THE STATE OF NEW HAMPSHIRE

BEFORE THE

SITE EVALUATION COMMITTEE

DOCKET NO. 2012-01

**APPLICATION OF ANTRIM WIND ENERGY, LLC
FOR A CERTIFICATE OF SITE AND FACILITY**

**PREFILED DIRECT TESTIMONY OF RICHARD R. JAMES
ON BEHALF OF INTERVENORS OPPOSED TO
ANTRIM WIND, LLC
July 30, 2012**

Q: Please state your name, position and business address.

A: My name is Richard R. James, I am the Principal Consultant for E-Coustic Solutions, Okemos, Michigan.

Q: What are your qualifications to speak to the application section on noise?
A: Please see the attached review document for my full qualifications and biography.

Q: What was your reaction to the information put forth in the turbine noise section of the Antrim Wind Energy, LLC application authored by Robert O'Neal of Epsilon Associates, Inc. of Maynard, MA?
A: Again, please refer to the attached review document.

Q: Do you have any further comments you would like to add?
A: I would like to reserve the right to supply supplemental comments later within the framework of the rules for this process.

Q: Does this conclude your testimony?
A: Yes.

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CRITIQUE OF EPSILON ASSOCIATES, INC., SOUND LEVEL ASSESSMENT REPORT, NOV. 17, 2011
PREPARED FOR THE: ANTRIM WIND ENERGY PROJECT, ANTRIM, NH
CRITIQUE BY: RICHARD R. JAMES INCE, E-COUSTIC SOLUTIONS, OKEMOS, MI
DATE: JULY 30, 2012

INTRODUCTION

This review was conducted on behalf of three intervenor groups in the Antrim Wind Energy, LLC application for Certificate of site and facility before the State of New Hampshire Site Evaluation Committee.[1] This Critique is part of their public comments on the proposed Antrim Wind Energy Project (referred to here as "AWEP" or the "Project) proposed by Antrim Wind Energy, LLC. Information regarding this project was taken from the Application and other documents available at: http://www.nhsec.nh.gov/2012-01/ and http://www.antrimwind.org/.

The focus of this review is on the sections of the application relating to noise and its impact on people and wildlife in the region of impact and from the testimony and papers of Mr. Robert O'Neal representing Epsilon Associates, Inc. of Maynard, MA working on behalf of AWEP. Additional materials from other cases involving their representation of a wind utility developer are also used as background for comments here-in.

QUALIFICATIONS

I am the Owner and Principal Consultant for E-Coustic Solutions, of Okemos, Michigan (P.O. Box 1129, Okemos MI 48805). I have been a practicing acoustical engineer for 40 years. I have been actively involved with the Institute of Noise Control Engineers (INCE) since I started my career in the early 1970s and have full Member status in the Institute. My clients include many large manufacturing firms, such as, General Motors, Ford, Goodyear Tire & Rubber, and others who have operations involving both community noise and worker noise exposure. In addition, I have worked for many small companies and private individuals. My academic credentials include appointments as Adjunct Professor and Instructor to the Speech and Communication Science Departments at Michigan State University and Central Michigan University. Specific to wind turbine noise, I have worked for clients in over 60 different communities. I have provided written and oral testimony in approximately 30 of those cases. I have authored or co-authored four papers covering topics from how to set criteria to protect public health, demonstrating that wind turbine sound immissions are predominantly comprised of infra and low frequency sound, and conducted a historical review of other types of noise sources with similar sound emission characteristics, such as noise induced Sick Building Syndrome, that have known adverse health effects on people exposed to their sound.

My work with local communities and citizens groups around the U.S. and Ontario, Canada has focused on the question of how to integrate industrial wind turbines into rural communities. Please see the attached biographic information for my background and experience in wind energy noise and health. In this review I would like to share my understanding of siting criteria for modern industrial scale wind turbines and the impact of the wind turbine noise on people and wildlife.

I have visited sites throughout the Midwest from western Iowa to the coast of Maine, and Ontario to West Virginia where wind turbines were either operating or proposed. I have also reviewed the noise criteria and setbacks proposed by States, Provinces and local government bodies for wind farms in

[1] Richard Block, 63 Loveren Mill Road, Antrim, NH on behalf of the North Branch Residents Intervenors Group; Janice Duley Longgood, 156 Salmon Brook Road, Antrim, NH of the Abutting Property Owners Intervenors Group; Katharine Elizabeth Sullivan, 156 Willard Pond Road, Antrim, NH on behalf of herself.

the far western US as well as New Zealand, Australia and the U.K.. This has given me broad exposure to a number of different situations each with their own requirements.

REVIEW

Based on this I find five (5) issues that have a particular importance for this review. I would like to focus on these points.

FIRST-SETBACK DISTANCE

Setbacks from property lines to the nearest turbine of less than 2 kilometers (1.25 miles) are clearly inadequate for extremely quiet rural communities. The presence of nearby highways will not mask or otherwise offset the noise from wind turbines.[2] This is especially true in rural communities where nighttime highway traffic is light. Wind turbine noise is distinctively annoying and is not addressed when criteria using dBA weighting and long averaging times are used.[3] [4] [5] The reports and documents submitted on behalf of the Project do not correctly or adequately describe the impact of the proposed project on the host community, or its residents whose homes and properties are close to the footprint of the project. Further, the Epsilon report does not apply the appropriate normalization factors to the community noise criteria promoted in the "Levels Document" by the US EPA. Epsilon chooses to offer criteria suitable only for urban communities with prior experience with night time noise instead of adjusting those criteria for rural communities with no prior experience with nighttime noise. Figure 1 shows the adjustments that need to be applied to the sound levels the EPA document recommends for urban/suburban communities with prior noise exposure to make them apply to rural communities with no prior experience with noise exposure. Epsilon's report applies none of these correction factors. As shown in the circles drawn on Figure 1 there are 15 dB of adjustments needed. This would make the recommended day/night sound levels for the rural community 40/30 dBA (L_{dn}) and 33.6 dBA (L_{eq}) not the 55/45 dBA (L_{dn}) and 48.6 dBA (L_{eq}) presented in the Epsilon report.

Table D-7
Corrections To Be Added To The Measured Day-Night Sound Level (L_{dn}) Of Intruding Noise To Obtain Normalized L_{dn}[d-3]

Type of Correction	Description	Amount of Correction to be Added to Measured L_{dn} in dB
Seasonal Correction	Summer (or year-round operation)	0
	Winter only (or windows always closed)	-5
Correction for Outdoor Noise Level Measured in Absence of Intruding Noise	Quiet suburban or rural community (remote from large cities and from industrial activity and trucking)	+10
	Normal suburban community (not located near industrial activity)	+5
	Urban residential community (not immediately adjacent to heavily traveled roads and industrial areas)	0
	Noisy urban residential community (near relatively busy roads or industrial areas)	-5
	Very noisy urban residential community	-10
Correction for Previous Exposure & Community Attitudes	No prior experience with the intruding noise	+5
	Community has had some previous exposure to intruding noise but little effort is being made to control the noise. This correction may also be applied in a situation where the community has not been exposed to the noise previously, but the people are aware that bona fide efforts are being made to control the noise.	0
	Community has had considerable previous exposure to the intruding noise and the noise maker's relations with the community are good	-5
	Community aware that operation causing noise is very necessary and it will not continue indefinitely. This correction can be applied for an operation of limited duration and under emergency circumstances.	-10

Figure 1-Table D-7 from EPA Levels Document (1974)

Epsilon also provides references to the World Health Organization's 1999 Community Noise Guidelines without also providing the cautions in that document for communities exposed to low frequency sounds. Further, they ignore the 2009 World Health Organization's Night Time Noise Guidelines which find the threshold of adverse health effects to start when nighttime noise outside a home is 40 dBA ($L_{eq\ night\text{-}outside}$) or greater .

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[2] Pedersen, E., van den Berg, F., Why is Wind Turbine Noise poorly masked by road traffic noise?, Inter-noise 2010, Lisbon, Portugal June 13-16, 2010 (invited paper)

[3] Thorne, R, "The Problems with "Noise Numbers" for Wind Farm Noise Assessment," Bulletin of Science, Technology and Society, Pg 262-290, August 2011

[4] Bray, W. James, R., " Dynamic measurements of wind turbine acoustic signals, employing sound quality engineering methods considering the time and frequency sensitivities of human perception," Noise-Con 2011, Portland Oregon. (Invited paper)

[5] It should be noted that all papers published in the Bulletin of Science, Technology and Society are peer reviewed as part of Sage Publications standard policy.

