Notes on

Low Frequency Noise from Wind Turbines

with special reference to the

Genesis Power Ltd Proposal, near Waiuku NZ

Prepared for Genesis Power/ Hegley Acoustic Consultants

by

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Low Frequency Noise from Wind Turbines

A review of low frequency noise was recently completed by the writer (Leventhall, 2003). In this, low frequency noise is defined as from about 10Hz to 200Hz, whilst Infrasound is from 20Hz down to a very low frequency, say 1Hz. In practice, it is normally only necessary to consider the range 10Hz to 200Hz .

Noise sources in Wind turbines. Wind turbines were not included in the review of low frequency noise, as they were not considered to cause low frequency noise at problem levels. There are three main noise sources in wind turbines. .

1. Turbulence from the blade tip, which is the highest frequency produced by the turbine and may be in the range 500 to 1000Hz.

2. Gear and other mechanical noise, which may be in the range 20Hz to 100Hz

3. Small pressure pulses caused when the blades interact with the wind flow at the tower. As these have a fundamental frequency of about 1Hz, analysis of their noise gives frequencies in the infrasound region, but at very low, inaudible levels.

The swish – swish – swish noise, which is associated with wind turbines, is a modulation of a higher frequency, the blade tip turbulence, and does not contain low frequency noise. For example, compare an amplitude modulated radio signal, which contains only the carrier and sidebands**. As some complainants may be incorrectly referring to the low frequency modulation as low frequency noise, it is important to understand that it does not contain low frequencies.**

There are several methods of reducing the low frequency noise of wind turbines.

- Orienting rotors on the "upwind" side of the turbine tower avoids the low frequency sounds associated with the passage of the blades through the tower's wind shadow, as occurs on "downwind" machines. In this way, the pressure pulses, which were produced by early versions of downwind machines over 20 year ago, are considerably reduced. It was these pressure pulses which led to the perception that significant infrasound is associated with wind turbines. Modern turbines are all upwind and have very low levels of infrasound.

- Tubular towers and nacelles are streamlined, and produce little sound from the wind. If we consider a tower diameter of 2m and wind speed of 15m/s, the Srouhal frequency for turbulence shedding, f = 0.2(velocity/dimension) Hz, is then 1.5Hz and will be lost in the fluctuations which are inherent in the wind.

- As blade aerofoils have become more efficient, more of the wind is converted into rotational torque and less into acoustic noise.

Tonal Noise
In addition to wide band low frequency noise, tonal noise may also occur from wind turbines. The tonal noise may have both mechanical and aerodynamic origins.

Tonal noise due to mechanical sources is typically associated with the rotation of mechanical equipment, and pure tones tend to be related to the rotational

frequencies of shafts and generators and the meshing frequencies of the gears. Tonality differs between turbines and may also vary between tests of the same turbine model. However, the control of tonal noise from the mechanical systems is similar to that of noise control of any machine noise and can be achieved by attention to gear teeth, adding baffles and acoustic insulation to the nacelle, using vibration isolators and vibration mounts for major components, and designing the turbine to limit noises from being transmitted into the overall structure. These steps are part of the normal design of modern wind turbines.

General Spectrum of Wind Turbines

Many wind turbines, even though from different manufacturers, have similar spectra, as shown in Figs 2 and 4. This is because modern wind turbines are of similar construction. Some examples of noise from wind turbines are

1. A report (Snow, 1997) gave detailed measurements, using 1/24th octave band analysis in the range from 0.36Hz to 60Hz, of noise from a wind farm consisting of eleven 450kW turbines, the make of which was not stated in the report. The measurement distance was 100m. It was shown that harmonics of the 1.5Hz blade frequency could be detected up to the tenth harmonic, and possibly higher. The levels of the lower harmonics were generally below 70dB and fell rapidly in level above 4Hz. All were well below the hearing threshold at their frequencies. However, it was suggested in the report that there might be occasional circumstances when the noise could be detected, although these were not enumerated. A spectrum (1/24 octave band) is shown in Fig 1 for a single turbine. The infrasound levels in Fig 1 are all below the hearing threshold.[1] G-weighted levels(ISO:7196, 1995) were also taken of the noise and shown to be in the 60dB to 70dB range, which is well below the level expected to cause complaints of infrasound.

2. A test report from Vestas on their V 52 – 850kW turbine gives many spectra under different operating conditions (Windtest, 2002) . A typical spectrum, taken at about 80m from the wind turbine, is shown in Fig 2. Here the analysis bandwidth is 2Hz. Fig 2 shows a spectrum which rises up into the lower frequencies, reaching a maximum of about 70dB. There are peaks superimposed on the spectrum as follows:

Several peaks below 100Hz
A peak at nearly 200Hz
A peak at 600Hz

It is difficult to compare Figs 1 and 2 as the frequency ranges and analysis bandwidths are different. Fig 1 has a constant percentage bandwidth of about 3% and is plotted on a logarithmic frequency scale, whilst Fig 2 has a fixed bandwidth of 2Hz and is plotted on a linear frequency scale. However, the rapid spectrum fall off into the higher frequencies is shown on both figures, whilst the constant percentage bandwidth of Fig 1 reduces the rate of fall off into higher frequencies as compared with the constant bandwidth of Fig 2.

[1] To place infrasound in perspective, when a child is swinging high on a swing, the pressure change on its ears, from top to bottom of the swing, is nearly 120dB at a frequency of around 1Hz.

3. A report from Bonus on their 1.3MW turbine gives spectrum details (DELTA, 2003) In addition, the DAT test tape on which the DELTA report is based, was made available to the writer. This enabled a detailed low frequency analysis to be performed in addition to the range up to about 2000Hz, which is normally given in wind turbine test reports. Thus the information available was.

