Wind Turbines and Low Frequency Noise: Implications for Human Health.

Low Frequency Noise (LFN)

First of all what is low frequency noise? It is noise, as the name suggests, at the lower frequencies of the audible range. It is general accepted to be within 20 to 200 hertz. Less than about 20 hertz is termed infrasound, because it is not usually audible to the human ear. ILFN (Infrasound-low frequency noise) is another abbreviation I shall use, as in some instances infrasound is comparable to LFN.

Noise that can be felt

Unlike higher frequency noise, ILFN is not just audible – it is also perceptible! [i] The human ear can hear infrasound down to a frequency of 12 hertz, after which it is perceived as single cycles of the sounds along with a **sensation of pressure at the eardrums**.[ii] ILFN is also a useful tool in the military in the form of long range acoustic devices[iii] . Various parts of the human body resonate to differing frequencies of ILFN[iv]. Likewise any building structure can respond in a similar way causing annoyance and distress to the occupants. In the worst case scenario structures can collapse.[v]

As such it is not a benign phenomenon which is restricted to the aesthetics of noise – it can be very intrusive and distressing in other ways.

Noise that is selective in who it disturbs

I quote directly from the words of Dr Geoff Levanthall in a report prepared for DEFRA in 2003:

"LFN causes EXTREME distress to a number of people who are sensitive to its effects… Such sensitivity may be a result of heightened sensory response within the whole or part of the auditory range or may be acquired. The noise levels are often low, occurring in the region of the hearing threshold, where there are considerable individual differences.

The World Health Organization is one of the bodies which recognizes the special place of low frequency noise as an environmental problem".[vi]

Noise than can alter human mood

ILFN affects brain activity. According to a study done in Britain in 2003, people were exposed to an ILFN frequency of 17 hertz during a concert:

> "The presence of the tone resulted in a significant number (22%) of respondents reporting anxiety, uneasiness, extreme sorrow, nervous feelings of revulsion or fear, chills down the spine and feelings of pressure on the chest.[30][31] In presenting the evidence to British Association for the Advancement of Science, Professor Richard Wiseman said, "These results suggest that low frequency sound can cause people to have unusual experiences even though they cannot consciously detect infrasound." [vi]

The story doesn't end here. There are other research papers that link wind turbine infrasound with perceptions of ghosts[vii] and anxiety.[viii]

Noise that travels through walls and terrain

Again from Levanthall: "Infrasound is difficult to stop or absorb. Attenuation by an enclosure requires extremely heavy walls, whilst absorption requires a thickness of absorbing material up to about a quarter wavelength thick…"[ix] Consider that the wavelength of 1hertz is 340m, 10 hertz is 34m, and 25 hertz 13.6m, there is therefore no reasonable way of affording protection to people against even 25 hertz: one will need walls that are over 6 meters thick!

Noise that travels very long distances

Whilst it would be expected that the ILFN would rapidly dissipate like other forms of noise over distance, one must be careful to put this into context. According to Levanthall:

> "The attenuation of sound in air… is very low at low frequencies. Other attenuating factors, such as absorption by the ground and shielding by barriers, are also low at low frequencies. The net result is that the very low frequencies of infrasound are not attenuated during propagation as much as higher frequencies" [x]

Under conditions of 20 degrees Celcius at 70% humidity, Levanthall states that noise at 63Hz will dissipate at only 0.1dB/km – i.e. negligible losses.

However, there is another factor to consider: noise dilution over distance. The loss according to Levanthall is about 6dB for each doubling of distance. However, what happens when dealing with 140 wind turbines in the region each producing ILFN? How does this noise energy "dilute" out over distance? It clearly doesn't follow a simple model of dissipation and instead interacts with the ILFN from other wind turbines (and other industrial sources such as open-cycle gas plants, one of which is due to be built just outside the village at Dalton).

What produces ILFN?

Again I quote from Levanthall: "Low frequency noise and infrasound are produced by machinery, both rotational and reciprocating, all forms of transport and turbulence. For example, typical sources might be, pumps, compressors, diesel engines, aircraft, shipping, combustion, air turbulence, wind and fans". [xi]

What about wind turbines?

Wind turbines certainly do produce ILFN. They are reverse fan mega machinery of unprecedented proportions. Such rotating machinery moves at up to 290km/h on the outer tip of the blade. The span is the same as that of a jumbo jet, and the surface area of their blades is extensive (hundreds if not over one thousand square metres in larger models). Their generator weighs tens of tonnes.

Although the larger wind turbines are "quieter" machines in terms of audible noise, they instead produce more ILFN.[xii]

Quiet backgrounds are associated with more noise annoyance.

The lack of background noise makes a dominant noise source more noticeable. Whilst this appears self-explanatory to any person living in rural area, it has also been the subject of investigation[xiii].The Capital and Southern Tablelands regions have no major industrial sources of noise, save traffic noise in Canberra, and the large wind turbine installations started in late 2008.

