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Why Turbine Noise Annoys

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Abstract

Industrial noise complaints and their development show a pattern that is well known to those who work in the noise field. A problem often starts with a specific complaint about part of an industrial operation. If unresolved and particularly if the complainant perceives the noise maker is being unhelpful or even obstructive it can develop more widely. After time the complainant may become stressed or suffer from lack of sleep with all the symptoms that go with those things.

Turbine noise is recognised as being more of a problem, decibel for decibel, than most other noise sources. This paper will argue that the reason for this is not because there is anything fundamentally different about wind turbine noise but that non-acoustic factors have adversely moderated people's perception of the noise. Wind farm developers and governments have entirely failed to respond to the problem. As a result the introduction of large scale renewable energy, which ought to be something that brings communities together, instead divides them.

The paper will also argue that there is no credible evidence to suggest that there is any syndrome or any exceptional infrasound associated with turbine noise and the symptoms described to justify such claims are no different from those exhibited by people annoyed by other types of noise. Those who claim there is something fundamentally different about wind turbine noise are doing a dis-service to those who suffer from it because it is a distraction from the real problems. Wind farms now have a nocebo effect. Whatever the real facts of any particular case are, residents believe they will suffer from noise and have health problems long before a wind farm is commissioned.

There is no doubt that a significant number of wind farms cause justifiable complaints but the suggestion that there is something inherently damaging distracts from the plight of those who really suffer from wind farm noise because it is too loud.

Introduction

I am not a medical expert but I do speak from over forty years as an acoustic consultant working frequently with those who complain about noise. The scenarios I have here are taken from many real life cases but do not relate to any individual. I work in the UK and what I say is related to my experience there though I suspect what I have to say will apply to many other countries.

It is established that wind turbine noise annoys more that most other noise with similar loudness[1]. Some people have put that down to some feature of turbine noise that we do not understand. In fact, it is much more likely that there is nothing special acoustically about turbine noise and that it is non-acoustic factors that make turbine noise more annoying than other forms of noise.

Scenario 1 – The Distribution Depot

I want to look first at a typical noise complaint from a common industrial source and a typically poor response to it - a distribution warehouse where goods were brought in by large lorry, unloaded by fork lift truck and then distributed to smaller vans. This had operated during the day without complaint for ten years. When night operations started a nearby resident complained. The response from the company was off-hand and nothing was done. The local authority investigated and found it to be a significant problem with not only high noise levels but banging and the noise of reversing bleepers. Not only was it too loud but it had a character that was objectionable. The local government negotiated to bring in mitigation. This took months and was largely ineffective. The complainant could not sleep. She developed mental and physical problems, she easily became angry, she felt tired all the time. She had difficulty concentrating even on simple tasks. She had dizzy spells usually in the house. She used to be able to get some relief from sleeping in her back bedroom where she could not hear the noise but now it seemed to be worse and he could hear it in the back bedroom as well. She was convinced that the operator was purposely carrying out his operation in the noisiest manner possible just to annoy her.

She complained to the local authority that the noise was worse. The authority said that the noise levels had been reduced and that the operator could not reduce them further and that there was nothing more they could do. She complained again to the operator but none of he emails or phone calls was returned.

Finally, after four years, the night time operation was stopped because the work pattern changed. But the complainant could still hear noise at night from the depot. It was now a problem during the day. She could even hear it at night in her back bedroom where she had not been able to hear it before – even though the operator and the local government had assured her that it did not operate at night. The problem continued and the complainant experienced vibration inside the house at night even though investigations showed that there was nothing approaching levels of human perception.

So even though the noise is stopped the complainant still hears it. She decides that it must be something the authorities have not considered. There must be some noise generating mechanism causing it. Building resonances perhaps creating ground vibrations, infrasound? Of course the complainant is being unreasonable. She has been driven to unreasonableness, not by the noise itself but by the arrogance and intransigence of the operator and the local government.

Factors that Determine Noise Impact

The factors that determine impact of a new noise source are complex and extend well beyond the loudness of the noise. They can be summarised as:

- Loudness in decibels – mostly compared with the pre-existing noise
- Character of the noise, that is to say mainly whether it has any tonality, and how the noise varies with time.
- The listener's perception of the noise and of the whole situation.