- Test Report on noise of Bonus 1.3MW turbines, prepared for Bonus by their consultant, DELTA Acoustics, Aarhus.
- Calibrated DAT tape of the noise recordings from the wind turbine on which the Test Report was based, supplied by DELTA Acoustics. Wind speeds during the recording were 5m/s to 8m/s

The following narrow band analyses were made using a Sony DAT TCD-D100 tape player and a Diagnostics Instruments PL22 FFT analyser.

- Spectrum to 2000Hz – frequency resolution 1.25Hz
- Spectrum to 200Hz - frequency resolution 0.125Hz

(Analyses were 4096 points, Hanning Window and Linear Averaging)

The waveform of the noise was also investigated using a digital oscilloscope and the tape listened to by playing through a low frequency loudspeaker.

It was found that there was some variation in the detail of the spectrum through the 1.5 hour length of the recording on the tape, although the main characteristics were constant.

Similarly, the waveform of the noise was variable, being controlled by large, very low frequency swings, presumably from gusts of wind.

Listening to the tape revealed the swish – swish pulsations, which are typical of turbines, at about one per second. These are related to the turbine blades passing the tower and are not low frequencies, but a modulation of higher frequencies. These pulsations tend to diminish with distance and to blur when there are multiple turbines.

Fig 3 shows the spectrum plotted up to 2000Hz. This should be compared with Fig 4, which is taken from the Noise Test Report by DELTA, consultants to Bonus. In Fig 4 , the comparable analysis is shown in the red line which is for linear averaging. Figs 3 and 4 have strong similarities. Exact correspondence should not be expected because of the variable nature of the spectrum. Also the band levels in the present analyses must be expected to be lower than those of the DELTA analysis, since narrower band widths are used.

There are peaks on Figs 3 and 4 at 1450Hz, 850Hz, 485Hz and a dip at about 150Hz. As the frequency lowers there is a rise on which other peaks are superimposed. The final maximum is at about 11Hz. The fall off below 11Hz may be an instrumentation effect. There are, in fact, large micro-fluctuations in air

pressure (natural infrasound) occurring from very low frequencies of , say 0.001Hz up to about 2Hz, but these are not relevant to disturbance by noise.

The similarities of Figs 3 and 4 give confidence in the analysis methods in relation to low frequencies and Fig 5 is the analysis up to 200Hz. Again, the general levels, where there are no distinct characteristics, must be expected to be lower than in Fig 3, because narrower band widths are used, but the levels of prominent tonal peaks are not so affected by the difference in bandwidth.

However, there are other factors which must be taken into account.

- The original measurements were made according to standardised methods with the microphone on a ground board and at 100m from the turbine. A correction of –6dB must be made for the pressure doubling of the ground board. Further corrections of –6dB must be made for each doubling of distance from the measurement position to a listener. That is, taking ground board and distance effects into account, the levels at 200m will 12dB lower than measured at 100m and the levels at 400m will be 18dB lower than measured at 100m.

- An analysis is an average over time, which obscures fluctuations. That is, the instantaneous levels will be both above and below the average. The variation will be small for the tone peaks from the turbine, which are due to machinery noise.

- There are people who are more sensitive and others who are less sensitive than the average hearing threshold. Threshold measurements on groups of subjects indicate that the standard deviation of the threshold is about 6dB. Therefore, allowing 12dB (two standard deviations) for variations in sensitivity of the hearing threshold, leaves the potential for about 2% of the population to be more sensitive than 12dB below average threshold.

Table 1 shows the predicted level in the open from a single turbine at 400m distance compared with the average hearing threshold (ISO:226, 2003).

Frequency Hz	Level dB at 100m	Predicted level at 400m in the open	Average hearing threshold dB
25.0	50	32	69
31.9	48	30	60
32.8	47	29	59
78.8	42	24	31
97.0	37	19	26
130	35	13	21
174	33	15	16

Table 1. Predictions for Bonus 1.3MW turbine

The proposed farm in New Zealand will contain 19 turbines. If the listener was equidistant at 400m from all turbines and if all turbines were synchronised to rotate in exact phase. The increase in sound level would be about 13dB. However, as perfect synchronisation is not normally achieved, even when attempted, the statistical increase in level is more likely to be about 7dB.

Comparing Table 1 predicted levels, plus 7dB for multiple turbines, with the average thresholds shows that the low frequency noise at 400m is, on average, below these thresholds except at 174Hz.

Greater distances reduce the sound levels and, of course, there is an additional fall off from outside to inside a house.

It is clear that, although low frequency noise is produced by wind turbines, the low frequency noise levels from modern machines, for which we can take the Bonus 1.3MW and the Vestas V 52 850kW turbinse as typical, of are low and are very unlikely to be problem at a few hundred meters from the turbines. The locations of the houses closest to the proposed installation are all more than 500m from the turbine and well out of a cautionary range

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Comments on Objectors' Statements

General comments. When a group of residents decide to object to a development, they often support each other with strong emotions, which can sometimes lead them astray. The emphasis on low frequency noise is an example if this. Over the past 30 years there has been a great deal of confusion and misinformation about low frequency noise, mainly in the popular media. Much of it can best be described as "hot air", but complainants' uncritical acceptance of what they have read in unreliable sources has two unfortunate effects.

- It detracts from those people who have genuine low frequency noise problems, often from industrial exhaust fans, compressors and similar.

- It undermines the credibility of the complainants, who may be harming their own cause in their apparent "grasping at straws" approach.

Specific comments

Objectors statements in the **"Another viewpoint for residents"** leaflet - See Appendix.

Health. There is some obscurity over the work carried out by Dr Osborne and Dr Harry in the UK. I have recently e-mailed both of them by for further information and received two very short replies.

Dr. Osborne replied with one sentence " I am an ordinary GP who has critically read the published work on low frequency noise".

No further information was offered, leading to the impression of a closed door.

Dr Harry replied with three short sentences "Thank you for your interest. At present our research is ongoing. I will be happy to let you have a copy of my results on completion".

