The Measurement of Low Frequency Noise at Three UK Wind Farms

Malcolm D Hayes

Hayes McKenzie Partnership

IoA Meeting 20th March 2007

Why undertake the Study

- A “Survey” undertaken by Dr Harry around a site in Cornwall indicated that Low Frequency Noise was resulting in Health Effects to Neighbours
- Dr Osborne article within the NW General Practioner Magazine;
- Articles within National Press: Daily Telegraph 25th Jan 2004: http://www.telegraph.co.uk/news/main.jhtml?xml=/news/2004/01/25/nwind25.xml

Dr Harry Survey Questionnaire

LIVING WITH TURBINES

This questionnaire has been written to try to assess if the erection of wind turbines near to your home has affected your physical, psychological or social wellbeing.

Please answer the following questions.

1) NAME (preferred but optional)

2) AGE 18-30 30-45
45-60 >60

3) OCCUPATION

4) ADDRESS and or POST CODE

5) Which wind farm is situated near your property?

6) How far away from your property is the nearest wind turbine?

7) How long have you been living at this property?

8) Do you feel that your health has in any way been adversely affected since the erection of the turbines Yes No

9) If yes please answer the following:-

Do you feel that since living near to a wind turbine/ turbines you have experienced excess of the following symptoms (i.e. more than you did prior to living near these structures)?

Headaches	yes	no
Palpitations	yes	no
Excessive tiredness	yes	no
Stress	yes	no
Anxiety	yes	no
Tinnitus (ringing in the ears)	yes	no
Hearing problems	yes	no
Sleep disturbances	yes	no
Migraines	yes	no
Depression	yes	no
Other – please specify		

If you have answered yes to any of the above, have you approached your doctor regarding these symptoms? Yes no

If yes please state any tests and/ or treatment initiated.

10) Do you feel that your quality of life has in any way altered since living near the wind turbines?
Yes No

If yes could you please explain in what way you feel your life has been altered?

Thank you for completing these questions. Please note that all your answers will be treated in confidence and that your personal information will not be passed on to any third party.
Please return to:- Dr Amanda Harry, West Hoe Surgery, 2 Cliff Road, West Hoe, Plymouth, PL1 3BP Please label your envelope NOISE SURVEY

Osborne Article

Royal College of General Practitioners North Wales Faculty: June 2003

North Wales Faculty Newsletter

Issue 4 June 2003

Important developments in Training and research in North Wales

Exciting new developments are happening in research and training in North Wales. These new developments can help to put North Wales on the academic map, and are important in the development of the North Wales Medical School.

Medical undergraduate training in North Wales has been lacking in the past. This means that North Wales general practices and hospitals are less likely to attract registrars/junior doctors. In his article about training medical undergraduates in North Wales DR Wood describes how the situation is changing. This gives some hope for appeasing the local recruitment crisis in the future.

DR Williams' article P3, usefully describes the local bodies involved in research and also provides information on research courses. A firm foundation is being built with all local academic bodies to enable research to happen locally.

DR L G Morgan-Editor.

Training Medical Undergraduates in North Wales

DR D G E Wood FRCGP

Just over seven years ago the undergraduate curriculum for Liverpool was dramatically revised. The student now spend a very considerable part of their training over the period of five years in community based sites. A very large part of the educational process is achieved through problem based learning consistent with the principles of adult education.

The then Director of Community Studies Professor John Blyth approached me to be involved in supervising students in clinical placements in North Wales. As a result of this, two and a half years ago the first group of students arrived in North Wales. They are all final year students who have already passed their final exams and spend the last year in various posts in more of an apprenticeship type role, which gives them an opportunity to get practical experience in consulting skills with new patients to learn new skills.

The students attend in groups of eight with a total

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ANNOUNCING THE ANNUAL HARVARD DAVIS LECTURE-

TO BE HELD ON 3RD SEPTEMBER 7PM AT GLAN CLWYD POSTGRADUATE CENTRE

Please see back pages for details

Caption competition Win a bottle of Champagne! See page 4 for details

The Physiological effects of wind farms

DR B V Osborne FRCGP

In 2001 I became involved in a campaign to prevent the erection of a windfarm on Mynydd Llanelian, a hill on the Llanrwst road above Bryn y Maen, near Colwyn Bay. It was proposed to construct 4 turbines, over 250ft tall, much higher than any elsewhere in Wales, with a projected total 1.3 MW output.

There is a public perception that wind power is "green" and has no detrimental effect on the environment. At Kyoto the United Kingdom agreed to reduce CO2 emissions by 10%. One way in which this could be achieved is by producing electricity from

"Wales has the largest concentration of wind turbines in Europe and 45% of all turbines in the UK"

solar, wind and tidal energy, instead of burning fossil fuels. The other, less popular, option is to reduce energy consumption.

However, the technology for harnessing wind power is inefficient.

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Contents

By DR Osborne

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Although Wales has the largest concentration of wind turbines in Europe and 45% of all turbines in the UK, the 160 turbines at Carno and Llandinam in mid Wales take one year to produce the same amount of energy that a coal fired power station produces in 4 days. Because wind turbines only generate for 25% of the time (either because there is insufficient momentum to turn the blades, or the wind is too strong), they must always be backed up by conventional power stations. In practice National Grid planners ignore their output. What is often also often forgotten is that erection of wind farms costs energy in terms of the production of steel and concrete for the towers and blades. Vehicles carrying materials burn fossil fuels and energy is also used in decommissioning after a brief 25yr life span. Although manufacturers claim that production energy input is negated after ten years, this figure is debatable, and many engineers would attest that there is no overall energy gain.

During our campaign I became aware that turbines have a number of physiological effects of on people. The principal effect on human beings is that produced by noise. The noise falls into two categories. There is a loud cranking sound produced by the gearing and rotation of the turbine head when the wind changes. This is intermittent, unpredictable and may be a nuisance on a summer evening when the sound carries to those sleeping nearby. However, it is the low frequency "whooshing" at about four Hertz, produced by the blades turning, which is particularly disturbing. This frequency resonates with the human body, the effect being dependent upon body shape. There are those on whom there is virtually no effect, but others for whom it is incredibly disturbing. There are personal accounts on the Internet written by Danes who have been forced to abandon their homes because of the psychological effect this noise has had upon them.

There is also anecdotal evidence from farmers in Ynys Mon that sheep grazing below turbines are slower to gain weight than their contemporaries elsewhere. This may also be related to low frequency noise. The blades may cause extreme disturbance due to the effect of flicker against a rising or setting sun. This may be a problem to those whose rooms face the turbines and to passing drivers. There is a theoretical risk of photogenic epilepsy, but no good evidence in the literature. Turbines partially obscured from view by the rise and fall of the land may appear to "cartwheel", resulting in intense vertigo.

Rotating turbines produce microwave radiation. This interferes with television, radio and radar and this led to the ultimate rejection of the windfarm. The hill next to Mynydd Llanelian, Cefn Du, is the site of the Police and Emergency transmitter. It was pointed out in the Planning Committee that the turbines would disrupt communication between the mast and the North Wales Police headquarters in Colwyn Bay, causing chaos with emergency transmissions all along the North Wales coast.

