Proposed Revisions to

Wind Energy Development Guidelines 2006

Targeted Review in relation to Noise, Proximity and Shadow Flicker – December 11th 2013

Comhshaol, Pobal agus Rialtas Áitiúil
Environment, Community and Local Government

<u>Contents</u> **<u>Page</u>**

Introduction

The Department of the Environment, Community and Local Government is currently conducting a targeted review of its Wind Energy Development Guidelines in relation to noise, proximity and shadow flicker. It is proposed to update the relevant sections of the existing Guidelines on these specific issues with the text set out in this document. There will also be a number of technical appendices developed to assist planning authorities in relation to noise assessment, monitoring and the setting of planning conditions.

As this is a targeted review focusing on specific issues, all the other sections of the Wind Energy Development Guidelines 2006 (including existing appendices) will remain in place. Concerns of possible health impacts in respect of wind energy infrastructure are not matters which fall within the remit of these guidelines as they are more appropriately dealt with by health professionals. However, the Department of Health has been made aware of the on-going review of the Wind Guidelines and any perspectives that they may have, relevant to the planning process, will be taken into account in finalising the revisions to the guidelines.

Written submissions on these proposed revisions to the Guidelines are invited up to February 21st 2014. Submissions on other sections of the Guidelines or additional matters will not be considered as it is not proposed to carry out a full review of the Wind Energy Development Guidelines at this time. Following consideration of the submissions made during this period of consultation, the revisions to the Guidelines will be finalised and issued to planning authorities under Section 28 of the Planning and Development Act 2000 (as amended).

Written submissions in relation to the Guidelines may be e-mailed or posted to:

Wind Submissions
Planning Section
Department of the Environment, Community and Local Government, Custom House, Dublin 1
Email: windsubmissions@environ.ie

In the interests of transparency, all submissions received (including the name of the person making the submission but not their contact details) will be made fully available online on the Department's website (www.environ.ie) and will be subject to the provisions of the Freedom of Information Acts 1997 and 2003. The onus is on persons making submissions not to include material of a private nature in the body of their submission.

Note: replace section 5.6 in the existing Guidelines with the draft text below.

5.6 Wind Turbine Noise

5.6.1 Key Objective

The approach to the assessment and control of wind turbine noise recommended in these guidelines seeks to achieve a balance between the protection of residential amenity of neighbouring communities in the vicinity of wind energy developments, and facilitating the meeting of national renewable energy targets.

5.6.2 Sound and Noise

Sound can be described in terms of both its loudness [1] and its pitch (or frequency)[1]. Sound level (loudness) and sound frequency (pitch) can both be objectively measured using suitable equipment.

Noise is unwanted sound experienced by a listener, and given the 'unwanted' component it can have a strong subjective aspect.

5.6.3 Wind Turbine Noise

Unlike other sources of sound, a key characteristic of wind turbine sound is that the level of sound changes with wind speed. This distinguishes it from other types of commercially and industrially generated sound which can commonly be assessed in neutral conditions with little or no wind.

Because wind turbine sound varies with wind speed, specific measurement and analysis methods are needed to assess noise from either proposed or operational wind farms.

Sources of wind turbine noise

There are two distinct types of sound sources associated with the operation of wind turbines, namely, aerodynamic noise caused by turbine blades passing through the air and wind moving around the turbine tower, and mechanical noise created by the operation of mechanical elements in the hub and nacelle such as the generator (See Glossary of Terms).

In general, wind turbines produce very little noise when not turning. Some sound is produced from yaw motors, blade pitch actuators, brakes, and hydraulic pumps in the nacelle. (See Glossary of Terms).

The transformer at the base of the turbine is energised and may produce some sound. These sound sources are generally not as loud as aerodynamic noise and so they are rarely the cause of noise complaints.

