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November 9, 2010

Mr. Ben Brazell
EDR
217 Montgomery Street
Suite 1100
Syracuse, NY 13202

Subject: EverPower Allegany Wind Project
Background Sound Levels and Noise Impact Issues
Response to Comments by Mr. Rick James, E-Coustic Solutions

Reference: L-110510-A

Dear Mr. Brazell:

I have reviewed a series of letters and reports, ranging in date from February 19, 2009 to May 3, 2010, prepared by Mr. Rick James of E-Coustic Solutions, which are highly critical of our work on the EverPower Allegany Wind Project. The three specific documents are listed below.

A. Letter to Gary A. Abraham, Esq., Feb. 19, 2009
B. Letter to Gary A. Abraham, Esq., Feb. 22, 2010
C. "A Report on Background (Ambient) Sound Level At Selected Sensitive Receivers, Olean/Allegany, NY, April 22-24, 2010", May 3, 2010

Before I get to the substantive flaws in Mr. James' analysis, I must state that I am disappointed by the defamatory tone of these letters, which, taken together, clearly insinuate that the survey methodology, data analysis, and noise modeling have been biased in favor of the project. As a Professional Engineer with over 19 years of experience in power industry acoustics, I am fully aware of the various standards and measurement techniques that Mr. James claims should have been used for this assessment, but the fact of the matter is that many aspects of these standards do not apply to the special case of wind turbine sound emissions and specialized techniques are required for which no standards currently exist. The sensible and rational techniques we have developed are based on extensive field experience with wind projects – and are techniques that I would want to see used if a project were proposed adjacent to my own house. Our approach to this assessment would have been identical whether we are engaged by the developer, the Town or any other party.

The technical issues raised in the letters tend to boil down to the following complaints, which will be briefly addressed below:

- Our background sound levels are developed as a function of wind speed
- The sound levels are correlated to local wind speed at the measurement position
- The L90 statistical measure should be used to quantify background sound levels

- Our design background sound level is the level "when the turbines are the least audible"
- The study should be repeated by an independent consultant
- The design background level should be based on a single short-term measurement made on a calm night
- Our test methodology does not adhere to accepted standards
- The measurements are corrupted by wind-induced microphone distortion
- Dr. Schomer criticizes our background sound survey at Cape Vincent
- Noise modeling based on ISO 9613-2 is invalid for wind turbines
- The input turbine sound power levels are based on the IEC 61400-11 test results
- The project will lead to sleep disturbance according to WHO guidelines
- Low frequency noise is not sufficiently addressed and project noise "will result in adverse health impacts"
- The example measurements of low frequency wind turbine noise are expressed as A-weighted spectra "playing tricks with the data"

Our background sound levels are developed as a function of wind speed

Surveys of long-term environmental background levels in rural areas commonly yield results that vary from 20 dBA to 55 dBA. In the absence of any prominent man-made noise sources, which is normally the case at wind turbine sites, this variance is almost entirely due to wind-induced sounds. For any other type of project besides a wind farm, such as a conventional fossil fueled plant, a design value at or near the low end of this range would be used to characterize the background because a facility generating a constant noise output and completely independent of environmental conditions would be most prominent when the background was the lowest. However, in the unique case of a wind farm the noise level generated by the project is entirely a function of wind speed. Unlike a conventional power plant, a wind project generates no noise at all during calm conditions; specifically, calm conditions at hub height. Consequently, the background sound level during calm conditions is of no relevance to the potential audibility of the project; rather, it is the background sound level when the turbines are actually operating that must be compared to project noise. That is why sound levels are correlated to the wind speed that was occurring when they were measured.

The sound levels are correlated to local wind speed at the measurement position

The most common misconception about this correlation is that we are comparing the sound levels to the wind speed occurring near ground level at the microphone. This is completely incorrect. The wind speed used for the Allegany regression analysis was measured by the mast top anemometer 180 ft. (55 m) above the crest of the ridge where the turbines are proposed (this wind speed is subsequently normalized to a standard elevation of 10 m above ground level per IEC 61400-11 so that it can be directly compared to turbine sound power levels, which are always expressed in terms of this standard elevation wind speed). Consequently, the wind speed that the turbine rotors would experience is compared to the concurrent sound levels measured at the six survey positions, some of which were in protected ravines at the base of the mountain where the wind speed was very probably negligible. This approach ties the wind conditions that would be directly associated with turbine operation to the background sound level at the nearest potential sensitive receptors. At low wind speeds below cut-in, for example, the project would be inactive because the wind speed used in the analysis was actually measured within the rotor plane and not at ground level.

The L90 statistical measure should be used to quantify background sound levels

The May 3 report (Document C) states on Page 4 that "Current procedures for predicting community response to any new noise source use the L_{A90} sound levels, as reported in this study. These are the correct metrics for describing pre-operational sound levels." This statement and a passage on Page 1 of Document B about the need to exclude contaminating noise events imply they we did not use the L_{A90} statistical measure. That is completely incorrect. The $L_{A90(10\ min)}$ measure was used in the regression analyses to derive the design levels of 35 and 37 dBA, for valley and mountaintop receptors, respectively. The L_{A90} level conservatively captures the "background" sound level during momentary lulls, such as between wind gusts, cars passing by or planes flying over.

Our design background sound level is the level "when the turbines are the least audible"

The last paragraph on Page 4 of Document A complains that "The [Hessler] report's novel method of interpreting (or misinterpreting) the background sound level near the project area based on conditions when the turbines are least audible (because it is already noisy outside from high winds) will always show wind turbines are more compatible with the community . . . Generally accepted standard dictate that background sound levels be determined under conditions when the turbines would be most audible." This statement implies that our design background levels were not based on the conditions when the turbine would be most audible when, in fact, they were.

Both the background sound level and the turbine sound level vary with wind speed. As delineated in Tables 3.3.1 and 3.3.2 of our report the design background levels for valley and mountaintop locations were determined at the wind speed (7 m/s) where the turbine sound level was highest relative to the background level; or where the differential between these two values is greatest. Project audibility is theoretically lower under all other wind conditions higher and lower. At lower wind speeds, for instance, the turbine sound level drops off faster than the background level so, relatively speaking, there is more masking noise available. At very low wind speeds the project would be idle.

