development locations and consider whether there is a possibility that any households in the area would suffer reception problems.

Some further detailed technical information that may be useful to those making assessments is provided in Appendix 1 of this document. In the specific case of wind farms, the BBC provides an on-line tool (see Section 6.26.2) which is intended to offer an initial assessment of a turbine's potential impact on television reception.

Neither Ofcom nor the broadcasters (BBC, ITV etc.) offer advice on the potential effects of individual proposed developments on broadcast reception.

Reception surveys

Desktop surveys provide an indication a development's potential to affect reception. However, the only definitive quantitative way to determine whether a building development has had an effect upon television reception is to carry out a reception survey of the affected area. Two surveys would be required: one to assess the quality of reception prior to the commencement of any building work, and one after completion. Ofcom does not carry out this kind of survey, and the developer would need to engage the services of a suitably equipped contractor.

As a minimum, a reception survey should make measurements of a number of parameters at intervals that are appropriate to the density of the local population and the size of the development. For example, it may be appropriate to measure every few metres in a densely populated area, whereas much larger measurement intervals may be appropriate in sparsely populated rural areas, perhaps at individual properties. For a comprehensive survey, measurements of the following parameters should be made for each channel broadcast from the transmitter:

i) An assessment of which transmitter is in use by viewers.

ii) Measured field strength at 10m height.

iii) For analogue TV services, an assessment of the picture and sound quality to the 5 point scale[2].

iv) For digital TV services, a measurement of carrier-to-noise (C/N) ratio, Modulation Error Ratio (MER), pre-viterbi Bit Error Rate (BER) or similar parameters, in order to provide an indication of available decoding margin and/or absolute signal quality.

v) Note of any impairments such as ghosting, patterning, and break-up on the picture, or of buzzing, clicking and break-up on the sound.

vi) If ghosting or 'ringing' is evident on the analogue picture, a check should be made for the presence of any corrupted characters on the teletext display on a domestic television set.

4.2 Fixed wireless links and wind farms

Ofcom provides a fixed link clearance service to help ensure compatibility between proposed wind turbines and existing fixed point to point links that make use of Ofcom-assigned spectrum. When Ofcom are notified of a proposed wind farm location, we will carry out the following:

i) For fixed link systems above 1 GHz which are assigned and licensed by Ofcom, a check is made to determine whether any part of the wind farm falls either within 500 metres of the path between the link terminal locations or within 500m of the terminals themselves.

ii) If either check is positive, then Ofcom will provide the wind farm proposer with the fixed link licence number(s) and contact details for the licensees identified so that the wind farm developer can liaise with the appropriate fixed link system operator(s) for further co-ordination.

iii) For scanning telemetry systems Ofcom will endeavour, where practicable, to forward the received wind farm clearance requests to Atkins Ltd and the Joint Radio Company (JRC), who carry out the clearance process for scanning telemetry links in their assigned spectrum. They will check whether any part of the wind farm falls within 1 kilometre of the path between the link terminals, or the terminals themselves, of a point to multi-point system operating between 457.5 MHz to 464 MHz. Although Ofcom will endeavour to forward received requests, wind farm proposers are advised to also email, or send postal requests, direct to Atkins Ltd and JRC (contact details are given in Section 6 of this document).

[2] The 5-point grading scale is a method for classifying picture and sound degradation. The five classes are
Grade 5 imperceptible
Grade 4 perceptible, but not annoying
Grade 3 slightly annoying
Grade 2 annoying
Grade 1 very annoying
Full details are set out in the International Telecommunication Union's publication ITU-R BT.500.

iv) Atkins Ltd and JRC will respond directly to the wind farm developer with the results of the clearance check, Ofcom has no further involvement in the process.

More information on our wind farm clearance procedures is available on our website at www.ofcom.org.uk/radiocomms/ifi/licensing/classes/fixed/Windfarms/.

4.3 Television re-broadcast links

In some areas, the broadcasters use small relay transmitters to fill in local reception deficiencies. These relay transmitters pick up signals from one of the UK's main transmitters and re-broadcast them. This is called a re-broadcast link.

As well as affecting domestic reception directly, large structures can interrupt the signals that pass between a main television transmitter and smaller relay transmitters. There are around 50 main transmitters and over 1,100 smaller relay transmitters located around the UK.

The broadcasters use the transmission company Arqiva to distribute and transmit their programmes. Arqiva would be able to comment on whether a proposed development might cause a problem to one of the re-broadcast links between a main transmitter and a relay. Contact details for Arqiva are given in section 6.4.

Section 5

Remedial measures for TV reception

5.1 General

The following information concentrates on TV reception rather than other wireless services, as television is the technology most widely affected by new developments.

Where television reception is affected by a new development, there are a number of potential options for restoring reception. The choice of mitigation option will depend on local circumstances, and not all remedial measures will be available or appropriate in all cases.

