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EVERGREEN WIND POWER II, LLC
OAKFIELD WIND PROJECT
AROOSTOOK COUNTY, MAINE

Response to Powers Trust Objection

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Resource
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Engineering

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STATE OF MAINE
CHARLES F. WALLACE, JR.
No. 4941
LICENSED
PROFESSIONAL ENGINEER

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LIST OF ACRONYMS

ANSI	American National Standards Institute
dB	Decibel (Unit of Sound Pressure Level)re 20 Micropascals*
dBA	Decibel A-weighted
DEP	Department of Environmental Protection
Hz	Hertz (cycles per second)
ISO	International Organization for Standardization
kVA	Kilovolt-Ampere
L_{A1}	Sound Level Exceeded 1% of a Measurement Period (dBA)
L_{A10}	Sound Level Exceeded 10% of a Measurement Period (dBA)
L_{A50}	Sound Level Exceeded 50% of a Measurement Period (dBA)
L_{A90}	Sound Level Exceeded 90% of a Measurement Period (dBA)
L_{Aeq}	Equivalent Sound Level (dBA)
$L_{Aeq\text{-}Hr}$	Hourly Equivalent Sound Level (dBA)
L_w	Sound Power Level
L_{wA}	A-weighted Sound Power Level
mph	Miles per hour
MRSA	Maine Revised Statutes Annotated
RSE	Resource Systems Engineering

* Sound Pressure Level is represented by the term Sound Level in this report.

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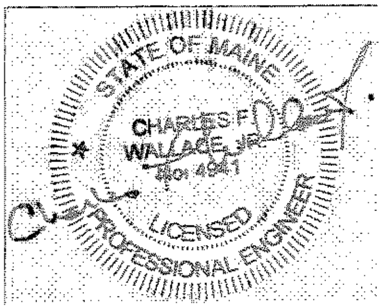

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Oakfield Wind Project: SOUND MODELING and REVIEW

Resource Systems Engineering (RSE) has extensive acoustic experience that includes modeling wind turbines and measuring operations of wind farms for compliance with regulations. Appendix 1 summarizes RSE's experience.

RSE developed a computer model to estimate sound levels from simultaneous operation of wind turbines at all 36 possible turbine locations for the Oakfield Wind Project. The acoustic model was developed using the CADNA/A software program to map area terrain in three dimensions, locate proposed wind turbines and calculate outdoor sound propagation from the wind turbines. RSE calculated sound levels for simultaneous operation of the 36 GE 1.5sle wind turbines at full sound power as defined by GE Energy. The wind turbines were evaluated as *point sources* using a sound power level of 109 dBA. This is 5 dBA higher than GE Energy's specification for this turbine model.

GE Energy's specification for this turbine type is 104 dBA, determined in accordance with IEC 61400-11, Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques, edition 2, 2002. The sound model used to evaluate sound level attenuation from the wind turbines to the receiver points was calculated in accordance with ISO 9613-2 "***Attenuation of sound during propagation outdoors***". ISO 9613-2 is an international standard commonly used for predicting sound levels from a noise source for moderate downwind condition in all directions.

To compensate for the uncertainty factor inherent in GE Energy's determination of sound power output, 2 dBA was added to the GE specifications. In addition, another 3 dBA was added to the specified wind turbine sound power levels to compensate for the estimated accuracy of the ISO 9613-2 calculation methods. Consequently, the overall adjustment to the rated sound power levels from GE specifications added 5 dBA, yielding a sound power level of 109 dBA for model calculations. This adjusted sound power level coincides with the highest end of the range of actual sound level measurements of similar operating wind turbines under a variety of weather and site conditions. This includes four rounds of operational testing at Mars Hill under various site and weather conditions and two rounds of testing at Stetson Wind in May and September 2009. Both Mars Hill and Stetson measurements were recorded during stable atmospheric conditions and when turbine sounds were most noticeable.