I have not discussed the ecological effects of wind farms, which are considerable. My own objections were concerns for the wildlife (the area hosts over 50 bird species, brown hare and is adjacent to an SSI) and aesthetic (the turbines would have been highly visible, being far larger than those recently erected on Moel Maelogan). When the wind farm proposal was rejected there was no appeal and the parent company has subsequently gone into liquidation. However, the farm at Moel Maelogan is now operational and there are already plans to increase the number of turbines there from 3 to 11. The Bryn y Maen protestors have not been successful in keeping turbines out of the Conwy Valley.

(DR B V Osborne is a Freelance GP, a Freelance GP Coordinator and Chair of the HRC)

Training Medical Undergraduates in North Wales

BY DR Wood

(continued from page 1)

of five separate groups between September and June. There are at present forty students in a year sometimes one or two more, sometimes a few less. They spend seven weeks in North Wales at present accommodated in one of the local hotels. They are attached to one practice where they will have opportunity to do consultations and also to spend time with other members of the primary health care team and to go out visiting with community based staff.

"Planned increase in medical Students"

"More practices will need to become involved"

Because of the already planned increase in the numbers of medical students going to universities, Liverpool will be increasing their numbers very considerably over the next couple of years and we have been asked to consider increasing the number of students we take from forty to sixty and eventually to eighty. As a result of this we are in the process of attempting to recruit more practices who would wish to become involve in having students. At the present time we have twelve practices that are involved on a rota system with the eight students that we take each time.

The general feedback from the students is that they value their time in North Wales extremely highly. The feedback from practices is that they

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Osborne Article

- Dear Pete

  We've contacted Dr Bridget Osborne, the author of the "research" that you refer to. She originally spoke briefly to the Sunday Telegraph after another GP gave them her home telephone number but she never told them that she had presented a paper to the RCGP. She has written an article that appeared in the RCGP North Wales Faculty Newsletter last year but this is NOT a scientific paper and she doesn't want it being sent out. She has sent us a paper on low frequency noise on the government's own DEFRA website that she says would cover any questions on this issue. I've attached this paper to the email in case it is of interest/use.

  Please let me know if you have any other queries.

  Regards,

  Richard Whittome
  Information Manager
  RCGP

A Review of Published Research on Low Frequency Noise and its Effects

- Report for DEFRA by Dr Geoff Leventhall: May 2003
- Provides a detailed summary of the issues associated with Infra-sound and Low Frequency Noise
- http://www.defra.gov.uk/environment/noise/research/lowfrequency/

What is Low Frequency Noise?

- Normal Hearing Range : 20 - 20 kHz
- Low Frequency Range : 20 - 160 (250) Hz
- Infrasound Range : < 20 Hz

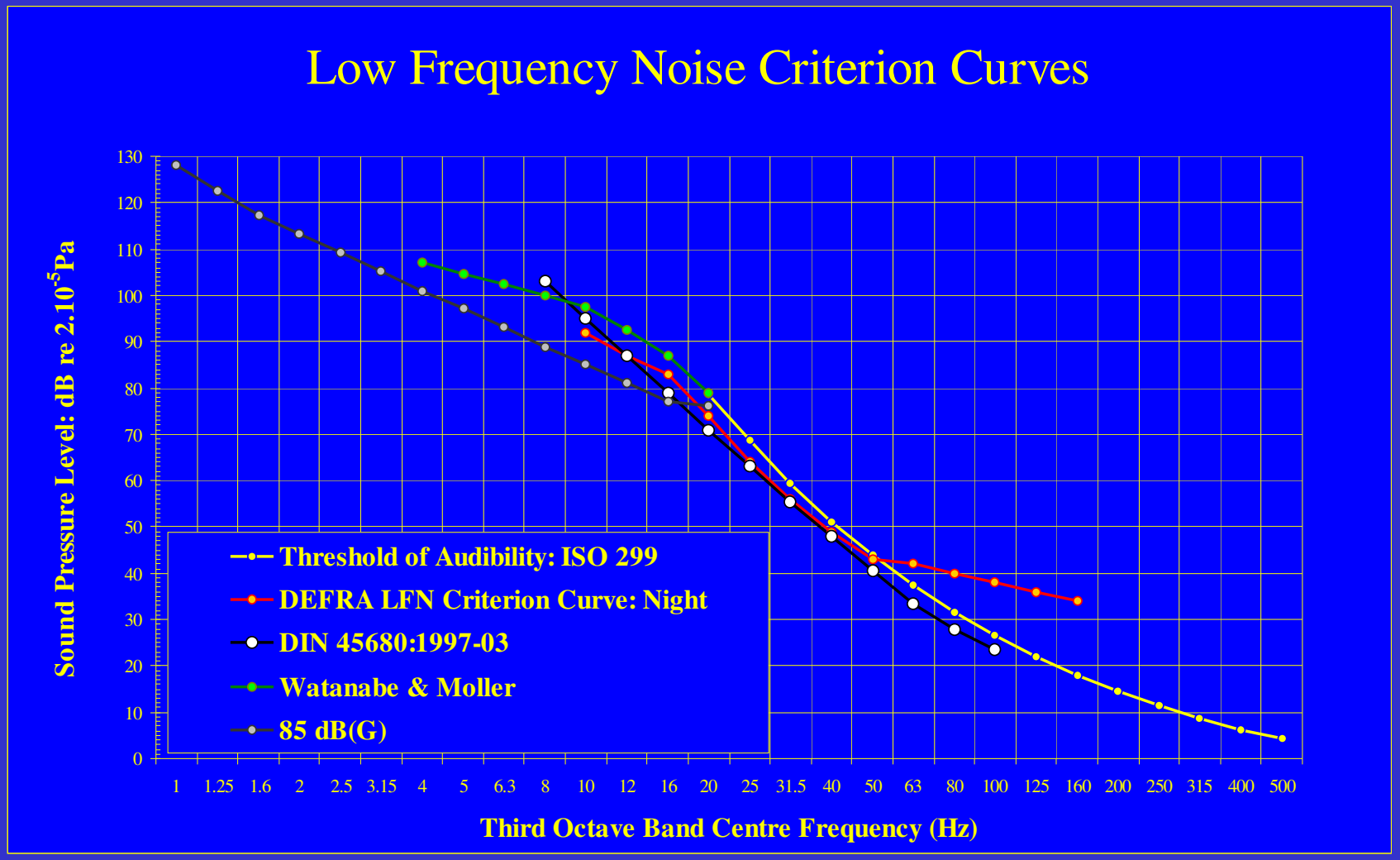
Low Frequency Noise Study

- To look at three sites in UK which have been reported in National Newspapers to be subject to high levels of low frequency noise;
- To undertake measurements at these sites to determine the level of exposure;
- To report collected data for public dissemination

