## 5. SURVEY OF PUBLIC REACTION TO NOISE FROM WIND FARMS

### Introduction

One element of the work of the Working Group was to assess the circumstances which have or have not resulted in complaints by the public over noise from wind farms. A survey of public reaction to noise from wind turbines as reported to Environmental Health Departments was therefore conducted, based upon the operational wind farms in England and Wales as of February 1994. A list and brief description of the wind farms used in the survey is given in Table 5 and Fig 1 shows their location.

**Table 5 Operational wind farms in England and Wales (Feb 1994)**

| Wind Farm | Turbine Manufacturer | No. | Rated Power kW | Total Capacity kW |
|---|---|---|---|---|
| Cemmaes, Powys | WEG | 24 | 300 | 7200 |
| Kirkby Moor, Cumbria | Vestas | 12 | 400 | 4800 |
| Chelker, Yorkshire | WEG | 4 | 300 | 1200 |
| Ovenden Moor, Yorkshire | Vestas | 23 | 400 | 9200 |
| Delabole, Cornwall | Vestas | 10 | 400 | 4000 |
| Penrhyddlan and Llidiartywaun, Powys | Mitsubishi | 103 | 300 | 30900 |
| Rhyd-y-groes, Anglesey | Bonus | 24 | 300 | 7200 |
| Blyth Harbour, Northumberland | HMZ | 9 | 300 | 2700 |
| Orton Airport, Cumbria | Carters | 10 | 300 | 3000 |
| Goonhilly Downs, Cornwall | Vestas | 14 | 400 | 5600 |
| Cold Northcott, Cornwall | WEG | 22 | 300* | 6700 |
| Blood Hill, Norfolk | Vestas | 10 | 225 | 2250 |
| Taff-Ely, Mid Glamorgan | Nordtank | 20 | 450 | 9000 |
| Carland Cross, Cornwall | Vestas | 15 | 400 | 6000 |
| Coal Clough, W Yorkshire | Vestas | 24 | 400 | 9600 |
| Llangwyryfon, Dyfed | WEG | 20 | 300 | 6000 |
| Haverigg, Cumbria | Vestas | 5 | 225 | 1125 |
| Royd Moor, S Yorkshire | Bonus | 13 | 450 | 5850 |

* Includes 1x400 kW Turbine

A questionnaire was sent to local authorities having wind farms in their areas. A summary of the results of this survey appears in Table 6 and a more detailed discussion follows.