But isn't the noise level within the "guidelines"?

The question is: what guidelines? There are no current guidelines on low frequency noise that I am aware of that are being applied to the wind turbine industry. In fact some wind industry proponents suggest on online sites that wind turbines do not produce infrasound, even when there is evidence to the contrary. The character of wind turbine noise is known to make it especially intrusive, arising from amplitude modulation associated with blade passage past the tower, and the dominance of low frequencies in the received sound spectrum. These are implicated in sleep disturbance and deprivation, and the resultant adverse health effects.[xiv]

Moreover, the A-frequency weighted sound pressure level or "sound level" is the most common sound descriptor. However, the A-weighting has a significant restriction in that it does not permit measurement or assessment of low frequency sound. Noise standards need to include appropriate measures to calculate the impact of low frequency noise and vibrations indoors at impacted dwellings.

What's been happening in the Capital/Southern Tablelands regional environment since 2009?

If I was asked this question before June 2011, I wouldn't know what you were talking about. Given my bitter experience, now I do.

Since late 2008 the first large industrial wind turbines were being installed in the region at Cullerin Range and at Lake George. Then in 2010 more large wind turbines started going up at Walwa, and in 2011 even more out at Lake George at Woodlawn.

As with everything in life, some are more sensitive than others to unhealthy environmental factors. Already one family had moved out of the region, either in late 2010 or early 2011 because this strange noise was extremely stressful. Some of their neighbours also noticed the noise, but no one knew what it was.

In early 2011 it was my turn. Swarms of scarab beetles? Invisible mosquitoes? Grumbling Mother Earth? And plenty of anxious, sleepless nights!

By June 2011 the time for guesswork was over – this weird noise was so loud and terrifying that it was making my ear drums resonate. Then my enquiries started and one of my neighbours already believed they had worked it out: wind turbines and ground vibrations.

Then on July 21st and 22nd 2011, there was another climax here on the hills north of Yass – for two nights, I couldn't sleep much at all. There was this horrible distressing resonance in my ears. I struggled to get more than three or four hours of sleep. I performed more enquiries with people in the region.

Several neighbours were hearing the noise. Many people in Northern Canberra are also hearing the noise. A few are having their health destroyed – they just can't get a decent sleep on some nights. They find the noise at times unbearable and highly distressing.

One doctor mentioned to me a case of a woman in northern Canberra who was very distressed by a humming noise and a feeling of thrusting pulses in her house. This same doctor also started noticing the strange hum a few months later.

Some dog owners are at a loss as to why their dogs behave so weirdly on some nights – they become unsocial, vegetative beings that avoid affection or attention.

The startling coincidence was that of the many people I spoke to with regards to the nocturnal noise on the 21st and 22nd July 2011, 50% didn't sleep well, but only 10% noticed the hum on those days.

To date the descriptions of the noise that I have received include: "V8 engine noise", "diesel engine noise", "lawn mower noise". A smaller number also feel thrusts of air pressure hitting around at their head, much like when one slams a door.

It is worse indoors than outdoors. When I have been able to track the stories of several individuals simultaneously, the descriptions of time and intensity are very similar.

More importantly NONE of these cases started prior to 2009 – most started in 2011.

Isn't this just hearsay? Where is the evidence?

There is plenty of evidence that wind turbines are "noisy" both in audible noise but also ILFN. But the most profound and far reaching claims come from the military.

In Eskdalemuir, Scotland, the Ministry of Defence initially put a blanket ban on wind turbines within 80km of the United Kingdom seismic monitoring site because of concerns that wind turbines would interfere with the detection of nuclear explosions. [xv]

Clearly, wind turbines create significant amounts of ILFN and ground vibrations that spread over long distances, meaning that currently recommended setback distances for turbines are out of touch with reality.

What's happening in Warrnambool, Victoria?

There have been two reports from Warrnambool, Victoria. [xvi] [xvii] which include details very similar to what I describe above. The closest turbines appear to be about 35-50km away with many more about 70km away.

The descriptions of the noise have included:

> *"A mystery noise is driving several Warrnambool residents to despair one even selling her house to escape the incessant drone.*
>
> *Two residents in Mitchell Street and two others, less than a kilometre away in Alice Place, have aired their annoyance over what they describe as a low, turbine-like noise in their north-east neighbourhood."*

“Three other residents also said they too found it hard to sleep, especially on calm nights when the sound was more noticeable. ‘It's not excessive, just irritating and sometimes it keeps me awake night after night,’ one retired woman said.”

"I thought I was going mad until I read that others had also heard the noise," said 85-year-old Mavis Campbell of Cherlin Drive.

"It's been affecting my health and blood pressure and has been going on for a few years.

"I would describe it as a pulsating sound like a diesel engine."

The best hint in this situation is that it has been going on for “a few years”. But most people have been noticing it more recently. Note that most wind turbines around Warrnambool had been installed over the last three to five years. The most recent addition has been the massive turbines at Glenthompson last year about 70km away. The pumping station at Warrnambool may be just another source of ILFN added to the existing load of noise, and not the primary cause of the problem.