Thus, neither of them seems willing to share information at the moment. Their initial release was to the press, and it is possible that they may have been surprised at how their work was handled and are now in a backing–off phase. (This often occurs with media-naive professional people, who do not understand how it operates.)

Therefore, it has not been possible to evaluate the work of either of these practitioners, which, as far as I know, has not yet been published in a way which has enabled it to be peer reviewed.

Their patients may well have been experiencing adverse symptoms, but we have to keep in mind that people who have failed, for whatever reason, in strong objections to a development, build up in themselves a level of unfulfilled expectations and consequent stress, which peaks after the failure and can overload their coping capabilities. This leads them to lay the blame on whatever straw they can clutch. This is especially so in group activities, where mutual support may turn to a mutual, interacting misery, which worsens the situation.

The statement in the objectors' leaflet that "Low frequency noise can cause many of these adverse problems" is rather meaningless without reference to levels of the noise. One of the failings of objectors is to consider only frequencies and neglect the relevance of noise levels. The very low levels of low frequency noise and infrasound which occur from wind turbines will not normally cause problems. If problems have occurred, it is possibly for some other stress-related reason.

The statement that the British Government is concerned etc etc is incorrect. I am connected with the work at Salford University, as an adviser, and can state that noise from wind turbines was specifically **excluded** from the work, which concentrates on industrial and similar sources. This is an example of media distortion, willingly absorbed by receptive minds.

The reference to my own work is misleading. Some reports stated that I had "endorsed" the work of Drs Osborne and Harry. However, I did not know about their work until it appeared in the media and the quotation from me relates to work published before they released their work to the media. I cannot endorse or comment on their work without seeing it but, as shown above, they are not yet willing to share it with me.

I do agree that low frequency noise can be a background stressor, leading to typical stress symptoms. However, the low frequency noise levels must be above threshold, which is unlikely to occur for wind turbine noise, especially indoors. There is not a lot of difference between low frequency noise and higher frequency noise in this respect. Any audible noise can be disturbing. The main difference is in the way in which

hearing contours come closer together as the frequency decreases, which leads to a more rapid growth in loudness at low frequencies when noise is above threshold.

Noise The statements under this heading are very imprecise and contain no back-up information. Research shows very little of what they claim. For example:

It is only the media, and its receptive adherents, who regard low frequency noise as a problem from wind farms.

It is true that low frequency noise carries greater distance than higher frequency noise, because its attenuation in air is lower. However, low frequency noise still has an attenuation of 6dB per doubling of distance, due to geometrical spreading.

The WHO has expressed concern about low frequency noise. This is mainly in relation to use of the dBA for measuring spectra with a high low frequency content. However, we have shown that wind turbines do not have significant low frequency noise. Consequently, there is not a lot to be gained by a C-weighting measurement.

It is not clear whether the reference to hub height is to the noise or the wind speed. Clearly, noise should be measured or predicted for where it is perceived. The wind speed measurement is laid down in international standards and objections to this should be taken up with the standardising committee.

Property prices. The most detailed study to date, published about a year ago, showed no effect.

See:

Effect of wind development on local property values

http://www.repp.org/articles/static/1/binaries/wind_online_final.pdf

The legal case in the UK, which is often quoted, was a one-off, and possibly contained an element of reprimand of the vendor for deliberately withholding information from the buyer.

Animals. Animals graze normally in fields close to wind turbines, particularly sheep and cows. Horses can be startled by unexpected sound and sights, but it is well known that horses accommodate to loud noises and previously threatening occurrences. This is demonstrated every time a horse is ridden along a busy street. Therefore it is likely that horses, which are stabled in the vicinity of a wind turbine, will accustom to the sound and sight of these. An often quoted example, given in a UK Government publication (www.dti.gov.uk/renewable/wind_qa.html) is of a riding school which has wind turbines on the same farm and the owner rides horses round the wind farm.

The British Horse Society suggests at least 200m between a wind turbine and the nearest equestrian route.

Comments on the paragraph **"Wind Power Farms are a Health Hazard and Make People Sick"** See Appendix

In this Dr Osborne is quoted as referring to "low frequency noise that causes vibrations that you can feel through your feet and chest. This frequency resonates with the human body –their effect depending on body shape. There are those on whom there is virtually no effect, but others for whom it is incredibly disturbing".

This is a typical example of concentrating only on frequencies and forgetting about levels. There is also a misunderstanding of the difference between acoustical stimulation and direct vibration stimulation Very high sound levels are required to be felt through the chest. We can sometimes feel this if a heavy truck passes as we are walking in the street. The levels here are far, far greater (40 –50dB or more) than those from wind turbines. A typical chest resonance is in the 40Hz to 80 Hz region. (See Fig 12 of Leventhall 2003)

Comments on the piece from the Westmorland Gazette This has been referred to under property values above.

Comments on the quotation from David Bellamy.

The complainants from Askam who took the local authority to Court lost their case. The wind farm is not a statutory nuisance.

It should be noted that the Heath and Safety Executive deals with very high noises. There are other explanations for United Utilities withdrawing the Buxton proposal, as shown in the following.

Extract from web page of Tom Levitt, the MP for Buxton region on http://www.tomlevitt.labour.co.uk/ViewPage.cfm?Page=2849

"Local, national and international environmental issues frequently demonstrate how residents of High Peak have a conscience which goes well beyond their garden gates.

The matter of a proposed wind farm at Buxton is one such example. I want to see diversity in energy production and this may be a suitable place for a wind farm. Carried out sensitively it could be an initiative to be proud of. The site is not in the national park but is visible from it. A balance needs to be achieved that will preserve the best of the landscape whilst generating energy efficiently from a new and renewable source.

I very much welcome the proposal by United Utilities to construct an 8-turbine wind farm to the south of Buxton. If sited sensitively, this innovation could be a pollution-free source of energy, sufficient to power a town the size of Buxton and saving 30,000 tons of carbon dioxide each year.