Although errors in the Epsilon sound propagation computer model are covered below, it is worth noting that similar bias in the report is observed in Epsilon's predicted operational sound levels presented in the tables and contour maps of sound levels. The Epsilon models represent the predicted sound level from wind turbines operating under weather conditions of a neutral atmosphere and low wind shear. These conditions are specified in the IEC test standards that Epsilon describes but, what is not disclosed is that they result in the lowest noise emissions from the wind turbines, not the "worst-case" sound levels that are claimed in the report. Using the results of the model which represents operation with a neutral atmosphere and low wind shear, Epsilon concludes that a separation distance of 2600 feet is acceptable. Nothing could be further from the truth. Evidence of wide spread complaints of sleep disturbance and other adverse health effects from the many projects in the U.S., Canada, and other countries where wind turbines were similarly located is not discussed[6]. These complaints are often associated with nighttime operation during a stable atmosphere with high wind shears above the temperature inversion boundary. This is a common weather condition in the temperate zone that has been shown to be present between 30 and 60% of all warm season nights[7,8].

The wind industry and its supporters respond to these complaints as being sporadic and motivated by reasons not associated with adverse health effects. Yet, in Norfolk County, Ontario, where turbines are located 500 meters or more away from homes it was reported that of 140 homes in the vicinity of the wind turbines over 40 have been abandoned[9]. CBC news reported after a review of documents obtained under the Freedom of Information Act, that in another community with 133 wind turbines there have been over 200 formal complaints lodged with the Ontario Ministry of Environment since the project started operation[10]. In the U.K., the BBC reports on a recent court case awarded damages to a family that lived 3000 feet from the nearest wind turbine[11]. In spite of claims that it is not necessary to require a separation distance of over one mile, the experiences of communities with similar wind turbine projects show otherwise. People living at distances of a mile or more from wind turbines on flat land <u>are</u> experiencing adverse health effects from sleep disturbance at night from audible turbine noise. People living on the slopes of ridges or in the valley below the ridges where utility scale wind turbines are operating report problems at distances of 2 miles or more.

It must be understood that these complaints have two distinct aspects. A large number of the people who file complaints are concerned with the audible sounds from turbines they hear on their property and inside their homes, especially during evening and nighttime periods when they are trying to relax or sleep. A subset of these people have complaints about other aspects of wind turbine sound emissions that are not audible, but instead interfere with their sense of balance or cause sensations like stuffiness in the ears, headaches, and general malaise. These symptoms are not a result of the audible sounds being processed by the auditory functions of the cochlea but are instead from infra and low frequency sound mediated by the cochlea's vestibular organs. These organs are stimulated at sound pressure levels far below the level required for the sounds to be heard. The characteristic noise from industrial scale wind turbines that is related to this second class of complaints is currently believed to be a result of in-flow turbulence of the air stream entering the path of the blades. The turbulence results in dynamically modulated infra and low frequency sound emitted in short duration bursts (under 100 msec) of acoustic energy with peak sound pressure levels 30 to 40 dB higher than the sound pressure in the valleys between them. Even though these may not be reach the

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[6] Phillips, C. V. "Properly Interpreting the Epidemiologic Evidence About the Health Effects of Industrial Wind Turbines on Near-by Residents" Bulletin of Science, Technology, and Society, 2011 31:303

[7] Van den Berg, G.P., "Effects of the wind profile at night on wind turbine sound" Journal of Sound and Vibration, 2003

[8] Schneider, C. P. " Measuring background noise with an attended, mobile survey during nights with stable atmospheric conditions," Proceedings of the 2009 InterNoise Conference, Ottawa, Canada, August 23-26, 2009

9 Pearce, D. "Noise Complaints to be Investigated," Simcoe Reformer, July 15, 2010

[10] Seglins, D., and Nicol, J. "Ontario wind farm risks downplayed: documents," CBC news, Sept. 22, 2011 at 5:23 AM

[11] BBC News, "Lincolnshire wind farm noise case settled" November 30, 2011

threshold of audibility, recent research by Dr. Alec Salt and others has demonstrated that they can cause disturbances to our organs of balance (vestibular organs in the cochlea).[12] [13]

SECOND-BACKGROUND SOUND LEVEL

Background sound levels submitted on behalf of the Project's developers and/or operators are described as ambient sounds which include the effects of short term events including engine and tire noise from vehicles on roads and sounds of nature like insects, birds, and leaf rustle. Measurements of background sounds use a statistical method to establish the L_{90} (the sound level representing the quietest 10% of the time such that transients are excluded). While it may appear reasonable to consider these transient sounds in evaluating the impact of the AWEP, these sounds are not properly included when evaluating pre-operational background sound levels. The critical background sound levels are those that are present during the quietest time that the new noise emitter will be operating. For wind turbines, this is the quiet time of night when surface winds are calm, vehicles are not present in any significant number, and other man-made and natural sounds that create transients are at an absolute minimum. The appropriate L_{90} levels are those for the quiet time of night, not the noisier times of the day and should be carefully screened to exclude sounds from insects, frogs, birds and other sounds that are seasonal.

The purpose for determining the background sound level is to set a floor against which the new sounds are judged. When there is a difference between the pre-operational L_{90} for the quiet times at night and the sounds that would be expected from wind turbine operations of 10 dB or more it should be expected that the community will consider the new noise as "objectionable." Greater differences create higher levels of objection. Comparison of the before and after conditions during other noisier times of the day/night or when including transient sounds are not useful in assessing community response. The Epsilon report includes these other noises in its background noise assessment and puts the emphasis on these noisier times without disclosing that such comparisons are not appropriate for quiet rural communities that are considering a wind project that will operate 24/7/365.

Wind turbines often operate at full noise emissions during nighttime weather that has no surface winds to produce leaf rustle because upper level wind where the blades are located can be disconnected from the lower surface levels winds. It is not true that wind turbines only operate when the wind is blowing if one is considering surface level winds. Rural community nighttime background sound levels are routinely in the range of 20 to 25 dBA L_{90} for properties not near roads with significant night time traffic. Those near such roads may have L_{90} levels of 25 to 28 dBA. It is these values that are shown in the graphs of background sound in the Epsilon report for nighttime conditions, but the report does not discuss the need to use these low noise times to set the pre-operational background sound levels choosing instead to focus on higher noise conditions during the day and from transient and seasonal noise sources.

The problem is compounded by the choice of measurement locations. The selected measurement locations are too close to traffic routes or other local noise sources such that they do not reflect the quiet nature of the rural wilderness community. The Epsilon report notes traffic noise as being significant at all five (5) test sites. One of the test sites also notes that water noise is significant. These are indications of test site selection that is not intended to show the quiet nature of the community but instead bias the background readings upwards to make the new noise source appear to be more compatible than it really would be if the measurements were taken at locations away from the roads and other sources like the water noise. The measurements used to collect this information

[12] Salt A, Kaltenbach J, "Infrasound from Wind Turbines Could Affect Humans," Bulletin of Science, Technology and Society, Pg 296-302, August 2011

[13] Krogh C, Gillis L, Kouwen N, Aramini J, " WindVOiCe, a Self-Reporting Survey: Adverse Health Effects, Industrial Wind Turbines, and the Need for Vigilance Monitoring," Bulletin of Science, Technology and Society, Pg 334-345, August 2011

do not meet any recognized national or international standard[14]. Had the background studies met the procedural and protocol requirements of the American National Standards Institute's (ANSI) S12.9 and S12.18 standards for measuring the residual background outdoor sounds the study would have reported much lower background sound levels. The end result is an upward biased assessment of background sound levels. The Epsilon report overstates the characteristic soundscape of the community as experienced by the local population and wildlife by as much as 10 to 15 dBA. Use of this data to evaluate the potential for negative impacts of the people living near the project leads to a conclusion that the wind turbine noise will not be a source of noise pollution at the homes and properties near the project[15]. Had background noise been properly measured the conclusion would be that the Project will have a significant, continuing impact on the adjacent communities and wilderness areas.