Assessment Methodology

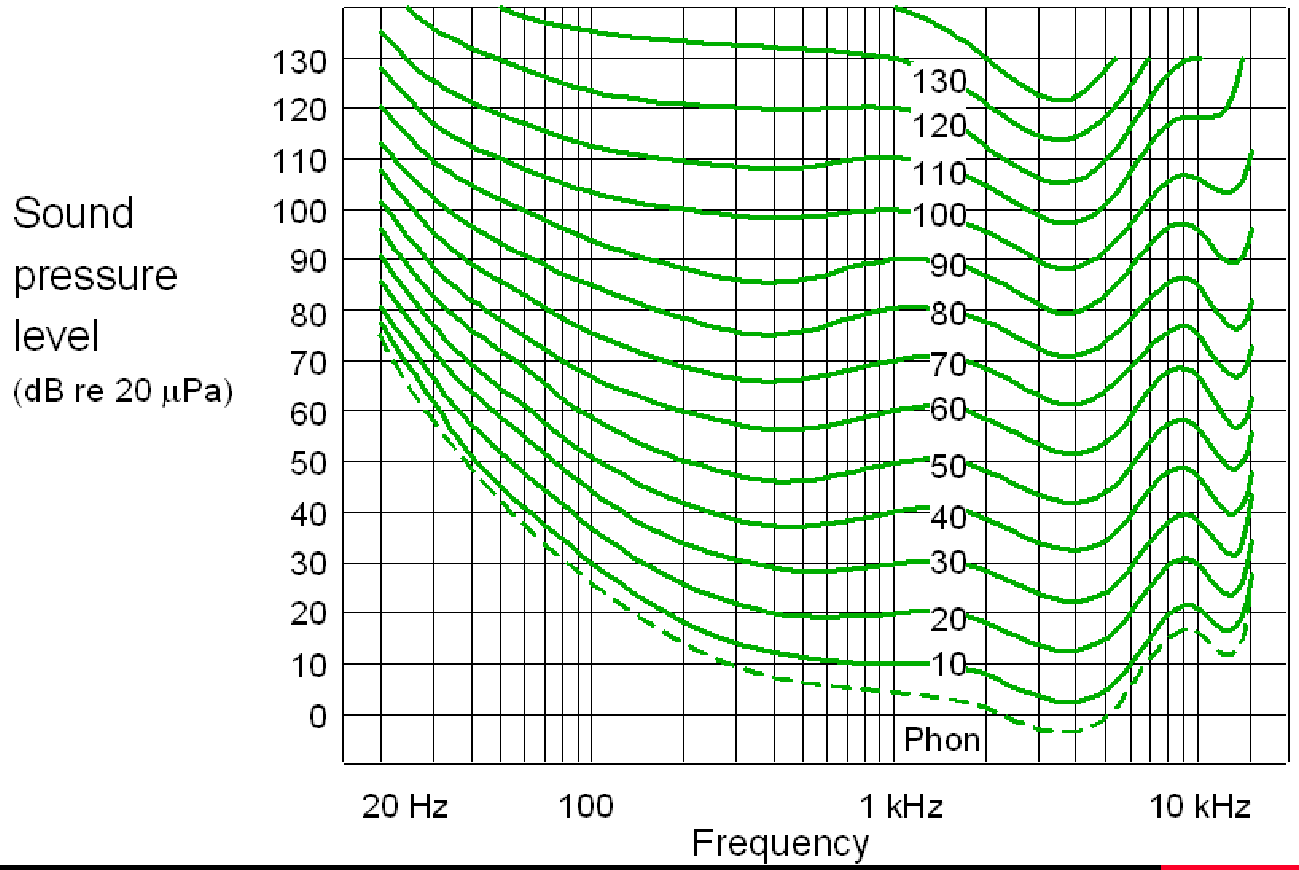
- DEFRA Document: *Proposed criteria for assessment of low frequency noise disturbance*
- http://www.defra.gov.uk/environment/noise/research/lowfrequency/index.htm

Noise Criteria

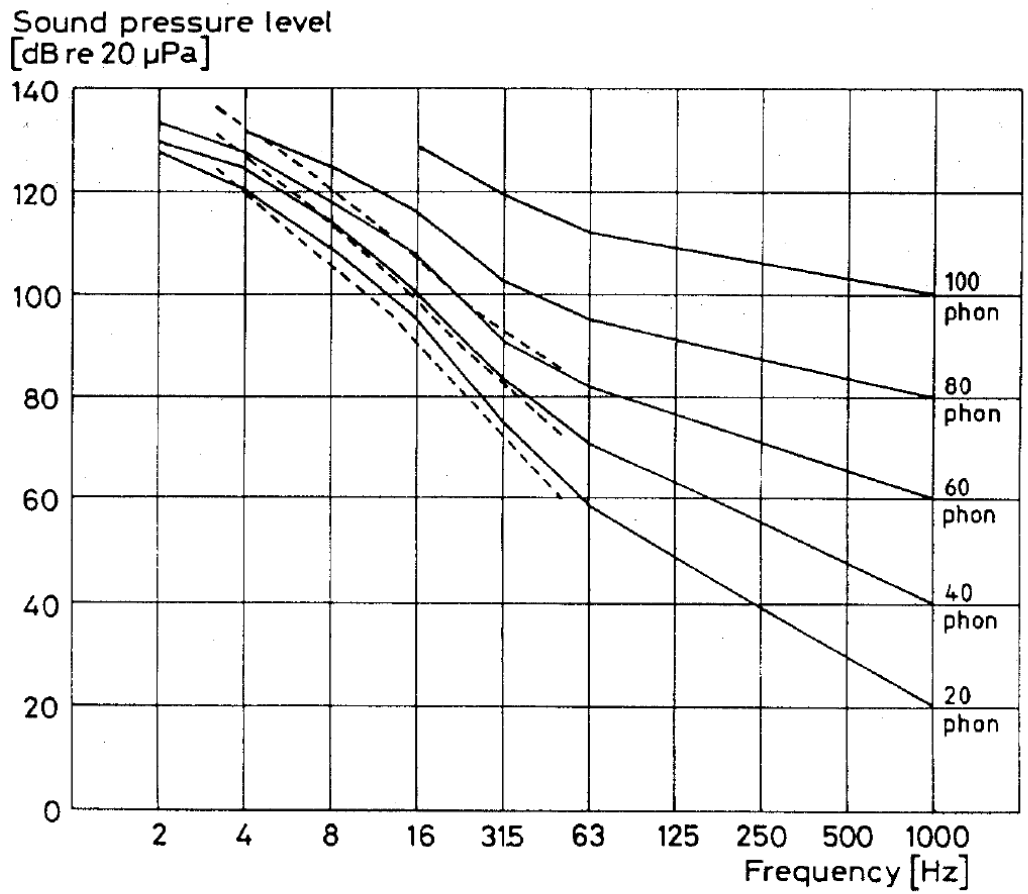


Low Frequency Loudness

Normal Equal Loudness Contours for pure tones



Infra-sound Loudness



Loudness measurements.

