PAGERPOWER

Written Scheme for Television Interference

Prepared for Arcus Consultancy Services Ltd

Fazakerley Waste Water Treatment Works - Single Wind Turbine

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INTRODUCTION

Purpose of this Document

This document sets out Pager Power's recommended approach for the assessment of potential disruption to television (TV) services as a result of Fazakerley Waste Water Treatment Works Single Wind Turbine development should a complaint be received.

This document sets out the process that will be followed in order to discharge the relevant planning condition as set out below:

> *Prior to the First Export Date, a scheme setting out a protocol for the assessment of electromagnetic interference (including to television reception) and the remedial measures to be taken, in the event of any complaint being received, shall be submitted to and approved in writing by the Local Planning Authority. The operation of the wind turbine shall be in accordance with the approved protocol.*
>
> *REASON: In the interests of protecting residential amenity and to ensure the appropriate mitigation measures are put in place.*

Wind turbines can cause disruption to electromagnetic TV signals. In cases where interference attributed to a wind turbine development is experienced, the developer can have the responsibility to mitigate the impact in accordance with any relevant planning condition.

This document presents:

1) The recommended procedure for quantifying the interference effect;
2) The recommended procedure for determining whether the interference is due to the wind turbine development;
3) A schedule of mitigation options.

Process

- Detailed modelling and analysis will be undertaken to predict the areas where TV reception could be impacted by the wind development.
- Any interference complaints will be comprehensively investigated. Measurements at complaint locations will be taken and evaluated against pre-construction analysis to determine the cause of any interference.
- The following sections of this document describe the modelling method employed by Pager Power and the recommended approach for measuring TV reception quality. Technical details regarding the modelling are shown in the Appendix of this document.

ASSESSMENT APPROACH

Desk Study and Modelling

Terrestrial television signals propagate from transmitters to receiving aerials which in turn are connected to television receiving equipment.

The area surrounding the development is likely to be served by the Winter Hill Transmitter. This is one of the main TV transmitters in the UK. It broadcasts only digital services.

The figure below shows the location of the Winter Hill Transmitter relative to the wind turbine location.

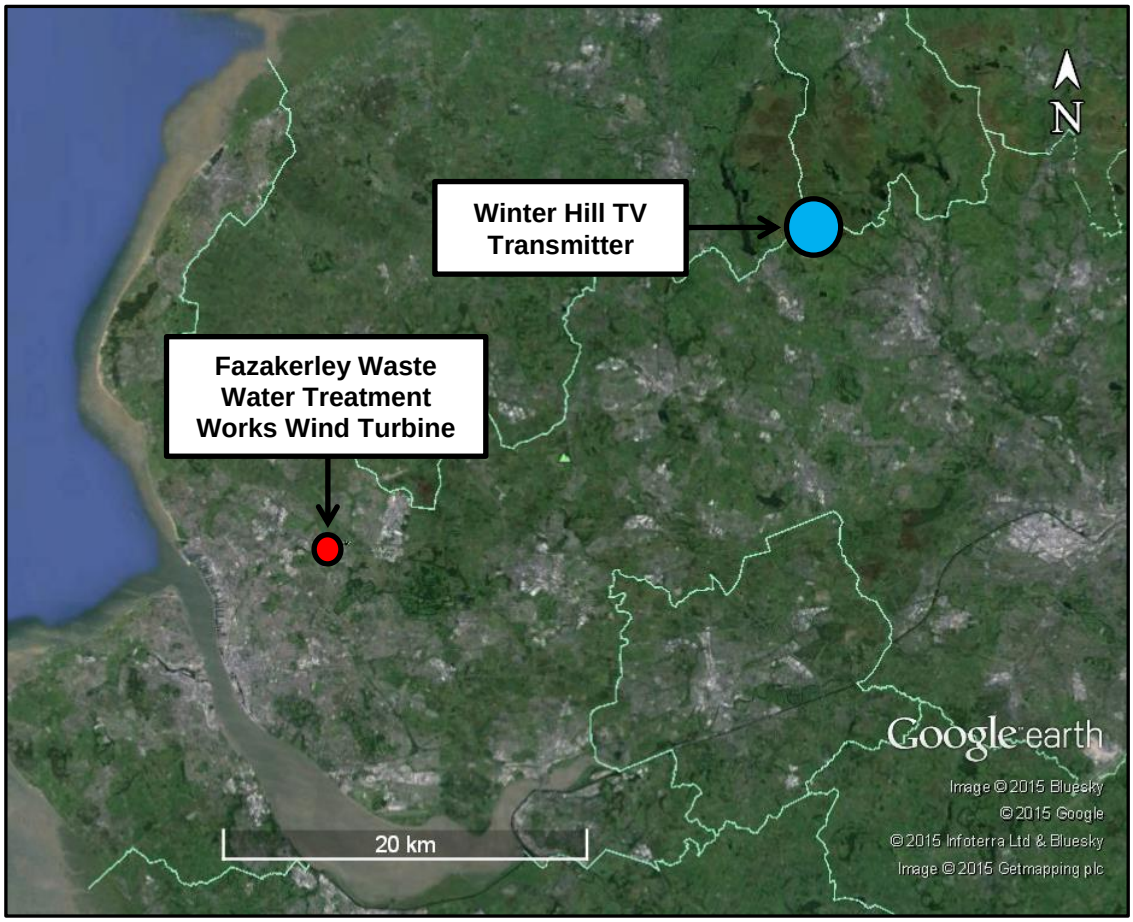

Figure 1: Winter Hill Transmitter - Fazakerley Waste Water Treatment Works Wind Turbine