The ISO 9613-2 methodology utilized by the CADNA/A model has been recommended for use in modeling wind turbine noise by an independent working group of European acoustical scientists. See Bowdler et al., *Prediction and Assessment of Wind Turbine Noise*, Acoustics Bulletin, March /April 2009. The prediction model run for Oakfield used inputs that calculate attenuation due to distance, atmospheric absorption and intervening terrain. Conservative factors were applied for ground absorption assuming a mix of hard and soft ground. The surfaces of nearby lakes were specifically mapped and assigned no ground absorption as appropriate for a hard, reflective surface.

The RSE sound model and its results have undergone extensive scrutiny by the Town of Oakfield. The Town of Oakfield formed a special Wind Energy Committee (Committee) to evaluate the project, and retained independent counsel and independent consultants to scrutinize all aspects of the project. The Committee review included the SLODA Permit Application and supporting technical documents, with a special focus on sound. Mr. Kenneth Kaliski, PE, Director of Environmental Services for Resource Systems Group, INCE Board of Directors and Chair of several INCE sponsored wind energy conferences, was selected to conduct the Town's analysis. Mr. Kaliski is a well known acoustical engineer experienced with wind energy projects. Mr. Kaliski has published several journal articles including specific papers on modeling wind turbine sound propagation. He also has extensive experience measuring sound from operating wind energy projects in New England.

On behalf of the Oakfield Committee, Mr. Kaliski requested and First Wind/RSE provided additional information to supplement the sound report in the SLODA application. RSE provided Mr. Kaliski with the entire electronic file so that he could independently evaluate RSE's Oakfield sound model and all of its inputs and results. Mr. Kaliski completed a sensitivity analysis that evaluated various model settings, independently calculated sound level estimates and found that RSE's model and settings were appropriate and may be conservative. Mr. Kaliski's findings are contained in the detailed Committee report forwarded to the DEP along with specific recommendations by the Town of Oakfield for conditional approval of the project. The Committee found RSE's sound model reasonable in the application of the manufacturer's sound power specifications using the ISO 9613-2 Standard to determine appropriately conservative sound levels expected from the project.

Another level of technical scrutiny of RSE's Oakfield ***Sound Level Assessment*** is currently under review by DEP's own independent acoustical engineer, Mr. Warren Brown, owner of EnRad Consulting of Old Town, Maine. Mr. Brown has extensive academic and professional credentials and experience measuring sound levels from a wide variety of major and minor industrial and commercial developments. He is the primary, independent consultant providing peer reviews of sound level studies and compliance assessments for the DEP - including wind energy projects. Mr. Brown is also primarily responsible for development of a very rigorous compliance assessment protocol designed specifically to evaluate compliance of wind energy projects in Maine with DEP Chapter 375.10 *Control of Noise*. This protocol includes requirements for site and operating conditions, measurement and reporting requirements to evaluate tonal and short duration repetitive sounds (SDRS) (See Appendix 2: *Wind Turbine Sound Compliance Assessment Plan*). Mr. Brown evaluated the same modeling protocol for the Rollins Wind Project and found the RSE modeling results "yield a reasonable if not conservative estimate". (See Appendix 3, *Rollins Wind Project Sound Level Assessment – Peer Review*).

Recently, RSE's Oakfield sound model has also been verified as appropriate and conservative by two rounds of quarterly testing during routine operations at the Stetson Wind Project in May and September 2009. Verification was determined by comparing the 2009 as-built model predictions to actual measurements taken during routine facility operations at or near full sound power. The measurements were taken during stable atmospheric conditions when turbine noise was most noticeable with little or no extraneous sounds present during the reported measurement periods (See Appendix 4: LURC Q1 & Q2 Compliance test reports). As reflected in LURC Q1 and Q2 reports, the highest sound levels at the downwind position are 1 to 3 dBA less than Stetson as-built model predictions. As expected from addition of 5 dBA to the GE sound power specification and extensive measurements at Mars Hill, the Stetson model accurately predicted that measured results from operations were at or below model predictions. The protocol used for the Stetson measurements is consistent with the recent *Wind Turbine Sound Compliance Assessment Plan* dated April 6, 2009 and prepared for Rollins Wind Project to address the initial concerns noted by W. Brown during the March 5, 2009 conference call identified in the Powers Trust Objections.