——— **Møller and Andresen**

------- **Whittle**

Loudness of pure tones at low and infrasonic frequencies: Jnl. Low Freq Noise Vibn: 21, 78 – 87: Moller & Andresen

The audibility of Low Frequency Sounds: Jnl Sound Vbn 21, 431 – 448, Whittle, Collins & Robinson

Other Low Frequency Noise Criteria

- G-Weighted Sound Pressure Levels: Threshold of Audibility = 85 dB(G)
- Danish Low Frequency Noise Levels: dB $L_{pA,\,LF} < 20$ dB : from 10 – 160 Hz

Danish Infrasound and Low Frequency Noise Limits	Infrasound, L_{pG}	Low frequency noise, $L_{pA,LF}$	Usual noise limit, L_{pA}
Dwelling, evening & night	85 dB	20 dB	30 dB / 25 dB
Dwelling, day	85 dB	25 dB	30 dB (day & evening)
Classroom, office etc.	85 dB	30 dB	40 dB
Other rooms in enterprises	90 dB	35 dB	50 dB

Table 3. Recommended limits for infrasound (L_{pG}), for low frequency noise ($L_{pA,LF}$), and the normal noise limit for noise from enterprises (L_{pA}, used when the enterprise and the dwelling are in the same building). All levels in dB re 20 µPa.

Where to Undertake Measurements

- Internally at location where noise experienced
- At a location which is worst-case, i.e. close to room boundaries
- Additional measurements of external noise at façade and in free-field conditions (ETSU-R-97 Location)

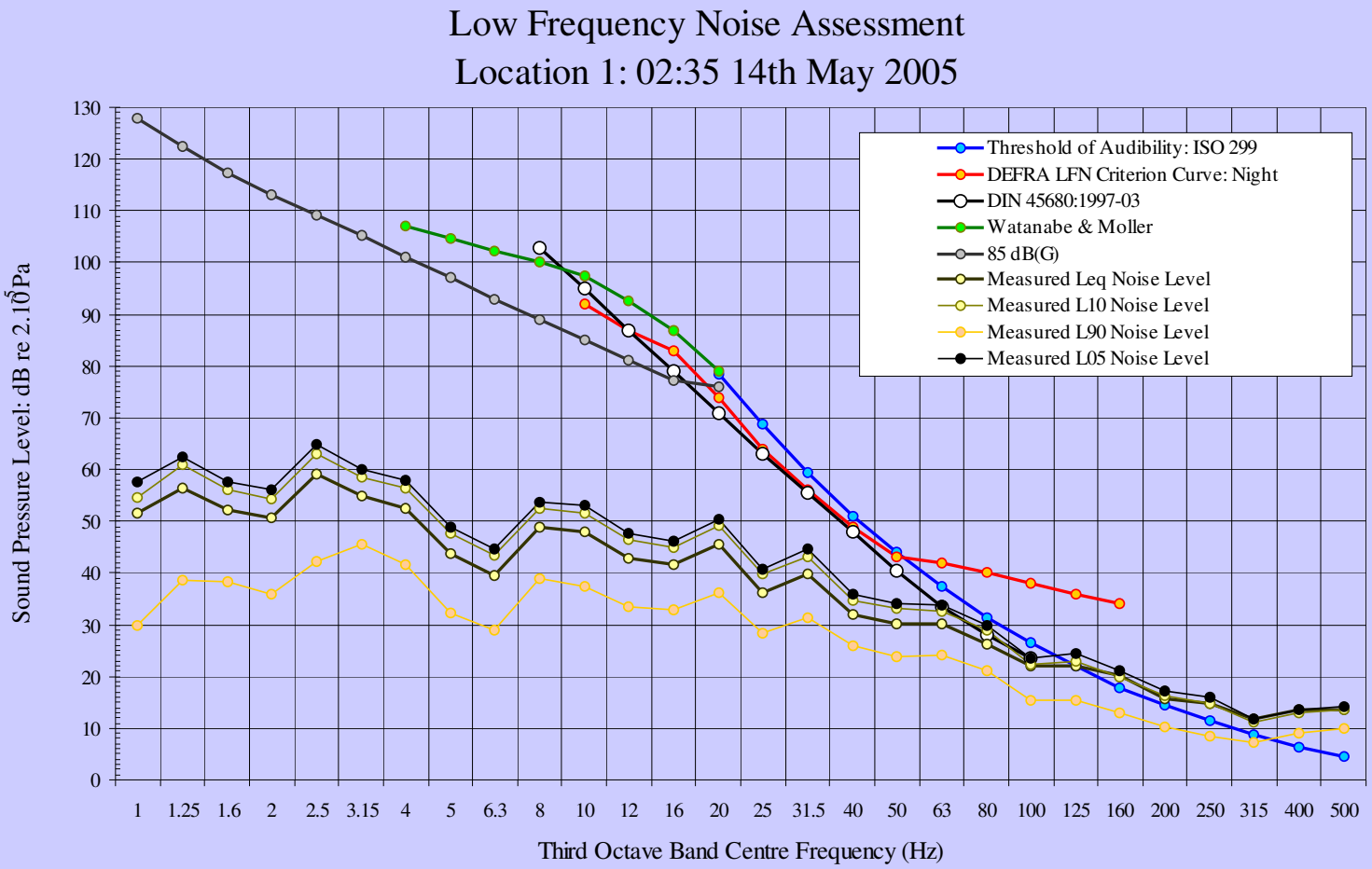
Accessing Measurement Locations

- Site 1: 2 Locations: 1 Measured
- Site 2: 2 Locations: None Measured
- Site 3: 1 Location: 1 Measured
- Site 4: 2 Locations: 2 Measured