The Epsilon report uses these measurements as the basis for the entire community which implies that sounds at other areas distant from the traffic routes will have similar high sound levels. Nothing could be further from the truth. Background sound levels (L_{90}) at measurement locations away from roads and local noise sources in communities of this type are routinely in the mid 30 dBA L_{eq} range during daytime and, at night after traffic and man-made activities begin to drop off, the levels drop to the low 20 dBA Leq range. Had the proper background readings been collected the increase in sound level caused by the wind turbines would be 10 to 20 dBA near residential properties. An increase of this amount will result in the new sounds being considered highly objectionable and likely a source of sleep disturbance. In a wilderness area the sounds will increase by 20 to 30 dBA near or within the footprint of the proposed turbines. This will have a deleterious impact on wildlife because it will reduce the listening area for mating calls and for predator avoidance.[16]

THIRD - COMPUTER MODEL

Computer model estimates of operational sound levels from the proposed projects understate the impact of the turbines on the community by a wide margin and provide no margin for errors in the calculations. The computer model estimates do not include confidence limits as is appropriate for any scientific or engineering study (conservatively this would add 3.6 dB to all predicted values and contour lines) nor does the model reflect operation of the turbines during nighttime during periods of stable atmospheric conditions when in-flow turbulence and/or high wind shear increase the noise emissions by 6 to 10 dBA above the values reported in the Epsilon model. [17] As stated earlier in the discussion on background sound level, these weather conditions are common during warm season nights.

Had the modeling properly addressed the increased sound power emitted by wind turbines from atmospheric conditions, topography with ridge mounted wind turbines, and small inter-turbine spacing, the dBA sound levels predicted for the sensitive receiving locations would have been much higher. These conditions include those of:

- nighttime atmosphere with a stable boundary layer (temperature inversion) and high wind shear above that boundary layer (e. g. high wind shear),
- periods of atmospheric turbulence, as is likely for turbines mounted on high locations with rough terrain, and

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[14] ANSI-ASA S12.9 Part 2, (R2008) Measurement Of Long-Term, Wide-Area Sound,
ANSI-ASA S12.9 Part 3 (1993 R 2008) Short Term Measurements with Observer Present,
ANSI-ASA_S12.9_Part_1_(R_2003) Quantities and Procedures for Description and Measurement of Env. Sound, and
ANSI-ASA_S12.18-1994_(R2009) Procedures for Outdoor Measurement of SPL.

[15] Noise pollution: the emission of sound that unreasonably interferes with the enjoyment of life or with any lawful business or activity.

[16] Barber, J.; Crooks, K.; Fristrup, K.; "The costs of chronic noise exposure for terrestrial organisms" Elsevier, Sept. 2009, pgs 180-189

[17] Van den Berg, G.P., "Effects of the wind profile at night on wind turbine sound" Journal of Sound and Vibration, 2003

- inter-turbine wake-induced turbulence created when turbines are located with inter-turbine spacing of less than 5 to 7 rotor diameters (new information indicates this may need to be more like 10 to 15 rotor diameters)[18] to prevent inter-turbine wake turbulence. Turbines in the current layout appear to be as close as 3 rotor diameters (116 meter diameter times 3 is 348 meters or 1142 feet).

IEC61400 WIND TURBINE GENERATOR SYSTEMS STANDARDS INCLUDING PART 11 ACOUSTIC NOISE MEASUREMENT TECHNIQUES

The purpose of this standard is to provide a uniform methodology that will ensure consistency and accuracy in the measurement and analysis of acoustical emissions by wind turbine generator systems. The standard was prepared to standardize the tests used by wind turbine manufacturers in rating their products. It is does not purport to report the "worst case" sound emissions as implied in the Epsilon study. It is designed to provide test results that meet well-defined acoustical emission performance requirements under a standard weather condition and operational modes for the purpose of allowing a purchaser to compare one make and model to another. This is similar in concept to the standardized tests used to rate automobile city and highway gasoline mileage. If the conditions for operation differ from the test conditions the results will also be different.

This standard is used to determine the sound power level emitted by wind turbines under conditions defined as "normal" operation. Normal operation is specified as weather conditions that are not severe and represent operation with low and definable wind shear. Such conditions are normally defined as a "neutral" atmosphere where the windshear will generally be in the range of 0.15 or less and in general under 0.20. This weather condition is commonly observed during daytime of warm seasons and in particular can be described as a warm sunny afternoon in the temperate zone. Under low wind shear conditions the wind speed does not increase significantly between the height where the blade is lowest in this rotation and the top where it is at its highest peak. This allows the anemometer located on the turbine's hub to calculate the optimum angle of attack of the blades and RPM of the hub for maximum efficiency in extracting energy. Because inefficiency in extracting energy results in increased noise, heat, turbulence, and additional stresses on the blades the lowest noise immission condition for wind turbine occurs is when it is most efficiently extracting energy from the wind.

ISO 9613-2: ACOUSTICS-ATTENUATION OF SOUND DURING PROPAGATION OUTDOORS, PART 2: GENERAL METHOD OF CALCULATION:

This standard specifies engineering methods for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of noise sources. The method is applicable, in practice, to a great variety of noise sources environments. It is applicable to most situations concerning road or rail traffic, industrial noise sources, construction activities, and many other ground based noise sources. It does not apply to sound from aircraft in flight, or to blast waves from mining, military, or similar operations. It is validated only for noise sources that are located close to the ground (approximately 30 m difference between the source and receiver height). It is also limited to noise sources that are within 1000 m of the receiving location. Meteorological conditions are limited to wind speeds of approximately 1 m/s and 5 m/s when measured at a height of 3 m to 11 m above the ground. When all constraints, including these, are met by the situation being modeled the procedure is accurate within a +/- 3 dB range. However, use of the model for ridge mounted wind turbines does not meet a number of the ISO standard's assumptions, so tolerances will be greater than the referenced +/- 3 dB.

REAL WORLD CONDITIONS NOT CONSIDERED IN ISO AND IEC STANDARDS

In a paper by William Palmer, P.ENG., the effect of varying wind shears on wind turbine noise is explored[19]. Figure 3 shows an example of the optimal weather conditions for a windshear of 0.14

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[18] Calaf, M.; Meneveau. C.; Meyers. J.; "Large eddy simulation study of fully developed wind-turbine array boundary layers," Journal of the American Institute of Physics, 015110-1 to 015110-16, January 25, 2010

[19] Palmer, W. P,Eng, "A new explanation for Wind Turbine Whoosh, Wind Shear," Third International Meeting on Wind Turbine Noise, Aalborg, Denmark, June 2009.

with no stability layer (temperature inversion boundary). The IEC test uses this weather condition to measure the sound power levels emitted by the turbines. The Epsilon report used that data for its model. The problematic situation is when there is high-level windshear, such as 0.44, without a stable boundary layer. Because there will be a significant difference in the wind speed at the bottom and at the top of the blades rotation path the windshear of 0.44 will be more difficult for the turbine to find the optimum operating mode then for the 0.14 windshear. The low wind shear condition follows a logarithmic relationship described as the Power Law which permits the estimation of a wind speed at some arbitrary height such as the hub from the wind speed at a lower height such as a 10 m meteorological tower. The higher wind shear conditions are much more complex and depend on the height of the stable boundary layer. They also do not follow the simple Power Law or other simple formulas often presented by the acoustical consultants in explanations of how they developed their model.

