

Submission to EBR # 010-6516 Concerning Regulations to Accompany the G.E.A.

John Harrison – July 21st, 2009

Introduction

First, I support the rational introduction of renewable energy into the mix of sources of electrical power in Ontario. However, I believe that the future competitive position of Ontario must be protected and that means that electricity costs must be competitive with those in other provinces and with other countries. As things are now, Ontario has a relatively large proportion of its energy from low-carbon and low-cost sources (mainly hydro-electricity and nuclear), far larger than European countries. It is irresponsible for Ontario to be offering such large feed-in-tariffs for wind and solar energy when the earlier competitive bidding process was producing far more proposals than requested by and required by the Ontario Power Authority at significantly lower prices. These high prices will return to haunt Ontario in the future. It is also irresponsible to the well-being of Ontario to be introducing wind-power before a manufacturing industry to produce and install wind turbines has come into being. Every turbine imported into Ontario means \$2M going to Europe or the USA, and probably more as much of the shipping and installation is also sourced off-shore. Secondly, as a member of Wind Concerns Ontario (WCO), I have read the WCO position statement and support it in its entirety. As someone with extensive knowledge of sound waves and their propagation, I will focus my submission on the topic of noise regulation.

The present regulations and those in draft form in the “Proposed Content for the Renewable Energy Approval Regulation under the Environmental Protection Act” are quite inadequate as we know from the health complaints of a large number of Ontario rural residents (McMurtry 2009) and the large discrepancy between the setbacks from homes allowed by the Ontario regulations and the recommendations of health and other authorities (Pierpont 2009). This submission will address this discrepancy and make recommendations.

The Draft Noise Regulations

The draft regulations were at some point in their genesis an attempt to improve upon the October 2008 limits. The absolute limit of 40 dBA, compared with the previous allowance of up to 11 dBA for masking noise, at last recognizes that masking noise is a myth at night-time. If anything is needed to put the final nail in the coffin of the masking noise myth it is the summer night-time wind speed gradient coefficient of 0.47 measured by Zephyr North at the site of the proposed Columban Wind Generation Project in Ontario. However, the draft regulations are otherwise irrational. Although the matrix of setbacks gives the impression that the interest of rural residents has been taken into account, this is in fact nonsense. All that a developer has to do is to perform a noise assessment with the October 2008 regulations and we are right back where we started. Such an assessment is very straight-forward using commercial software. The input consists of the GPS co-ordinates of the receptors and turbines which is required to use the matrix anyway. Even the transformer setback is a sham because an acoustic barrier that

breaks the line of sight does not work. At a distance of 1000m the apparent height of a noise source for a receptor downwind is 5x the actual height. This is discussed in the “bible” of wind turbine noise references: “Wind Turbine Noise” (Wagner 1996). Therefore, a barrier needs to be considerably higher than given by a line joining the transformer to the upper level of nearby residences.

Given that the draft regulations allow developers to use the October 2008 regulations and that for any large project the developer has to use these regulations, it is vital that the October 2008 regulations be revised to reflect the mandate of the Ministry of the Environment. That is, to uphold the Environmental Protection Act to protect the health and well-being of Ontario residents and to allow them the full enjoyment of their property. To date, the Ministry of the Environment is failing in this responsibility.

Rational Noise Guidelines

There are a number of deficiencies in the Ontario regulations. Every one needs to be addressed before any more turbines are approved for installation.

a) Intrusion: Rural regions are very quiet, probably below 25 dBA at night. This means that the Ontario guidelines are allowing a 15 dBA intrusion above background and, given the annoying characteristic of turbine noise, this is too much. There is no need to allow this large an intrusion. Germany, which has a population density 20 times larger than that of Ontario and has a well-developed wind energy generation system supplying 6.4% of its electrical energy, has a night-time noise limit of 35 dBA. In another instance, New Zealand, in section 5.3.1 of its draft regulations, is introducing a secondary noise limit of 35 dBA for evening and night-time in low background environments.

b) Amplitude Modulation: Wind turbine noise is periodic in the blade passage frequency. It is clear from the work of van den Berg (2005). It is clear from the Salford report (Moorhouse et al 2007) published by the British Wind Energy Authority. It is acknowledged by MOE in its October 2008 turbine noise regulations. The consensus is that it amounts to about 5 dBA of amplitude modulation. This amplitude modulation is averaged away by regulations based upon an L_{eq} . However, the ear does not average and this swooshing sound adds significantly to the annoyance associated with turbine noise. A 5 dBA penalty is needed to account for the amplitude modulation.

