

**THE ASSESSMENT AND RATING OF NOISE FROM
WIND FARMS**

The Working Group on Noise from Wind Turbines

Final Report
September 1996

PREFACE

This report describes the findings of a Working Group on Wind Turbine Noise. The aim of the Working Group was to provide information and advice to developers and planners on the environmental assessment of noise from wind turbines. While the DTI facilitated the establishment of this Noise Working Group this report is not a report of Government and should not be thought of in any way as replacing the advice contained within relevant Government guidance.

The report represents the consensus view of the group of experts listed below who between them have a breadth and depth of experience in assessing and controlling the environmental impact of noise from wind farms. This consensus view has been arrived at through negotiation and compromise and in recognition of the value of achieving a common approach to the assessment of noise from wind turbines.

Members of the Noise Working Group:

Mr R Meir, Chairman	DTI
Dr M L Legerton, Secretary	ETSU
Dr M B Anderson	Renewable Energy Systems
Mr B Berry	National Physical Laboratory
Dr A Bullmore	Hoare Lea and Partners
Mr M Hayes	The Hayes McKenzie Partnership
Mr M Jiggins	Carrick District Council
Mr E Leeming	The Natural Power Company Ltd
Dr P Musgrove	National Wind Power Ltd
Mr D J Spode	North Cornwall District Council
Mr H A Thomas	Isle of Anglesey County Council
Ms E Tomalin	EcoGen Ltd
Mr M Trinick	Bond Pearce Solicitors
Dr J Warren	National Wind Power Ltd

EXECUTIVE SUMMARY

INTRODUCTION

1. This document describes a framework for the measurement of wind farm noise and gives indicative noise levels thought to offer a reasonable degree of protection to wind farm neighbours, without placing unreasonable restrictions on wind farm development or adding unduly to the costs and administrative burdens on wind farm developers or local authorities. The suggested noise limits and their reasonableness have been evaluated with regard to regulating the development of wind energy in the public interest. They have been presented in a manner that makes them a suitable basis for noise-related planning conditions or covenants within an agreement between a developer of a wind farm and the local authority.

2. The noise limits suggested have been derived with reference to:

- existing standards and guidance relating to noise emissions
- the need of society for renewable energy sources to reduce the emission of pollutants in pursuance of Government energy policy
- the ability of manufacturers and developers to meet these noise limits
- the researches of the Noise Working Group in the UK, Denmark, Holland and Germany
- the professional experience of members of the Working Group in regulating noise emissions from wind turbines and other noise sources
- the discussion of the issues at meetings of the Noise Working Group and with others with appropriate experience.

3. The Noise Working Group has sought to protect both the internal and external amenity of the wind farm neighbour. Wind farms are usually sited in the more rural areas of the UK where enjoyment of the external environment can be as important as the environment within the home.

4. The guidance contained within this report refers to the operation of the wind farm and is not appropriate to the construction phase.

NOISE LIMITS

5. The Noise Working Group recommends that the current practice on controlling wind farm noise by the application of noise limits at the nearest noise-sensitive properties is the most appropriate approach. This approach has the advantage that the limits can directly reflect the existing environment at the nearest properties and the impact that the wind farm may have on this environment.

6. Given that one of the aims of imposing noise limits is to protect the internal environment, one might consider it appropriate to set these limits and hence monitoring locations at positions within the building. There are, however, some practicalities to take into consideration which lead us to believe that the current practice of setting external limits on noise is the more sensible approach; these factors are described in detail in Chapter 6 of the full report.

7. The noise limits applied to protect the external amenity should only apply to those areas of the property which are frequently used for relaxation or activities for which a quiet environment is highly desirable.

8. The Noise Working Group considers that absolute noise limits applied at all wind speeds are not suited to wind farms in typical UK locations and that limits set relative to the background noise are more appropriate in the majority of cases.

9. Only by measuring the background noise over a range of wind speeds will it be possible to evaluate the impact of turbine noise, which also varies with wind speed, on the local environment.