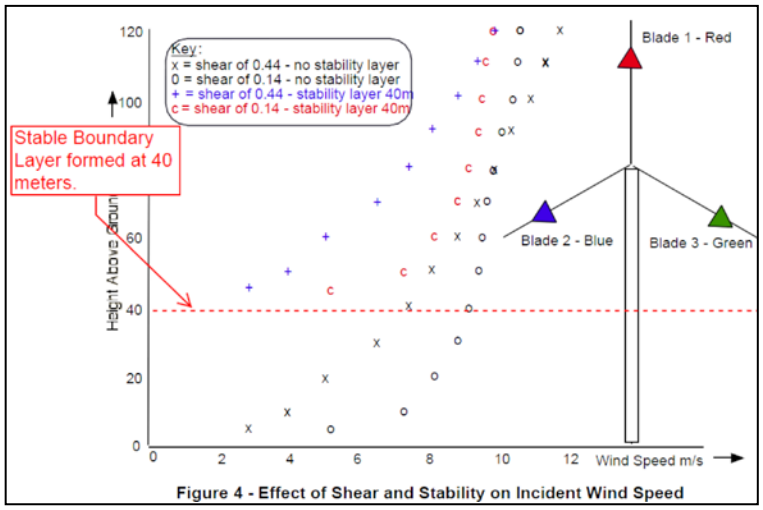

Figure 2- Example of wind shear in neutral and stable atmospheres

At night, after the sun's heating of the ground stops, the ground cools. The convection currents present in the daytime that cause the warmed air next the ground to rise upwards to mix gradually with the upper level winds in a smooth gradient also stop. A cool layer of air forms at the ground and extends upwards to the boundary layer which will form at altitudes often between 20 m to 100 m or more above the ground. This boundary layer causes a complete disconnect between the wind speeds below it and above it. Below the boundary layer winds are often calm or even still. There is insufficient wind to cause leaf rustle or other sounds associated with surface level winds. Figure 4 which is extracted from Mr. Palmer's paper shows the stable boundary at 40 m by stopping the "+" and "c" markers for windshear at that height. These are the two curves on the left side of the figure. It is important to understand, that when a stable boundary layer forms the winds above the boundary layer are often moving at a very high rate and that rate increases rapidly with height. It is not uncommon to see wind shear coefficients of 0.7 or higher when these conditions form.

To compound the situation, the stable boundary layer can be at elevations of 100 meters or more. If the stable boundary layer forms at an elevation higher than the bottom of the blades rotation path the blade will descend into it. Under these conditions the turbine blades which are under wind load above the stable boundary layer lose that load when they enter the still air below the boundary layer. This is a situation that the turbine operating system, which depends upon one hub level anemometer, cannot detect nor can it adjust the blades to account for this change. It is this condition that Mr. Palmer believes produces the maximum sound power from the turbine blades and is responsible for the deeper more penetrating blade "thumps" that are the source of complaints during nighttime. Other researchers like Dr. Swinbanks think that there is also some interaction between the blades and the wind being slowed slightly in front of the tower that can produce these deep thumps. Measurements of turbines operating under this condition have shown blade whoosh (amplitude modulation) of 8 to 15 dBA above the normal sound levels. For the situation of high wind shear without the stable boundary layer blade whoosh (amplitude modulation) normally ranges from 5 to 8 dBA.

Van den Berg's early work supports these more recent reports. This phenomenon was studied for over a year by Dr. Fritz van den Berg for his graduate thesis titled: "The Sounds of High Winds." In

"The Sounds of High Winds" Dr. van den Berg presents a method for determining the increased sound power emitted by wind turbines for various mismatches between the optimum angles of attack for the blades and what occurs when the blades are not at the optimum angle due to high wind shear. He shows that increases of 10 dB can be expected for angle mismatches of 9° or more. Even slight mismatches of 4 to 7° can increase sound power by 3 to 8 dBA.

SUITABILITY OF MODEL CALCULATIONS

Although the acoustical consultants who work for the wind turbine project developers use ISO based models world-wide; the ISO algorithms have not been validated by any independent peer-reviewed process for use in siting wind turbines. General-purpose industrial, rail, and traffic noise models are developed using commercial software packages such as Cadna/A™ and SoundPLAN™ 7.0 which are based upon this ISO standard. The practice of using these commercial packages was promoted by the British Wind Energy Association (BWEA) and trade associations in other countries in a set of guidelines known as ETSU-R-97. The wind industry has promoted use of these guidelines in countries around the world. This practice was not followed by many of the countries in the European Union because of their concern about the limitations of the method and its use for predicting wind turbine sound propagation. For example, there are alternate models that have been developed specifically for wind turbines in the Nordic countries. These models, have been validated by peer-reviewed independent studies and used in those countries.

If the model was developed to address the concerns noted above, such that it represented commonly occurring "worst case" conditions, this project would predict sound levels at the closest homes of 50 dBA or greater. When compared to the background sound levels at night of 20-25 dBA the wind turbines will increase pre-existing community sounds by 25 to 30 dBA. There is no rational basis for claiming that this increase will not be highly objectionable to people living near the turbines. The project as it is now presented will be a source of complaints and threats of lawsuits as have other similar projects which had similar "rosy scenario" predictions in the application's sound study.

FOURTH-HEALTH RISKS

My experience with industrial wind projects is that wind turbine utilities that appear to meet local requirements in the permitting stage often produce sound levels at the properties and homes of people adjacent or within the Project that lead to complaints once operation commences. Many of these exceed the 40 dBA $L_{(night\text{-}outside)}$ limit set by the World Health Organization (WHO 2009) for safe and healthful sleep. Exceedances of the WHO recommended levels will result in a high level of community complaints of both noise pollution, sleep disturbance, and nuisance. In addition, there is mounting evidence that for the more sensitive members of the community, especially children under six, people with pre-existing medical conditions, particularly those with diseases of the vestibular system and other organs of balance and proprioception, and seniors with existing sleep problems will be likely to experience serious health risks.

INFRA AND LOW FREQUENCY SOUNDS AND THEIR IMPACT ON PEOPLE

The Epsilon report focuses only on audible sound and relies on A-weighted sound levels for decision making. It summarily dismisses infra-sound and low frequency sound by stating that wind turbine sound does have such characteristics. In spite of these assertions, other independent acousticians and medical professionals have repeatedly reported field tests showing that wind turbine sounds are heavily weighted to the infra and low frequency end of the acoustic spectrum. The level of annoyance produced by wind turbine noise also increases substantially for low frequency sound, once it exceeds a person's threshold of perception. A recent paper by Dr. Henrik Moller shows that as the wind turbines get larger (e.g. longer blades and higher towers) the sound emissions shift downward in the spectrum producing a lower dBA rating while the over-all acoustic energy in the

lower frequencies increases dramatically.[20] There is no reason to assume that the proposed new turbine for the Project will not have a similar characteristic.

Because infra and low frequency sounds from wind turbines also include significant dynamic modulation in the frequency range from the blade passage frequency of from 1 Hz or less, up to about 10 Hz, standard acoustical instruments such as 1/3 octave band analyzers and FFT analyzers using band filtering cannot be used to measure the short duration pulsations. This is covered in detail in the Bray/James paper referenced earlier. Instrumentation with 1/3 octave band resolution of the spectrum sound pressure levels can only be used for assessing steady state infrasound (sounds lasting many seconds or minutes), and even then, the readings may understate the total acoustic energy and the maximum sound pressure levels if care is not taken to address any amplitude pulsations or changes in frequency[21].

Infrasound is often incorrectly presumed to be in-audible until sound pressure levels reach amplitudes of 90 to 100 dB or more in the frequencies from 10 Hz and lower. However, when considering the most sensitive people, the thresholds drop approximately 6-12 dB. Further, the Thresholds of Perception referenced in the Epsilon report and its technical papers are for a <u>single, steady, pure tone under laboratory conditions</u>. Wind turbine sounds are a complex mix of tones, all within the same critical band. It is possible that for many people they will be audible at levels much lower than what is required for a single, steady, pure tone.

The combination of people with extra sensitivity and the presence of a complex set of tones in the range from 0 to 20 Hz puts the infrasound sound pressure level peaks measured on receiving properties and inside homes within the threshold of perception for a subset of the population. Claims that wind turbine infra sound is "not significant" because it does not reach the amplitudes needed to exceed the Thresholds of Perception are mischaracterizing the situation. The truth is we only know the Thresholds of Perception for single steady pure tones. When the sounds are more complex, as for wind turbines with their multiple combinations of tones and tone fragments with varying types of amplitude and frequency modulation, we do not know the Threshold of Perception. All we know is that it will be lower than for a single steady pure tone.

VESTIBULAR VS. AUDITORY PERCEPTION

There are more ways a sound can be perceived than just as audible sound. Perception mediated by the vestibular organs does not involve 'hearing' the sound. (see Salt, Pierpont and others) For audible sounds in the infra and low frequency range the annoyance and the sense of loudness increases more rapidly than the more readily audible mid-frequency sounds. Sound measured as dBA is biased toward 1,000 Hz, the center of the most audible frequency range of sound pressure. Low frequency sound is in the range below 200 Hz and is more appropriately measured as dBC for low frequency sound or in dBG for infrasound. As a result use of dBA criteria misses an important aspect of wind turbine noise and is not appropriate as a criteria for noise sources that have low frequency content.