5.2 Improvements to existing aerial installations

In cases of mild to moderate disruption to TV reception, it is sometimes possible to restore services by improving the quality of the existing aerial installation. For example, installing a higher gain external aerial may improve the received signal levels. Finding an alternative mounting point for the aerial where the effect of an obstruction is less pronounced, may also help. The higher an aerial is mounted from the ground, the greater the signal strength it is likely to receive.

If the problem is due to signal reflections, a more directional aerial may help reduce the severity of ghosting on analogue TV. Where signals are being reflected into the back of a viewer's aerial, it may be possible to reduce the problem by replacing the aerial with one that has a higher rejection to signals from the rear (known as a higher front to back ratio). More information is provided in Annex 1.

5.3 Reception from alternative transmitters

Because the coverage areas of neighbouring TV transmitters often overlap slightly, many viewers are potentially covered by more than one TV transmitter. Viewers affected by a new development may therefore be able to receive unobstructed signals from an alternative transmitter. Re-directing household aerials to the new transmitter would be required, and new aerials may need to be installed. Note that the national and regional variations carried by the alternative transmitter may not always match local viewers' preferences.

Digital UK provide a postcode checker, www.digitaluk.co.uk/postcodechecker, which offers an indication of which analogue and digital transmitters are likely to serve individual postcodes. These results should ideally be confirmed by local reception surveys in areas where disruption due to new developments may occur.

5.4 Digital terrestrial reception

Digital terrestrial TV (Freeview, or DTT), offers a high degree of resistance to some of the signal impairments (particularly delayed image interference) which can spoil analogue TV reception, and may offer an alternative in areas where digital coverage is available. However, until digital switchover takes place, the power of the Freeview transmitter network is necessarily restricted to deliberately low levels, and most lower-powered 'relay' transmitters will not carry digital signals in advance of digital switchover.

Digital transmitter powers will however be increased to around ten times current levels when digital switchover takes place in each region of the UK. At the same time, digital signals will be added to the relay transmitter network. These improvements will greatly increase the

availability and robustness of digital terrestrial reception. More information on the schedule for digital switchover is available from Digital UK at www.digitaluk.co.uk.

5.5 Satellite and cable reception

Satellite and cable services can offer an alternative means of receiving TV in areas where terrestrial coverage is impaired or unavailable. Cable services are generally only offered on a subscription basis, and have limited geographic availability.

Satellite TV is available over nearly the whole UK, and can offer both subscription and non-subscription services. Sky's websites, www.sky.com and www.freesatfromsky.co.uk offer information on their subscription and subscription-free services respectively, and www.freesat.co.uk offers information on subscription-free services on the separate 'Freesat' service from the BBC and ITV.

5.6 Construction of a digital 'self-help' transmitter

Self-help transmitters are low power 'relay' transmitters, which are constructed and operated on a private basis. A self-help transmitter may offer a means of restoring terrestrial TV reception to a community affected by a new development.

Because self-help transmitters use frequencies which are primarily allocated for use by the broadcasters, prospective self-help operators need to obtain a Wireless Telegraphy (WT) Act licence from Ofcom. Licences can only be issued in areas where sufficient interference-free transmission frequencies are available, and where the operation of a self-help transmitter would not impact on current or anticipated alternative uses of these frequencies, or on the efficient use of the spectrum more generally.

Self-help licences can only be issued for relaying digital terrestrial (not analogue) services, and Ofcom will normally only consider applications for new self-help transmitters in regions which have undergone digital switchover. This is because the coverage and interference characteristics of terrestrial TV services will change at switchover. It may therefore be that digital reception becomes possible from one of the broadcaster-maintained transmitters at switchover, even though analogue reception (or digital reception from the pre-switchover digital network) is not currently available, or is impaired.

As privately operated systems, funds for building a self-help transmitter would need to be secured by the operator. In the case of reception disruption due to a new development, these costs would normally fall to the developer. In addition, Ofcom would normally pass on the costs of the frequency planning work required for each proposed self-help transmitter to the applicant.

More information on Ofcom's policy on licensing digital self-help transmitters is available on our website at www.ofcom.org.uk/consult/condocs/selfhelp/statement/.

Section 6

Further information

Please note that neither Ofcom nor the BBC will comment in detail on individual developments.

6.1 Ofcom

Ofcom wind farm clearance for fixed links

www.ofcom.org.uk/radiocomms/ifi/licensing/classes/fixed/Windfarms

Television transmitter lists and location maps

Ofcom produces maps showing the locations of the UK's TV transmitters, as well as lists of the frequencies and powers used by the transmitter networks. These are available at www.ofcom.org.uk/tv/ifi/tech.