The study should be repeated by an independent consultant

A new background survey was, in fact, carried out by Conestoga-Rovers & Associates in early June of 2010 under contract from the Town of Allegany to independently evaluate the validity of our survey results[1]. Measurement positions were established in the valley on Chipmunk Road and on the ridge top in an approach similar to ours. Sound levels were measured on a continuous basis in 1 hour increments for 17 days. Any dependency between sound levels and wind speed was not considered. The reported overall result for the more critical valley receptors was an L_{A90} background sound level of 35 dBA, which agrees exactly with our design value for valley receptors. The report concludes "The overall average L90 values range from 33 to 35 dBA during the wind conditions of interest, which are similar to Hessler's previous study that established the overall L90 background levels as a function of the 7 m/s wind speed design value".

[1] Conestoga-Rovers & Associates, "Ambient Sound Level Assessment, Town of Allegany, New York, Ref. No. 630631, September 27, 2010.

The design background level should be based on a single short-term measurement made on a calm night

Mr. James asserts that the brief field measurement survey he carried out in April of 2010 on behalf of the opposition group Concerned Citizens of Cattaraugus County (CCCC) where one 2 hour spot sample taken at four locations during calm nighttime conditions better characterizes the environmental sound levels within the project area than our survey, where over 2000 measurements were made at each of 6 positions over 15 days, or the 17 day CRA survey carried out independently on behalf of the Town. This is clearly a nonsensical notion.

Moreover, the James methodology would base the potential noise impact from the project on the background level that only occurs during calm conditions when the project is either completely idle or the rotors are only just starting to slowly turn without generating any significant noise. This is comparing apples to oranges, since the project, by definition, requires windy conditions to operate. The stated justification for this approach is that there are times when the wind and thermal gradients are such that it is sufficiently windy at hub height for the project to operate but nearly calm and therefore quiet at ground level (i.e. stable atmospheric conditions). While this does occasionally occur at most sites, it is more of an extreme case than a commonplace situation, as suggested. In any case, this eventuality has already been implicitly taken into account in our analysis where the wind speed normalized from the rotor swept area (180 ft. above the ridge crest) has been compared to the background sound levels at ground level. If these stable atmospheric conditions had occurred during the survey they would have manifested themselves as very low sound levels during windy conditions. Figure 1 below summarizes the results of our 2008 survey for sheltered valley locations. There are only a handful of data points, representing 10 minute periods, when the sound level was relatively low during windy conditions, such the reading of 32 dBA during a 10.4 m/s wind, but these points are essentially outliers. As can be seen in the plot, it could just as easily have been close to 45 dBA during such wind conditions.

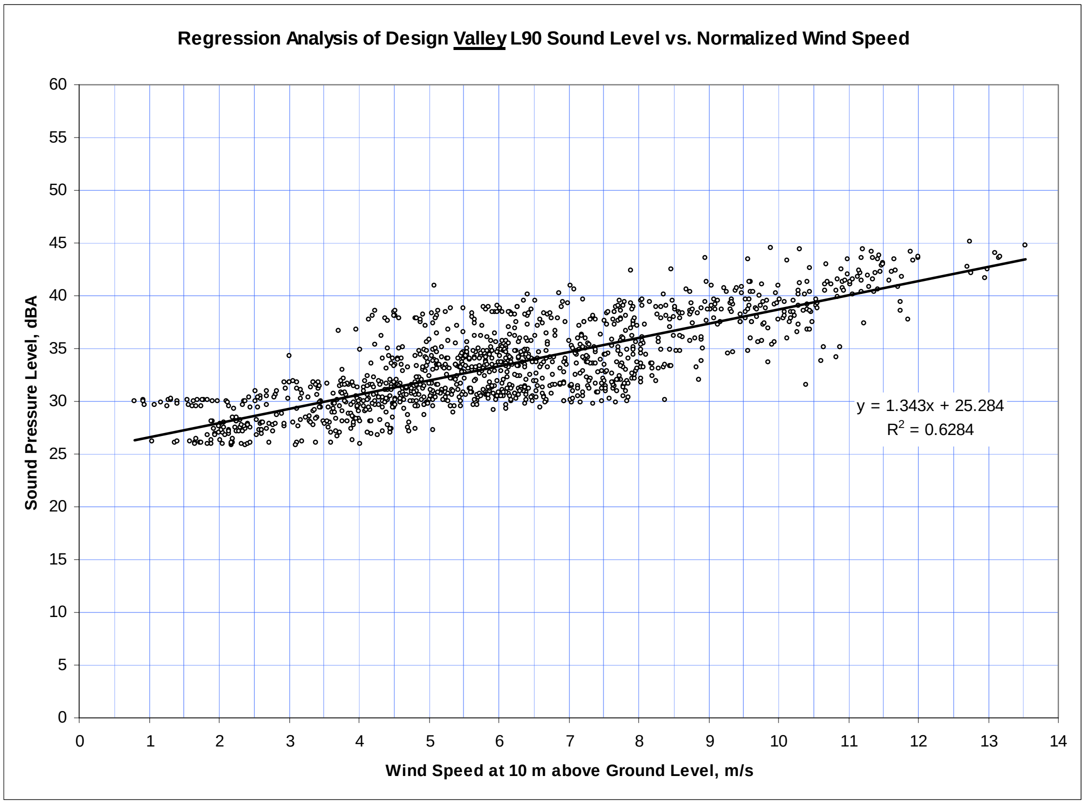

Figure 1 *Survey Results for Valley Receptors (HAI Report 1827-111308-D, Jan. 27, 2010)*

The levels of 22 to 28 dBA measured by Mr. James in April 2010 largely agree with what we measured during calm conditions. For example, we would say the average L90 sound level during 1 m/s wind conditions was 27 dBA. In essence, the entire James survey result is a single dot at the lower left of the data cluster in Figure 1.

Our test methodology does not adhere to accepted standards

The James survey report is cloaked in an air of apparent unimpeachability by its repeated references to ANSI, ASA, and ISO standards and our work is roundly criticized for not adhering to various standards, such as ANSI S12.18. The fact of the matter is that this standard was not written with wind turbines and their unique circumstances in mind and, in fact, essentially makes itself irrelevant to wind turbine applications by limiting the wind speed under which measurements may be made to 5 m/s. In fact, there is currently no standard, accepted or otherwise, that describes exactly how a background sound survey for a wind project should be performed. Our methodology was developed through practical field experience and did not, as suggested on Page 1 of Document B, derive from ETSU-R-97 *The Assessment and Rating of Noise from Wind Farms*, since we were employing this test approach before that document was issued in September of 1996. Moreover, the correlation between sound levels and wind speed is one of the few aspects of ETSU-R-97 that was not refuted by Dick Bowdler in his “ETSU-R-97 Why it is Wrong” white paper, in which he mentions that that is the way he looks at background sound levels at wind sites.