For many years it has been presumed that only infra and low frequency sounds that reached the threshold of audibility for people posed any health risks. Many acoustical engineers were taught that <u>if you cannot hear a sound, it cannot harm you</u>. Recent research has shown that the human body and auditory system is more sensitive to infra and low frequency noise (ILFN) than previously believed. This perception is not one that is 'heard' but rather it is one that involves the organs of balance (vestibular systems) and is often "felt." The vestibular portion of our auditory system can

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[20] Moller, H., Pedersen, C., "Low frequency noise from large wind turbines," Journal of the Acoustical Society of America, 129 (6), June 2011.

[21] A paper co-written by this reviewer and Wade Bray of Head Acoustics which presented the findings of an analysis of wind turbine low and infrasonic sound that shows these micro-time pulsations are present at levels that exceed the threshold of audibility for steady pure tones and also by the vestibular process identified by Salt et. al.. These papers were referenced earlier in this review.

respond to levels of infra and low frequency sound at pressures significantly lower (as much as 30-40 dB) than what is needed to reach the thresholds of audibility.[22]

Dr. Nina Pierpont has conducted a study of the effects of infra and low frequency sound on the organs of balance that establishes the causal link between wind turbine ILFN and medical pathologies. This research is discounted by the wind industry as not meeting standards for epidemiology and that it is not 'peer-reviewed.' Neither accusation is correct. The type of epidemiological study conducted by Dr. Pierpont is termed a case-crossover study. Dr. Carl Philips, a highly respected epidemiologist not associated with the wind industry has said: [23]

> *"In particular, my scientific analysis is based on the following points, which are expanded upon below:*
>
> *"1. Health effects from the turbine noise are biologically plausible based on what is known of the physics and from other exposures.*
>
> *"2. There is substantial evidence that suggests that some people exposed to wind turbines are suffering psychological distress and related harm from their exposure. These outcomes warrant the label "health effects" or "disease" by most accepted definitions, though arguments about this are merely a matter of semantics and cannot change the degree of harm suffered.*
>
> *"3. The various attempts to dismiss the evidence that supports point 2 appears to be based on a combination of misunderstanding of epidemiologic science and semantic games. "*
>
> *Also,*
>
> *"There is ample scientific evidence to conclude that wind turbines cause serious health problems for some people living nearby." And,*
>
> *"The reports that claim that there is no evidence of health effects are based on a very simplistic understanding of epidemiology and self-serving definitions of what does not count as evidence. Though those reports probably seem convincing prima facie, they do not represent proper scientific reasoning, and in some cases the conclusions of those reports do not even match their own analysis."*

Dr. Pierpont's study and report was peer-reviewed by some of the top experts in the U.S. and Britain who have experience with vestibular disturbances and adverse health conditions. These reviews were included in the published final report. Any criticisms leveled at Dr. Pierpont's work by supporters of wind power utilities are not supported by the facts.

There is new research to support Dr. Pierpont's study. It is not from the traditional fields that have provided guidance for acoustical engineers and others when assessing compatibility of new noise sources and existing communities. Instead it comes from the field of research into auditory and vestibular function. A recent peer reviewed paper by NIDCD/NIH researcher Dr. Alec Salt, reported that the cochlea responds to infrasound at levels 40 dB below the threshold of audibility.[24] These studies show how the body responds to extremely low levels of energy not as an auditory response, but instead as a vestibular response.

In a personal communication, this reviewer asked Dr. Salt the question: "Does infrasound from wind turbines affect the inner ear?" Dr. Salt responded:

> "There is controversy whether prolonged exposure to the sounds generated by wind turbines adversely affects human health. The un-weighted spectrum of wind turbine noise slowly rises with decreasing frequency, with greatest output in the 1-2 Hz range. As human hearing is insensitive to infrasound (needing over 120 dB SPL to detect 2 Hz) it is claimed that infrasound generated by wind turbines is below threshold and therefore cannot affect people. The inner hair cells (IHC) of the cochlea, through which hearing is mediated, are velocity-sensitive and insensitive to low frequency sounds. The outer hair cells (OHC), in contrast, are displacement-sensitive and respond to infrasonic frequencies at levels up to 40 dB below those that are heard."

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[22] Salt et. al.

[23] Philips, Carl v., " An Analysis of the Epidemiology and Related Evidence on the Health Effects of Wind Turbines on Local Residents," for Public Service Commission of Wisconsin docket no. 1-AC-231, Wind Siting Rules, July 2010.

[24] Salt, Alec, "Responses of the ear to low frequency sounds, infrasound and wind turbines", Hearing Research, 2010. This work was supported by research grant RO1 DC01368 from NIDCD/NIH

> "A review found the G-weighted noise levels generated by wind turbines with upwind rotors to be approximately 70 dBG. This is substantially below the threshold for hearing infrasound which is 95 dB G but is above the calculated level for OHC stimulation of 60 dB G. This suggests that most wind turbines will be producing an unheard stimulation of OHC. Whether this is conveyed to the brain by type II afferent fibers or influences other aspects of sound perception is not known. Listeners find the so-called amplitude modulation of higher frequency sounds (described as blade "swish" or "thump") highly annoying. This could represent either a modulation of audible sounds (as detected by a sound level meter) or a biological modulation caused by variation of OHC gain as operating point is biased by the infrasound. Cochlear responses to infrasound also depend on audible input, with audible tones suppressing cochlear microphonic responses to infrasound in animals. These findings demonstrate that the response of the inner ear to infrasound is complex and needs to be understood in more detail before it can be concluded that the ear cannot be affected by wind turbine noise."

During the summer of 2009, this reviewer conducted a study of homes in Ontario where people had reported adverse health effects that they associated with the operation of wind turbines in their communities[25]. The study involved collecting sound level data at the homes and properties of these people, many of who had abandoned their homes due to their problems. This study found that sound levels in the 1/3 octave bands below 20 Hz were often above 60 dB and in many cases above 70 dB. Since the shape of the spectrum for wind turbine sound emissions is greatest at the blade passage frequency which was below the threshold for the instruments used it can be assumed that the sound pressure levels in the range of 0 to 10 Hz exceeded 70 dBA. Given the statement by Dr. Salt that vestibular responses would start at levels of 60 dBG or higher this data supports the hypothesis that there reason to consider the potential for a link between the dynamically modulated infra sound produced by wind turbines and reported adverse health effects. Since the time of that study at least five (5) homes have been purchased by the utility operators because of health effects on the owners and many others have been abandoned as stated earlier in this review because the owners did not have the economic resources to hire an attorney to fight for a buy-out.

Adverse health effects related to inaudible low frequency and infra sound have been encountered before. Acoustical engineers in the Heating, Cooling and Air Conditioning (ASHRAE) field have suspected since the 1980's and confirmed in the late 1990's that dynamically modulated, but inaudible, low frequency sound from poor HVAC designs or installations can cause a host of symptoms in workers in large open offices[26]. The ASHRAE handbook devotes considerable attention to the design of systems to avoid these problems and has developed methods to rate building interiors (RC Mark II) to assess them for these low frequency problems[27].

Unlike the A-weighted component, the low-frequency component of wind turbine noise "*can penetrate the home's walls and roof with very little low frequency noise reduction*.[28]" Further, as discussed in the 1990 NASA study the inside of homes receiving this energy can resonate and cause an increase of the low frequency energy over and above what was outside the home. This makes the infra and low frequency sound immissions from wind turbines more likely to be an indoor problem than an outdoor problem where the audible sounds, such as blade swish and other wind turbine noises in the mid to high frequency range will dominate the soundscape.

Today, there is a renewed interest in the effects of low frequency sound from wind turbines. A paper titled: "*Infrasound, The Hidden Annoyance of Industrial Wind Turbines*," by Prof. Claude Renard of the Naval College and Military School of the Fleet (France) concludes:

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[25] James, R. R., "Comments Related to EBR-010-6708 and -010-6516" Comment ID 123842, 2009

[26] Persson Waye, Kirsten, Rylander, R., Benton, S., Leventhall, H. G., Effects of Performance and Work Quality Due to Low Frequency Ventilation Noise, Journal of Sound and Vibration, (1997) 2005(4), 467-474.