How Turbines Cause Interference

Wind turbines are large rotating structures that can interact with terrestrial TV transmitter signals. A turbine can block the signal, which affects aerials in the wind development shadow. A turbine can also reflect the signal in other directions, which can affect aerials in the general vicinity of the wind development.

When considering interference due to wind turbines it is usual to consider direct signals – those that pass from transmitter to receiver in a straight line and reflected, or indirect, signals. The reflected signal goes from the transmitter to a turbine and then on to the receiver.

Standard receiving aerials are directional meaning that signals from the direction of the transmitter are amplified and signals from other angles are attenuated.

Detailed modelling, in accordance with the methodology described in Appendix A, will be undertaken for the Winter Hill Transmitter.

Digital TV

The interference mechanisms for digital transmissions are the same as those for analogue transmission. The main difference is the manner in which the interference is manifested on the TV screen.

Digital transmissions tend to be robust to small amounts of interference, but are drastically affected by more severe interference.

The modelling methodology is applicable to digital transmissions.

Reception Surveys

Following the desk based modelling and analysis, if interference effects have been predicted then a TV baseline reception survey will be undertaken in the areas where interference is possible. The survey will capture the current reception strength and quality. It will also confirm which transmitters are serving individual areas. However, if no interference effects have been predicted then no TV survey will be undertaken.

The TV baseline reception survey will allow for accurate comparison before and after construction of the wind turbine in the event that complaints are received.

Further reception measurements can be undertaken post-construction as appropriate in the event of interference complaints.

INVESTIGATING COMPLAINTS

Procedure for Addressing Interference

Notification for complaints regarding TV interference will be limited to a fixed period of 12 months after final commissioning of the development. A post-construction TV reception survey will be undertaken at any complaint location, if required.

Evaluation of the location relative to any required modelling or post-construction TV measurement will reveal whether the interference is likely to be attributable to the wind development. Wind turbine related interference is typically characterised by varying power levels, with a periodicity that is linked to the speed of the rotor.

If it is found that the interference is attributable to the wind development, mitigation will be put in place. The recommended process can be summarised in the following three steps.

Step 1 Carry out measurements at relevant locations where complaints have been received. Characterise interference based on any modelling results and survey measurements to determine the cause. Investigate receiving equipment where appropriate. This will be undertaken within one month of receiving notification from the Local Planning Authority.

Step 2 Determine whether the interference is attributable to Fazakerley Waste Water Treatment Works Single Wind Turbine based on Step 1.

Step 3 Apply mitigation if required, based on Step 2. This will occur within 3 months of receiving the resident's initial letter. The requirement for the implementation of such measures will be addressed on a case-by-case basis.

ALLEVIATION OF INTERFERENCE

Schedule of Mitigation Options

Below is a list of standard actions to mitigate TV reception issues caused by a wind turbine:

1. Replacement of receiving aerial with a more directional, or higher gain, aerial;
2. Repositioning the receiving aerial so that its received signal is stronger;
3. Directing the receiving aerial to an alternative transmitter that covers the area and retuning the television accordingly;
4. Upgrading antenna cabling and connections;
5. Installation of signal amplifiers;
6. Development of a bespoke local solution using a receiving aerial some distance from the dwelling;
7. A combination of the above;
8. Replacing terrestrial reception equipment with satellite or cable reception equipment.

Actions 1-5 are unlikely to occur as individual solutions and are likely to be deployed in combination.

Actions	Basis
Combination of #1-5 aerial system upgrade	Per residence
#6 bespoke reception system	Per residence / per area
#7 combination of 1-6	Per residence / per area
#8 satellite installation	Per residence

The requirement for the implementation of such measures will be addressed on a case-by-case basis.

APPENDIX – MODELLING METHODOLOGY

Relevant Parameters

The following parameters are considered within the model:

Carrier to Interference Ratio

The likelihood of television interference is determined by considering the strength of the direct, or carrier, signal in comparison to the reflected, or interfering, signal. The Carrier to Interference Ratio (CIR) quantifies the relative strength of the direct and reflected signals.