But isn’t this just tinnitus?

The fact that one cannot locate the source noise does not mean it’s all in the head.

According to the Renewable Energy Research Laboratory of the University of Massachusetts: “Because of long wavelengths, infrasound may **not appear** to be coming from a specific location”[xviii]

All those who describe the noise, at a distance of 30km and beyond, agree it is external to their head, and some can even feel the pulsing sensation of infrasound on their body or hear or feel the subtle rattling of home structures.

Where does the problem stop?

This is a difficult question to answer. On two occasions when the ILFN nuisance was at its worst, I travelled out west. On one occasion I discovered that it appeared to have dissipated at Wee Jasper, 70km away from the closest turbines. On another occasion, and by far the worst of all days, the problem had dissipated when arriving at Young about 100km from the closest turbines.

Truly these figures appear subjective, outrageous, and for most, impossible to believe. However, I am reporting my findings that have taken hours and days to determine. I’m not just plucking figures out of the air.

What are the peculiarities of wind turbine ILFN?

Empirically, wind turbine ILFN travels upwind almost as well as it does downwind. (NASA has confirmed this observation with smaller wind turbine models)[xix]. It is also more intense during atmospheric inversions (consistent with the phenomenon described by Van den Berg[xx] &[xxi]) and becomes dramatically worse when the atmosphere is moist, particularly prior to major rain events.

Where are we heading to with ever increasing numbers of wind turbines?

That is precisely what I wish you to think about. If you feel that you are one amongst the majority that doesn't hear the ILFN from the wind turbines, then it is a case of guesswork over how many more wind turbines it will take before you start the same problem. You may also want to ask how many more turbines it will take to drive those already suffering into a total state of despair and be forced to move out of the region.

What should any politician or official be doing?

Research is required to establish the nature of the problem and its solutions.

Meanwhile the only responsible position is to call for a moratorium on all wind developments. It is also necessary to ask questions about giving respite to the existing sufferers, particularly those who live at close range to the wind turbines where the problem is at its worst. Wind turbines should at least be SWITCHED OFF during sleeping hours, and particularly during weather conditions which are conducive to ILFN such as inversions, or pre-rain events.

Wind turbines are not "farms". They are industrial zones that create much ILFN and consequent grief.

And my final warning is that wind turbines are just one unique piece of recent mega machinery. Careful consideration should be to other new regional industry arrivals e.g. gas plants that may create similar problems and add the "ILFN load" of the region.

By George Papadopoulos, September 2012.

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[i] The Sixteenth International Congress on Sound and Vibration, Krakow, 5-9 July 2009: "Hearing with your body: the influence of whole-body vibrations on loudness perception"

[ii] http://en.wikipedia.org/wiki/Infrasound#cite_note-27

[iii] http://www.globalsecurity.org/military/systems/munitions/accoustic.htm

[iv] Wind Turbines, Noise and Health, February 2007. By Dr Amanda Harry M.B.Ch.B. P.G.Dip.E.N.T.

[v] http://en.wikipedia.org/wiki/Resonant_frequency

[vi] http://en.wikipedia.org/wiki/Infrasound#cite_note-27

[vii] "Wind Turbines and Ghost Stories: The Effects of Infrasound on the Human Auditory System" Hsuan-hsiu Annie Chen and Peter Narins, Acoustics Today, Volume 8, Issue 2, April 2012; http://www-old.library.ucla.edu/pdf/Chen.Paper.pdf

[viii] The Bruce McPherson infrasound and low frequency noise study. December 14, 2011 by Stephen E. Ambrose, INCE (Brd. Cert.) and Robert W. Rand, INCE Member. The link to the paper is found at: http://randacoustics.com/wind-turbine-sound/wind-turbines-published-articles/the-bruce-mcpherson-ilfn-study/

[ix] "A Review of Published Research on Low Frequency Noise and its Effects": Report for Defra by Dr Geoff Leventhall.p.8. http://archive.defra.gov.uk/environment/quality/noise/research/lowfrequency/documents/lowfreqnoise.pdf

[x] Same as ix.p.8.

[xi] Same as ix.p.7.

[xii] http://asadl.org/jasa/resource/1/jasman/v129/i6/p3727_s1?isAuthorized=no "Low-frequency noise from large wind turbines" H. Moller and C.S. Pedersen: J. Acoust. Soc. Am. Volume 129, Issue 6, pp. 3727-3744 (2011)

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[xiv] Harrison, J. P. (2011). Wind turbine noise. Bulletin of Science, Technology & Society, 31(4), 256-261
[xv] http://www.keele.ac.uk/geophysics/appliedseismology/wind/
[xvi] http://www.standard.net.au/story/153226/mystery-noise-causing-sleepless-nights-in-north-east-warrnambool/
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