[27] The study also showed that NC curves are not able to predict rumble. This use of NC curves was disproved in the 1997 Persson Waye, Leventhall study. Use of the RC Mark II procedures is more appropriate for this use.

[28] Kamperman and James (2008), p. 3.

> *"The information given above is enough to understand that it is better not to be exposed to infrasound which propagates far from its point of origin and against which it is impossible to protect oneself due to the long wavelengths.*
>
> *"Those most affected by exposure to infrasound are rural inhabitants living in proximity to wind turbines, and those working in air-conditioned offices.*
>
> *"The people in the former category are exposed to the infrasound 24 hours a day, whereas people in the latter category are only exposed to infrasound 6 hours a day.*
>
> *"The most important issue is therefore to know what intensity of infrasound can be tolerated without inconvenience over these periods of time.*
>
> *"We do not have the answer to this question."*

For some unknown portion of the community, there will be a risk of the adverse health effects currently described as Wind Turbine Syndrome mediated through the body's organs of balance (vestibular) and proprioception. This is a different set of symptoms and causes than what would be expected of higher levels of infra and low frequency sound and are not related to the audibility of the ILFN. Papers, of which Epsilon staff were co-authors, on infra and low frequency sound only consider adverse health effects to occur when the sound pressure level of the noise source exceeds the Threshold of Perception of audibility of steady pure tones. Given the discussion above it should be clear that the human auditory system is more likely to perceive a sound that has multiple tones that vary in frequency and amplitude over short periods of time, as does wind turbine noise, than a steady pure tone.

The combination of the above negative factors in the reports prepared as submittals regarding the Project's wind turbine noise emissions/pollution will result in sleep disturbance for a significant fraction of those who live a mile or more away. Chronic sleep disturbance results in serious health effects. Further, some people will be at risk of the adverse health effects collectively described as Wind Turbine Syndrome as a result of the infra and low frequency sounds emitted by multi-megawatt wind turbines.

FIFTH-IMPACT ON WILDLIFE

In the early 1990's the US DOD conducted a series of studies to identify the impact of high noise levels on the soldier's ability to avoid detection and to communicate as a team. The results of these studies showed that high noise levels, as are found inside military vehicles like tanks, greatly reduce the ability of the soldiers to identify and eliminate the enemy. They also result in a higher kill rate of our troops. This is not an difficult argument to understand. If the sound levels are high enough to limit team communication then mistakes are made and that slows response time. If the soldier is trying to avoid the enemy at a perimeter guard post, then the higher the sound level from machines on the post, the shorter the distance is for the soldier listening for enemy activity to hear the sound of an approaching enemy. The results of the studies was that hearing health and noise became field readiness issues that were at the top of the lists for correcting. A soldier today is equipped with devices to improve the listening area and noise inside military vehicle cabins is being reduced.

There is an equivalent issue with wildlife. Reference 16, "The costs of chronic noise exposure for terrestrial organisms" presents the problems increased noise in the habitat makes for wildlife. While the focus of most permitting panels is on the effects of noise on the human population it must be understood that there will be a wider effect throughout the foot print of the project and extending into the wilderness areas of the ridge and adjacent undeveloped areas. This effect will extend out to distances of 2 km or more from the boundary of the Project but will be most severe along the top of the ridge where sound levels from turbines may be as high as 60 dBA or more. The listening radius for wildlife that use sound for mating calls and predator avoidance shrinks by half for every 6 dB increase in the background sound level. For wildlife that are close to turbines this may have a dramatic effect on reproduction rates and kills. Decreasing the listening radius so dramatically may potentially make some of the wildlife an "endangered species" for this region.

CONCLUSION

Information provided by Epsilon on behalf of the Project developer on topic of health risks, presence and significance of infra and low frequency noise, noise limits and setbacks, background sounds in rural communities and computer modeling studies are incorrect, incomplete, inadequate, and/or otherwise misleading. Any implied or stated assertions that there is no research supporting concerns that wind turbine sound emissions at receiving properties and homes can result in adverse health effects do not reflect current understanding of independent medical and acoustical research. [29] [30]

My experience with industrial wind projects is that wind turbine utilities that appear to meet local requirements in the application and permitting phase often produce sound levels at the properties and homes of people adjacent or within the Project that lead to complaints of adverse health effects once operation commences. Many of these complaints will be from people living in homes where under common weather conditions the nighttime sound levels will exceed the 40 dBA $L_{(night\text{-}outside)}$ limit set by the World Health Organization (WHO 2009) for safe and healthful sleep. Exceedances of the WHO recommended levels will result in a high level of community complaints of both noise pollution, sleep disturbance, health effects, and nuisance. There is mounting evidence that for the more sensitive members of the community, especially children under six, people with pre-existing medical conditions, particularly those with diseases of the vestibular system and other organs of balance and proprioception, and seniors with existing sleep problems will be likely to experience serious health risks.

The soundscape in non-residential areas used for outdoor recreation will no longer be the natural sounds of nature but instead the industrial sounds of wind turbines. The belief that the noise from the roads and leaf rustle will somehow 'mask' the wind turbine sounds is not supported by current research.

These concerns are not hypothetical. There are many similar large scale wind turbine projects operating in the U.S. and around the world. Many of these projects resulted in complaints from people living near or inside the project's footprint of night time sleep disturbance and symptoms that are described for Wind Turbine Syndrome. These projects were granted permits based on the same process of assessing background sound levels and computer modeling that were used for this Project. Given the analysis above it is reasonable to conclude that this project will join the ranks of wind utilities that cause adverse health conditions and noise pollution if it is approved.

This project should be rejected based on the concerns raised in this report. As currently proposed the Project is not compatible with the Antrim community and current land use.

END OF REVIEW

Richard R. James, INCE
For E-Coustic Solutions

July 30, 2012

[29] Krogh C, Gillis L, Kouwen N, Aramini J, " WindVOiCe, a Self-Reporting Survey: Adverse Health Effects, Industrial Wind Turbines, and the Need for Vigilance Monitoring," Bulletin of Science, Technology and Society, Pg 334-345, August 2011

[30] Krogh, C.; Horner, B.; "A Summary of new evidence: Adverse health effects and industrial wind turbines," Society for Wind Vigilance, www.windvigilance.com, August 2011."

Biographical References

Others Submitted Separately

BIOGRAPHICAL SKETCH

NAME	POSITION TITLE	BIRTHDATE
Richard R. James	Principal Consultant, E-Coustic Solutions	3/3/48
	Adjunct Instructor, Michigan State University Adjunct Professor, Central Michigan University	

EDUCATION

INSTITUTION	DEGREE	YEAR	FIELD OF STUDY
General Motors Institute, Flint, MI	B. Mech. Eng.	1971	Noise Control Engineering

RESEARCH AND PROFESSIONAL EXPERIENCE:

Richard R. James has been actively involved in the field of noise control since 1969, participating in and supervising research and engineering projects related to control of occupational and community noise in industry. In addition to his technical responsibilities as principal consultant, he has developed noise control engineering and management programs for the automotive, tire manufacturing, and appliance industries. Has performed extensive acoustical testing and development work in a variety of complex environmental noise problems utilizing both classical and computer simulation techniques. In 1975 he co-directed (with Robert R. Anderson) the development of SOUND™, an interactive acoustical modeling computer software package based on the methods that would be later codified in ISO 9613-2 for pre and post-build noise control design and engineering studies of in-plant and community noise. The software was used on projects with General Motors, Ford Motor Company, The Goodyear Tire & Rubber Co., and a number of other companies for noise control engineering decision making during pre-build design of new facilities and complaint resolution at existing facilities. The SOUND™ computer model was used by Mr. James in numerous community noise projects involving new and existing manufacturing facilities to address questions of land-use compatibility and the effect of noise controls on industrial facility noise emissions. He is also the developer of ONE*dB(tm) software. He was also a co-developer (along with James H. Pyne, Staff Engineer GM AES) of the Organization Structured Sampling method and the Job Function Sound Exposure Profiling Procedure which in combination form the basis for a comprehensive employee risk assessment and sound exposure monitoring process suitable for use by employers affected by OSHA and other governmental standards for occupational sound exposure. Principal in charge of JAA's partnership with UAW, NIOSH, Ford, and Hawkwa on the HearSaf 2000tm software development CRADA partnership for world-class hearing loss prevention tools.