The measurements are corrupted by wind-induced microphone distortion

There is a lengthy discussion of wind-induced microphone distortion in Document B and it is asserted that our test results are subject to error from “windscreen failure”. This is completely untrue and the measurements are valid. We know this because in 2008 we carried out a study of windscreen performance at a laboratory in Germany where a variety of common windscreens were subjected to known air flow velocities in the test duct of a massively silenced wind tunnel[2]. Through this testing it was possible to quantify the level of false signal noise in terms of frequency and incident wind speed. Moreover, this study confirmed that this measurement error affects the low end of the frequency spectrum (only) such that it does not have a significant adverse impact on the measurement of A-weighted sound levels until the wind speed is very high indeed and well beyond the range relevant to most background surveys. For all wind turbine field surveys, including the Allegany work, we use a special weather-treated oversize (7” diameter) windscreen, which was found to be the best performer in wind tunnel study; i.e. it exhibited the least distortion. At Wind Turbine Noise 2009 in Aalborg Denmark I gave a paper[3] on the specific application of these study results to wind turbine field work. I did not see Mr. James at this conference or at the preceding two in 2007 and 2005.

Dr. Schomer criticizes our background sound survey at Cape Vincent

In an ironically similar situation, Dr. Paul Schomer was hired by an opposition group Wind Power Ethics Group of Cape Vincent with the evidently premeditated agenda of essentially demonstrating through measurements of his own that our background sound level survey for the Cape Vincent Wind Project was flawed and that the reported sound levels were above what they should have been. We had previously carried out two surveys at the site; one in the summertime and one in the wintertime at the insistence of the client in an effort to be complete and investigate possible seasonal differences. At the time Dr. Schomer was engaged only the summertime results, which were grossly elevated and largely meaningless due to insect noise and other contamination, had been made public by the developer. Dr. Schomer set up equipment at locations he deemed quieter and more appropriate than ours, using a test set up at each location that he deemed correct and appropriate and made measurements at a time of year when no insect noise was present. A report was subsequently issued in May of 2009[4] trumpeting his inevitably lower results and denouncing our results in a surprisingly strident manner.

The fact of the matter is that we had no intention of using the obviously contaminated summer results for any purpose other than to show that summer sound levels can be relatively loud and would have based any impact analysis on the winter survey results, which were much lower and in keeping with the normal findings of such surveys. We were never engaged, however, to prepare an impact assessment for that project but one was prepared without our knowledge or involvement by an environmental firm employed by the project developer. It was this assessment, which I have still never seen or read, that apparently sparked the hiring of Dr. Schomer by the WPEG.

Once the winter survey report was released shortly after these events it became apparent that our winter survey results were comparable to and in many cases even lower than the results obtained by Schomer.

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[2] Hessler, G. F., Hessler, D.M., Brandstaett, P., Bay, K, “Experimental study to determine wind-induced noise and windscreen attenuation effects on microphone response for environmental wind turbine and other applications”, *Noise Control Engineering Journal*, J.56, July-August 2008.
[3] Hessler, D., *Wind Tunnel Testing of Microphone Windscreen Performance Applied to Field Measurements of Wind Turbines*, Third International Meeting on Wind Turbine Noise, 17 – 19 June 2009, Aalborg, Denmark.
[4] Schomer, P. Dr., *Background Sound Measurements and Analysis in the Vicinity of Cape Vincent, New York,* prepared for the Wind Power Ethics Group, May 11, 2009.

Consequently, it had to be admitted that all the grievances about our test positions (allegedly too close to roads in some cases), equipment set up (on poles instead of tripods) and general approach were moot and completely unfair. A letter to us from Dr. Schomer attesting to this unfortunate series of events is attached for reference.

Noise modeling based on ISO 9613-2 is invalid for wind turbines

Returning to the James critique of our Allegany study, there is a lengthy diatribe in Document A declaring that ISO 9612-2 *Acoustics – Attenuation of Sound during Propagation Outdoors*, the most universally used sound propagation standard that essentially all modeling programs are based on, is “poor at replicating the way turbine sound emissions will propagate in the real world” and essentially invalid for wind turbine applications. This standard apparently is only good for low wind speeds, sources lower than 30 m, and Mr. James left out the often-cited distance limitation of 1000 m. This claim is commonly made, as it is made here, with no suggestion as to how the calculations should have been “correctly” done. These reservations seem legitimate on paper and are somewhat understandable when they come from individuals with little or no experience measuring the actual sound emissions of wind turbines and comparing them to calculated predictions; but field experience testing operational projects strongly suggests that sound propagation from wind turbines is, in fact, very accurately predicted by ISO 9613-2 – probably because, from an analytical viewpoint, turbines are simple point sources suspended in space and spherically radiating sound waves.

Over many surveys of completed projects and at many test positions the results have been consistent in the sense that the model prediction at any given wind speed agrees very well with the mean measured level, as illustrated below in Figure 2 showing measured project sound levels at a house surrounding by 11 turbines at various distances. The scatter in the data is inevitable and results from some of the factors mentioned by Mr. James, such as turbulence, unstable wind speed or direction, temperature stratification, the wind gradient, etc. These perturbations above and below the mean sound level are a unique characteristic of wind turbines but cannot be individually calculated or predicted. Only the mean level is predictable. That is why the possibility of excursions is discussed verbally in the report as in the following excerpt from the conclusions of our January 27, 2010 assessment:

> predictions made using ISO 9613, the worldwide standard for noise propagation calculations, characterize sound levels under average or normal conditions. There will be times when atmospheric conditions, temperature gradients and wind shear gradients cause sound levels at any given location to vary above and below the nominal or mean prediction value. This means that higher sound levels from the project may temporarily occur from time to time.