- *As a result of public concern, not least from the Peak District National Park, United Utilities announced last summer that it would not be pursuing the application for a wind farm at this stage. Whilst of course the application would*

have been subjected to the full rigour of the planning process, I believe that a formula could have been found that would have enabled a small scale but viable wind farm to have been established whilst minimising damage to the environment."

Summary

The rational study of low frequency noise, its effects and criteria for control, has been bedevilled by exaggerations, half truths and misrepresentations, much of it fomented by media stories over the last 35 years. The result in the UK, and it is probably similar in other countries, is that an incorrect concept, "low frequency noise is a hazard", has taken root in the national psyche, where it lies dormant waiting for a trigger to arouse it. The current trigger is wind turbines. Previous ones have been gas pipelines and defence establishments. When this is coupled to the failing, which we all have, of generally believing what we want to believe, it is seen that it is not easy to persuade lay people of the truths of low frequency noise which can be summarised as.

- High levels of low frequency noise are required for perception, increasing as the frequency reduces.
- The ear is the most sensitive receptor in the body. If you cannot hear it you cannot feel it.
- Continuous audible low frequency noise can be a nuisance, as can any other noise, but it must be above threshold for this to occur.
- Where problems often arise with predominantly low frequency noise is because the A-weighted assessment methods do not cater for it. This leads to the noises being dismissed as not a nuisance, leaving unhappy complainants in a stressed state.

However, the above points must be considered in the light of the very low levels of low frequency noise from wind turbines.

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Windtest. 2002. Report of acoustical emissions of a wind turbine generator system of the type V-52-850kW 103 dBA. Report WT 2454/02.

APPENDIX. Statements etc from objectors referred to in the text

Another viewpoint for residents. Proposed wind power station near Waiuku

Over the past few weeks there has been a lot of information published from Genesis regarding the Wind Power Station they propose to put close to the Waiuku township.

The Waiuku Windfarm Information Group has spent hundreds of hours researching on the internet, collecting newspaper articles from overseas and speaking to various overseas sources to get an understanding of the impacts of Wind Stations on the community. **There is no other wind power station in New Zealand that is comparable.**

HEALTH

The power company says:

They are not aware of any adverse effect on people's health.

Scientists and Doctors say:

- Doctors have carried out medical surveys on people living by wind power stations, their results find that symptoms include - headaches, sleep deprivation, anxiety, dizziness, migraines, depression, nausea and palpitations.
- Low frequency noise causes many of these adverse problems.
- Due to these findings, the British Government are now concerned. They have commissioned Scientists to research the effects of noise from wind turbines on human health.
- A review published on low frequency noise by Dr Geoff Leventhall classified low frequency noise as a background stressor which may lead to chronic psychological and physiological damage.

NOISE

The power company says:

The power company doubt there'll be any effects from the noise.

They rarely mention the low frequency noise emitted by Wind Turbines.

Research Shows:

- Low frequency sound is regarded as a major cause of the noise problems associated with wind farms.
- Low frequency noise carries great distances.
- This problem has been recognised by the World Health Organisation. As a result of their findings the WHO feels the evidence available on low frequency noise is sufficiently strong to warrant immediate concern.
- Scientists and professors state that noise tests should be conducted using the "C Weighting" method. This is to allow more accurate prediction of low frequency noise. The "A Weighting" method is used for this proposed site.
- University reports state that tests should be taken at hub height (60 metres) for more accurate prediction. Wind tests were conducted at 10-30 metres at this proposed site.

continued

PROPERTY VALUES

The power company says:

There is unlikely to be any adverse effect on property values.

International Property Valuers and Real Estate Agents says:

- International property valuers have suggested that property values can drop by as much as 30% when a property is near a wind power station.
- Properties further away can also be affected especially if wind turbines are in their view.
- Some people overseas have been unable to sell their property and are trapped in an intolerable position.
- We have on hand several international letters and articles from Real Estate Agents and Property Valuers — one of these FPD SAVILLS a global multinational — they say salability of property is another concern. Many properties that are (or will be) near a wind power station are extremely hard to sell.
- There is no other wind farm site in NZ to compare.

SAFETY

The power company says:

The turbines are safe.

The accidents involve old turbines.

"There have been no recorded injuries to any members of the public and very few safety incidents."

Pictures and Articles Show:

- There are countless reports of wind power station accidents (several from 2004). Reports come in weekly of more accidents and safety issues.
- Many of these recent accidents involve turbines that range from newly constructed to 3 years old. They are not all "old technology".
- There are records of turbine parts found on roads, houses, cars, fields (we have documentation of these accidents).
- There have been 21 deaths to workers. There has been one death involving a member of the public (May 2000).

VISUAL

The power company says:

Some people won't like them.

You Decide

- Country Life, a United Kingdom magazine asked readers to nominate the worst eyesores in Britain . . . **Windfarms ranked at number one on the list.**
- 19 turbines x 3 blades each = 57 rotating blades causing shadow flicker.
- These turbines will change the environmental aspect of our rural, sunset coastline.
- You will see the turbines from the beach.
- Comment from a neighbour overseas "the blades rotating is like someone constantly trying to get your attention".

Continued

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EFFECTS ON ANIMALS

The power company says:

There is little effect to horses.

Equestrians say

- International and Olympic horse riders are refusing to ride at events close to wind power stations.
- Stud owners are reporting frequent injuries to horses from fright due to the windfarms.

CONSTRUCTION

The power company says:

We have a traffic management plan.

- There could be approx 5,000 truck movements over a period of up to 12 months (stage 1). They will use Kariotahi Road, a busy beach access road for the community and our young people, which has had a high level of serious accidents.
- They will use King Street bypass which has a high pedestrian volume, schools, kindergartens, emergency services and our elderly pedestrians.
- How will the intersection be changed to accommodate heavy construction through our town.
- It will effect everybody who commutes along the Glenbrook Road with more danger and delay.