Objections as to Sound

The ***Objections of the Trustees of Martha A. Powers to Oakfield Wind Project,*** September 28, 2009, sent via e-mail to Mark Margerum, DEP Project Manager cites ***Objections as to Noise*** as one of four areas containing inaccuracies that should form the basis for denial of the SLODA Permit. The submission relies on anecdotal evidence and a report from Mr. Richard R. James (James), INCE, principal of E-Coustic Solutions, to critique RSE's Oakfield ***Sound Level Assessment.*** Mr. James provided: ***Comments on Oakfield Wind Project, Evergreen Wind Power II, LLC Regarding Wind Turbine Noise and Its Impact on the Community, October 15, 2009.*** The remainder of this report responds to Mr. James' ***Comments.***

Response

Either Mr. James did not read the extensive publicly available reports for projects cited in his ***Comments,*** or if he did, he has misunderstood or mischaracterized the results. Mr. James presents a number of unsupported claims alleging misdeeds or technical flaws in RSE's work, and impugns the credibility of wind energy acoustical engineers and consultants in general. Mr. James provides no evidence of his own independent modeling or measurements of any wind energy project in Maine or New England. He provides no references to national or international standards or principles of physics in support of his positions, and he does not acknowledge the relative accuracy of RSE's original Mars Hill sound model and adjustments to the model that have occurred since then and are reflected in this and other projects. Mr. James does provide several published references in support of his **Comments** but often uses the information improperly or incorrectly.

To facilitate a logical response to the **Comments**, the specific issue raised in the E-Coustics report or Powers Trust submission is set forth below in italics and numbered. RSE's response to the issue follows the italicized text.

RSE did not provide an assessment of public health as this is outside RSE's field of practice but did provide comparative information of actual measurement results with published scientific and technical information.

I. General Comments [pages 2-4 of E-Coustics report].

1. E-Coustics critiques the Sound Assessment prepared by RSE on the basis that RSE purportedly failed to apply lessons learned from Mars Hill or appropriately disclose the monitoring results from Mars Hill or their purported significance. E-Coustics Report at 2-4.

The results of four rounds of extensive quarterly sound level testing of GE 1.5 sle wind turbines operating at Mars Hill were specifically used to calibrate the model and apply model adjustments to Oakfield. The measurement protocol approved by Maine DEP required that each quarter of testing occur under conditions when sound levels from wind turbine operations were most noticeable (i.e. strong upper levels winds and light surface winds). RSE evaluated weather and operating forecasts daily to identify suitable test periods for next day mobilization. A total of 266 hours of operations testing were completed simultaneously at multiple positions over the four rounds of quarterly measurements. Mars Hill measurements were based on hourly sound levels under a variety of full turbine operations and were not reviewed as a measurement average.

Sound level measurement results for all hours of testing were reported in great detail along with surface wind, turbine hub height winds, and turbine electric power generation of the nearest five turbines. These measurements provide test data under a considerable range of seasonal weather and site conditions including a wide range of temperature, humidity, wind speeds and direction, temperature and wind gradients, stable atmosphere, frozen ground and blade icing. The results are a matter of public record and both First Wind and RSE have taken steps to ensure that the public is aware of and has access to those results. Importantly, this information was used by RSE to calibrate the sound model for use at Oakfield. As clearly stated in the RSE ***Sound Level Assessment*** report, the model for Oakfield includes appropriate adjustments to represent the high end of the measured wind turbine sound levels under a wide range of conditions.

2. E-Coustics states that "residents located at distances of 2,000 to 3,000 feet from ridge mounted GE 1.5 MW turbines [in Mars Hill] are reporting extremely high noise levels (over 50 dBA) in excess of predicted values and adverse health effects." E-Coustics Report at 3.

