10th International Conference on Wind Turbine Noise

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Post Conference Report

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First of all I want to thank the various people who took over the organisation of the conference days as, at short notice, I was unable to go to the conference in person. But I was there throughout remotely. And thanks also to the session chairs and everyone else who helped.

We have resisted having hybrid conferences as we believed they do not work but, as Andy McKenzie said, WTN2023 disproved this idea because what we ended up with was essentially hybrid. But I would want to qualify that. I think it worked because it was primarily on site. Out of over 40 presentations only three were remote; I don't believe it would have worked if half the presentations had been remote.

This year we had the usual new work – particularly increasing use of Apps in a range of applications – and advances in knowledge. But in spite of all the excellent work people have done, in some area our knowledge has not moved ahead much in the last ten years.

Here is a summary of the sessions. I don't generally mention authors names in my report because everyone makes a contribution. I make no apology for the fact that it is a mix reporting what happened with a few of my own comments thrown in. It is just a snapshot. If you want to know all the good work that has been done you will need to read the proceedings.

Propagation

There is still a lot of pressure from developers to develop more accurate propagation models to provide more confidence in turbine layout and maximise output within noise limits. This year there were papers outlining novel modelling methodology.

We hear that the UK IOAGPG might need some modifications to the upwind and crosswind attenuation values that were originally derived from work in the United States over 30 years ago. We heard about how flow within a wind farm influences noise levels and about modelling the uncertainties of propagation. There was a welcome presentation on propagation noise over water, about which we need to know more. This shows that further work is needed to improve the accuracy of propagation calculations over water.

Discussion on propagation spent quite a time discussing for how long limits could be exceeded. At one extreme the trend is towards long term average such as Lden and at the other, limits that must never be exceeded.

Mode Management

I originally suggested, before we got abstracts in, that this was going to be an increasingly important subject. So I would have liked to have had more papers but that is the way these conferences work. Bo, in his introduction said that mode management was going

to become more important as developers tried to get maximum production without exceeding noise limits and I agree that this is likely.

The three papers described methodologies for optimisation which in themselves were useful and interesting. There was a good discussion of nearly half an hour but I would have liked to have heard something on whether running turbines to the limit all the time was reasonable interpretation of regulations.

Guidelines and Regulations

We heard about regulation in US, Chile, Netherlands though as part of that there was information about many countries. The paper by Koppen particularly had a review of several European countries.

One thing emerging in several presentations and in the forum is what do the noise limits mean. Do they mean "never to be exceeded" or "exceeded on average" or something else. "Not exceeded ever", I think would be the interpretation in UK. However, you can not know whether a wind farm exceeds the limit at an instant because you can't separate turbine noise from background noise. So we have to measure over a finite period, probably several hours at least, with turbine on and off to derive turbine noise only.

There is pressure in some quarters to move to Lden, as used in WHO, but there are practical issues with that which were only briefly touched on. There was some talk in the streaming chat of wholly inappropriate local regulations being made under pressure from lobbyists. Of course as scientist and engineers we resent politicians introducing regulations that we believe to be clearly inept!

There was a discussion about the meaning of health. The WHO definition (Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity) is often quoted. The WHO definition was written in 1946 as part of its constitution. It was suggested that, under WHO, nobody has health and the WHO definition is not appropriate for formulating noise regulations. It was also suggested that annoyance is not a health issue but a risk factor for stress just as sleep disturbance is a risk factor for poor health.

In the forum on Guidelines and Regulations it was stated that we were asking the same questions as we were asking 18 years ago. We haven't solved the basics. Are we going to be asking the same questions in another 20 years? It was felt that while we were unlikely to reach an international consensus on noise limits it ought to be possible to reach a consensus on basics. Background noise, what kind of windshields, noise floor of the meter and so on.

A poll showed top two priorities for areas needing work to establish more about their impact were character – Tonality and Amplitude modulation. Then the impact related to relative and absolute noise levels. Then sleep disturbance and low frequency noise, then "other" and finally the influence of infrasound.

It is well understood that non-acoustic factors are more important than noise level and character. But we were discussing that 10 years ago with regard to wind turbine noise and 50 years ago in the case of aircraft noise. Apart from Health Canada, who looked at aggregate annoyance including shadow flicker, visibility, lighting etc, little work has been done on this.

Source Noise

The theme was noise reduction beyond serrations.

There is still a lot of research being carried out on methods of reducing noise at source – mainly the reduction of trailing edge noise. Serrated trailing edges are now commonplace but there is work on other methods. Some of them are passive - porous trailing edges, vortex generators, serrations and brushes but active noise reduction is also being researched such as blowing or suction. So source noise modelling work is still very active with new modelling techniques and ones using less computational power. The consensus was that passive system will dominate. Active solutions would create more maintenance and may not last the life of the blades.