WHERE WILL IT STOP

- How many wind power stations will we have?
- Genesis Energy have already admitted they are interested in two further Wind Power Station sites — **A total of three so far.** Another power company has approached members of our community about possible wind farm sites.

Please see our display in the foyer of the Waiuku Library.

So who do you believe?
Your decision will affect this community forever.

DISCLAIMER: We have endeavoured to make every effort to ensure the accuracy on the information we have presented on Wind Power Stations — information has been obtained from various sources on the internet, newspapers, articles, overseas sources and public's personal experience.

Wind Power Farms Are A Health Hazard & Make People Sick!
(Arnold Wolfcaste)
Date: *Jan 24 2004*

"There is a public perception that wind power is 'green' and has no detrimental effect on the environment," said Dr Osborne. "However, these turbines make low-frequency noises that can be as damaging as high-frequency noises. "When wind farm developers do surveys to assess the suitability of a site they measure the audible range of noise but never the infrasound measurement - the low-frequency noise that causes vibrations that you can feel through your feet and chest. "This frequency resonates with the human body - their effect being dependent on body shape. There are those on whom there is virtually no effect, but others for whom it is incredibly disturbing."

A report by Dr Geoff Leventhall, a fellow of the Institute of Physics and Institute of Acoustics, has endorsed the findings. "Low-frequency noise causes extreme distress to a number of people who are sensitive to its effects," it says.

and

From The Westmorland Gazette
A Furness couple have won a legal ruling proving that the value of their home has been "significantly diminished" by the construction of a windfarm nearby, reports Justin Hawkins.

Barry Moon and his partner Gill Haythornthwaite live in the shadow of the wind turbines at the controversial Ireleth windfarm near Askam. When they bought Poaka Beck House in 1997, the couple were unaware the arrival of the windfarm was imminent. Previous owners David and Diane Holding failed to tell the prospective buyers in spite of the fact they had vigorously opposed the initial application for the windfarm in 1995 and objected at the subsequent public inquiry in March 1997.

District Judge Buckley decided that this amounted to "material misrepresentation" and ordered the Holdings to pay compensation of 20 per cent of the market value of the house in 1997, £12,500, plus interest, because of damage to visual amenity, noise pollution and the "irritating flickering" caused by the sun going down behind the moving blades of the turbines 550 metres from the house.

In so doing, he made what is believed to be the first ruling of its kind relating to windfarms. He also made the Holdings pay legal costs and a further £2,500 as compensation for "nuisance and distress".

News of the ruling comes as debate rages about West Coast Energy Ltd's application to build Whinash windfarm on fells between the A6 at Shap summit and Tebay. If it goes ahead, Whinash will be England's biggest windfarm with 27 turbines, each 115 metres tall.

A report on **Wind Farms, Myths and Facts by David Bellamy** that states:

Fact: *The pro-wind lobby argue that the noise from wind farms is minimal and that it does not disturb people significantly. However many people living near wind turbines report that this is not the case and find that their lives are blighted by the background noise of the turbines. For example, a community in Cumbria that has a wind farm almost on their doorstep has spent the last four years desperately fighting the local authority over the noise issues and is finally taking them to court over mal-administration.*

Recently United Utilities withdrew their proposal for a wind farm in Buxton not because it would blight the second most well used National Park in the World but because the Health and Safety Executive have their sound testing department nearby – the noise of the turbines would have distorted the results of their tests.