The first factor is loudness and in particular loudness relative to the background noise before the development. Some wind farms are simply too close to housing. I have no doubt, for example, that most of the subjects in Dr Pierpont's investigation[2] had a genuine grievance related simply to the loudness of the noise. Half were less than 750m away from a turbine and the nearest 305m. In the same way I do not doubt that most of those people who were the subject of Dr Harry's report [3] 70% of whom were less than 750m away had a genuine grievance related directly to the loudness of the noise.

The second factor is the character of the noise. I am going to leave tonal noise and other frequency characteristics on one side – not because they are unimportant but because when they occur with wind turbines they can nearly always be mitigated. The dominant characteristic of turbine noise that cannot be mitigated completely is amplitude modulation or AM. All modern large turbines exhibit AM and this has been explained by Oerlemans [4] when the observer is close to the turbines and at greater distances in specific directions. The effect is merely the directivity and Doppler amplification of the noise. Upwind or downwind of the turbine this reduces quite rapidly with distance but Oerlemans has shown that it can project over longer distances in the cross wind directions. This is what is often called "swish". If it is present in the noise at a receiver, the noise is perceived as being more annoying than if the noise has no modulation. It can become impossible not to notice the noise.

However, there appears to be another type of AM. It is sometimes called thump on the basis that some people including Salford University [5] van den Berg [6] and me have suggested that it has a faster rise time than the swish described by Oerlemans. It seems possible now that this fast rise time is not a feature but that the fundamental difference is that there is a low to mid frequency component (125 to 250Hz) to the AM in thump which does not occur in swish. However, we do not know this at the time of writing. Research to investigate this is still being carried out [7] and, by the time of the Conference more may be known. The paper by Bass et al gives more details of this research. What we do know is that people's descriptions of it suggest it is subjectively worse than swish. It seems, anecdotally at least, to be penetrating and relentless. It is also frequently perceived indoors which may be understandable if it is around the same frequency as the weak resonance region of double glazing units.

Perception

I now want to turn to the key factor in wind turbine noise – Perception. Public health officers and noise consultants are well aware that listeners' attitudes to any noise are important. Many of us are familiar even with extreme versions of this where people complain of noise which is non-existent because they have a grudge against the noise maker. The man who complains about noise from his ex-employers premises because he was made redundant. The racist who complains about noise from an Indian restaurant.

A number of large surveys of noise annoyance from aircraft were published in the late 1960s and in the 1970s when there was a big expansion of jet aircraft movements. An American study [8] concluded that people who were highly annoyed by aircraft noise had a high fear of aircraft crashing, high susceptibility to noise, felt that there was some misconduct on the part of the airport or airline staff and did not rate the airport as important as most people. The noise level to which they were exposed did not correlate highly with their annoyance.

Eveline Maris [9] wrote in The Social Side of Noise Annoyance in 2008 that *Based on a meta-analysis of several survey studies, it has been estimated that the effects of acoustical (e.g., the loudness, pitch, predictability) and non-acoustical variables (e.g., perceived control, personality traits like noise sensitivity, and attitudes towards the sound and its source) each account for about one third of the variance in annoyance scores (e.g., Job, 1988; Fields, 1993; Guski, 1999). The final 33% of the variance is considered error variance.*

She carried out research to test this hypothesis.

Participants are told that they are engaged in a study on effects of sound on people's performance during exams. As part of the experiment, they will take an exam while being exposed to sound. Half the participants are taken through a "fair" procedure in which three types of aircraft noise are described and asked to select the one which they think will cause them least annoyance. The other half are given a "neutral" procedure where they are not asked to choose.

In the second test half the participants are given an "unfair" test. They are informed that they will be listening to a 15-min sample of their choice: nature sounds, a radio programme, or aircraft sound. They make their choice of sounds (not usually aircraft) and the experimenter then selects aircraft noise irrespective of the subject's choice and leaves the test booth saying "I have set the computer to aircraft sound."

Maris established that when the exposer was unfair, annoyance was higher. In her conclusion she says *A person's evaluation of the sound is affected by the social process between themselve(s) and the operator(s) of the source. The results from the laboratory experiment confirm that the unfairness of the sound management procedure influences the evaluation of the sound. Relative to a neutral sound management procedure, an unfair procedure is found to yield collective excess annoyance*.