Quarterly sound level testing of wind turbine operations at Mars Hill resulted in no measured sound levels from wind turbines over 50 dBA at distances of 2,000 to 3,000 feet. Position MP-6A is located 2,100 feet east of the turbine string where turbine sound levels during full sound output ranged from 40 to 47 dBA. The bulk of these sound levels were measured downwind and ranged from 43 to 46 dBA. The reported sound levels may include some contribution from ambient sound levels. Measurements and observations indicated that sound levels above 47 dBA (including a small number over 50 dBA) were caused by sounds from wind forces acting on vegetation and terrain and were not attributable to wind turbines alone.

3. E-Coustics acknowledges that inputs to the model used in Mars Hill have been adjusted, but then states that using a point-source model likely underestimates actual impacts by at least 5 dBA. E-Coustics Report at 3 and Footnote 1. The Powers Trust submission also objects to the use of point source calculations in the sound modeling. Powers Trust Submission at 6.

The accepted international standard for determining sound power levels from wind turbines treats wind turbines as point sources. See IEC 61400-11, Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques (2002) (See Appendix 5, IEC 61400-11.) Consistent with IEC 61400-11, RSE modeled wind turbines as point sources. The accuracy of RSE's model has been verified by the 2009 measurements taken at the Stetson Wind Project (Appendix 4, Stetson LURC Q1 and Q2 reports) and a recent technical report, *Prediction and*

Assessment of Wind Turbine Noise by Bowdler et al. (Acoustics Bulletin, March/April 2009 at 36-37).

Neither the E-Coustics Report nor Powers Trust Objection provides an objective scientific basis that the proposed Oakfield wind turbine array should be modeled as a line source for the relevant distances to receiver points at Oakfield. They make a theoretical argument conflicts with the empirical data gathered at the Stetson project verifying that a point source model is a conservative predictor of sound levels for a wind project. The point source model used to predict turbine noise for the Oakfield Project has been proven to be 1 to 3 decibels below model predictions for the highest sound levels measured downwind under atmospheric conditions most favorable to sound propagation. See LURC Q1 and Q2 Compliance Test Reports in Appendix 4.

The Power's Trust's assertion that line source and point source calculations will only yield similar results at distances exceeding the length of the line source is similarly refuted by the Stetson measurements. The monitoring positions where actual turbine sound emissions were measured are far closer to the sources than the length of the turbine string. See Stetson LURC Q1 Report at 4 and 30. Even at those locations, the model – treating the turbines as point sources – was a conservative predictor of sound propagation.

Modeling the turbines as point sources is consistent with accepted international standards and has been demonstrated to be appropriate by the results of the Stetson Compliance Reports for two rounds of quarterly testing.

4. E-Coustics states that "The Oakfield Wind project will result in nine (9) of residences (Sites R1 to R9 in Figure 1) that have not signed easements (ten (10)) being within 1860 and 2690 feet of one of more wind turbines. Figure 1 illustrates the extent to which the proposed footprint of the wind utility will encroach on residential homes. According to Table 3 of the RSE Noise Study people in these homes will be exposed to sound levels of 42 to 45 dBA on a regular basis day and night." Report at 4.

The receiver points referred to are the nine nearest "protected locations" (defined by DEP regulation) in each direction from the project where easements are **not required** because the predicted hourly sound levels are at or below the Maine DEP quiet nighttime limit of 45 dBA. The predicted sound levels represent the high end of the expected range of sound levels that may occur when the wind turbines are operating at or above 60% electric power production (i.e. 100% sound power). The turbines will not always be operating at full sound power output. The model calculations also assume the receiver points are simultaneously downwind of all the turbines, which will not be the case in reality. In most cases, the receiver positions are located 500 feet closer to the wind turbines than the homes because the Maine DEP nighttime limits apply 500 feet from the house for large lots and at the nearest lot lines for smaller lots. Audible broadband sound levels "in the homes" will be further reduced by that distance and the attenuation of the building structure.