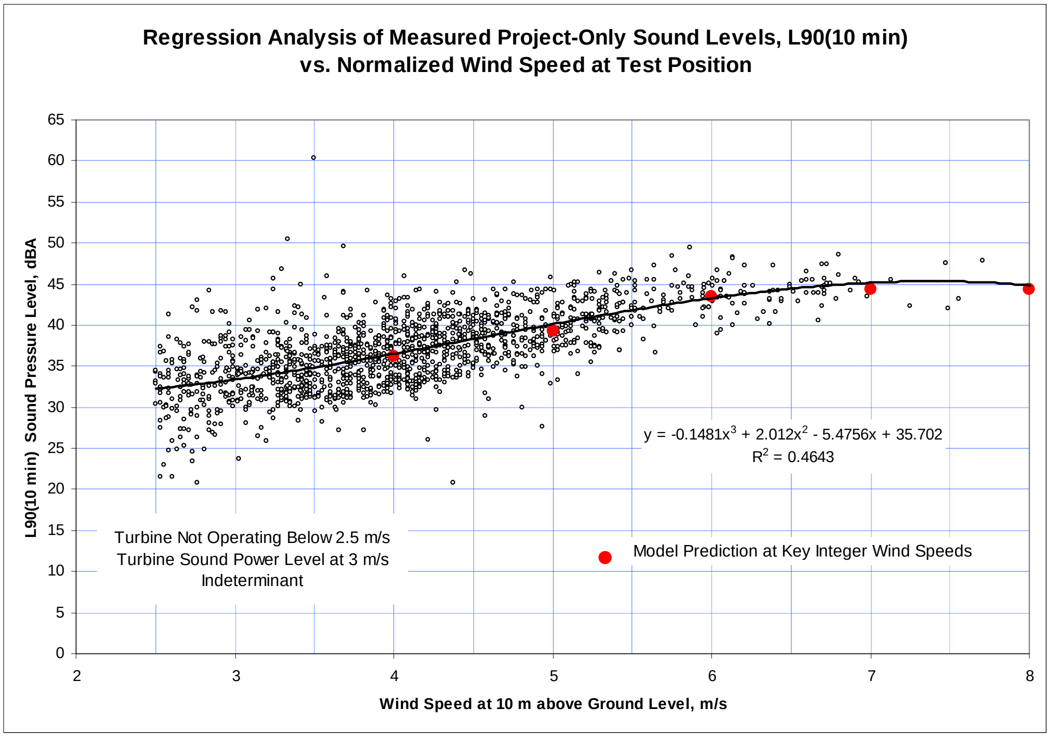

Figure 2 *Typical Measured Project Level Compared to Model Predictions at Key Wind Speeds*

Modeled vs. measured results at the same measurement location are compared in a different way in Figure 3 where the predicted and measured levels over a three day period are plotted as a function of time rather than wind speed. The blank sections are when the project is idle due to winds below cut-in speed. It can be seen that the analytical predictions follow the actual level in a realistic manner overstating the project sound level about half the time and understating it the other half of the time. In general, based on our experience, we would contend that modeling wind turbines with ISO 9613-2 is about as accurate as one could hope for.

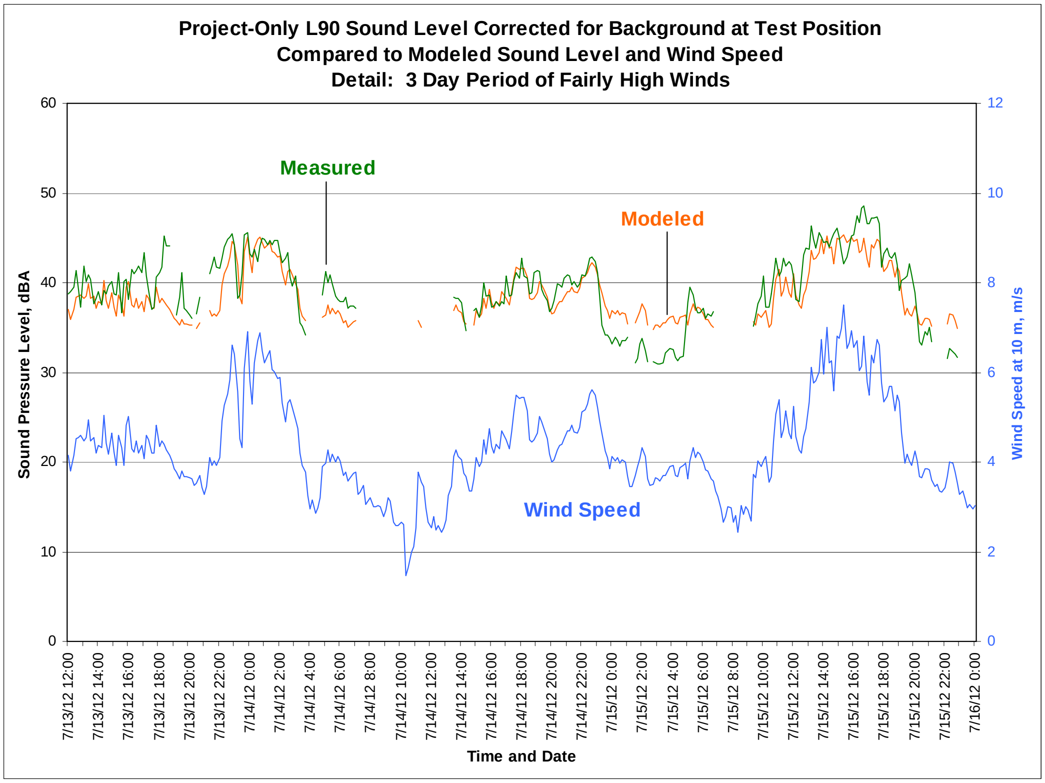

Figure 3 *Typical Measured Project Level Compared to Model Predictions*

The input turbine sound power levels are based on the IEC 61400-11 test results

Mr. James complains (Document B, p. 3) that the input sound power levels used in our noise model come from tests performed in accordance with IEC 61400-11 *Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques*, Second Edition 2002-12. The assertion is that "optimum weather conditions" are exploited to minimize turbine sound levels and that we did "not attempt to reproduce the conditions that lead to worst-case sound emissions".

We have conducted this difficult and meticulous test and I can assure you that at no time did the notion of waiting for optimum weather conditions enter my head. There is no conspiracy to minimize the sound levels measured during these tests, which are mostly performed by accredited and highly respected engineering firms in Germany, such as Kaiser-Wilhelm-Koog GmbH. In fact, the challenge is usually just being on hand to take measurements during the high wind conditions necessary to complete the test over the range of required wind speeds (6 to 10 m/s). The feared variance is presumably the scatter illustrated in Figure 2 above. As previously mentioned, there is no practical method of calculating excursions from the average sound level or mathematically reproducing them so the test results cannot be somehow adjusted to "worst-case sound emissions" – nor do they need to be. The modeled sound level in Figure 3 is based directly on IEC 61400-11 test results with the only variable being wind speed. Half the time the model overestimates the actual sound level and half the time a higher level exists.

