Comment on Wind Speed Gradient and the October 2008 Noise Regulations

There remains some confusion concerning the requirement in the October noise regulations that a developer must measure the average night-time wind speed gradient and the impact of the measurement on the increasing limit (40 to 51 dBA) with increase in wind speed. This comment is an attempt to shed light on this significance.

Ontario allows a developer to go above 40 dBA at a residence if the wind speed is larger than 6 m/s. The allowance is based upon measurements of ambient noise due to wind blowing through vegetation. I do not know the source of the measurements. However, the Ontario regulations were based upon the UK ETSU-R-97 regulations.

First, I must explain that there is a wind speed gradient in the atmosphere. Basically, this is because friction at the ground reduces the wind speed to essentially zero at ground level. In the simplest case of no turbulence, there will be laminar flow. That is, there will be a wind speed gradient with the wind speed gradually increasing with height. The Ontario regulations were based upon the wind speed at the hub height of 80 metres being about 1.5 times the wind speed at a height of 10 metres which is proxy for the height at which people live.

Next, manufacturers make measurements which allow them to determine the sound power of their turbines, treating them as a point source of sound. The point source is at hub height. They make simultaneous measurements of wind speed using an anemometer which is generally at a height of 10 metres. They will do this during the daytime when the wind speed at hub height is indeed about 1.5 times the wind speed at 10 metres. Next, the manufacturer presents the measurements as a graph of sound power as a function of wind speed at 10 metres.

A developer then takes the manufacturer's graph and calculates the sound pressure level at all of the residences around a proposed turbine or neighbouring clusters of turbines. There is an internationally accepted prediction code for the calculation. The developer has to ensure that the sound pressure level (noise!) is below the Ontario limit for all wind speeds. As an aside, the developer can and does ignore excess noise due to turbulence in the atmosphere, the amplitude modulation of the sound pressure level, and the inherent uncertainty in the manufacturer's specifications and in the prediction code; these are matters that I arguing about with MOE.

Before October, 2008, that was all there was to it. However, there were Dutch complaints of noise disturbance from turbines operating at night-time. Investigation showed that the likely cause was an enhanced night-time wind speed gradient. Confirmation came with a multitude of test tower and meteorological tower wind speed measurements from various countries. It was demonstrated that at night-time the wind speed at the hub height could be 2.5, and higher, times the wind speed at a height of 10 metres. Bill Palmer confirmed this for SW Ontario using wind farm output power measurements. MOE refused to accept this, even going so far as to commission Dr. Ramakrishnan to write a report criticizing the Dutch work. I made a close study of the

Ramakrishnan report and had no trouble trashing it – it was a travesty! Bill Palmer was similarly critical. In any case the meteorological evidence was overwhelming. MOE had no option but to back down. The Oct. 2008 regulations, which of course are part of the Sept. 2009 GEA regulations, now dictate that a developer must present a measurement of the average summer night-time wind speed gradient. The ones that I have seen in recent Environmental Noise Impact Assessments and in a paper at the Canadian Acoustical Association meeting (Niagara-on-the-Lake, Oct. 2009) give the average summer night-time wind speed at the hub height to be about 2.5 times the wind speed at a height of 10 metres.

The significance is at follows:

Suppose that a manufacturer's specifications are as follows:

Wind Speed at 10 metres (m/s)	4	6	8	10
Turbine Sound Power (dBA)	101	103	105	107

From this, I deduce the following table: The second row is the presumed wind speed at the hub of the turbine when the manufacturer made the measurements, assuming that the wind speed at the hub was 1.5 times the wind speed at a height of 10 metres (wind speed ratio is 1.5). The fourth row is an example sound pressure level at a residence calculated using the prediction code. The fifth row is the Ontario limit. The limit depends upon the wind speed shown in the first row. The turbine is in compliance.

Wind Speed at 10 metres (m/s)	4	6	8	10
Wind Speed at Hub (m/s)	6	9	12	15
Turbine Sound Power (dBA)	101	103	105	107
Sound Pressure Level at Residence (dBA)	38	40	42	44
Ontario Limit (dBA)	40	40	45	51

Note that the sound power of the turbine depends upon the wind speed at the hub. Consider the case that the wind speed ratio is 2.5. The hub wind speed will now be larger for any particular 10-metre wind speed and so will the turbine sound power.

Wind Speed at 10 metres (m/s)	4	6	8	10
Wind Speed at Hub (m/s)	10	15	20	25
Turbine Sound Power (dBA)	103.5	107	108	108
Sound Pressure Level at Residence (dBA)	40.5	44	45	45
Ontario Limit (dBA)	40	40	45	51

The turbine is no longer in compliance. The acoustic consultants are aware that the requirement to measure the wind speed gradient negates the masking noise allowance and almost certainly will not invoke it.

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