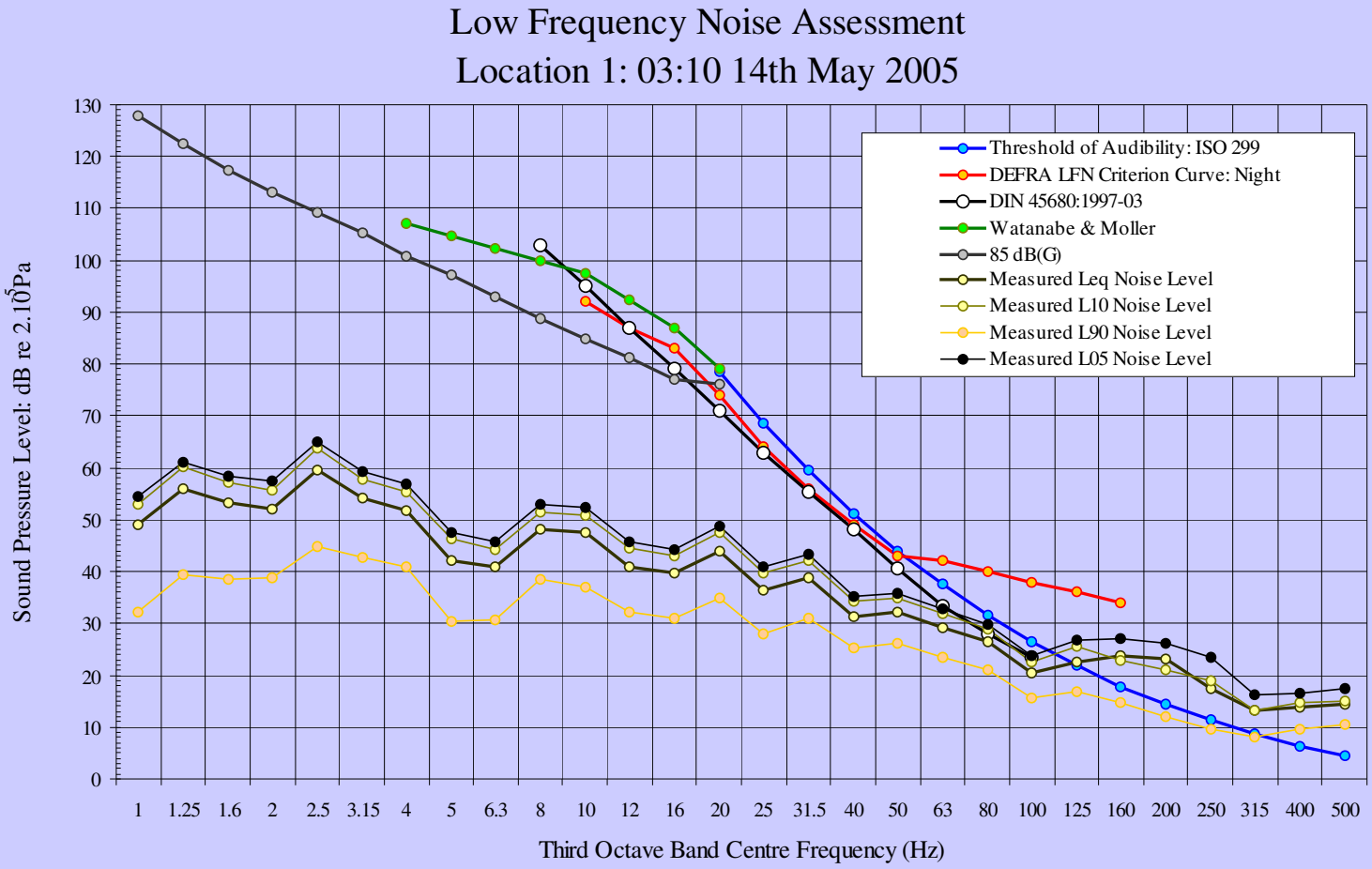
Reasons for No Measurements

- Availability of resident
- Changes in circumstances

Site 1 Location 1



Site1 Location 1



G-Weighted Levels

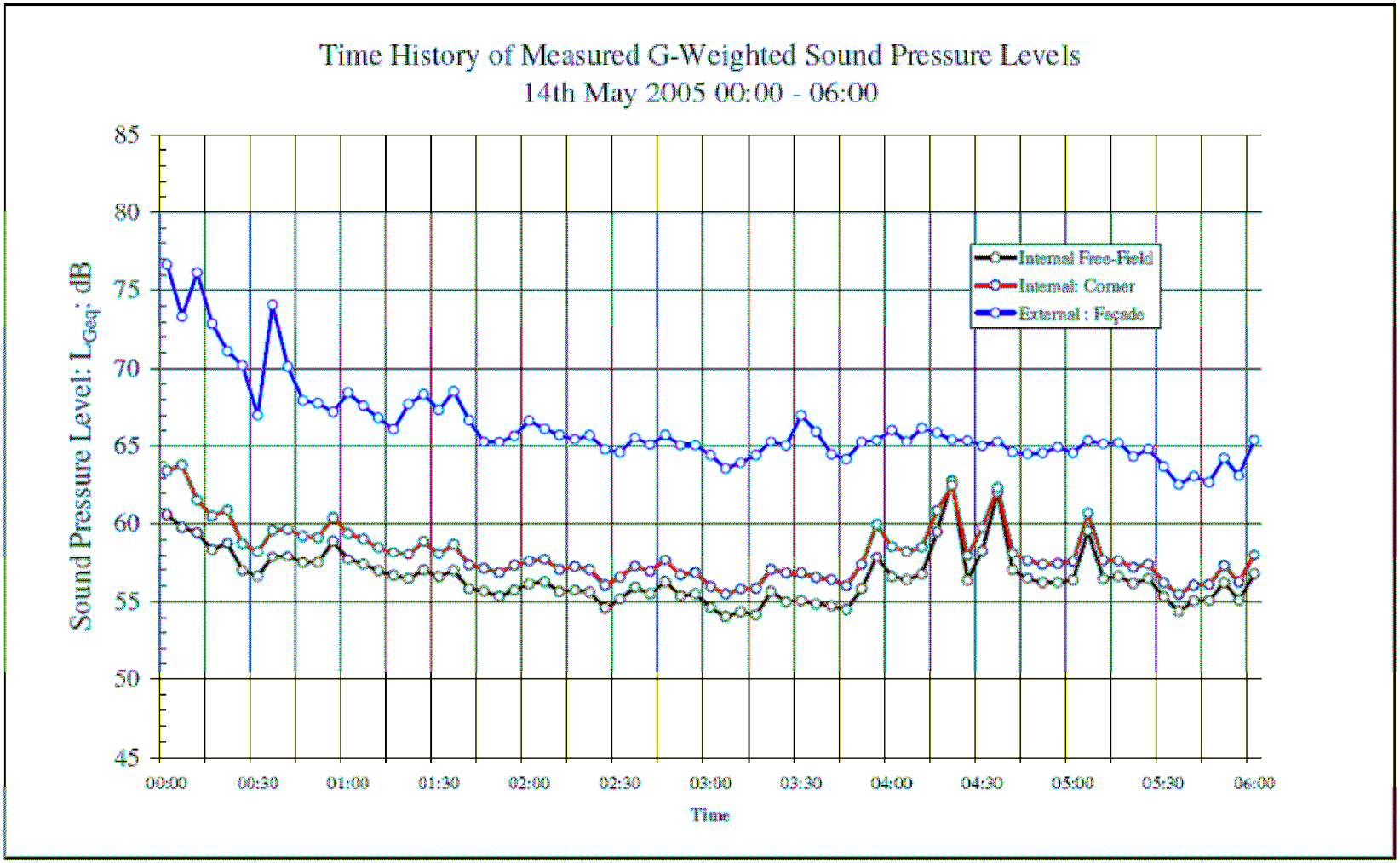


Figure 26: Time History of G-Weighted Sound Pressure Levels: 14th May 2005

$L_{pA,LF}$ Levels

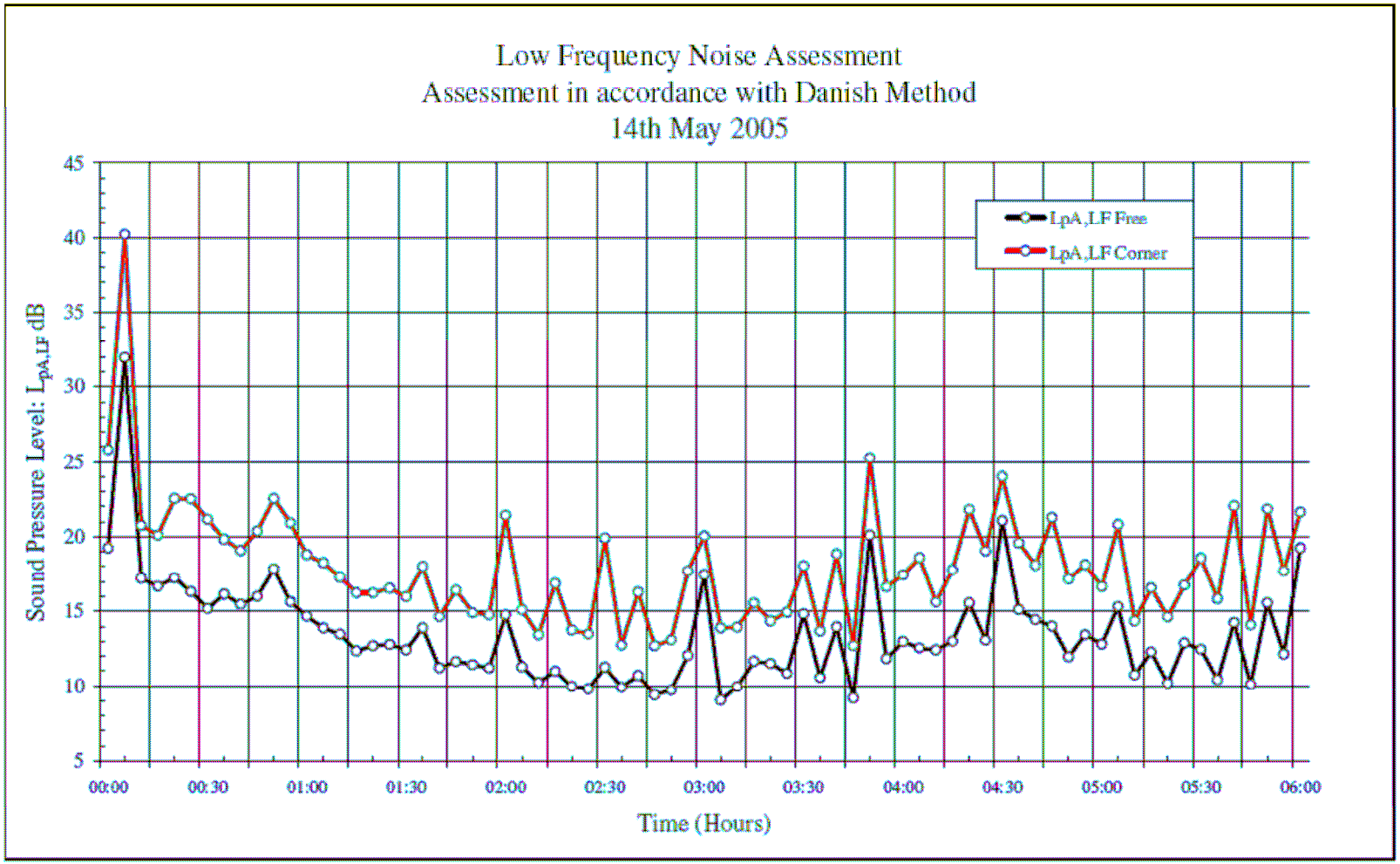


Figure 27: Time History of $L_{pA,LF}$ Internal Noise Levels

Site 2

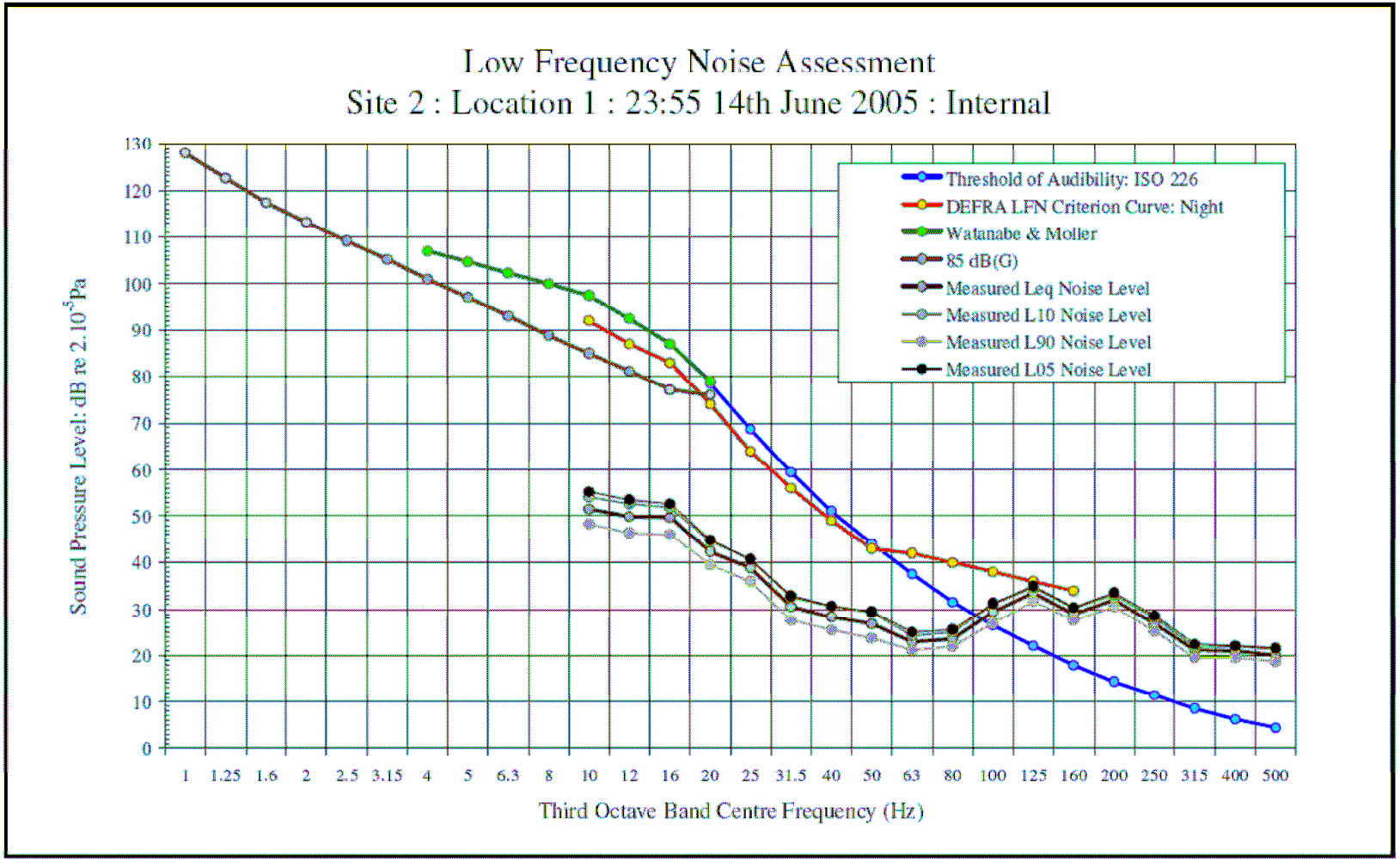


Figure 34: Site 2: Internal: 23:55: 14th June

Site 2: Windows CLosed

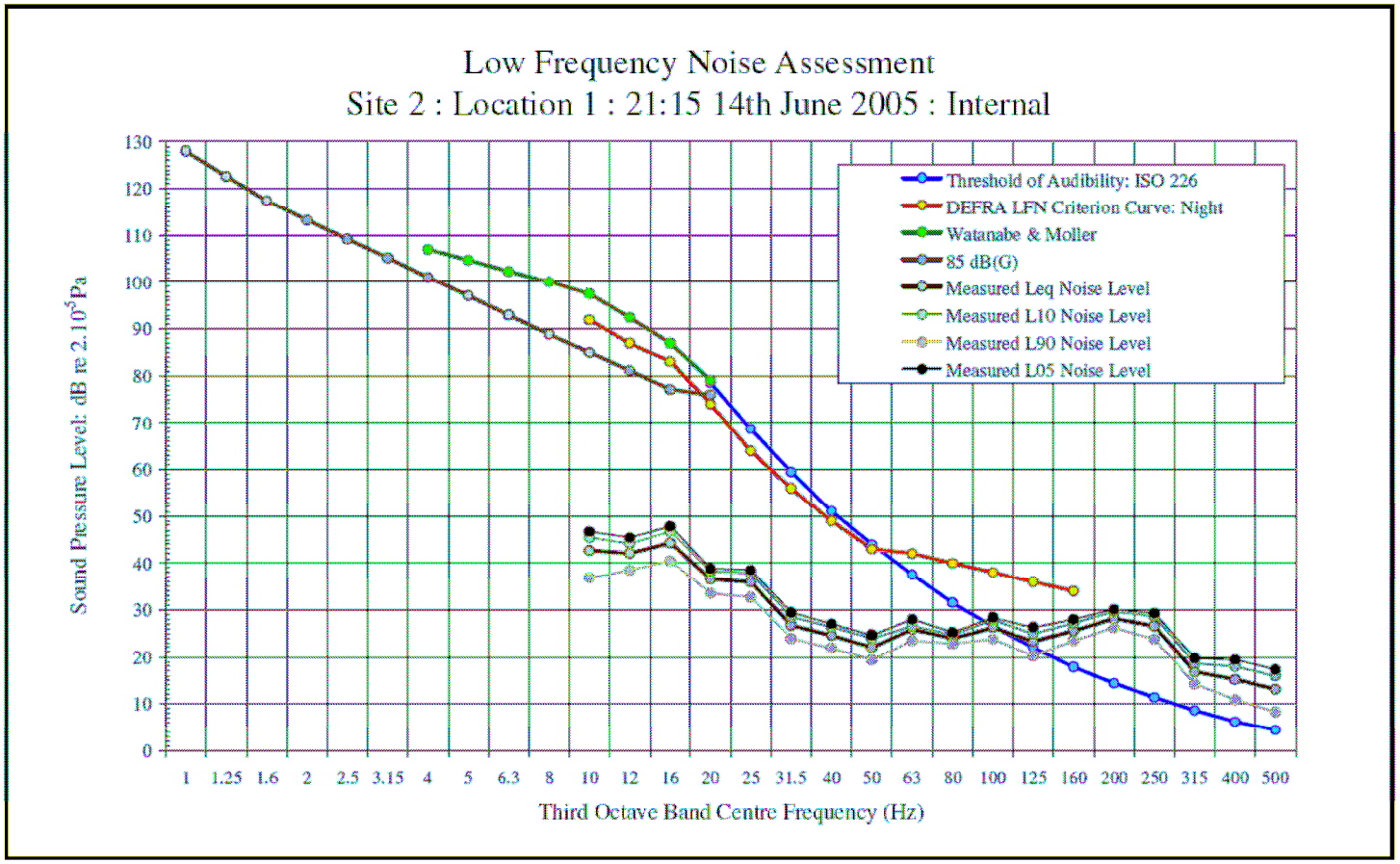


Figure 36: Representative internal noise data with windows closed

Site 2: $L_{pA,LF}$ Levels

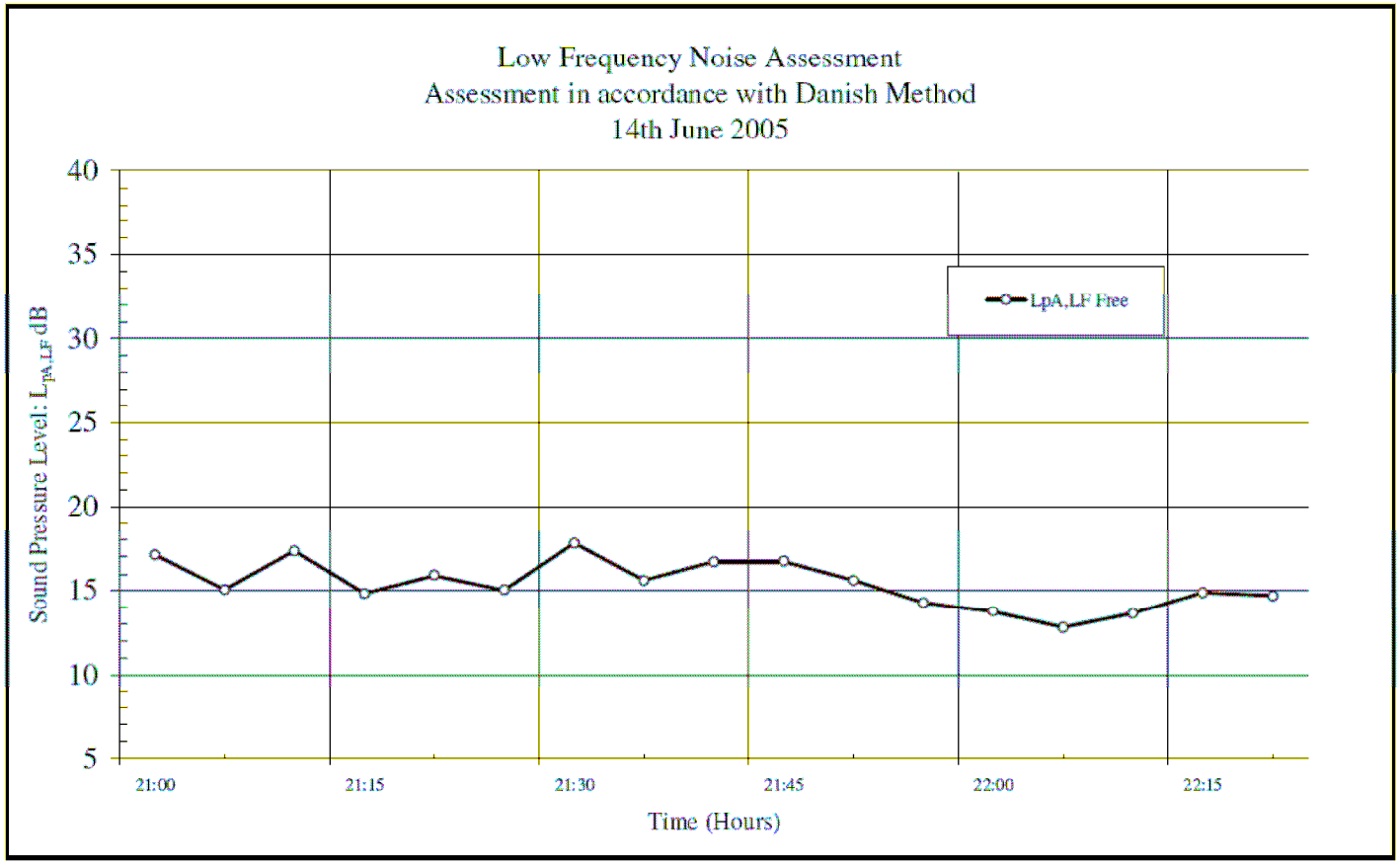


Figure 37: Time History of internal $L_{PA,LF}$ noise levels

Site 3: Location 1

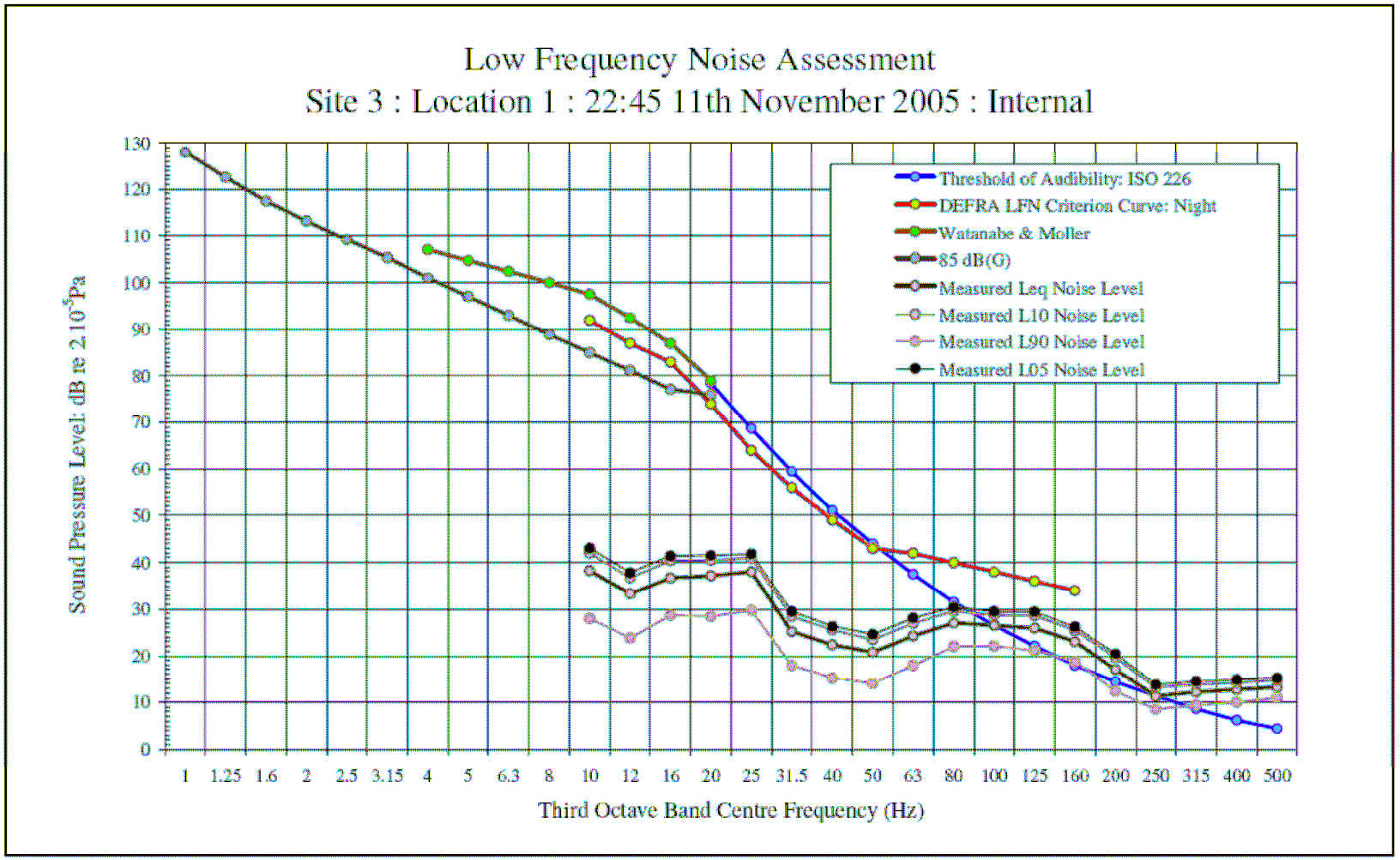


Figure 48: Sample of internal noise levels when downwind of wind farm