The project will lead to sleep disturbance according to WHO guidelines

Numerous references are made in the letters (such as Document B, p. 3) to the World Health Organizations guidelines relating sound levels to sleep disturbance. In general, the threshold for "safe sleep" is stated as an outdoor sound level of 30 dBA, whereas the actual recommended night noise level is 40 dBA ($L_{night, outside}$), with 55 dBA as an "interim target". The 2009 *Night Noise Guidelines for Europe* conclude for outdoor sound levels ranging from 30 to 40 dBA: "A number of effects on sleep are observed from this range … However, even in the worst cases the effects seem modest. $L_{night, outside}$ of 40 dB is equivalent to the lowest observed adverse effect level (LOAEL) for night noise." The expected mean sound level from the Allegany project at all surrounding residences is generally below 40 dBA and, in the vast majority of cases, substantially below 40 dBA. We do not suggest that all possibility for sleep disturbance can be ruled out, but the likelihood of any significant or widespread issues seems remote based on the WHO guidelines.

Low frequency noise is not sufficiently addressed and project noise "will result in adverse health effects"

The persistent belief that tremendously high levels of infrasonic and low frequency noise from the turbines will cause all sorts of adverse outcomes, such as vestibular and cardio-vascular problems, is, of course, brought up in all three documents and we are criticized for not giving the issue the attention it so richly deserves. The simple fact of the matter is that the actual levels of low frequency noise from wind turbines are insignificant and well below the levels commonly experienced by everyone every day.

In Document A (p. 5) there is an odd line of reasoning that basically says that I ignored the recommendations of George Hessler, "who understands the role low frequency sounds can play in community complaints", when evaluating low frequency noise with respect to the Allegany project. Mr. James cites a 2004 *Noise Control Engineering Journal* article by George Hessler giving some recommended C-weighted design levels for industrial sources.

First of all, this article was not written with wind turbines in mind. A much more recent paper by George Hessler specifically discussing the subject of low frequency noise from wind turbines is attached[5], which shows that the low frequency sound level experienced everyday when driving a car is dramatically higher than the low frequency sound levels measured at 45 different wind turbine sites. Vestibular and cardio-vascular health issues associated with low frequency noise exposure resulting from driving are, of course, unknown. The paper concludes: "We are of the firm opinion that LFN is not a valid issue to be continuously debated for each and every wind turbine project."

Secondly, with respect to C-weighted noise limits, there is no practical way of measuring C-weighted sound levels under windy conditions due to wind-induced microphone distortion. C-weighted sound limits are perfectly appropriate for gas turbine installations where the measurements can be taken under totally calm wind conditions but, from a practical standpoint, this metric cannot be applied to wind turbines because any measurement of operational wind turbines must be taken, by definition, during moderately windy conditions. The wind tunnel testing of windscreen performance alluded to earlier (Note 2) found that elevated levels of false signal noise will be observed in the low end of the frequency spectrum even at low wind speeds no matter what type of windscreen is used. What this means is that any casual sound level measurement in an exposed field in the presence of even a light breeze will record

[5] Hessler, G., *A Note on the Debate on Health Effects from Low Frequency Noise (LFN) from Modern Wind Turbines*, Currently being prepared as a technical paper for presentation at Wind Turbine Noise 2011 (April 2011, Rome).

apparently high levels of low frequency noise – whether a wind turbine is present or not. This measurement error, which is not widely recognized, is probably one of the principal reasons wind turbines are mistakenly believed to produce high levels of low frequency noise. A-weighted sound levels are almost unaffected by this low frequency distortion but C-weighted levels are completely dominated and skewed by this phenomenon.

The example measurements of low frequency wind turbine noise are expressed as A-weighted spectra "playing tricks with the data"

The accusation that the example measurements of wind turbine sound spectra presented in Section 3.6 of our report are deliberately manipulated to downplay low frequency noise is absurd. The point of both charts, Figure 3.6.1 showing Sondergaard's results and Figure 3.6.2 showing some comparable measurements we made, is that the turbine-off sound levels in the low end of the spectrum are identical to the turbine-on levels demonstrating that the level of low frequency sound from the turbines is obviously inconsequential. Just to further illustrate the point the data shown in Figure 3.6.2 (our measurements) are replotted below without A-weighting (A-weighting was only used in the first place to make our measurements directly comparable to the way Sondergaard presented his results). Note that the three turbine-off measurements are similar to the turbine-on measurements in the low frequency region of the spectrum below 50 Hz, showing that the turbine sound level in the low frequencies is comparable to or even less than the background sound level at a rural upstate New York State wind project site.