An interesting suggestion was that, while tip noise is not currently a significant component of turbine noise, as trailing edge noise is reduced, it could become more important. And can some noise reduction measures such as vortex generators, generate noise themselves (they can).

Also question whether cyclic pitch could be used to reduce AM. There was some resistance to the idea because of maintenance cost. Are we also sure that cyclic pitch variation could reduce AM?

Impact on People

The use of Apps to allow residents to report their reaction to turbine noise and other aspects of turbines is becoming more common. Residents can use the app when annoyed and sometimes when they are not annoyed. In one case, the app included non-acoustic factors. The idea of the apps is that people feel they have more control if they can report annoyance easily. Also gives operators a better understanding of conditions under which annoyance occurs. The app often provides each residence with information about predicted noise levels and other factors such as shadow flicker.

In passing, reference was made that A-weighting and Leq was not an appropriate parameter for relating to annoyance. This probably needs more research but needs to be put into context. The original work over 25 years ago related to noise in general and simply showed that different noises with the same A-weighted level had different annoyance because they had different frequency content and different temporal characteristics.

Other conclusions were that wind turbine infrasound did not disturb sleep and that wind turbine noise was slightly less likely to cause sleep disturbance than road noise at the same dBA value.

Several delegates at the conference are taking part in IEA's Task 39. In particular WP4 and WP5. WP4 deals with the assessment of wind turbine noise and its impact on humans and WP5 deals with other aspects of perception and acceptance.

The principal speaker in the forum looked at the impact of wind farm noise from a qualitative point of view and particularly how noise is different things to different people. This is a variation on the theme to which we return time and again and to which we returned this time, that non-acoustic factors are more important than sound level and even sound character. We really need to explore this further if we are going to understand people's reaction to wind turbine noise better.

One suggestion was that the strongest predictor of annoyance in wind farm neighbours is the planning process. However, its not clear whether it is the process itself or the result of the process (to allow the wind farm to be built) that is the problem and more work needs to be done. But trust is certainly a factor.

Whilst there has been more research and some useful work, our overall knowledge of the situation has not changed much in the last 10 years. Though we can predict the proportion of the population annoyed at a particular noise level we cannot get anywhere near predicting the impact on any individual because the level of noise is only a minor factor. Should we be looking at soundscape techniques as an answer to this?

Compliance

The main subject matter of the compliance session was, perhaps not surprisingly, how to solve the low signal/noise problem during compliance testing. Of course this problem only arises when noise limits are set at receiver locations. Some jurisdictions base limits on sound power level checks on turbines so perhaps that is the simplest way to solve that problem.

Methods were described to separate data sets into different noise sources and particularly wind turbine noise and the rest. The use of proxy locations was also discussed so that measurements could be made at an intermediate point between receiver and turbines.

We should also not forget that, in many jurisdictions, noise limits are related to wind speeds so the accuracy of wind speed measurement is as important as sound level measurement. And that of course raises the question of where and how you measure the wind speed.

Miscellany

This was a group of papers that I found difficult to put in a simple category. As it turned out it was a most interesting selection.

The first was a discussion of methods for apportioning noise limits between a number of wind farms. This is becoming a major difficulty in the UK, though it did not appear to have the same significance elsewhere.

Bo asked if the uncertainty of a measurement is zero does the measurement disappear? And gave us a very interesting presentation on uncertainty and its importance.

The third paper looked at the increase of sound power level as turbines get bigger. Ten or so years ago we were predicting the increase of turbine rating from 2 to 6MW would raise sound power levels by about 5dB based on the power/sound power relationship of smaller turbines. As it turns out that increase has only been a little over 2dB probably due to the lower than expected increase of tip speed. With the use of TES the increase is little more than 1dB.

The final two papers related to AM and we heard how highest AM appears to be in the 6m/s area and in crosswind and downwind directions. There is less AM as distance increases and applying restricted mode or fitting TES usually reduces AM.

In a particular location surveyed, annoyance from AM started as soon as it became audible and occurred for 1% to 50% of the time with a median modulation of 1.5 to 2.5dB.

Tonal Noise

With larger turbines it is possible that tonal noise will become more likely. The presentations were mainly on methodology to prevent or to reduce tonal noise at source particularly reducing the transmission of vibration to components of the turbine that radiate noise by decoupling rotating parts from the radiating structure. In one case vibration was reduced by tuned mass dampers which were relatively lightweight.

Work was also described on tone propagation to receptor points. This relies partly on the narrow band spectrum of the background noise so a library of background noise levels would be helpful if warranties for tones at receptor points are to become a reality.