Aerodynamic noise

[1] See glossary of terms

Aerodynamic noise from the interaction between wind and turbine blades is generally the dominant sound source experienced from wind turbines. Modern wind turbine blades begin to rotate and generate electricity at hub height wind speeds of around 3 to 4 metres per second, a speed referred to as the 'cut-in' wind speed. Maximum power output is generally reached at hub height wind speeds of around 10 metres per second, a speed referred to as 'rated power'.

From cut-in the sound level generally increases with wind speed and power output but differs in level depending on the type of turbine used. The two main types of turbine in use are pitch controlled[2] and stall[3] regulated turbines. The aerodynamic sound from a stall regulated turbine continues to increase with wind speed but a pitch regulated turbine's sound level generally reaches a maximum at rated power and remains constant, or decreases slightly as wind speed continues to increase.

Mechanical noise

Mechanical noise sources associated with wind turbines include the generator, gearbox and other parts of the drive-train. Mechanical noise can be tonal in nature in some cases. Improvements in gearbox design and the use of anti-vibration techniques have resulted in significant reductions in mechanical sound generation. The most recent direct drive machines have no high-speed mechanical components and therefore mechanical noise levels are generally reduced. Mechanical noise in the nacelle can be attenuated by conventional noise control methods. These include measures to reduce vibration forces in moving parts such as improved acoustic and vibration isolation around rotating equipment as well as improved sound insulation design of nacelle and machinery housings.

Special audible characteristics

These are the distinctive characteristics of noise which may be associated with both aerodynamic and mechanical wind turbine noise and which can cause annoyance at lower levels of intensity than a sound without such characteristics. Examples of special audible characteristics are tonality, impulsiveness, amplitude modulation, low frequency noise and infrasound.   (See Glossary of Terms).

The assessment of these special audible noise characteristics presents challenges as illustrated in Marshall Day Acoustics report[4] .

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[2] Pitch controlled turbine means it includes controls to rotate the angle of the blades depending on the wind speed in order to regulate output and rotational forces

[3] Stall regulated turbine means the blades are locked in place and do not adjust during operation. Instead the blades are designed to increasingly "stall" as wind speeds increase to control power output and protect the turbine from excessive wind speeds

[4] "Examination of the Significance of Noise in Relation to Onshore Wind Farms" Marshall Day Acoustics. (November 2013).

Note. It is intended to address the assessment of wind turbine noise in detail (including the potential for special audible characteristics) in the form of Best Practise Guidance to be contained in Appendix 1

5.6.4 Setbacks as a noise control method

The relationship between distance from a wind turbine or wind farm and noise effects is significantly variable and a direct correlation between separation distance and wind turbine generated sound levels is not clear . This is due to a variety of factors which are not directly related to distance but which can affect the transmission of sound, including:

- topography (hills have a major impact on sound propagation);
- ground cover types; and
- wind speed and direction.

Because of the lack of correlation between separation distance and wind turbine sound levels, the use of a defined setback of turbines from noise sensitive properties to control noise impacts is not considered appropriate.

Note - there should be a minimum separation of 500m between any commercial scale wind turbine and the nearest point of the curtilage of any property in the vicinity in order to provide for other amenity considerations e.g. visual obtrusion

This separation distance does not apply to small scale wind energy developments generating energy primarily for onsite usage.

5.6.5 Absolute Noise Limits as a control method

The use of an absolute noise limit is considered the most appropriate method to control noise impacts from wind energy development in proximity to noise sensitive properties and in areas of special amenity value. (See definition at 5.6.6 below). An absolute limit is easier to understand and apply than some other noise control methods while still providing an assessment that is based on expected and/or measured levels of noise from a wind farm. It offers the following advantages:

- It will provide a consistent level of protection for noise sensitive properties as wind turbine sound emission levels and site topography can be directly accounted for during a compliance assessment.
- It will take account of the number of turbines proposed for a particular project and the reduction in noise level as sound travels from the wind farm to noise sensitive properties.
- It will promote technological advances for reduction of turbine noise as it provides an incentive to manufacturers to design quieter turbines.