The reference to the "*Project WINDFARMperception: Visual and acoustic impact of wind turbine farms on residents*" (University of Gothenburg, 2008) that found levels over 45 dBA to be annoying to 28% of surveyed residents would support First Wind's adoption of the quiet

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nighttime limit of 45 dBA at receiver locations up to 500 feet closer to wind turbines than the houses. Mr. Kaliski relied on the same study in connection with the Oakfield Review Committee process and concluded that "there are no statistically significant adverse health effects at or below an exposure level of 45 dBA. See Oakfield Report at p. 13-15.

II. Comments Related to Wind Turbine Sounds [pages 4-6 of E-Coustics report]

5. E-Coustics critiques the practice of reporting and predicting sound levels using the A-weighting scale and argues that the practice of doing so masks a potential source of significant problems. E-Coustics Report at p. 4-6. E-Coustics also argues that wind turbine sound includes a significant low frequency and infra sound component that is or should be of concern. E-Coustics Report at 10-13 and 18-20.

Maine DEP Chapter 375.10 noise standards were established to regulate audible sound and therefore the sound level limits are expressed in terms of dBA, which is a measurement of sound that is weighted by frequency to simulate the hearing response of humans. The A-weighting scale is the world-wide standard for expressing sound levels in terms that relates to human audibility and therefore for regulatory purposes. Specifically, sound is audible to humans at frequencies that range from 20 to 20,000 Hz, with greater sensitivity above 1,000 Hz. Sound levels in the lower frequencies are reduced (or "weighted") by a specific decibel level appropriate for quantifying audibility. This does not mean that the sound levels in the lower frequencies are not accounted for, obscured or masked. Instead, the A-weighting is a factoring of sound levels by frequency so that scientists, engineers, and regulators are expressing sound levels in terms related to human perception. IEC 61400-11, the accepted international standard for determining sound power levels from wind turbines, specifies the use of A-weighted sound levels for characterizing wind turbine noise.

During the Oakfield Committee Review process, RSE prepared a response to an information request from Mr. Kaliski, RSG for a "Low frequency sound analysis". The RSE response is dated July 22, 2009 (see Appendix 5) and provides sound level measurements of operating GE 1.5sle wind turbines at the Stetson project for frequencies ranging from 6 to 20,000 Hz. These un-weighted (dB) sound level measurements show that the highest sound levels in the low frequency range occurred when the nearest wind turbine was shutdown and the prominent sounds were from ambient sources such as wind acting on trees. The measurement position was at the end of the turbine string where the nearest turbine would provide approximately 80% of the sound energy (see Appendix 4, Stetson LURC Q2 Report).

The RSE response to Kaliski also compared the measured low frequency sound levels to the threshold of hearing, infrasound criteria established by the Denmark Environmental Protection Agency and guidelines for low frequency sound published by the American National Standards Institute (ANSI) S12.2-2008 (see Appendix 6, figures shown as Exhibit 1 and Exhibit 4). Comparisons of measured sound levels from Stetson with relevant guidelines and standards demonstrate that there will not be adverse low frequency or infrasound impacts due to sound levels from operation of the proposed Oakfield Wind Project.

Findings from review of sound level assessments and analysis of low frequency sound impacts by W. Brown of EnRad Consulting for the Rollins project and K. Kaliski of RSG on behalf of the Oakfield Review Committee, lead to the same conclusion. In his review of the Rollins Sound Level Assessment, W. Brown states "Infrasound, sonic frequencies <20 Hz, have been widely accepted to be of no concern below the common human perception threshold of 85-90 dBG for non-pure tone sounds. There is insufficient, broadly accepted evidence to conclude otherwise. Numerous national infrasound standards limit industrial facilities, impact equipment and jet engines, but wind turbine infrasound levels fall far below these standards. Wind turbines, rotating, under conditions necessary for power production produce a measurable broadband (lower frequencies) amplitude modulation of sound ("swoosh" and/or "thump") at ±1 Hz, which should not be confused with infrasound. The A-weighting scale is widely used in noise ordinances, equipment specification and sound control regulation. The introduction of C-weighting for the assessment of wind turbine sound is preliminary and unrefined on a broad basis. Current international wind turbine acoustic output standards do not require dBC or dBG rating." (see Appendix 3, Rollins Wind Project Sound Level Assessment – Peer Review, W.L. Brown, April 2009 at 6).