Ofcom Advisory Team (for interference and general enquiries)
Riverside House
2a Southwark Bridge Road
London
SE1 9HA
tel: 020 7981 3040
www.ofcom.org.uk/contactus

6.2 BBC

The BBC provides an internet-based wind farm assessment tool, which is intended to provide a 'first pass' indication of whether reception problems might be caused by wind turbines. The tool is not intended to provide an alternative to more detailed desktop or field studies of potential impact, and developers should not rely on the tool as the sole means of gauging possible problems. The tool, and notes on its use, are available at:

www.bbc.co.uk/reception/info/windfarms.shtml

BBC Reception Advice
PO Box 1922
Glasgow G2 3WT
tel: 03700 100 123
www.bbc.co.uk/reception

6.3 Digital UK

Information on predicted analogue and digital terrestrial television coverage is available on Digital UK's website at www.digitaluk.co.uk/postcodechecker, along with further information on the switchover timetable and alternative reception options. Select 'I am in the aerial installation trade' for full details of predicted coverage at individual postcodes.

6.4 Arqiva

The transmission company Arqiva can comment on the potential for a development to cause problems with the broadcasters' re-broadcast links.

Arqiva (spectrum planning)
Crawley Court
Winchester
SO21 2QA
email: tim.shergold@arqiva.com

6.5 JRC (Joint Radio Company)

Scanning Telemetry clearance on behalf of the electricity and gas public utilities.

JRC (Joint Radio Company)
Dean Bradley House
52 Horseferry Road
London
SW1P 2AF
email: windfarms@jrc.co.uk

6.6 Atkins Limited

Scanning Telemetry clearance on behalf of the water public utilities and non-public utility licensees.

Atkins Limited
200 Broomielaw
Glasgow
G1 4RU
email: john.jennow@atkinsglobal.com

6.7 Other contacts

BWEA (British Wind Energy Association)
Greencoat House
Francis Street
London SW1P 1DH
Tel: 020 7901 3000
email: info@bwea.com
web: www.bwea.com

Department for Communities & Local Government
Planning Policy Guidance 8: Telecommunications (PPG-8)
www.communities.gov.uk/publications/planningandbuilding/ppg8

Annex 1

The impact of wind farms on domestic television reception – technical details

The nature of wind turbines means that they can present their own distinct issues in relation to TV reception.

Generally, commercial-grade turbines have a number of common characteristics. These are:

- turbines are rarely sited closer than 250 metres away from domestic properties
- the nacelle (the generator housing at the centre of blade rotation) and the blades are typically mounted on a narrow, cylindrical, concrete tower
- the blades are normally constructed of non-metallic material such as GRP, although they invariably contain metallic components such as a strengthening member, lightning conductor and balancing weights
- the orientation of the blades corresponds to the wind direction
- the usual speed of blade rotation is between 15 and 30 RPM

In practice the tower or nacelle rarely have any effect on TV reception; the impact on reception is solely on account of the rotating turbine blades. As the blades are moving objects, in terms of both their rotational speed and orientation, their effect is variable and hard to predict. When the combined effects of a number of turbines that comprise a wind farm are considered, the result is considerably more difficult to predict.

1.1 Shadowing and reflection effects

The two mechanisms responsible for the disruption, as with buildings, are shadowing and reflection effects as described earlier in this document.

The size of the shadow zone is dependent on the orientation of the blades, and is at a maximum when the axis of the rotor is in line with the direction of the transmitted signal. The received signal strength varies in a cyclic manner, in time with the blades' rotation.

Reflection effects vary with the rotation of the blades and the orientation of the nacelle. A further complication is that the strength of the reflected signal is dependent on the length and area of the metallic components inside the blade.

1.2 The area affected

Disruption to analogue television reception is shown as a characteristic flickering of the picture, and can lead to a loss or 'freezing' of digital terrestrial reception. The affected area around the turbine, a combination of the 'shadow' zone, and the 'reflection' zone, is roughly shaped like a keyhole (like that shown in Figure 4). The actual shape and size of this is dependent on the number and type of turbines, and the topography between: the broadcasters' transmitter and the turbine; the broadcasters' transmitter and the viewers' receiving aerials; and the turbine and the viewers' receiving aerials. Nevertheless, for the purposes of assessing the likelihood of interference, the 'shadow' zone may be considered

to be a sector with a radius up to about 5 km, and the 'reflection' zone a circle of radius of about 500 metres. As noted previously, if the wind farm is on a prominent hilltop, reflection effects can be caused to households some distance away, in exceptional circumstances such effects have been noted at up to 20km distant from the wind farm.

1.3 Reduction of a wind farm's impact

The siting of the turbine or turbines can reduce the severity of disruption. If possible, turbines should be at least 500 metres from any viewer. Disruption caused by wind farms with more than one turbine may be reduced if one turbine could be placed within the 'shadow' area of another. The measures to reduce disruption at the location of the affected viewers, outlined in Section 6, are also relevant to the effect of wind turbines. A more directional receiving aerial can be used to reduce the level of delayed image interference, and the information in section 1.5 below illustrates this.