Wind turbine technology development has brought about continuous improvement in reducing noise and more recently provided the option of control interventions to fine tune the noise envelope through occasional power production reduction. The noise emissions of more recent wind turbine models are therefore generally less than those of equivalent older wind turbines and the trend of noise reduction with technology advancement is expected to continue, driven by planning regulation that controls the noise measured at adjacent noise sensitive properties.

5.6.6 What is a Noise Sensitive Property?

For the purposes of these draft guidelines, noise sensitive properties are defined as dwelling houses, including those which have planning permission but are not yet built, and other buildings for long term residential use such as nursing/retirement homes.

The definition also includes hospitals, schools and places of worship.

It may also include areas of special amenity value (and for which a quiet environment is desirable) the preservation of which is included as an objective in a development or local area plan.

5.6.7 What limit should apply?

A noise limit of 40dBA[5] attributable to one or more wind turbines, should be applied in order to restrict noise from wind turbines at noise sensitive properties.

This limit is an outdoor limit, which should not be exceeded at noise sensitive properties at any wind speed within the operational range of any turbine (i.e. from cut-in until maximum rated power level is reached). The limit applies to the combined sound level of all turbines in the area, irrespective of which wind farm development they may be associated with.

The limit will apply irrespective of time of day or night.

The outdoor limit of 40dBA takes into account World Health Organisation findings in relation to night time noise [6] and the review of international practice undertaken by Marshall Day Acoustics. The Marshall Day review indicates that 40dBA is commonly used in different countries as an absolute limit. Furthermore it may be considered to be in the lower end of the range of limits applied internationally, thus indicating a somewhat more stringent limit on wind energy development sound production than is generally the case.[7]

Generally the reduction in noise levels between the outside of a dwelling and the inside would be approximately 10dBA or more. Consequently an outdoors limit set at this level would generally

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[5] Noise limits are expressed in terms of dB $L_{A90\ 10min}$ as determined in accordance with the Best Practice Technical Appendixes (to be developed). Refer to the Glossary of Terms for a definition of LA90 and to the Best Practice Technical Appendices for a description of how to apply the limits to either proposed or operational wind farms.

[6] "Night Noise Guidelines for Europe" World Health Organisation (2009)

[7] "Examination of the Significance of Noise in Relation to Onshore Wind Farms" Marshall Day Acoustics. (November 2013).

result in a noise level of about 30dBA or less inside a dwelling. This is based on the dwelling facades and roof being of reasonable construction and assumes one window is ajar for ventilation.

5.6.8 Where does the limit apply?

The 40dBA noise limit applies to outdoors locations within the curtilage[8] of noise sensitive properties. For areas of special amenity value the 40dBA limit applies at the boundaries of such areas identified in a development/ local area plan.

5.6.9 Possible exceptions

Exception to Noise limit

Where there are a limited number of noise sensitive properties within the area between the wind energy development and where the 40dBA noise limit applies, it may be possible for the development to proceed provided the owner(s) of the relevant properties are supportive of the development. Under these circumstances the owner of the property or properties must provide written confirmation to the satisfaction of the planning authority that they understand that their property may experience noise levels higher than the 40dBA noise limit and that they have no objection to the proposed wind energy development. In such circumstances the planning authority may consider departing from the 40dBA limit.

Exception to Setback

An exception may also be provided to the minimum 500m setback for amenity purposes, where the owner(s) of the relevant property or properties are content for the proximity of turbines to be less than the minimum setback. As with noise limits above they must provide written confirmation to the satisfaction of the planning authority that they have agreed to a reduced setback and have no objection to the proposed wind energy development.

5.6.10 Noise assessment methodology: Pre construction

Computer based noise prediction models can be used to estimate sound levels in the vicinity of a proposed wind energy development. The models can take account of various factors including the sound emission levels of the proposed turbines, wind speeds and directions, other climatic conditions, topography and ground conditions. Computed sound level predictions can also take account of the locations of all the turbines within a single wind energy development and the cumulative effect of all the turbines in a number of developments.

