Comments on:

Position Paper

of

The National Institute of Public Health

National Institute of Hygiene

Poland

on

WIND FARMS

by

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29 March 2016

Comments on: Position Paper of the National Institute of Public Health - National Institute of Hygiene – Poland on WIND FARMS [1]

1. This critique first considers specific statements made by the NIPH-NIH. Line numbers have been added to the NIPH-NIH document, which is attached. Following the specific points some general comments are made on Direct and Indirect Effects on Health, Criteria and Infrasound.

2. Line 8. The suggestion that

   "wind farms located too close to buildings used as a permanent human residences may have adverse impact on the comfort of life and health of the inhabitants living in the vicinity" is a weak statement because it is self-evident. Any noise located "too close" to people may cause a problem, not just windfarms. Similar wording was used in the decision of an Environmental Review Tribunal in Ontario, Canada in 2011, considering appeals against permission to build a wind farm (Demarco and Muldoon 2011), which included the statement:

   This case has successfully shown that the debate should not be simplified to one about whether wind turbines can cause harm to humans. The evidence presented to the Tribunal demonstrates that they can, if facilities are placed too close to residents. The debate has now evolved to one of degree. [Page 207]

   However, after giving this opinion, the Tribunal found that wind turbines designed according to Ontario regulations **did not** cause serious harm to human health. The minimum separation distance for Ontario is 550m.

   In the past few years there have been 12-15 further Environmental Review Tribunals in Ontario. None of these have found that wind farms, when designed according to the criteria required by Ontario regulations, cause harm to human health.

3. Line 13. This describes the parameters which are required for prediction of the wind turbine sound level at a distance. Manufacturers provide sound power outputs for their wind turbines and prediction of sound level at a distance is carried out using well established methods. Prediction then permits any potential risks to human health from noise to be assessed.

4. Line 15. Considerable emphasis has been placed on infrasound. Infrasound was initially used by objector groups to cause anxiety in residents near proposed wind farms and has escalated through repetition. However, there is no clear evidence that infrasound at the very low levels from wind turbines has any effect on people

[1] This critique is based on a translation provided by the Polish Wind Energy Association

(Leventhall 2006). Whilst there are anecdotal claims of effects, what evidence is available indicates that a resident's attitude to wind turbines, and their beliefs about them, are the most important factors in determining its effect on them. (Crichton, Dodd et al. 2013 , Crichton, Dodd et al. 2014, Rubin, Burns et al. 2014 , Walker and Cerrano 2015, Tonin, Brett et al. 2016) Infrasound is referred to again in Section 29.

5. Line 17. Amplitude modulation of wind turbine noise, when it occurs, may be a problem to some residents. However, a survey in the UK showed that the problem occurred very infrequently. (Moorhouse, Hayes et al. 2007). The UK Institute of Acoustics has established a Working Group to consider methods of assessment of wind turbine amplitude modulation.[2] The report of the group on the assessment of amplitude modulation has not yet been released, but a method of quantifying the modulation has been developed. The next step is to relate modulation to subjective response.

6. Line 19. The distance required to prevent damage from ice throw is well known and given by the following simplified formula (Seifert, Westerhellweg et al. 2003)

$$d = (D+H)*1.5$$

   where d is the ice throw maximum distance (m), D is the hub height (m) and H is the rotor diameter (m).

   Thus, for a large turbine, 100m hub height and 100m rotor diameter, the ice throw maximum distance is 300m. This is less than the distance to residences.

7. Line 20. Rotor failures are rare, but may occur. Current work indicates that the throw of rotor parts is likely to be less than 200m. (Carbone and Afferrante 2013). The probability of throw is also discussed by Rogers et al and blade throw is unlikely to be a problem for neighbouring residences. (Rogers, Slegers et al. 2011). Note that blade throw, which depends on many factors, is discussed on a probability basis and longer throws become progressively improbable.

8. Line 22. If shadow flicker is a problem it can be controlled by stopping the turbine for the time that the sun is in the low position which causes the effect.

9. Line 23. Electromagnetic radiation is not a problem for properly constructed wind farms.

10. Line 24. Sleep disturbance is very subjective. Many people have poor quality sleep, even in the absence of external noise.

[2] The present writer is a member of this Group

11. Line 25. Stress and depression may result from long term disturbance from any noise source. However, this is very subjective and is strongly influenced by a person's perception of the source and their feelings about it.

12. Line 28. The paper mentions current regulations but does not describe or reference these. The paper does not take into account the considerable experience of other countries in developing regulations to protect residents.