10. The Noise Working Group is of the opinion that one should only seek to place limits on noise over a range of wind speeds up to 12m/s when measured at 10m height on the wind farm site. There are four reasons for restricting the noise limits to this range of wind speed:

- Wind speeds are not often measured at wind speeds greater than 12m/s at 10m height
- Reliable measurements of background noise levels and turbine noise will be difficult to make in high winds
- Turbine manufacturers are unlikely to be able to provide information on sound power levels at such high wind speeds for similar reasons
- If a wind farm meets noise limits at wind speeds lower than 12m/s it is most unlikely to cause any greater loss of amenity at higher wind speeds

11. The recommendation of the Noise Working Group is that, generally, the noise limits should be set relative to the existing background noise at nearest noise-sensitive properties and that the limits should reflect the variation in both turbine source noise and background noise with wind speed. We have also considered whether the low noise limits which this could imply in particularly quiet areas are appropriate and have concluded that it is not necessary to use a margin above background approach in such low-noise environments. This would be unduly restrictive on developments which are recognised as having wider national and global benefits. Such low limits are, in any event, not necessary in order to offer a reasonable degree of protection to the wind farm neighbour.

12. Separate noise limits should apply for day-time and for night-time. The reason for this is that during the night the protection of external amenity becomes less important and the emphasis should be on preventing sleep disturbance. Day-time noise limits will be derived

from background noise data taken during quiet periods of the day and similarly the night-time limits will be derived from background noise data collected during the night.

Quiet day-time periods are defined as:

All evenings from 6pm to 11pm,
plus Saturday afternoon from 1pm to 6pm,
plus all day Sunday, 7am to 6pm.

Night-time is defined as 11pm to 7am.

13. Consideration has also be given to circumstances where a more simplified approach, based on a fixed limit, may be appropriate.

14. The Noise Working Group is agreed that the $L_{A90,10min}$ descriptor should be used for both the background noise and the wind farm noise, and that when setting limits it should be borne in mind that the $L_{A90,10min}$ of the wind farm is likely to be about 1.5-2.5dB(A) less than the L_{Aeq} measured over the same period. The use of the $L_{A90,10min}$ descriptor for wind farm noise allows reliable measurements to be made without corruption from relatively loud, transitory noise events from other sources.

15. The limits to be proposed relate to free-field (except for ground reflections) measurements in the vicinity of noise-sensitive properties.

16. The Noise Working Group is of the opinion that absolute noise limits and margins above background should relate to the cumulative effect of all wind turbines in the area contributing to the noise received at the properties in question. It is clearly unreasonable to suggest that, because a wind farm has been constructed in the vicinity in the past which resulted in increased noise levels at some properties, the residents of those properties are now able to tolerate higher noise levels still. The existing wind farm should not be considered as part of the prevailing background noise.

17. Wind turbines operate day and night dependent upon wind speeds. It will be necessary to acquire background noise data for both day- and night-time periods because:

- the absolute lower limit is likely to be different for day- and night-time operation
- the noise limits are to be related to the background noise levels
- background noise levels may be different in the day than during the night.

18. It is proposed that the background noise levels upon which limits are based and the noise limits themselves are based upon typical rather than extreme values at any given wind speed. An approach based upon extreme values would be difficult to implement as the difference in measurements between turbine noise and background would depend upon the length of time one is prepared to take data. A more sensible approach is to base limits upon typical or average levels but to appreciate that both turbine and background noise levels can vary over several dB for the same nominal conditions.

19. The variation in background noise level with wind speed will be determined by correlating $L_{A90,10min}$ noise measurements taken over a period of time with the average wind speeds measured over the same 10-minute periods and then fitting a curve to these data.

20. The wind farm noise limits proposed below refer to rating levels in a similar manner to that proposed in BS 4142 in respect that additions are made to the measured noise to reflect the character of the noise.