[8] The curtilage of a domestic dwelling house for the purposes of these draft guidelines is defined as the land immediately surrounding a dwelling house which is used for purposes incidental to the enjoyment of the dwelling house as such and excludes any open fields beyond the immediate surrounds of the dwelling. In the case of buildings associated with other noise sensitive properties the curtilage would be the area in the immediate surrounds of the relevant buildings.

Further details on noise assessment and an appropriate methodology for modelling noise to suit the application of the proposed absolute limit will be included as a Best Practice Technical Appendix within the final guidelines

5.6.11 Noise assessment methodology: Post construction

Once a wind farm is built and operating, noise levels can be measured at locations around the wind farm to confirm whether the facility complies with the applicable noise limit at noise sensitive properties.

The specific location of the measurements will vary from project to project. However, the measurements can often be carried out directly at noise sensitive properties. In cases where this is not practical because of the influence of extraneous noise, other monitoring locations may need to be chosen.

Further details on appropriate measurement methodologies will be included as a Best Practice Technical Appendix within the final guidelines.

Note: replace section 7.5 in the existing Guidelines with the draft text below.

Para 7.5 **Noise, including Construction Noise** amended as follows

Conditions relating to the control and management of sound emissions from wind turbines are attached to planning permissions for wind energy development so as to protect the amenity of noise sensitive properties. Appropriate conditions in this context are set out in broad terms in Appendix 3[9]

Note: additional text *(in italics)* to para 1 section 7.7 in the existing Guidelines.

General environmental monitoring conditions should be avoided, apart from where specific requirements in relation to environmental matters are part of the planning permission. Effective monitoring is necessary to provide evidence of compliance with environmental conditions, such as noise limits or wildlife considerations. *It is recommended that planning applications make clear who the appropriate contact person would be to deal with any complaints or issues that might arise during both the construction and operation stages of a wind energy development. Further details on Monitoring and Appropriate Noise Control Post Construction will be contained in Appendix 2*

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[9] Note. More detailed guidance regarding conditions will be provided as part of the final guidelines which will be adopted in 2014. This more detailed guidance will contain a model set of conditions.

Appendix 1 Best Practice in regard to Noise Assessment

This Appendix will outline the data and modelling requirements for wind turbine noise assessment. This is a work in progress and the final guidelines will provide an Appendix which contains a Best Practice Guide to the assessment and modelling of wind turbine noise (including special audible characteristics)

Matters to be referenced in Appendix 1 will relate to:

- Wind farm noise prediction methods;
- Special Audible Characteristics;
- Commissioning Requirements;
- Cumulative Noise.

Appendix 2 Monitoring and Appropriate Noise Control Post Construction

This is an indicative list of the matters to be examined in this Appendix in order to provide a robust monitoring and compliance regime post construction.

- Noise sensitive locations and representative locations.
- Noise survey methodology.
- Complaints (How to deal with under RMCEI[10]).
- Monitoring post commissioning (To be agreed with LA and time frame).
- Monitoring on foot of complaints (To be agreed with LA and time frame).
- Remedial actions (Time frame and measures needed).

[10] "Recommendations for Minimum Criteria for Environmental Inspection" – European Council Recommendation (2001/331/EC)

Appendix 3 Planning Conditions

The following is an indicative list of the matters which are to be reviewed in the context of appropriate conditions on a planning permission. It is intended to consider the provision of a number of model conditions for use by planning authorities.

- Limits on noise levels.
- Commissioning report on noise levels.
- Compliance noise surveys during life of wind farm.
- Remediation measures to be implemented if non- compliance is found.

Glossary of terms

LA90

LA90 is the A-weighted sound level that is exceeded for 90% of the measurement interval during a single measurement period. For example, during a measurement interval of 10 minutes, it is the level that is exceeded for nine minutes, thus excluding the highest level sounds which occur during the period. In practice the higher level sounds which are excluded would for example include a car passing, a dog barking or such other short-duration sounds unrelated to wind turbine-generated sound.