1966-1970 Co-operative student: General Motors Institute and Chevrolet Flint Metal Fabricating Plant.

1970-1971 GMI thesis titled: "Sound Power Level Analysis, Procedure and Applications". This thesis presented a method for modeling the effects of noise controls in a stamping plant. This method was the basis for SOUND™.

1970-1972 Noise Control Engineer-Chevrolet Flint Metal Fabricating Plant. Responsible for developing and implementing a Noise Control and Hearing Conservation Program for the Flint Metal Fabricating Plant. Member of the GM Flint Noise Control Committee which drafted the first standards for community noise, GM's Uniform Sound Survey Procedure, "Buy Quiet" purchasing specification, and guidelines for implement-ing a Hearing Conservation Program.

1972-1983 Principal Consultant, Total Environmental Systems, Inc.; Lansing, MI. Together with Robert R. Anderson formed a consulting firm specializing in community and industrial noise control.

1973-1974 Consultant to the American Metal Stamping Association and member firms for in-plant and community noise.

1973 Published: "Computer Analysis and Graphic Display of Sound Pressure Level Data For Large Scale Industrial Noise Studies", Proceedings of Noise-Con '73, Washington D.C.. This was the first paper on use of sound level contour 'maps' to represent sound levels from computer predictions and noise studies.

Nov. 1973 Published: "Isograms Show Sound Level Distribution In Industrial Noise Studies", Sound&Vibration Magazine

1975 Published: "Computer Assisted Acoustical Engineering Techniques", Noise-Expo 1975, Atlanta, GA which advanced the use of computer models and other computer-based tools for acoustical engineers.

1976 Expert Witness for GMC at OSHA Hearings in Washington D.C. regarding changes to the "feasible control" and cost-benefit elements of the OSHA Noise Standard. Feasibility of controls and cost-benefit were studied for the GMC, Fisher Body Stamping Plant, Kalamazoo MI.

1977-1980 Principal Consultant to GMC for the use of SOUND(tm) computer simulation techniques for analysis of design, layout, and acoustical treatment options for interior and exterior noise from a new generation of assembly plants. This study started with the GMAD Oklahoma City Assembly Plant. Results of the study were used to refine noise control design options for the Shreveport, Lake Orion, Bowling Green plants and many others.

1979-1983	Conducted an audit and follow-up for all Goodyear Tire & Rubber Company's European and U.K. facilities for community and in-plant noise.
1981-1985	Section Coordinator/Speaker, Michigan Department Of Public Health, "Health in the WorkPlace" Conference.
1981	Published: "A Practical Method For Cost-Benefit Analysis of Power Press Noise Control Options", Noise-Expo 1981, Chicago, Illinois
1981	Principal Investigator: Phase III of Organization Resources Counselors (ORC), Washington D.C., Power Press Task Force Study of Mechanical Press Working Operations. Resulted in publishing: "User's Guide for Noise Emission Event Analysis and Control", August 1981
1981-1991	Consultant to General Motors Corporation and Central Foundry Division, Danville Illinois in community noise citation initiated by Illinois EPA for cupola noise emissions. Resulted in a petition to the IEPA to change state-wide community noise standards to account for community response to noise by determining compliance using a one hour L_{eq} instead of a single not-to-exceed limit.
1983	Published: "Noise Emission Event Analysis-An Overview", Noise-Con 1983, Cambridge, MA
1983-2006	Principal Consultant, James, Anderson & Associates, Inc.; Lansing, MI. (JAA), Together with Robert R. Anderson formed a consulting firm specializing in Hearing Conservation, Noise Control Engineering, and Program Management.
1983-2006	Retained by GM Advanced Engineering Staff to assist in the design and management of GM's on-going community noise and in-plant noise programs.
1984-1985	Co-developed the 1985 GM Uniform Plant Sound Survey Procedure and Guidelines with James H. Pyne, Staff Engineer, GM AES.
1985-Present	**Adjunct Instructor, Michigan State University, Department of Communicative Sciences and Disorders**
1986-1987	Principal Consultant to Chrysler Motors Corporation, Plant Engineering and Environmental Planning Staff. Conducted Noise Control Engineering Audits of all manufacturing and research facilities to identify feasible engineering controls and development of a formal Noise Control Program.
1988-2006	Co-Instructor, General Motors Corporation Sound Survey Procedure (Course 0369)
1990	Developed One*dB(tm), JAA's Occupational Noise Exposure Database manager to support Organizational structured sampling strategy and Job Function Profile (work-task) approach for sound exposure assessment.
1990-1991	Co-developed the 1991 GM Uniform Plant Sound Survey Procedure and Guidelines with James H. Pyne, Staff Engineer, GM AES. Customized One*dB(tm) software to support GM's program.
1990-2006	Principal Consultant to Ford Motor Company to investigate and design documentation and computer data management systems for Hearing Conservation and Noise Control Engineering Programs. This included bi-annual audits of all facilities.
1993-2006	GM and Ford retain James and JAA as First-Tier Partners for all non-product related noise control services.
1993	Invited paper: "An Organization Structured Sound Exposure Risk Assessment Sampling Strategy" at the 1993 AIHCE
1993	Invited paper: "An Organization Structured Sound Exposure Risk Assessment Database" at the Conference on Occupational Exposure Databases, McLean, VA sponsored by ACGIH
1994-2001	Instructor for AIHA Professional Development Course, "Occupational Noise Exposure Assessment"
1996	Task Based Survey Procedure (used in One*dB(tm)) codified as part of ANSI S12.19 Occ. Noise Measurement
1995-2001	Coordinate JAA's role in HearSaf 2000tm CRADA with NIOSH, UAW,Ford, and HAWKWA
1997-Present	Board Member, Applied Physics Advisory Board, Kettering Institute, Flint Michigan
2002-2006	Member American National Standards Accredited Standards (ANSI) Committee S12, Noise
2005-Present	Consultant to local communities and citizens groups on proper siting of Industrial Wind Turbines. This includes presentations to local governmental bodies, assistance in writing noise standards, and formal testimony at zoning board hearings and litigation.
2006	Founded E-Coustic Solutions
2008	Paper on "Simple guidelines for siting wind turbines to prevent health risks" for INCE Noise-Con 2008, co-authored with George Kamperman, Kamperman Associates.
2008	Expanded manuscript supporting Noise-Con 2008 paper titled: "The "How To" Guide To Siting Wind Turbines To Prevent Health Risks From Sound"

2009 "Guidelines for Selecting Wind Turbine Sites," Kamperman and James, Published in the September 2009 issue of Sound and Vibration.

2010 Punch, J., James, R., Pabst, D., "Wind Turbine Noise, What Audiologists should know," Audiology Today, July-August 2010

2011 Jerry L. Punch, Jill L. Elfenbein, and Richard R. James , "Targeting Hearing Health Messages for Users of Personal Listening Devices," Am J Audiol 0: 1059-0889_2011_10-0039v1

2011 Bray, W., HEAD Acoustics, James, R., "Dynamic measurements of wind turbine acoustic signals, employing sound quality engineering methods considering the time and frequency sensitivities of human perception," invited paper for Noise-Con 2011, Portland OR

2012 James, R., "Wind Turbine Infra and Low Frequency Sound: Warning Signs that were not Heard," Pending publication 2012 by the Bulletin of Science, Technology and Society a publication of Sage Publications.

2012 Appointed to a three year position as Adjunct Professor in the Department of Communication Disorders at Central Michigan University.