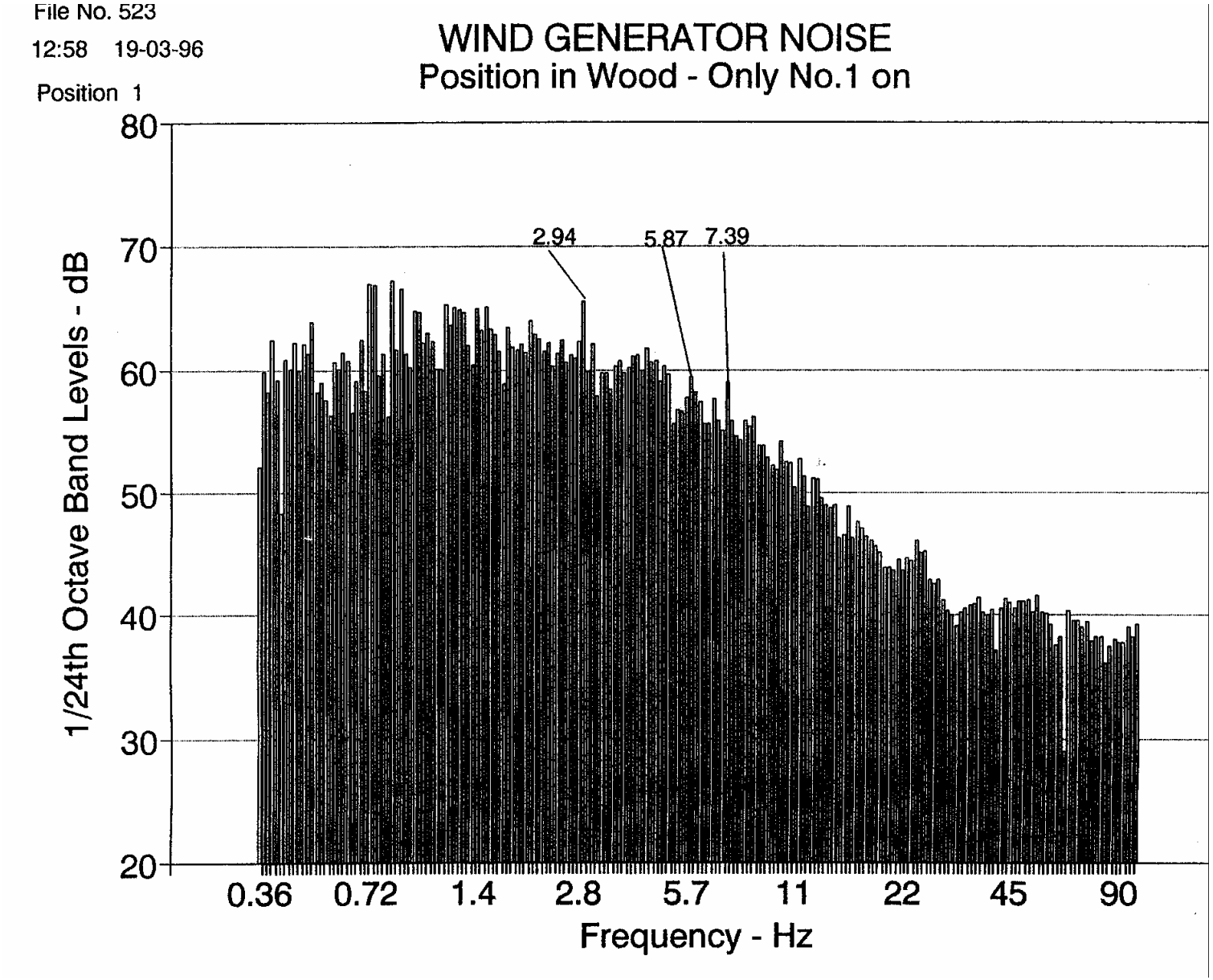

Fig 1. Low frequency noise from a wind turbine. 1/24 octave band analysis

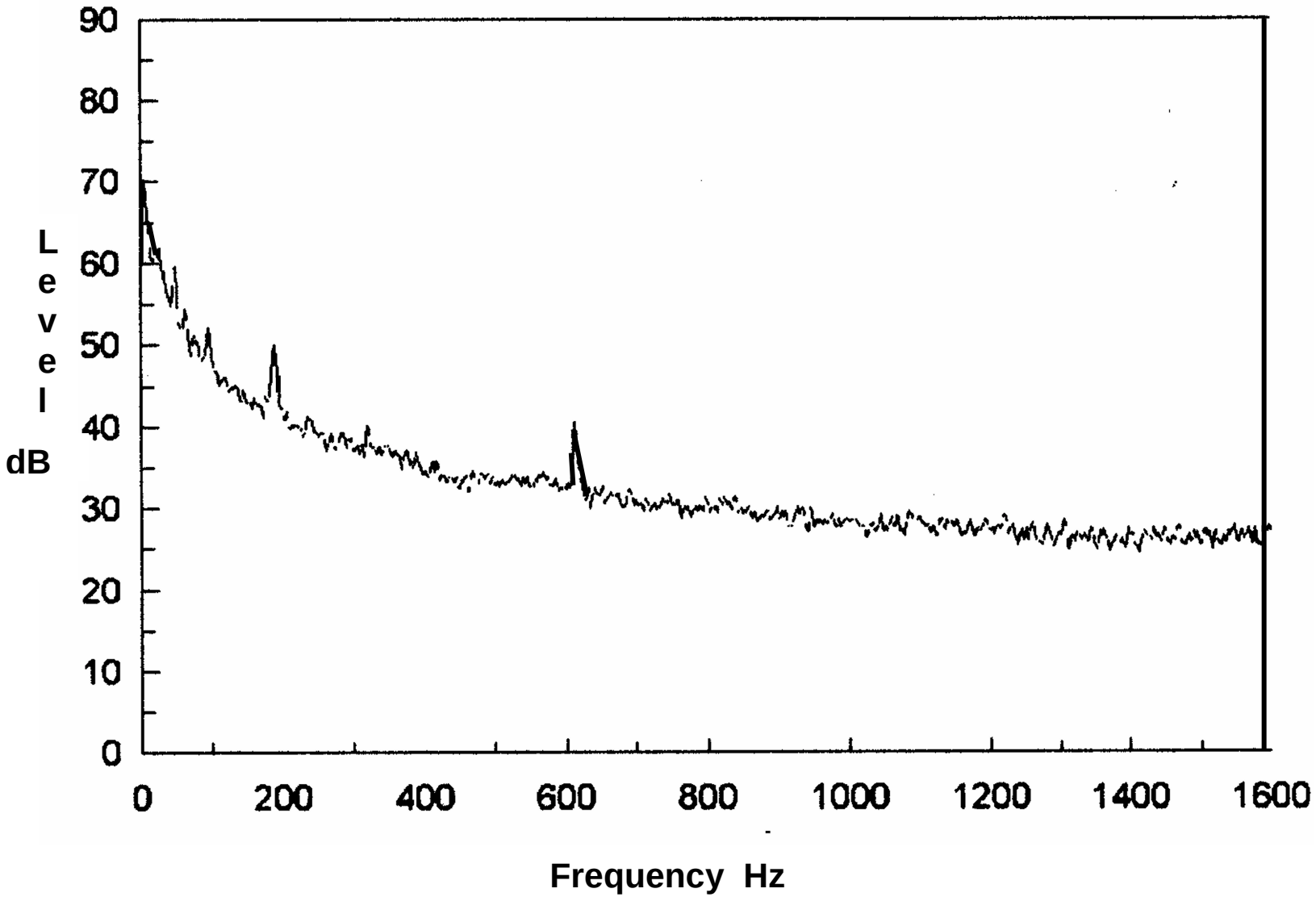

Fig 2 Vestas V52 - 850kW wind turbine. Typical noise at 10m/s wind speed