Sound Pressure

Sound pressure is measured in terms of decibels, which are generally denoted as dBA. The audible range of sound levels for humans is commonly considered to span from 0dBA, the hearing threshold, to about 120dBA, where sound levels can cause pain.

The decibel scale is logarithmic and not linear in nature. This means that if, for example, two instances of the same sound level occur at the same time and each has a sound level of 30dBA, their combined level will be 33dBA, and not 60dBA.

Average sound levels in city street traffic would typically be about 65 - 80dBA, while a conversation between a small number of people would be about 60dBA. A quiet office would be in the range 50-65dBA, while the humming of a refrigerator when running would be around 40dBA.

Sound Frequency

Sound comprises a range of frequencies extending from the very low, such as a rumble of thunder, to high frequencies, such as those generated by a clash of cymbals. Allowing for individual variation, the audible range of frequencies for the human ear is generally in the region of 20Hz to 20,000Hz.

Frequency weighting is the process by which sound levels are corrected to account for the non-linear frequency response of the human ear.

An A-weighted decibel measurement scale is frequently used as the basis for measurement and regulation as this scale is designed to approximate the response of the human ear over a range of frequencies.

Sound Impulsiveness

An impulsive sound has been described as “Transient sound having a peak level of short duration, typically less than 100 milliseconds”. Impulsive sounds may typically take the form of bangs and thumps.

Sound Types:

Amplitude modulation

If a sound has a noticeable change in sound level which is of a regular and repeating nature, this sound pattern can in some cases be described as displaying amplitude modulation. An example would be the sound of waves crashing on the shore.

Low frequency noise

The definition of low frequency noise can vary, but it is generally accepted to be within the range of 10Hz to 200Hz. Traffic noise would be considered to have low frequency content.

Infrasound

Infrasound occurs naturally in the environment (e.g. wind sound effects) and is generated by many human activities and the operation of many types of machines (e.g. motor cars, washing machines etc.). Infrasound generally occurs at frequencies below the normal range of human hearing, namely less than about 20Hz.

Tonality

Tonal noise has been described as containing a discrete frequency component, most often of a mechanical origin. Examples can include the hum from an electrical transformer located at the base of a wind turbine, which can exhibit low frequency tones, the dial tone on a phone, a mid-frequency tone, and whistling which tends to comprise higher frequency tones.

Wind Turbines:

Anemometer

The anemometer measures the wind speed and transmits wind speed data to the Controller.

Blades

Blades lift and rotate when wind is blown over them, causing the rotor to spin. They are most commonly made of glass, reinforced plastic or wood epoxy, but can be made of aluminium or steel. Modern turbines typically have three blades. These may vary in rotor diameter from 35 metres upwards.

Blade Pitch

The pitch motor turns (or pitches) blades out of the wind to control the rotor speed, and to keep the rotor from turning in winds that are too high or too low to produce electricity.

Blade Pitch Actuator

Adjusts the pitch angle of a rotor blade.

Brake

The brake stops the rotor mechanically, electrically, or hydraulically, in cases of emergency.

Controller

The controller starts up the machine at wind speeds of about 8 to 16 miles per hour (mph) and shuts off the machine at about 55 mph. Turbines do not operate at wind speeds above about 55 mph because they can be damaged by the high winds.

Gear box

The gearbox connects the low-speed shaft to the high-speed shaft and increases the rotational speeds from about 30-60 rotations per minute (rpm), to about 1,000-1,800 rpm; this is the rotational speed required by most generators to produce electricity. The gear box is a costly (and heavy) part of the wind turbine and engineers are exploring "direct-drive" generators that operate at lower rotational speeds and don't need gear boxes.

Generator

The generator produces AC electricity. Off-the-shelf induction generators are generally used.

Nacelle

The nacelle sits atop the tower and contains the key mechanical components of the wind turbine including the gearbox, generator, controller, and brake. A yaw mechanism is employed to turn the nacelle so that the rotor blades face the prevailing wind

Pitch controlled turbine controls are included to rotate the angle of the blades depending on the wind speed in order to regulate output and rotational forces

Rotor

Blades and hub together form the rotor.