21. Noise from the wind farm should be limited to 5dB(A) above background for both day- and night-time (with the exception of the lower limits and simplified method described below), remembering that the background level of each period may be different.

22. In low noise environments the day-time level of the $L_{A90,10min}$ of the wind farm noise should be limited to an absolute level within the range of 35-40dB(A). The actual value chosen within this range should depend upon a number of factors:

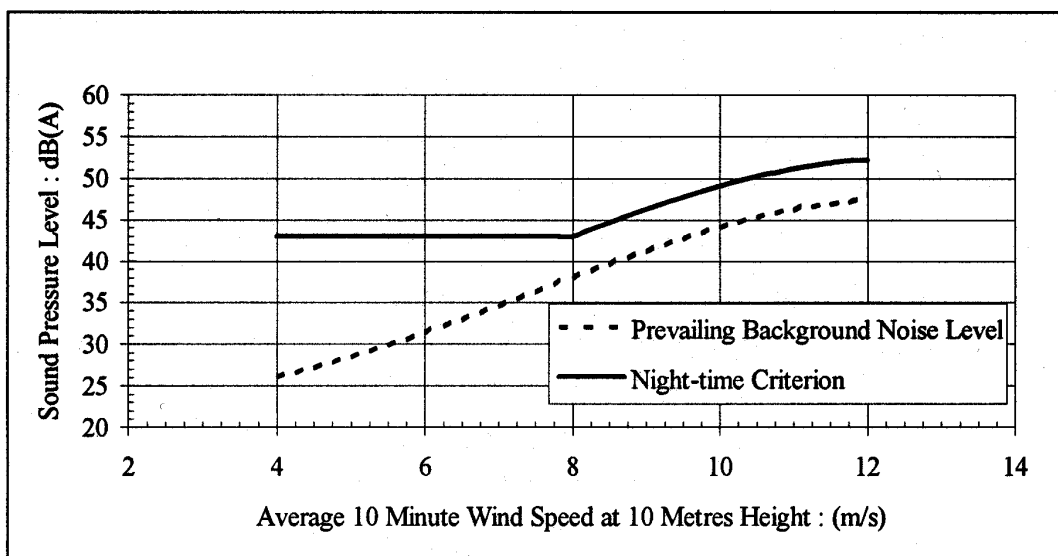
- the number of dwellings in the neighbourhood of the wind farm
- the effect of noise limits on the number of kWh generated
- the duration and level of exposure.

23. The Noise Working Group recommends that the fixed limit for night-time is 43dB(A). This limit is derived from the 35dB(A) sleep disturbance criteria referred to in Planning Policy Guidance Note 24 (PPG 24). An allowance of 10dB(A) has been made for attenuation through an open window (free-field to internal) and 2dB subtracted to account for the use of $L_{A90,10min}$ rather than $L_{Aeq,10min}$.

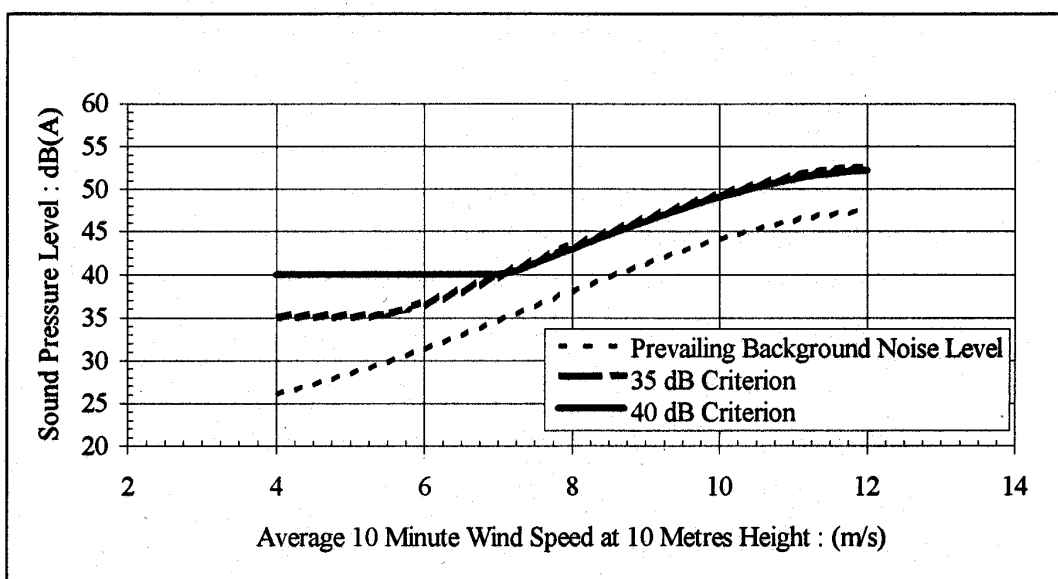
24. The Noise Working Group recommends that both day- and night-time lower fixed limits can be increased to 45dB(A) and that consideration should be given to increasing the permissible margin above background where the occupier of the property has some financial involvement in the wind farm.