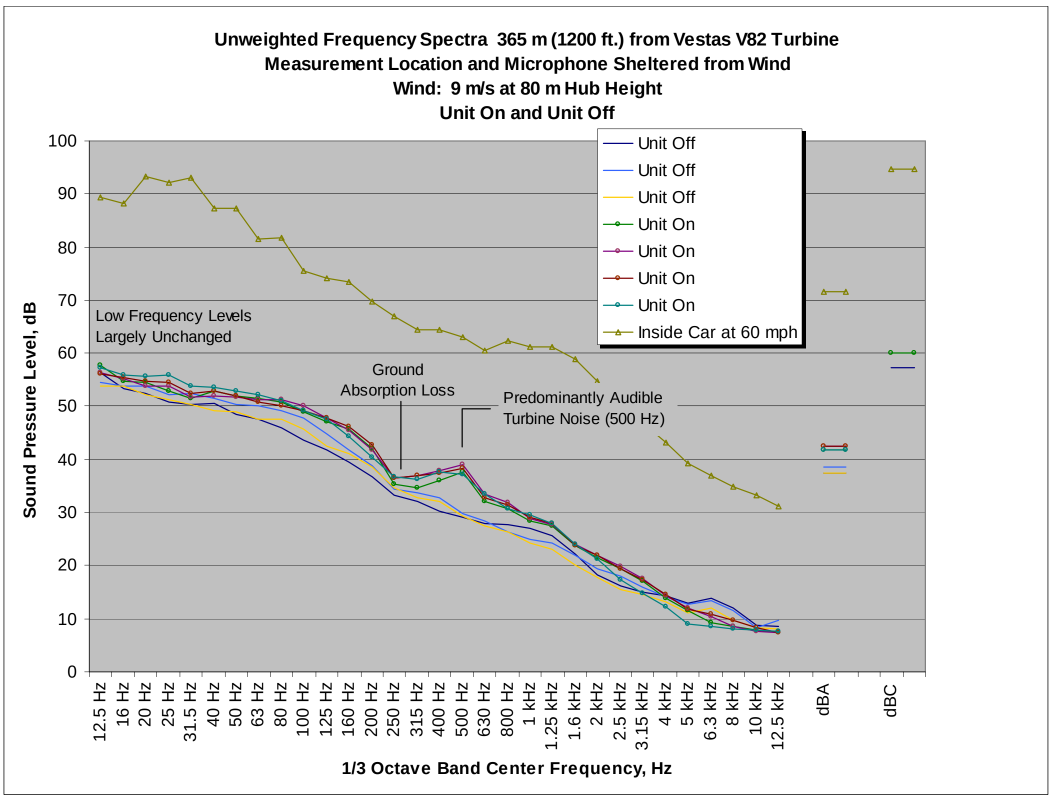

Figure 4

As a final note to give the measurements some context, Figure 4 also plots the sound level spectrum I recently measured in my SUV driving down the Pennsylvania Turnpike. The C-weighted sound level in particular, an indicator of the low frequency content of a sound is, is vastly higher in the truck (94 dBC) than measured 1200 ft. from a V82 wind turbine operating at full power (57 dBC or less).

I hope this sufficiently responds to the various concerns outlined in Mr. James' letters and reports; however, please let me if any further clarifications are needed.

Sincerely,

David M. Hessler, P.E., INCE
Principal Consultant
Hessler Associates, Inc.

Attachments: Letter from Paul Schomer to George Hessler, March 30, 2010

A Note on the Debate on Health Effects from Low Frequency Noise (LFN) from Modern Large Wind Turbines, George F. Hessler, Jr., P.E., Bd. Cert. INCE

SCHOMER AND ASSOCIATES, INC.
Consultants in Acoustics and Noise Control

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March 30, 2010

Mr. George Hessler
Hessler Associates, Inc.
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Haymarket, VA 20169

Dear George,

This letter is to set the record straight regarding our studies in the vicinity of Cape Vincent NY. Schomer and Associates, Inc. was called in to study the ambient noise in the Cape Vincent area, in part, because a draft EIS had been produced in 2007 that utilized your Summer measurements (your report dated November 2007)and a "rule-of-thumb" estimate for winter attributed to you (see for example tables on P. 121 of the DEIS). The DEIS said there would be a "winter" study by you that winter, and we now know that you completed this winter study and presented it to your client in March 2008. Unfortunate, the public was never informed of the receipt of your winter study or of its contents until shortly *after* the publication of our study late in 2008.

Had we had your winter study at the start of our study in May 2008, this would have significantly changed some of the focus and conclusions to our study. In particular, it is clear that your winter ambient levels are as quiet, or quieter than our quiet, late Spring levels, and that both your winter and our Spring data are significantly lower than your Summer measurements. Thus, we would not have needed to place such an emphasis on showing how the high Summer levels in the DEIS distorted the picture of the true, year-round ambient.

This letter does not mean we now agree with all of your methods and conclusions. In spite of these disagreements I continue to have high regard for Hessler and Associates and the many fine journal articles published by you.

Very sincerely,

Paul Schomer

Paul Schomer, Ph.D., P.E.
Member, Board Certified; Institute of Noise Control Engineering

A Note on the Debate on Health Effects from Low Frequency Noise (LFN) from Modern Large Wind Turbines

By

George F. Hessler Jr., P.E., Bd. Cert. INCE
Hessler Associates, Inc.

Introduction

There is an intense debate between proponents and opponents of wind projects on the question of health effects caused by LFN from modern wind turbines. Opponents using mainly early reports from obsolete-design downwind-turbine models declare LFN as an adverse health effect. Proponents point to the fact that there is no credible evidence showing LFN from wind turbines having any adverse health effects.

Hessler Associates has been a technical consultant on more than 50 wind projects with the primary duty of drafting Noise Assessment Analysis for project developers. We, and I might add most opponents of wind projects, are not qualified as experts on the subject of health effects. In our capacity, the LFN debate is addressed by referencing studies performed by qualified scientists in the field. However, while not health experts, we can apply engineering measurements, logic and common sense to form an opinion on the subject as described in this note.

LFN from Wind Turbines

Like countless other equipment sources, modern wind turbines do produce noise at low frequencies. Pedersen and Moller[1] report measurements down to four hertz in figure 4 of their presentation. This figure containing measurements from 45 turbines is reproduced below with a red smoothed curve added by the author to represent the latest available data on large modern wind turbines.

Note that tonal noise from the machinery nacelle is present in some measurements but this can be controlled by conventional noise abatement and is secondary to the aerodynamic noise caused by the rotating blades.

[1] Pedersen, C. S. & Moller, H., "An Analysis of low frequency noise from large wind turbines", Presented at the 14th International Meeting on Low Frequency Noise and Vibration and its Control, Aalborg, Denmark 9-11 June 2010