Stall regulated turbines have blades locked in place which do not adjust during operation. Instead the blades are designed to increasingly “stall” as wind speeds increase to control power output and protect the turbine from excessive wind speeds

Tower

Made from tubular steel, concrete, or steel lattice, the tower supports the structure of the turbine. Because wind speed increases with height, taller towers enable turbines to capture more energy and generate more electricity.

Transformer

This is a device for changing the voltage of the alternating current. Electricity is typically generated at less than 1000 volts by the wind turbine and the transformer “steps up” this voltage to match that of the national grid. This may be housed either inside or alongside the tower.

Wind direction determines the design of the turbine. Upwind turbines face into the wind while downwind turbines face away.

Wind vane

This measures wind direction and communicates with the yaw drive to orient the turbine properly with respect to the wind.

Yaw drive

Orients upwind turbines to keep them facing the wind when the direction changes. Downwind turbines don't require a yaw drive because the wind manually blows the rotor away from it.

Yaw motor

The yaw drive is powered by the yaw motor.

Note: replace section 5.12 in the existing Guidelines on Shadow Flicker with the draft text below.

5.12 Shadow Flicker

5.12.1 Background

Wind turbines, like other tall structures, can cast long shadows when the sun is low in the sky. The effect known as "shadow flicker" occurs where the rotating blades of a wind turbine cast a moving shadow which, if it passes over a window in a nearby house or other property results in a rapid change or flicker in the incoming sunlight. The effect will occur only for a short period during a given day and only under specific concurrent circumstances, namely when:

- The sun is shining and is at a low angle (after dawn and before sunset), and
- There is sufficient direct sunlight to cause shadows (cloud, mist, fog or air pollution could limit solar energy levels), and
- A turbine is directly between the sun and the affected property, and within a distance that the shadow has not diminished below perceptible levels, and
- There is enough wind energy to ensure that the turbine blades are moving.

The time period in which a neighbouring property may be affected by shadow flicker is completely predictable from the relative locations of the wind turbine and the property. Modern wind turbines have the facility to measure sunlight levels and to reduce or stop turbine rotation if the conditions that would lead to shadow flicker at any neighbouring property occur. Thus in practice with careful site design and appropriate mitigation, and most critically the use of appropriate equipment and software, no existing dwelling or other affected property (e.g. existing work places or schools) should experience shadow flicker.

5.12.2 Shadow Flicker Control

At distances greater than 10 rotor diameters, the potential for shadow flicker is extremely low, and accordingly this distance should determine a study area for the purposes of modelling the impact of potential shadow flicker. Every dwelling or other affected property within the 10 rotor diameter radius from each individual turbine should be included in the flicker study area.

Computational models can be used to accurately predict the strength and duration of potential shadow flicker during daylight hours for every day of the year. If a suitable shadow flicker prediction model indicates that there is potential for shadow flicker to occur at any particular dwelling or other potentially affected property, then a review of site design should take place involving the possible relocation of one or more turbines to explore the possibility of eliminating or substantially reducing the occurrence of potential flicker. Following such a review, if shadow flicker is not eliminated for any dwelling or other potentially affected property then measures which provide for turbine shut down to eliminate shadow flicker should be clearly specified. A Shadow Flicker Study for the purposes of modelling the impact of potential shadow flicker should accompany all planning applications for wind energy development

Note: replace section 7.14 in the existing Guidelines with the draft text below.

7.14 Shadow Flicker Planning Conditions

A condition should be attached to all planning permissions for wind farms to ensure that there will be no shadow flicker at any existing dwelling or other existing affected property, within 10 rotor diameters of any wind turbine. A further condition should be included which states that if shadow flicker does occur, then the necessary measures, such as turbine shut down during the associated time periods, will be taken by the wind energy developer or operator to eliminate the shadow flicker.