Scenario 2 – The Wind Farm

A neighbour is 650m from a newly constructed wind farm in a very quiet rural area. In what I will call week 1 the wind farm comes into operation. The neighbour is downwind in the prevailing wind and there can be day after day when he hears the relentless swishing and thumping noise. He finds it difficult to get to sleep sometimes and when he in on his patio on a summer evening it is worse because it seems to reflect on the walls of the house. He complains to the local council about it in week 3.. The council come and investigate and decide that there is a potential problem but they can't say whether it breaches the conditions imposed on the building of the wind farm so they ask the wind farm operator to investigate the matter in week 6. Nobody does anything so the neighbour complains again in week 9. The Council representative speaks to the operator who finally employs a noise consultant in week 12 and tells the council that this has been done. Nobody speaks to the complainant. In week 14 he complains again. He explains that he now can't get to sleep at night without sleeping tablets and he simply can't go out in the summer evenings when the wind is blowing from the turbines.

In week 16 he comes back from work and finds a tripod and a box and some other pieces of equipment in the open field beyond his garden fence. The next day he phones the local Council to ask them what is happening. They don't know. They suggest he phones the operator of the wind farm direct. He does that but the person he needs is not available. He leaves a message but nobody phones back. He calls the council and says that he can't get hold of anybody. The council say they can't really help because it's up to the operator to carry out the measurements.

By week 18 he is becoming extremely annoyed and frustrated. He goes to the doctor for more sleeping pills and asks if they have side effects because he is feeling anxious and also developing headaches that he never had before. The doctor changes his sleeping tablets. Later that week when he returns from work the equipment has gone. He is annoyed. No-one has ever contacted him about it. The location in the field bears no relation to his patio or to his bedroom where the problem is. He phones the council. They are very sympathetic but say that it is up to the operator to sort it out. More time goes by and by week 24 still nothing has happened. He phones the council regularly and gets the impression that they don't want to talk to him, that he is just a nuisance. As he gets more vocal about the lack of action the council get defensive. The impression is given that the complainant must be over-sensitive or even ill. The council's original view that there might be a problem has been forgotten by the council itself and by the complainant. The implications of dealing with a problem are too big to contemplate. But they say they will chase the operator up.

He visits the doctor again because he feels tired all the time and cannot concentrate on his work. He is getting irritable with his colleagues.

Week 26 comes and the council say they have received the operators report but they can't let him have it yet. Eventually in week 32 after a lot of trouble he manages to get a copy of the report that, after a good number of pages of technical stuff he does not understand, concludes that the noise level probably is not a breach of the conditions applied to the wind farm when it was given consent but they have not

really got enough evidence yet. He visits the doctor again because he is getting dizzy spells and feeling sick.

This man does not have Wind Turbine Syndrome, he is not affected by infrasound or vibrations or anything else mysterious. He is suffering from a noise that he finds unacceptable severely moderated by extreme annoyance and stress brought about by the intransigence of the local council and the arrogance of the wind farm operator. It is likely that all this could have been avoided if the matter had been handled properly by everyone concerned.

Mass Annoyance

This poor sound management and complaint management procedure does not merely affect the individuals who genuinely suffer from excessive noise. It now affects large numbers of people who only have the expectation of wind turbine noise in the future. One of the major changes in the last decade has been the ubiquity of the internet. Previously we, as noise consultants, met people with the symptoms I describe exposed to all sorts of industrial noise but the people themselves rarely communicated with each other. They never knew there were other people who had the same symptoms.

So when the people who had been genuinely affected by wind farm noise and been consistently ignored or ridiculed started communicating via the internet they discovered they had the same symptoms. The idea that their common factor was that they were exposed to levels of noise which were too high got lost somewhere because they had been brainwashed into thinking that there was something wrong with them – not the wind farms. They concluded there must be something special and different about the noise from wind turbines because the problem did not seem to arise with other noise sources. The reason other noise sources did not figure was because wind farms are high profile developments in every sense of the word.

The ideas of Wind Turbine Syndrome and Vibro-Acoustic Disease grew from this and spread so widely on the internet that now people who had an application for a wind farm in their area began to get concerned that, even if it was many kilometres away they might be adversely affected by noise from it and would certainly be made ill. What has now happened is that all wind farms, whatever their merits, face a long battle to get approval because of the misinformation that has built up.

The arrogance of many developers who felt they had a government given right to build wind farms where they liked drove this further forward as did consistent misinformation prevarication by government itself.