1.4 Assessment of wind farm interference

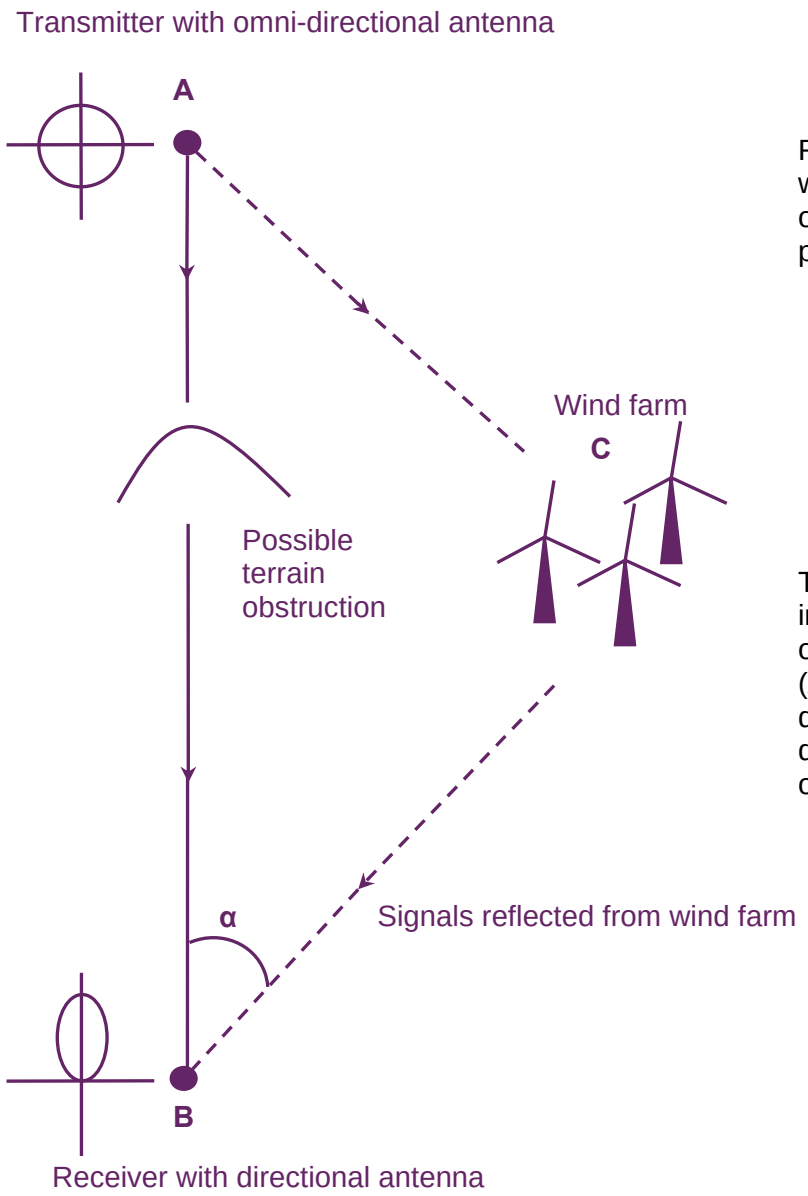
An indication of the impact a prospective wind turbine may have on television reception can be obtained using the BBC's web-based wind farm assessment tool. Neither the BBC nor Ofcom can carry out assessments of the potential impact of wind farms to terrestrial television reception.

The wind farm assessment tool can be found at:
www.bbc.co.uk/reception/info/windfarms.shtml

The tool is not intended to be a substitute for an on-site survey, commissioned by the developer, by which the potential for disruption to television services may more accurately be assessed.

If there is potential for disruption to television reception (predicted or measured) then the broadcasters and Ofcom recommend that local authorities should consider imposing a requirement for the wind farm developer to take remedial action (and this will typically require an on-site survey to determine appropriate remedial measures). These are the same as those given in section 4 of this document.

1.5 Reflection effects from a wind farm



Reflection effects will be worse if path AB is more obstructed by terrain than paths AC and CB.

The spacing of the delayed image (ghost) is dependent on the path difference (AC+CB)-AB. A path difference of 2 km gives a delayed image of one eighth of the picture width.

If α is greater than 60°, a standard aerial will normally provide sufficient discrimination against the reflected signal

For α between 15° and 60°, a more directional receiving aerial can be used to reduce the level of reflected signals 'seen' by the receiver.

For α less than 15° even changing to the best available aerial will not help and measures such as seeking reception from an alternative transmitter or platform such as satellite or cable may be necessary.