A high CIR means interference is less likely. A low CIR means that interference is more likely. The CIR is normally expressed in decibels (dB). The categories used by Pager Power for assessment of issues are shown in the table below:

CIR (dB)	Interference Level	Likelihood of Interference
<5	High	Likely
5 – 15	Medium	Possible
>15	Low	Unlikely

Free Space Path Loss

Television signals weaken over distance. The closer a receiver is to a transmitter the stronger its received signal will be. This reduction in signal strength due to separation distance is referred to as Free Space Path Loss (FSPL).

Electromagnetic Propagation by Diffraction

An electromagnetic signal may travel between two points, even when no direct line of sight exists between those two points. This is because transmission travels as a series of waves rather than as a direct ray. When no direct line of sight exists between the two points the signal is considerably weakened. This weakening is known as a diffraction loss.

International Telecommunications Union (ITU) Recommendation ITU-R P526-7 describes a method for calculating diffraction losses over regular terrain.

Total path loss for a specific path is determined by adding Free Space Path Loss to Diffraction Loss.

Radar Cross Section

The size of the interfering signal is dependent on the amount of energy that is reflected from the wind turbine. This reflective quality is known as the Radar Cross Section (RCS) and can be expressed in metres squared or in dBm^2.

A lot of work has been carried out to help determine wind turbine RCS by various parties although little work has been carried out at UHF frequencies. Values cited typically vary between 25 and 300 m^2 with instantaneous peaks reaching 3000 m^2 for a single wind turbine.

The moving and static parts of the turbine are often considered separately.

Pager Power's Approach

Having reviewed many relevant published works, Pager Power has arrived at a compound methodology including some additional factors such as:

- Triplicate calculations accounting for tip, hub and rotor bottom;
- Accounting for actual field strength;
- Calculating interference in accordance with the Dabis Method (Reference 6);
- Calculating interference in accordance with the ITU method (put forward in document BT805, Reference 1).

Following assessment by these various methods the following conclusions have been drawn:

- Although it is true that wind development interference appears more likely when the received signal is weak there is no direct relationship between direct signal strength and observed picture interference;
- Observed picture interference is directly related to the CI Ratio;
- The ITU-R BT805 method appears to be significantly more accurate than the Dabis method (Reference 6) for assessing observed interference;
- Summing of unwanted signals from each turbine to determine a total unwanted signal level appears to be reasonably accurate;
- The CIR threshold of 10dB cited by RES (see Reference 8) appears to be reasonable – it is certainly true that the threshold of 28-34 cited by BT805 (Reference 1) is too high when using this method. Observations on a 32 wind turbine development suggest that a threshold of 15dB may be more reasonable in this case;
- Pager Power's basis for concluding that the threshold in BT805 (Reference 1) is too high comes from experience of existing wind developments where interference effects have been modelled and recorded;
- Carrying out an assessment based on the hub height appears to be fairly representative – however there can be significant variation in CI Ratio over the blade span. In an example with no direct line of sight between transmitter and receiver the CI Ratio varies by 31dB between the top and bottom of the rotor. This is a large variation and should be considered or accounted for.

It was concluded therefore that triplicate calculations at tip, hub and rotor base should be considered. The principals of this calculation are as follows:

- The interference signal calculation should be carried out three times for each turbine – at tip, hub and rotor base;
- A weighted average of the three unwanted interference signal levels should be made (of absolute levels not decibel levels);
- A signal passing through the turbine at hub height is clearly going to be affected much more than one passing through the tip or rotor base so an increased weighting should be applied to the hub signal;
- The weighting applied to rotor tip and rotor base should be identical as the proportion of the signal passing through the rotor is identical at both heights;

- A geometric calculation suggested that following weightings be used for averaging:

Turbine Part	Weighting (%)
Tip	19.55
Hub	60.9
Rotor Bottom	19.55

- The following rounded values are used for calculation purposes:

Turbine Part	Weighting (%)
Tip	20
Hub	60
Rotor Bottom	20

REFERENCES

The following published works have been considered in the process of devising Pager Power's modelling approach:

1. International Telecommunications Union, Assessment of impairment caused to television reception by a wind turbine, Recommendation ITU-R BT805*, 1992
2. Bacon, DF, A proposed method for establishing an exclusion zone around a terrestrial fixed radio link outside of which a wind turbine will cause negligible degradation of the radio link performance, Radio Communications Agency, 2002
3. Hall, SH, The assessment and avoidance of electromagnetic interference due to windfarms, Wind Engineering Vol 16 No 6, 1992
4. Dabis, HS, The provision of guidelines for the installation of wind turbines near aeronautical radio stations, Civil Aviation Authority, CAA Paper 99002, 1999
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6. Dabis, HS, The establishment of guidelines for the installation of wind turbines near radio systems, Proceedings of the eighteenth BWEA Wind Energy Conference, 1996
7. FES, Wind Farms impact on aviation interests – final report, FES W/16/00614/00/REP, 2003
8. S Vila-Moreno, A Methodology to Assess Interference to TV Reception due to Wind Farms, RES, 2005
9. BBC, The impact of large buildings and structures (including wind farms) on terrestrial televisions reception