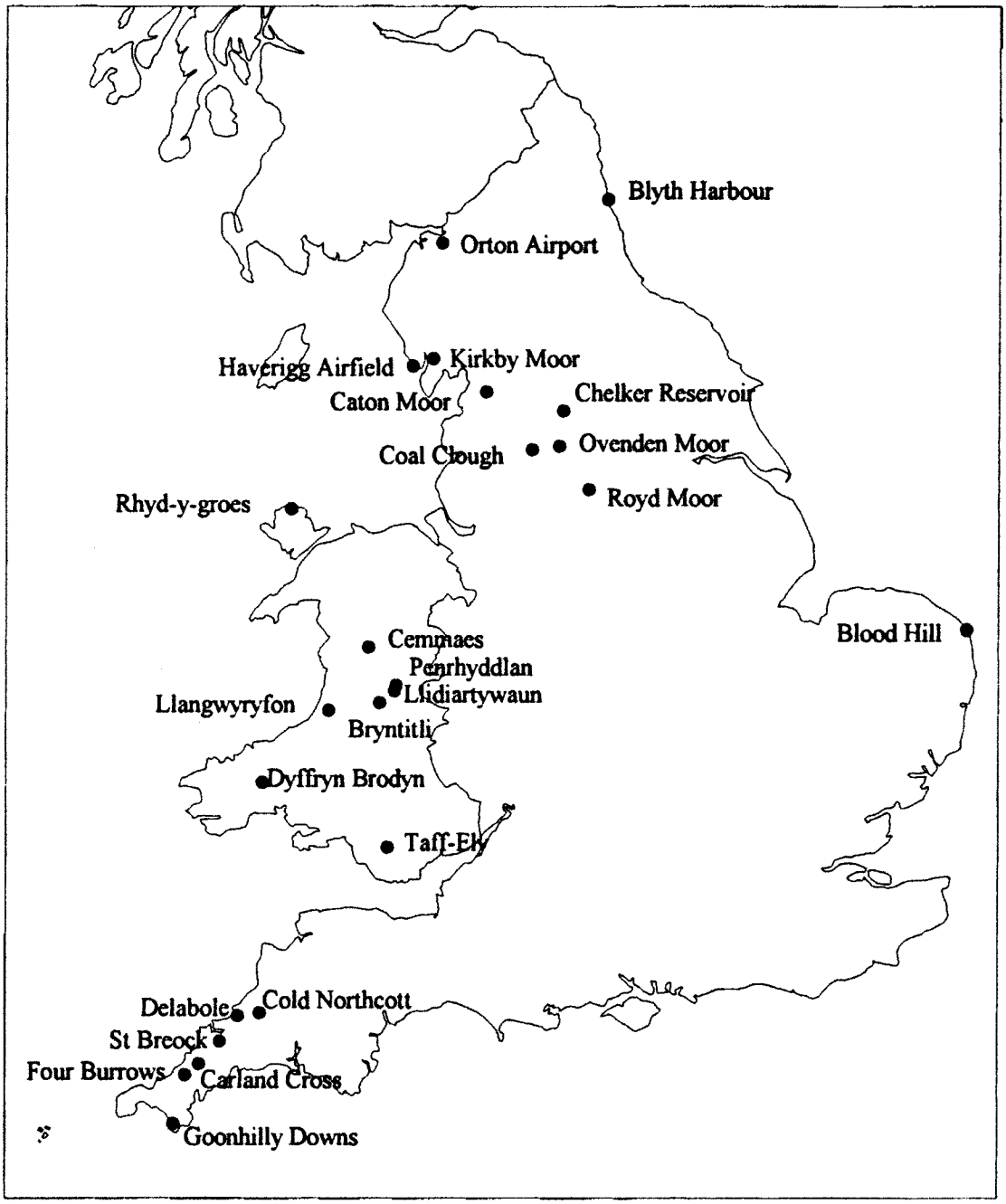


**Figure 1 Wind farms constructed under NFFO-1 and -2**

**Table 6 Summary of complaints from wind farms**
(figures in italics are from conversations on phone rather than from the questionnaire)

| Wind Farm | Distance from residences to wind farm (m) | Number of complaints | | | Aspects of noise leading to complaints | | | |
|---|---|---|---|---|---|---|---|---|
| | | Verbal | Written | Distant | Overall | Tones | Swish | Other |
| | | | | | | | | |
| *Cemmaes* | | *0* | *0* | *0* | *n/a* | *n/a* | *n/a* | *n/a* |
| *KirkbyMoor* | *700* | *0* | *0* | *0* | *n/a* | *n/a* | *n/a* | *n/a* |
| Chelker | 350-500 | 0 | 0 | 0 | n/a | n/a | *nidi* | n/a |
| Ovenden Moor | 320-630 | 0 | 0 | 0 | n/a | n/a | n/a | n/a |
| Delabole | 350-1380 | 15 | 7 | 5 | No | Yes | No | Yes |
| Penrhyddlan and Llidiartywaun | 700-1200 | | 5 | 2 | Yes | Yes | Yes | No |
| Rhyd-y-Groes | 400-600 | 1 | 1 | 0 | Yes | No | No | **Yes** |
| *Blyth Harbour* | | *0* | *0* | *0* | *n/a* | *n/a* | *n/a* | *n/a* |
| Orton Airport | | | | | | | | |
| Goonhilly Downs | | | | | | | | |
| Cold Northcott | 380-500 | 10+ | 5 | 1 | Yes | Yes | Yes | No |
| Blood Hill | 400-450 | 0 | 0 | 0 | n/a | n/a | n/a | n/a |
| *Taff-Ely* | | *1* | *1* | *0* | | | | |
| Carland Cross | 370-410 | 2 | 2 | 2 | Yes | Yes | **Yes** | **Yes** |
| Coal Clough | 420 | 0 | 0 | 0 | n/a | n/a | n/a | n/a |
| Llangwyryfon | | | | | | | | |
| Haverigg | 600, 1000 | 0 | 0 | 0 | n/a | n/a | n/a | *nidi* |
| Royd Moor | | | | | | | | |

**Effects of topography**

Following experience from mainland Europe, initial expectations had been that the noise from wind turbines would be most intrusive at wind speeds at and just above cut-in. It had been expected that as the wind speed increased, the background noise generated by the passage of wind through trees and around buildings would increase at a faster rate than the noise generated by the turbines. The margin of the turbine noise above background noise would then have been greatest at relatively low wind speeds with the turbine noise progressively drowned out as the wind speed increased. This has not always been the case, however, particularly at many of the sites at which complaints over wind farm noise have arisen. At Cold Northcott, Penrhyddlan and Llidiartywaun, Rhyd-y-Groes and Delabole the noise was felt to be more intrusive at hub height wind speeds of 8m/s and above. In some cases this is influenced by the switching to a higher turbine rotational speed in higher winds but is primarily because properties are frequently sited in sheltered areas. It is not unusual for turbines to be

operating in relatively strong winds on an exposed hill top location while some of the nearest properties in relatively sheltered valleys remain out of the wind and hence background noise levels can remain low in the absence of significant wind-generated background noise.