c) Uncertainty: No prediction is going to be 100% correct. The turbine manufacturer quotes an uncertainty of ± 1 or ± 2 dBA. One of the frequently used prediction codes, ISO-9613, specifically states an uncertainty of $\pm 3\%$. These are independent uncertainties and so will add in quadrature. Therefore the prediction for noise at a receptor will carry an uncertainty of ± 3 to ± 4 dBA. No self-respecting and responsible engineer would ignore the uncertainty in a design calculation; yet noise consultants do ignore this uncertainty and the engineers at MOE allow this neglect.

d) Turbulence: Many noise complaints draw attention to a component that sounds like a rumble (a dryer or a passing train that never passes!). This is probably excess low frequency noise associated with turbulent inflow of air into the blades. The turbulence has two sources, turbulence in the atmosphere and the turbulent wake from neighbouring

turbines. SODAR measurements (Barthelmie 2003) have shown that for $x/D \sim 5$, the turbulent intensity (TI) behind a turbine is comparable to the atmospheric TI (x is the distance behind the blade and D is the blade diameter). They were 5% and 7% respectively. Turbulent intensity is defined as σ/v where σ is the standard deviation of the wind speed v (Wagner et al 1996). The SODAR measurements were made every minute and the averaging time for σ and v was 10 minutes. Low frequency noise requires a faster time scale for the calculation of σ and hence of the appropriate TI. However, the important point is that turbulence about 5 blade diameters behind a turbine is significant. I note that for the Wolfe Island wind farm in Ontario about half of the turbines are within 6 blade diameters of an upwind turbine for the prevailing south-west winds.

Moriarty and Migliore (2003) and Moriarty (2004) working at the National Renewable Energy Laboratory in Golden CO, made a study of inflow turbulence noise from turbines, with both measurements and predictions. Below 1 kHz, the turbulent inflow noise can dominate the total turbine noise. For instance, with a TI of $I = 10.6\%$, at 100 Hz this noise is 30 dBA larger than the combined noise from all other aerodynamic sources. Doubling the frequency decreases the turbulence noise by 5 dBA; halving it adds 5 dBA. The noise power is proportional to I^2 , so that the sound pressure level falls by only 6 dBA as the TI is halved. The noise measurements bear out the predictions apart from the need for an adjustment for the averaging time for the determination of σ .

It is quite clear from measurements of the turbulent wake downwind of a turbine, the close proximity of turbines to each other at wind developments around the shores of the Great Lakes, the predictions of turbulent inflow noise calculations and the agreement with measured noise that it is vital that this noise source be a part of noise regulation. This noise will not go away at night when the day-time atmospheric turbulence gives way to the stable night-time atmosphere. Turbulent inflow noise is predominantly in the low frequency range below 1 kHz, particularly near the lower range of hearing, and where the absorption by the atmosphere is minimal. Enough is known that prediction of turbulence noise can be made both from prior wind speed test tower measurements and from the proposed layout of the turbines. Ontario needs to address this noise source in revised noise regulations.

Summary

The 40 dBA noise limit needs to be reduced to 35 dBA; there needs to be a 5 dBA penalty for the periodic or cyclic nature of turbine noise; a 3 to 4 decibel penalty needs to be added for the uncertainty in the turbine specifications and in the prediction code used to estimate the noise at a receptor; turbulence is a major contributor to turbine noise and needs to be included in the estimate of noise at a receptor. As shown by the references below, none of these things are new science. The presence of turbulence in the wake of a neighbouring turbine was known in detail 6 or more years ago and the calculation and measurement of turbulent inflow noise was published 5 years ago. Uncertainty is standard in any engineering prediction and has been for years. Amplitude modulation is a characteristic of turbine noise and was measured as far back as 2005. MOE long ago realized the role of amplitude modulation of noise in general in causing annoyance; it has chosen not to consider it for turbine noise for reasons that only MOE knows. Together,

these necessary modifications to the Ontario noise regulations for wind turbines will push setbacks from homes out to 1.5 km or more where they belong.

How to proceed: There are many regions of Ontario with wind speed averages of 6.5 m/s, are close to the Ontario grid and are distant from residential areas. This is where the wind developments belong. This idiotic policy of dotting turbines among residences as we see with Melancthon, Wolfe Island, Kincardine, Ripley and others has to stop. Not only is it causing annoyance and serious health concerns but the close packing is causing a decrease in efficiency. If a turbine is 6 blade diameters downwind of a neighbour, the upwind turbine steals 20% of its wind. As any turbine engineer knows, a 20% wind deficit is equivalent to a 50% decrease in power output. Wind projects on the Prairies, on the Great Plains, in France and Spain are well away from homes.

References

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