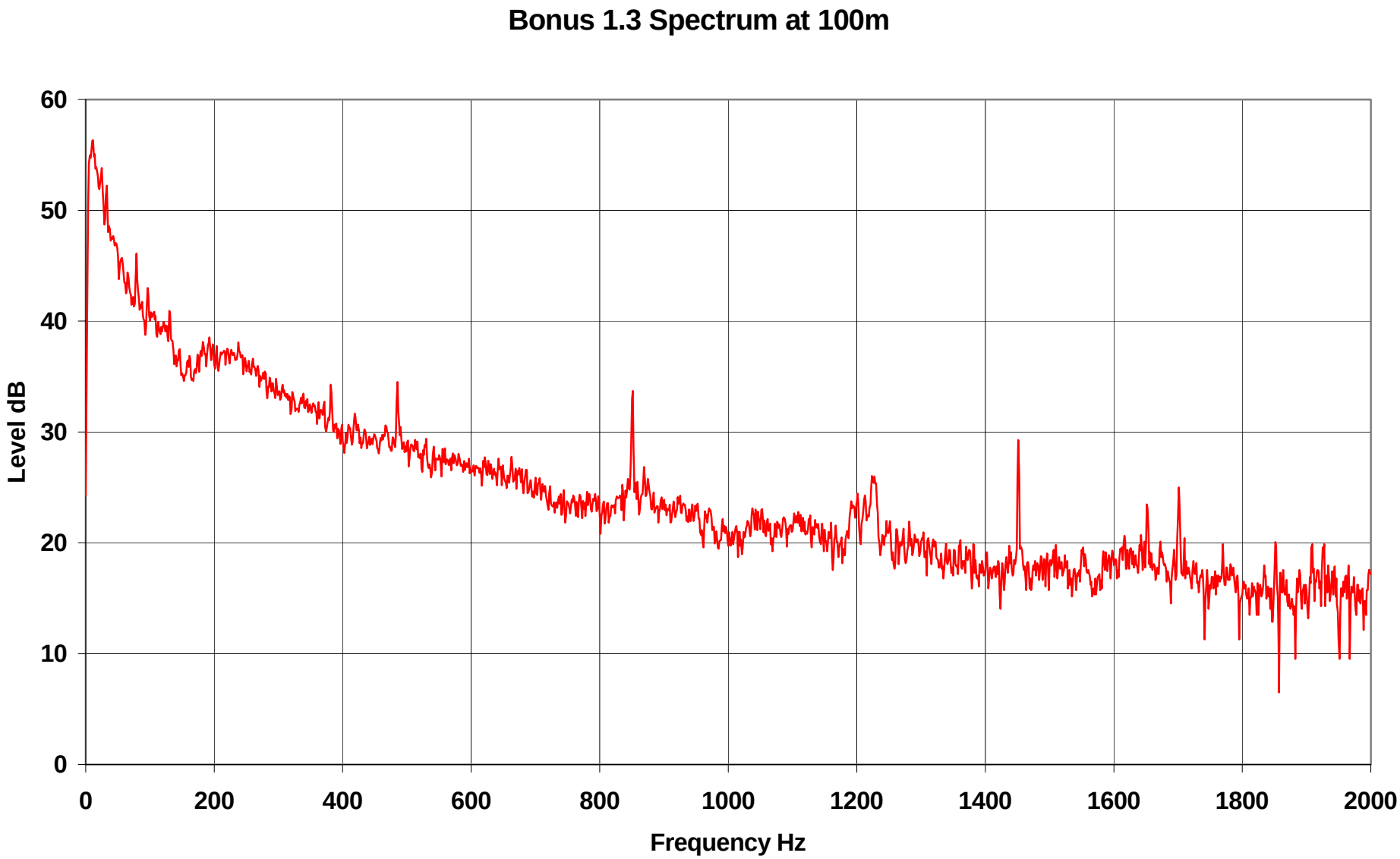

Fig 3. Analysis of noise on the DAT tape from Bonus 1.3MW wind turbine to 2000Hz

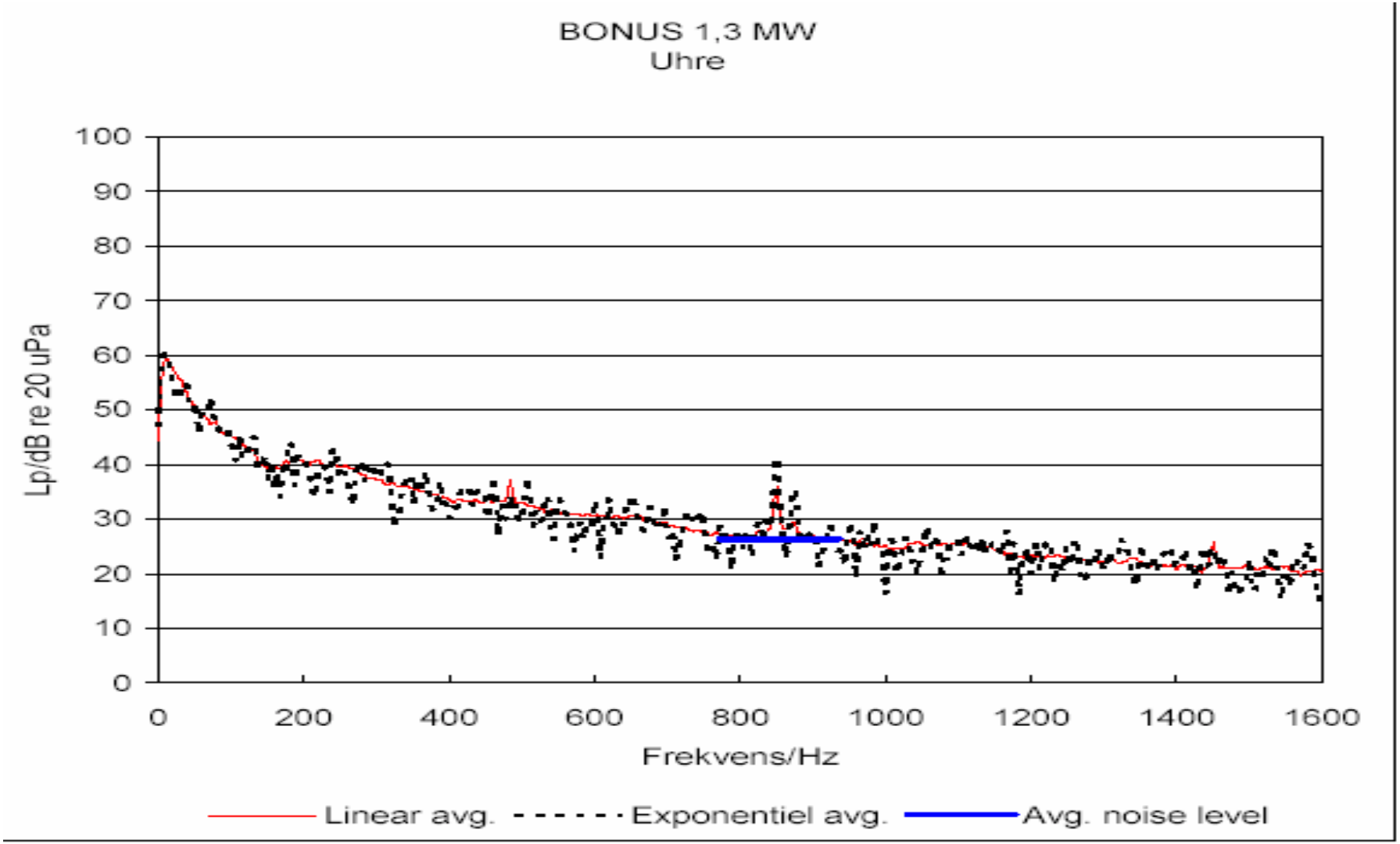

Fig 4 Analysis of noise on the DAT