> Ten years ago, we had developers saying that the noise would be inaudible when it turned out to be 10dB above background noise.
>
> Developers now hold what they call consultation meetings with the public when they say things like “We want to involve the community in the project. We want your views” and then when you ask what size the turbines are they can’t say because “its not been finalised yet”. People don’t feel they are being treated fairly

> The Government says “Advances in turbine technology have helped to avoid increased noise from larger turbines”. That is simply wrong. .A typical 0.5MW turbine in 1996 was 100dBA. Typical 3MW turbine 2011 is 107dBA.
>
> Government says there is “No evidence to suggest that AM is as a result of Turbine Size” when the people arguably with best knowledge of turbine noise in the UK told it in 2006 “The trend for larger more sophisticated turbines could lead to an increase in noise from AM”

Government in the UK consistently commissions, not real research into how problems and potential problems can be identified and solved, but research into how the existing established but out-of-date standards and beliefs can be applied in a more consistent and effective manner.

People perceive, rightly or wrongly, that

– Their lives will be blighted by these developments

– They will gain no benefit

– They pay subsidies in the form of Tax

– They pay more for electricity.

– Developers make all the money

The result is that that people believe that government and developers are covering something up. This merely reinforces the views of those people who already believe that there is something mysterious about wind farm noise.

Nonsense, Misinformation and Exaggeration

The stated government policy in the UK and in many other countries is that renewable energy projects should be driven by the private sector and that any environmental or other impacts in applications will be controlled by the planning system. This is a part of the democratic process of the country – the developer on the one side and the planning process representing ordinary people. If there are no objections to a proposal going through the planning system then it will be approved. So objectors to wind farms are doing more than exercising their right they are exercising their obligation to take part in the democratic process. Only by people objecting can there be any chance of testing whether or not the application meets all the reasonable standards for developments – imposed, after all, by the Government in the first place.

> Ed Miliband, now leader of the opposition in the UK but then minister in charge of dealing with climate change, said in 2009 “Opposition to wind farms should become as socially unacceptable as failing to wear a seatbelt” [10].
>
> In November 2010 RenewableUK – the trade and professional body for the UK wind and marine renewables industries said [11] that “England stands to lose over £1.3bn in investment that will directly create jobs and opportunities for local companies, funds for community activities and increased business rates for local authorities because of the actions of anti-windfarm campaigners”.

Let us look at these two statements. In the first one we have a government minister saying that people who exercise their democratic rights should be made social outcasts. In the second we have the developers association suggesting that if developers did not have to go through the democratic process they could create more jobs. It is these sorts of comments that build up resentment in people who are near wind farms or potential wind farms and in the end it is counter-productive because it makes people more determined and, quite often, more unreasonable.

Such comments bring statements of equal nonsense from the “other side”. A quotation from the Wind Turbine Syndrome website [12] says: “The noise makes the windows on his house rattle and he hears some turbines a mile away in his living room. On the walk to his mailbox, it can reach nearly 100 decibels.” At 900 feet of course it will be a noise problem – but not 100dB.

In an interview Dr Harry said that “low-frequency noise - which was used as an instrument of torture by the Germans during the Second World War because it induced headaches and anxiety attacks - could disturb rest and sleep at even very low levels. It travels further than audible noise, is ground-borne and is felt through vibrations," [13]

And another comment conveniently confusing sound power levels with the sound pressure levels is “A single modern wind turbine emits approximately 105 dBA of industrial noise pollution. To put 105 dBA in perspective, this is between the sound power level of a pneumatic hammer drill and a rock band. [14]

Conclusions

All this is a matter of great frustration to me as a noise consultant. Everyone involved, even I have to say, some noise consultants and other scientists, has handled this whole affair of wind turbine noise with an ineptitude that I have never seen before on this scale.

The large opposition to noise from wind turbines has developed because of the complete lack of proper noise management by developers and by government and the failure to address real issues when they arise. This means that the real issues become inseparable from myth and hyperbole.

In the UK central government has done nothing to deal with the small number of undoubted problems. It has done nothing to curb the excesses of the worst developments and, indeed, has generally supported them. It has allowed mass annoyance and objection to any wind farm developments to build up to an extent that it threatens the development of renewable energy generally. The result of this ineptitude is not trivial. It has had two serious results:

> Facing the problem of climate change, the challenge of the century that ought to have drawn communities together, has instead divided them.
>
> The painting of wind turbine noise as something mysterious does a dis-service to the real sufferers from plain ordinary wind farm noise because it makes them look like cranks. As a result nothing is done about their problems.

References

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