13. Line 32. There is international experience on prediction of wind farm noise and commercial computer programs are available to implement the prediction. These programs depend on the wind turbine sound power as the source levels and are not limited to 5m/s. It is not clear why the NIPH-NIH gives this limit and it is not referenced by them. The frequency range used is normally down to about 63Hz or lower. The relation of predicted levels to nuisance is a matter for the development of reliable criteria. This is considered further in Section 28.

14. Line 35. Comprehensive regulations are available and have been used for many years in countries around the world.

15. Line 38. The normal procedure is not to give a large distance limit, but to give a noise limit with a small minimum distance e.g.

    Maximum noise limit: 40dBA Leq
    Minimum distance: 550m

    This has been found to work successfully for wind turbines in other countries, for example Canada (Ontario 2008), where the 40dBA level is permitted to increase when the wind speed at 10m height increases above 6m/s.

16. Line 39. Modern methodologies already take into account all the proposals from NIPH-NIH and could be used in Poland. Sound propagation from wind turbines has been reviewed by Bullmore and Peplow (Bullmore and Peplow 2011)

17. Line 46. The methods are available in commercial computer programs, such as CADNA-A (Probst, Probst et al. 2013). It is not necessary to develop a new method.

18. Line 48. The determining factor should be the noise level and not the distance, although a relatively short minimum distance is required for safety and visual reasons, as in paragraph 15.

19. Line 52. A 2km setback between wind turbines and buildings is not generally required in other countries. The NIPH-NIH position paper claims that "the

recommended value stems from a critical review of study results published in peer-reviewed scientific journals”. However, it does not give any references to these journals. One should be aware that all peer reviewed journals are not of equal standard and that the quality of peer reviews is not equal.

20. Line 57. A distance of 0.5-0.7km is the typical distance at which noise criteria are satisfied and this range is used widely as a minimum separation distance. For example, 550m in Ontario.

21. Line 60. Low frequency sound from wind turbines travels further distances than higher frequency sound, but is typically inaudible at frequencies below about 50-60Hz. Modulation, which reduces with distance, does not occur all the time. Infrasound from wind turbines has not been shown to be a problem to residents.

22. Line 62, 65. As shown in sections 6 and 7 above, the required distance to account for throw is generally less than those separation distances which are required for noise control.

23. Lines 67, 69 These distances are not considered to be necessary in other countries. Published work does not support 50% of the population “disturbed” at 45dBA. Disturbance, or annoyance, should not be confused with audibility. It has been shown that less than 5% of the population are annoyed by wind turbine noise at 40dBA L_{den} (Janssen, Vos et al. 2011)

24. Line 71. Residents must be prepared to accept changes in their environment. They cannot expect the be completely insulated from developments
.

25. Line 75. If shadow flicker is a problem the turbines can be stopped under certain sun conditions. A large separation distance is not required.

26. General comments. The NIPH-NIH paper is unsatisfactory because it makes statements without referencing the source of the statements. Therefore the claims made in the paper cannot be verified and the paper becomes an unsubstantiated “opinion piece”.

27. **Direct and indirect effects of wind turbines on health**. There is no known direct physiological effect of wind turbine noise on humans, as the levels at residences are very low. However there may be indirect effects mediated by annoyance and consequent stress from wind turbines, resulting from visual reactions or perception of audible noise. These effects are caused by the response of a person to the presence of the wind turbines, where an antagonistic response causes stress, whilst a calm, unconcerned response does not. There have been many studies of effects of wind turbine noise on humans and none of

these has shown a valid negative impact other than for annoyance (Colby, Dobie et al. 2009). A large scale project from Health Canada has recently been completed (Health-Canada 2014) and the only effect found from wind turbine noise is that of annoyance. The Health Canada report is summarised as:

> *"The following were not found to be associated with WTN exposure:*
>
> *self-reported sleep (e.g., general disturbance, use of sleep medication, diagnosed sleep disorders);*
>
> *self-reported illnesses (e.g., dizziness, tinnitus, prevalence of frequent migraines and headaches) and chronic health conditions (e.g., heart disease, high blood pressure and diabetes); and*
>
> *self-reported perceived stress and quality of life.*
>
> *While some individuals reported some of the health conditions above, the prevalence was not found to change in relation to WTN levels."*
>
> And
>
> *The following was found to be statistically associated with increasing levels of WTN:*
>
> *Annoyance towards several wind turbine features (i.e. noise, shadow flicker, blinking lights, vibrations, and visual impacts).*

Thus, the only established consequence of wind turbine noise is annoyance. However, annoyance is not specific to wind turbine noise, but may occur with all noises and is very subjective.