Professional Affiliations/Memberships/Appointments

Research Fellow - Metrosonics, Inc.		American Industrial Hygiene Association (through 2006)
National Hearing Conservation Association (through 2006)		Institute of Noise Control Engineers (Full Member)
American National Standards Insititute (ANSI) S12 Working Group (through 2006)		Founder and Board Member of the Society for Wind Vigilance, Inc.
Adjunct Professor, CMU 2012-2015		Adjunct Instructor, MSU 2011-2014 (since 1985)

E-Coustic Solutions

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June 28, 2012

Summary of Court and Administrative Agency Cases for Richard R. James

Jurisdiction	Date	Case No.	Topic
Huron County, MI Zoning Board	04-04-2007	N/A	Oral testimony at Hearing on Permit Application before ZB by Noble Env. for Michigan Wind I on why 50 dBA criteria will result in complaints and litigation
Calumet County Board of Supervisors, WI	10-30-2007	N/A	Oral Testimony to County Board of Commissioners on requirements for sound criteria in a License and its Appendices related to Wind Energy Systems.
Logan County, IL, ZB/PC	05-01-2008	N/A	Oral Testimony on Wind Turbine Siting, Illinois Noise Regulations, and rebuttal of reports prepared on behalf of the Rail Splitter Wind LLC
Tazewell County, IL, ZB/PC	05-14-2008	N/A	Oral Testimony on Wind Turbine Siting, Illinois Noise Regulations, and rebuttal of reports prepared on behalf of the Rail Splitter Wind LLC
Laurel Mtn, WV (PSC)	08-05-2008	08-0109-E-CSCN	Oral Testimony on Wind Turbine Siting, background sound levels, and rebuttal of reports prepared on behalf of AES Laurel Mountain, LLC
Wellington, NZ (Hearing)	09-05-2008	N/A	Provide written and oral testimony at hearing to rebut reports prepared on behalf of Meridian Energy Ltd for Mill Creek Wind Utility
Beech Ridge, WV (PSC)	10-16-2008	05-1590-E-CS	Oral Testimony on Wind Turbine Siting, background sound levels, and rebuttal of reports prepared on behalf of Beech Ridge Energy, LLC
Record Hill Wind, ME (DEP)	02-18-2009 08-17-2009	#L-24441-24-A-N/L-24441-TF-B-N	Written Testimony on Wind Turbine siting and rebuttal of reports prepared on behalf of Record Hill wind, LLC
DeKalb County, IL	05-11-2009	Public Hearing	Oral Testimony on Wind Turbine Siting, background sound levels, and rebuttal of reports prepared on behalf of Florida Power and Light
Ontario, CA	07-24-2009	MOE EBR – 010 – 6708 and EBR-10-6516	Comments on behalf of APPEC (Association to Protect Prince Edward County), Proposed Ministry of the Environment Regulations to Implement the Green Energy and Green Economy Act, 2009
Buckeye Wind, Champaign-Urbana, Ohio	Oct.-Dec. 2009	OPSB Case No: 08-666-EL-BGN	Hearing on Application for Permit by Buckeye Wind before OPSB.
Glacier Hills, WI.	Sept.-Nov. 2009	WPSC Case 6630-CE-302	Hearing on Application for Permit by WEPCO for Glacier Hills project before Wisconsin PSC.
Record Hill Wind, Roxbury Pond, Me	March 2010	L-24441-24-A-Z L-24441-TF-B-Z	Hearing on Appeal before Maine DEP Board
Georgia Mountain Wind, VT	March 2010	PSB Docket No. 7508	Hearing before Public Services Commission
Goodhue, MN	July 21, 22, 2010	MPUC Docket No. IP/6701/CN-09-1186 and IP-6701/WS-08-1233	Hearing before PUC ALJ on application for Certificate of Need and Large Wind Energy System Site Permit for 78 MW Goodhue Wind Project
Madison, WI for CWESt	October 10, 2010	Clearinghouse Rule 10-057,	Senate Committee on Commerce, Utilities, Energy, and Rail Public Hearing onp Siting Wind Energy Systems
Georgia and Milton, VT	Nov. 2010	Hearing before Public Services Commission, Docket No. 7508	Hearing before PUC on application for permit to build wind turbine utility on Georgia Mountain
Saddleback Ridge Wind, Carthage, ME for Friends of Maine's Mountains	Nov. 2010	Hearing on Application	Application approval process before Maine's Dept. of Env. Prot. for ridge mounted turbines.

Chatham Ontario, Kent Breeze Wind	February 2011	Hearing before Ontario Environmental Board of Review	Hearing on whether project complies with Ontario regulations to protect health under the Green Energy Act.
Town of Albany, VT	February 2011	Hearing before Public Services Commission, Docket No. 7628	Hearing before PUC on application for permit by Green Mountain Power Corp. for Kingdom Mountain Wind, LLC.
State of Maine	July 7, 2011	Hearing before the Maine Board of Environmental Protection	Hearing before the BEP on a Petition for Rule Change for Maine's Chapter 375 Noise Regulations to add specific Rules for wind turbine noise.
State of Michigan Circuit Court of Leelanau county	Nov. 8-10, 2011	Case No: 11-8456	Complaint of Nuisance Noise and other effects of a 10KW Residential class wind turbine
Illinois, Bureau County, Federal: Friesland Farms, LLC, Pierson, Plaintiff, v. Big Sky Wind, LLC)	Dec. 30, 2011 (filed testimony) Feb. 1, 2012 Deposed	Case No. 10-01232	Complaint of noise annoyance and adverse health effects

List of Communities Where Other Services Were Performed

Wisconsin

1. Calumet County Board of Supervisors
2. Town of Calumet Supervisors
3. Town of Union, Wind Committee
4. Trempealeau County Wind Committee
5. Coalition for Wisconsin Environmental Stewardship (CWESt)
6. City of Green Bay, City Council

Illinois

7. Tazewell, County Zoning Board (Railsplitter)
8. Logan County Zoning Board (Railsplitter)
9. McLean County (White Oaks)
10. DeKalb County (Next Era)
11. Libertyville (Community Wind)
12. Bureau County Zoning Board

Iowa

13. Harris (Endeavor Wind)

California

14. East County (Tule Wind) (Citizens)

Minnesota

15. Goodhue County (Goodhue Wind)

Michigan

16. Bingham Twp., Ubly (Michigan Wind I)
17. Lake Township (Planning Commission)
18. Allegan County (citizens)
19. Clinton County (citizens)
20. Emmet County (Board and Planning Committee)
21. Sherman Twp, (Citizens)
22. Benzie County (Citizens)
23. Mason County (Citizens)
24. Reading Township (Planning Committee)
25. Riga Township (Citizens)
26. Michigan Public Service Commission (Public Hearing)
27. Merritt Township (Public Hearing before PC on FPL application)
28. Gilford Township (Public Hearing before PC)

Ohio

29. Champaign-Urbana (Citizens and Wind Committee)
30. Logan County (Citizens)

Washington

31. Skamania County (Public Hearing)

West Virginia

32. Laurel Mountain (Citizens)
33. Beech Ridge (Citizens)

Pennsylvania

34. Fayette County, (Citizens-South Chestnut Wind)
35. Schuylkill County (Citizens- Butler Wind Farm)
36. Juniata (Attorney for Citizens)

37. Folmont, (Citizens (SOAR))
38. Dunning, (Citizens (SOAR))

Vermont,

39. Georgia Mountain (Citizens)
40. Albany (Town of Albany)
41. Rutland (Public Presentation for Vermonters for Clean Environment)
42. DeerField (Appeal)

New Zealand

43. Mill Creek (Ohariu Preservation Society)

New York

44. Cohocton (Citizens)
45. Prattsburg (Citizens and Attorney)
46. Bliss, (Citizens and Attorney)
47. Town of Italy (Citizens and Attorney)
48. Machias, Yorkshire, Ashford (Cattaraugus County Citizens and Attorney)
49. Town of Allegany, Olean (Attorney)
50. Jordanville, (Otsego 2K)
51. Varysburg, (Citizens)
52. Orangeville, (Attorney)
53. Town of Malone (PSC Filings)

Maine

54. Roxbury Pond (Attorney and Citizens)
55. Mars Hill (Citizens)
56. Oakfield (Attorney)
57. Vinalhaven (Attorney)
58. Spruce Mountain (Attorney)
59. Saddleback Ridge (Attorney)

Ontario

60. Prince Edward County (Citizen and Attorney)
61. Amaranth-Shelburne (APPEC and Attorney)
62. Port Burwell and Clear Creek (APPEC and Attorney)
63. Ripley, (APPEC and Attorney)
64. Kent Breeze (Attorney)