**Change in attitude with time**

There was no firm evidence of complainants becoming accustomed to the noise and their level of concern diminishing as a result. Decreasing annoyance was seen at some wind farm sites but this was usually due to remedial action being taken to reduce the noise from the wind turbines. An example of this occurred at Delabole where the turbines on commissioning could under certain conditions produce a noise described as a "squawk". This was also observed at Carland Cross using the same model of turbines and was believed to be caused by an instability in the flow over the turbine rotor blades. The effect was remedied by making adjustments to the pitch control settings and application of tapes, or boundary layer trips, to the trailing edges of the blades. These boundary layer trips disturbed the boundary layer or air flow close to the surface of the blade, causing it to become turbulent rather than laminar. As a laminar boundary layer is a prerequisite for the excitation process to occur this eliminated the noise source.

At sites which have not been able to reduce noise levels to the satisfaction of residents, complainants have become impatient and shown increasing annoyance.

**Characteristics of the noise**

At all sites at which complaints have been made reference has also been made to particular characteristics of the noise. Mechanical noise of a tonal nature, usually from the gearbox, has been frequently cited as being an aspect of the noise leading to complaints. In cases where mechanical noise is present it is not surprising that this should lead to increased annoyance, as is reflected in the penalties for tonal content added to rating levels of noise in standards such as BS 4142.

Blade swish is a phenomenon more peculiar to wind turbines which has emerged as another characteristic which can under certain circumstances add to the likelihood of complaints. Swish was identified as being one aspect of the noise leading to complaints at Penrhyddlan and Llidiartywaun, Cold Northcott and Carland Cross. Recorded time trace data from a property near to Carland Cross showed peak to trough differences of the A-weighted noise up to 3dB in an open situation and up to 6dB in a location where multiple reflections from nearby buildings affected noise levels. A noticeable level of swish was also observed by the Environmental Health Officer at Coal Clough although no complaint has been made at this

Intermittent blade thump was cited as being a contributing factor leading to complaints at Carland Cross.

**Noise levels**

As illustrated later in Chapter 6 background noise and turbine noise levels can be quite variable and show a fair degree of scatter even when plotted against wind speed. From the often limited data available it has therefore not been possible to reach any firm conclusions on noise levels which are likely to lead to complaints, particularly as in many cases the character of the noise has been as influential as the actual noise level in leading to complaints.

**Time of day**

Indications of periods during which the noise was found to be most audible or most intrusive were generally the same irrespective of whether weekdays or the weekend were being considered. At Cold Northcott, Rhyd-y-Groes and Delabole night-time (22.00-06.00) was reported to be the period at which nearby residents found the noise most intrusive, along with the evening (18.00-22.00) at Cold Northcott and Delabole and early morning (06.00-09.00) at Rhyd-y-Groes.

**Relative impact, indoors compared to outdoors**

The level of intrusion was in general a degree less indoors than out of doors. If the level of intrusion was considered high outdoors it was low indoors; if the noise could only be heard faintly outdoors it was inaudible indoors. On some sites (Blood Hill and Chelker) the turbines were considered largely inaudible both indoors and outdoors. The finding that outdoor levels were found to be more intrusive than indoor levels is somewhat at odds with the previous finding that the intrusion was in some cases greater at night when you would expect people to be indoors.

**Reasons for absence of complaints**

Although this section has concentrated on the factors affecting the likelihood of complaints it should be noted that at eight of the thirteen wind farms for which we have data no complaints have been received. The most frequently given reason is (not surprisingly) the low noise levels or inaudibility of the wind farm. Perceived low noise levels are usually the result of one or more factors including:

- background noise levels being sufficiently high at all wind speeds to substantially mask the turbine noise
- relatively quiet turbines with little or no tonal content in the noise emissions
- relatively large separation distances between turbines and nearest residences
- public acceptability of the wind farm in general.

**Conclusions from the survey**

- The framework for assessing wind turbines needs to relate noise at residences to turbine noise, taking into account the possibility of nearest residences remaining sheltered from the wind when turbines are operating in moderate-to-high wind speeds.

- Once nearby residents are sensitised to noise they are unlikely to get used to it over a relatively short period of time (approximately 12-18 months at the time of writing).

- The assessment method should impose penalties for distinctive characteristics of the noise.

- The assessment method should take account of the lower background noise levels at night.

- By using best practice it is possible to develop wind farms which are unlikely to lead to complaints over noise levels from the nearby residents.