It is interesting to note that the effects which are described as "wind turbine syndrome" have been described previously as due to extreme stress from a variety of noises, occurring with a small number of very susceptible persons.(Nagai, Matsumoto et al. 1989) (Møller and Lydolf 2002) (Leventhall 2002) .

It should be noted that only a small percentage of the population have these extreme stress reactions to noise and that their susceptibility is reduced by instruction in suitable coping methods (Leventhall , Robertson et al. 2012). Perception of a noise does not mean that the noise is necessarily a nuisance.

28. **Criteria** Medical specialists and legislators approach criteria differently. Medical specialists deal with individuals – their patients - and are concerned for the well-being of each one as a unique person. A legislator considers people in the mass, and develops criteria for protection of the majority. For noise sources, this is normally achieved by a social survey, which relates number annoyed to a physical characteristic of the noise, such as dBA. A

decision is then made on where to set the limiting level of a protection criterion, which is often at a level at which it is known that, say, 10% of people are annoyed by the noise. Criteria do not protect the most sensitive persons, and are not intended to, although the special problems of the most sensitive may influence the criteria. [3]

The approaches of both Medical Specialists and Legislators are valid within their own spheres. However, problems may arise when one impinges on the field of the other, since criteria are not intended to protect all of the population. Those who remain unprotected tend to become vociferous in their complaints and attract publicity, whilst the "silent majority" are ignored. The unprotected make heavy demands on their clinicians.

However, it is only a small number of those exposed who display extreme responses to any noise source when that noise source complies with its appropriate criterion. A typical criterion level for wind turbines is 40dBA L_{eq} as shown in Paragraph 16, above.

City dwellers are exposed to many forms of noise, particularly from road traffic and from neighbours, whilst aviation noise affects a smaller number. However, city noise has become accepted as an element of city life and few persons experience very subjective extreme stress reactions to it.

29. **Infrasound.** Infrasound occupies a special place in concerns about noise from wind turbines (Leventhall 2013). However, this concern is based upon misunderstandings and incorrect information. Those who argued in the past that infrasound from wind turbines is a problem, based their arguments on a poor understanding of the very low levels of infrasound from wind turbines, which is typically 60dB lower than the hearing threshold at the "tone" frequencies of wind turbine blades, occurring in the region of about 1Hz to 10Hz. It was implied that the presence of any infrasound was harmful and the importance of the levels of the infrasound was ignored. This was eagerly accepted by objector groups who, again and again, repeated the adverse statements about infrasound until repetition caused these incorrect statements to become widely accepted as true fact. It has been a very interesting social phenomenon, showing the importance of repetition in moulding public attitudes. This is, of course, similar to the methods for advertising consumer products.

The misunderstandings which have arisen can be understood by comparing actual infrasound from wind turbines, shown in Fig.1, with statements from

[3] Protection of the most sensitive persons from the effects upon them of noise from all sources would bring the modern world to a halt.

leading objectors. Fig 1 shows the infrasound and low frequency noise, both inside and outside a residence at which there were complaints of adverse effects. The blade pass tones are visible in the 1Hz to 10Hz region The main point of the graph is to illustrate infrasound levels from wind turbines. For comparison, approximate infrasound hearing thresholds are: (Kuehler, Fedtke et al. 2015)