Principle Study Findings

Principal Study Findings

On the basis of the recordings made at the three locations and existing evidence from other work, the study concluded that:

- infrasound associated with modern wind turbines is not a source which will result in noise levels which may be injurious to the health of a wind farm neighbour;
- low frequency noise was measurable on a few occasions, but below the existing permitted Night Time Noise Criterion[1]. Wind turbine noise may result in internal noise levels within a dwelling that is just above the threshold of audibility, however at all sites it was always lower than that of local road traffic noise;
- that the common cause of complaint was not associated with LFN, but the occasional audible modulation of aerodynamic noise especially at night. Data collected showed that the internal noise levels were insufficient to wake up residents at these three sites. However once awoken, this noise can result in difficulties in returning to sleep.

Next Steps

Next Steps

The DTI will now carry out a peer review of the report by the Working Group on Noise From Wind Turbines[2] and the authors of "The Assessment and Rating of Noise from Wind Farms" (ETSU-R-97), in order to consider its findings relating to aerodynamic modulation, including a means to assess and apply a correction where aerodynamic modulation is a clearly audible feature. It is intended to complete this review and publish the final report and recommendations in Autumn 2006.

Peer Review

The Hayes McKenzie report noted that a phenomenon known as Aerodynamic Modulation (AM) was in some isolated circumstances occurring in ways not anticipated by ETSU-R-97. The report stated that concerns apparently relating to this phenomenon have been expressed in relation to only 5 out of 126 wind farms in the UK.

Government has taken the view that more work is required to determine whether or not AM is an issue which may require attention in the context of the rating advice in ETSU.

To assist with this work Government has brought together an advisory group (the NWG) drawn from acoustic experts, including former members of the Noise Working Group, to provide a peer review and guidance in the issue of AM. It is not within the terms of reference of the NWG to examine the assessment and rating advice in ETSU-R-97 beyond the issue of Aerodynamic Modulation. If in time it is felt appropriate to reflect AM in the context of the ETSU rating advice further information will be issued.

November 2006

On going studies

- Following review by the NWG, a further study funded by DEFRA/DTI into the potential of AM has been implemented. This study will provide an indication of whether this is a common problem. It is expected to report before the end of March 07.