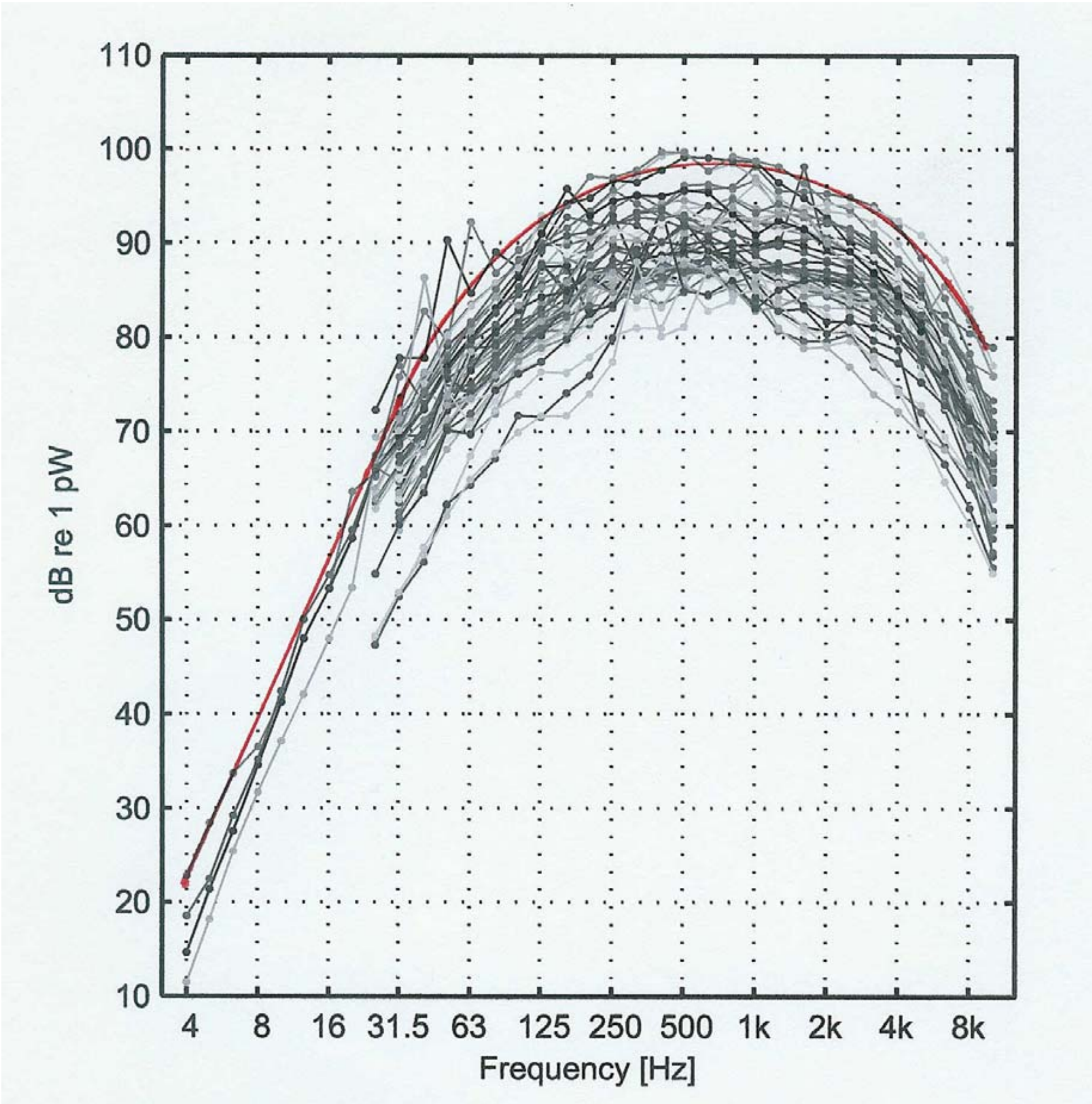

Figure 1: *A-weighted Measurements of 45 Wind Turbines from 75 kW to 3.6 MW. The Red Smoothed Line Represents the Sound Power of Modern Large Wind Turbines.*

Figure 2 below uses the developed sound power above to calculate the pressure level spectra at a typical wind project. The black symbol line is the red line in Figure 1 and the power is shown both A-weighted and un-weighted. The blue and red symbol lines are calculated by simply subtracting hemispherical divergence from the power without any excess attenuation for conservatism. The higher blue line would be 300 m from a single large turbine or 600 m from four turbines, typical set back distances.

In the infrasound frequency range below 20 Hz there is no significant building transmission loss so the pressure spectra would be this value inside or outside a residence. Above 20 Hz there are small transmission losses up to 100 Hz and larger above, but these have been neglected. It is recognized that interior room walls could also excite some resonance modes.

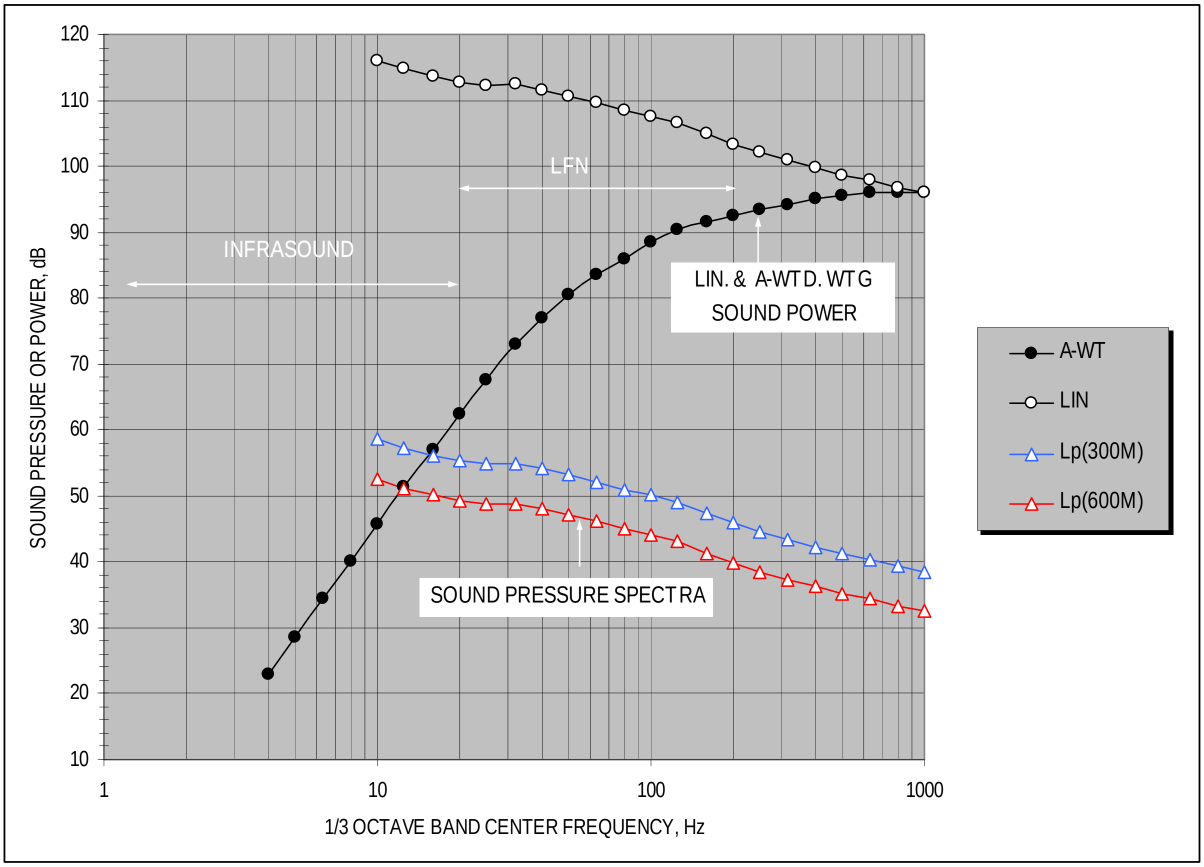

Figure 2: *Wind Turbine Sound Power and Typical Pressure Levels*

Infrasound and Low Frequency Levels

Infrasound can be easily created in a moving automobile by lowering a rear window at highway speed. In effect, one is inside a Helmholz resonator volume. A recent set of measurements is plotted below in Figure 3 and was created to evaluate a recently available LFN evaluation guide. Such LFN guides are developed by researchers at controlled exposure chambers with volunteer listeners.