Freq, Hz	2.5	5.0	10.0	20.0
Threshold dB	120	110	98	79

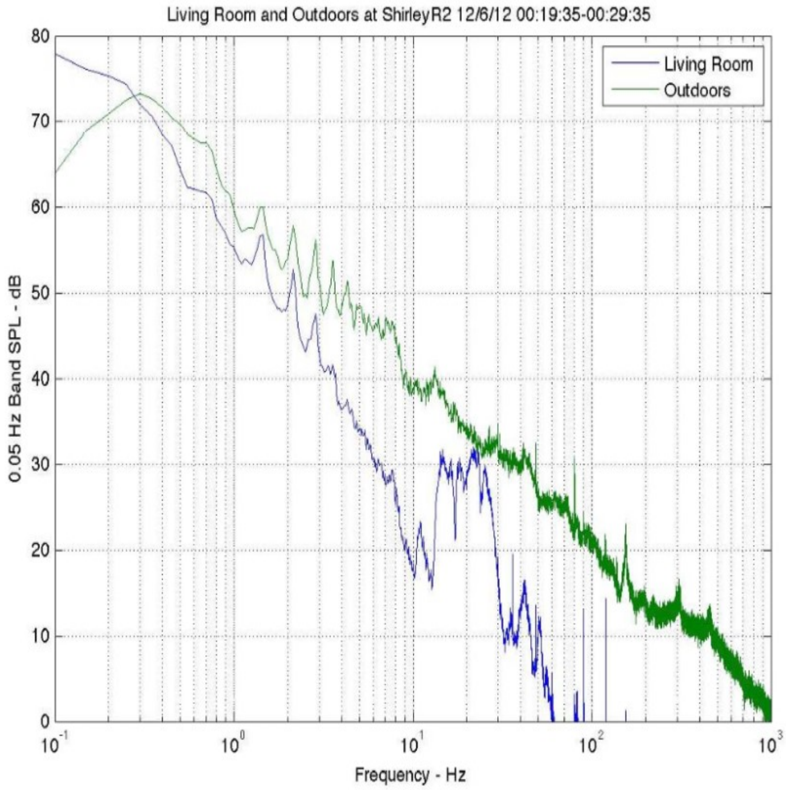

Fig 1 Infrasound from wind turbine

Thus the hearing thresholds for most of the infrasound region is above the top of the graph of Fig.1, which extends only to 80dB sound pressure level.

Criteria for infrasound. it is believed that only Denmark has developed these criteria, which are for low frequency noise in general, not only wind turbine noise, from 10Hz to 160Hz. The limit level is 20dB summed over the A-weighted one-third octave bands from 10Hz to 160Hz (Jakobsen 2012).

Consider statements on infrasound from leading objectors:

Sarah Laurie - Australia.   Laurie is the leading objector in Australia and makes unusual statements about subjective effects of infrasound from wind turbines. One of her main references, which appears to have had a strong influence on her, is a review of the effects of **high levels** of infrasound on people and animals, mainly in laboratory experiments (NIEHS 2001).

However, the levels referred to in the NIEHS review range from about 100dB to 170dB in the infrasound region, with many in the centre of this range. Laurie uses this publication in her objections to infrasound from wind turbines!

Prof Alec Salt - USA Salt is a neuroscientist who specialises in the hearing systems of guinea pigs. He has several publications which attempt to relate his work using infrasound to bias the ears of guinea pigs with infrasound from wind

Robert Dobie's letter regarding Salt & Lichtenhan
(*Acoustics Today,* Winter 2014)

Arguing that inaudible infrasound from wind turbines (WTs) might be harmful, Salt and Lichtenhan list five possible mechanisms that may lead to harm, but without mentioning the sound levels in the experiments they cite:

1. Biasing of audible sounds: the cited study used 50 Hz tones (≥ 84 dB SPL).
2. Endolymphatic hydrops: one cited study used ≥ 50 Hz tones (≥ 95 dB); the other used 30 Hz (120 dB).
3. Excitation of outer hair cell afferents: neither cited paper reported sound-evoked responses of these afferents.
4. Exacerbation of noise-induced hearing loss: the cited study used 30 Hz tones (100 dB).
5. Infrasound stimulation of vestibular sense organs: no studies were cited, but the VEMP test is mentioned.

All of these sounds would be audible and at least moderately loud (> 60 phons). In addition, their levels are at least 30 dB greater than those measured at the same frequencies at residential distances from WTs (O'Neal et al., 2011). Without evidence of effects at more realistic sound levels, the relevance of these mechanisms to WT sound is unsupported, as is the authors' statement that "we know this [lack of effect of inaudibleinfrasound from WTs] is highly unlikely."

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O'Neal RD, Hellweg RD, Lampeter RM 2011. Low frequency noise and infrasound from wind turbines. Noise Control Engineering Journal 59 (2): 135 – 157.

Fig 2 Letter from Prof Dobie

turbines. The most recent paper cited references to effects of infrasound, but did not give frequencies or levels. (Salt and Lichtenhan 2014).

Another specialist (Prof R Dobie), who was familiar with the literature, responded with a letter to the editor of the journal, pointing out the actual levels used in the papers quoted by Salt. The Dobie letter is in Fig. 2: (Dobie 2014)

Thus, the references used by Salt to support his paper are mainly for low frequency noise, not infrasound, and at high levels: levels which are higher than those from wind turbines.

Similar misunderstanding by objectors occurs throughout discussions of infrasound and wind turbines. Objectors consider only the presence of infrasound and not its level.

The present writer's opinion is that statements about effects of infrasound should not be accepted unless the levels and frequencies of the infrasound are quoted. Much of what is written about infrasound and wind turbines is incorrect. In the present writer's experience, infrasound from wind turbines is not a hazard to human health because of its very low level. However, expectations of an effect may lead to a response in persons who have been conditioned to be anxious about infrasound and who believe that they have been exposed. (Crichton, Dodd et al. 2014).

Although there is much speculation, and a few anecdotal reports, there is no evidence that infrasound at the levels and frequencies from modern wind turbines has any effect on residents.

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