25. For single turbines or wind farms with very large separation distances between the turbines and the nearest properties a simplified noise condition may be suitable. We are of the opinion that, if the noise is limited to an $L_{A90,10min}$ of 35dB(A) up to wind speeds of 10m/s at 10m height, then this condition alone would offer sufficient protection of amenity, and background noise surveys would be unnecessary. We feel that, even in sheltered areas when the wind speed exceeds 10m/s on the wind farm site, some additional background noise will be generated which will increase background levels at the property.

26. Graphical representations of the recommended limits appear in the figures overleaf based upon a fairly typical background noise curve. Both background levels and turbine noise are determined by best-fit curves through representative data.



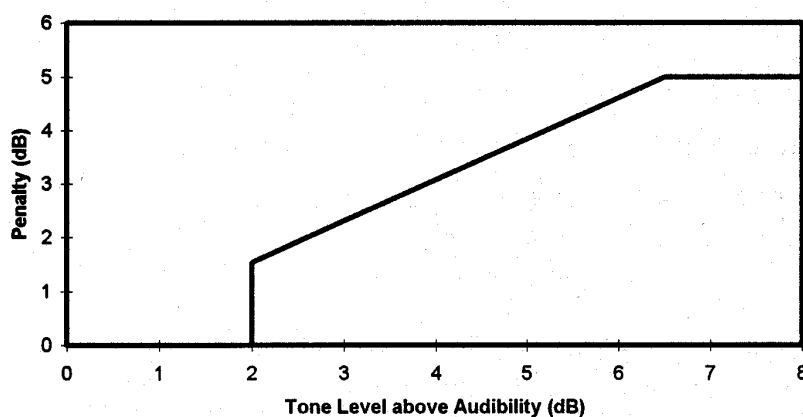
Example of night-time noise criterion



Example of day-time noise criterion

27. The noise levels recommended in this report take into account the character of noise described as blade swish. Given that all wind turbines exhibit blade swish to a certain extent we feel this is a common-sense approach given the current level of knowledge.

28. The Noise Working Group recommends that a tonal penalty is added to the measured noise levels in accordance with the figure below. The penalty incurred is related to the audibility of any tones produced by the wind turbines when measured using a prescribed method as represented graphically below.



Penalties for tonal noise

29. The Noise Working Group thought that it would be beneficial to present its recommendations in a form which might be useful to developers and planners. We therefore considered drafting planning conditions, but came to the conclusion that the necessary definitions of terms which would be required would make planning conditions too complicated. Therefore, it was decided to produce covenants for inclusion within an Agreement between a developer and a local authority. Conditions and Agreements (known as Planning Obligations) are discussed in Chapter 2. The Planning Obligation produced by the Noise Working Group is reproduced in Chapter 8 where it is supplemented by some Guidance Notes to which it refers. These Guidance Notes also serve as a useful summary of the proposed measurement procedure.