The dBC-dBA quantity for the infrasound spectra was 45 dBA clearly well over the investigative trigger level of 20 dBA suggested by many authors as an indicator that excessive LFN may exist in the spectrum under investigation. What was interesting in this experiment was that the trigger level was 25 dB for the all windows closed operation, i.e. the normal level in a sedan at speed. Subjectively, I have never sensed interior auto highway levels as “low frequency”.

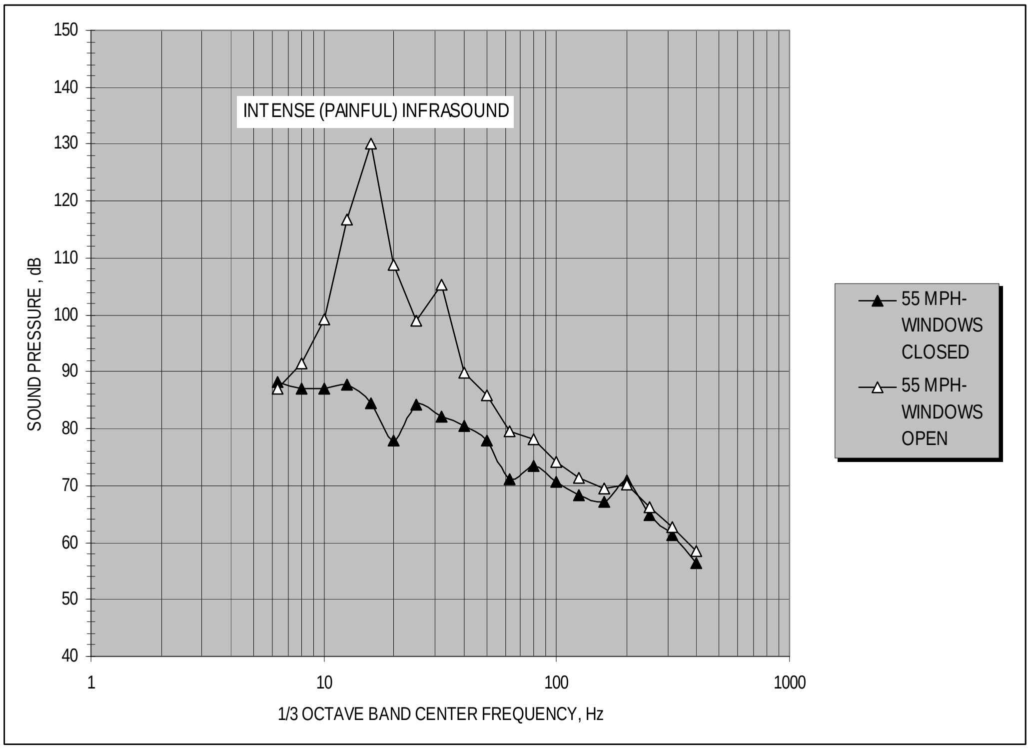

Figure 3: *Example of Infrasound Created by Opening a Rear Window in a Luxury Automobile at Highway Speed*

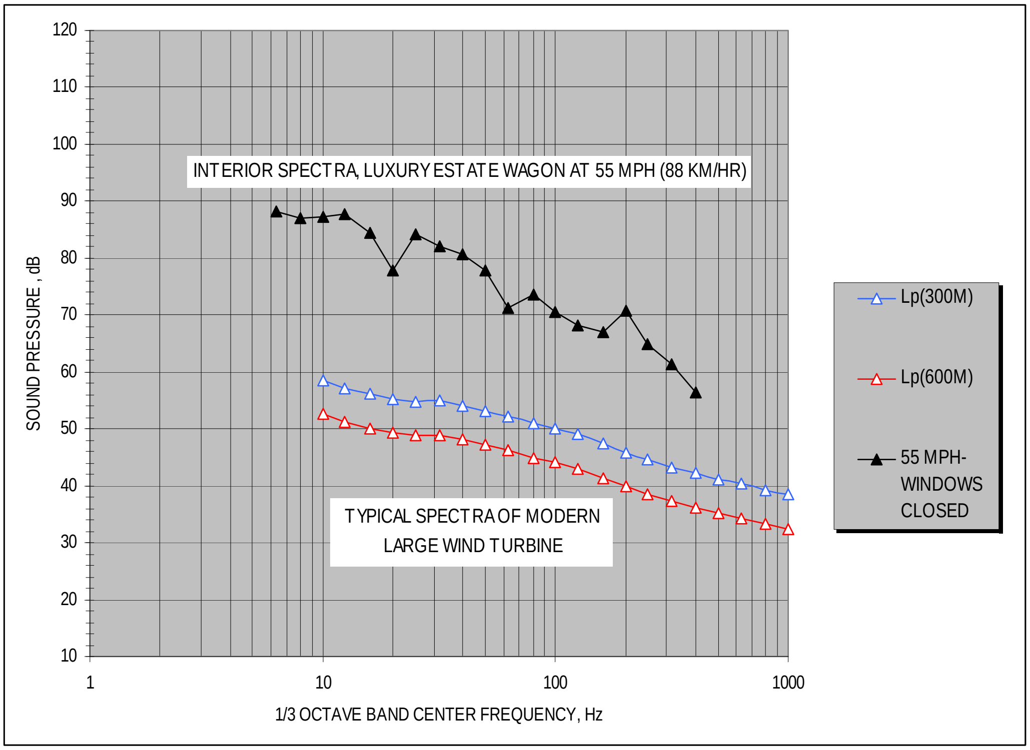

Figure 4: *Comparison of Frequency Spectra between a Luxury Automobile at Highway Speed and Typical Modern Large Wind Turbines*

Conclusions

Data from the infrasound investigation above and the estimated LFN from large modern wind turbines are compared in Figure 4 above. It is obvious from this graphic that LFN from wind turbines are very very low in magnitude and about 25 dB below the spectra in a luxury automobile at highway speed.

We can only conclude from this comparison that LFN from wind turbines is irrelevant to health effects. This conclusion is drawn from the fact that LFN health effects have never been suggested from the billions and billions of exposure hours by all age man, women and children to LFN noise spectra in automobiles. We are of the firm opinion that LFN is not a valid issue to be continuously debated for each and every wind turbine project.