tape from Bonus 1.3MW wind turbine.
(From report by DELTA to Bonus)

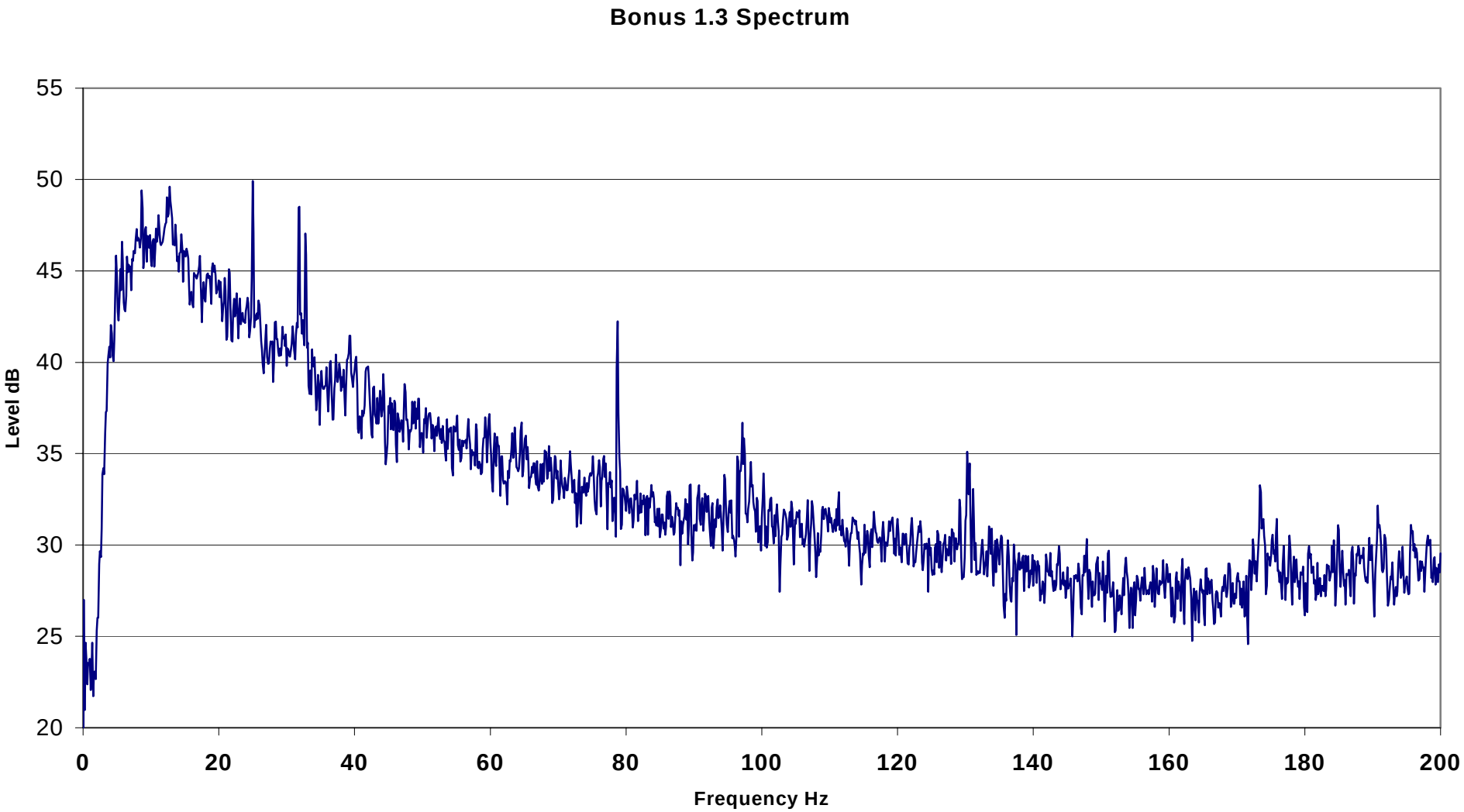

Fig 5. Analysis of low frequency noise from the DAT tape of noise from the Bonus 1.3MW wind turbine to 200Hz