The "How To Siting Guide" published by Kamperman and James, provides a graph of linear (unweighted) sound levels from wind turbines that is used to support the assertion that the low frequency content dominates the sound energy from wind turbine noise emissions (Kamperman/James at 9). Kamperman/James fail to provide any comparison of turbine low frequency sound levels to other manmade (transportation or industrial) or natural sources such as wind and therefore the graph is of limited value. Kamperman/James also rely on model estimates of wind turbine sound propagation without identifying the specific turbine model they used to "demonstrate" that low frequency sound levels inside buildings will occur above the hearing threshold and cause a constant rumble. No details are provided concerning the construct, assumptions or settings used in their propagation model and therefore the validity of the conclusions cannot be confirmed. Their unsupported conclusions certainly do not counter the more than 300 hours of data simultaneously collected at multiple positions at Mars Hill and Stetson, which clearly demonstrate low frequency sound from ambient wind noise commonly occurs at levels well above low frequency wind turbine sound levels. These findings are consistent with numerous scientific studies, including the following:

- Low Frequency and Infrasound Noise Immissions from Wind Farms and the Potential for Vibroacoustic Diseases, M. Hayes, 2006.
- Infrasound from Wind Turbines-Fact, Fiction or Deception, G. Leventhall, 2006.
- Low Frequency Noise from Large Wind Turbines, DELTA, 2008.
- The Sounds of High Winds, G.P. van den Berg, 2006.
- Noise Annoyance from Wind Turbines, E. Pedersen, Swedish EPA, 2003.

James at pg. 6 – Use and findings based on report by DELTA ("EFP-06 Project, Low Frequency Noise from Large Wind Turbines, Summary and Conclusions on Measurements and Methods" April 2008). Mr. James states "In fact, the DELTA study concluded that for each increase of 1 MW in power output the graph would shift upward by approximately 5 dB. Given that power to sound level relationship and the constant increase in the power rating of turbines being installed we could see the wind turbine sound levels increase another 25 dB by the time 5 MW turbines

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are commercially available." The exact statement was also made by James on page 4 of a report entitled "Comments on WEPCO's Glacier Hill Application and Supporting Documents Regarding Wind Turbine Noise and Its Impact on the Community" October 2009.

In review of Mr. James statement regarding the DELTA report, Bo Sondergaard, one of the authors, Specialist, Acoustics for DELTA states "I can see that you reference some of the work I and DELTA have made on low frequency noise from wind turbines. Unfortunately it seems that you have not understood the data and therefore misinterpreted the results of the investigation. I especially think about [your] figure 5 in the document and the text referring to this figure. First of all this is not the original figure from our reports and there should be some explanation on how it is achieved. Secondly you infer a conclusion from our work stating that the noise increases by 5 dB for every MW the power increases. We have never made any conclusion like that neither from the specific work on low frequency noise or from any other work and it is certainly not what we see." The full e-mail correspondence from DELTA dated October 26, 2009 is contained in Appendix 9. Mr. James has yet to respond to the comments from DELTA or issue revisions to reports containing this erroneous conclusion.

Based on the evidence provided, Kamperman/James are wrong in their assertion that "low frequency" sound is the primary cause of annoyance from wind turbines. Kamperman/James disregard the fact that the most prominent audible sounds from wind turbines are at frequencies above the low frequency range and are at frequencies where human hearing is more sensitive (i.e. 250 Hz to 1000 Hz).

III. Comments on Amplitude Modulation [pages 6-13 of the E-Coustics report]

6. E-Coustics argues that amplitude modulation is distinctively annoying and is not adequately accounted for in the mode and states "To compensate for the added annoyance of fluctuating or impulsive sound, the convention is to add a penalty of 5 dBA to computer model estimates of average sound levels to account for the increased annoyance from short term fluctuations in sound levels. The RSE report argues against applying this penalty claiming that the fluctuations in sound are only 2-3 dB and definitely not the 6 dB needed to trigger application of the penalty. The evidence collected by this reviewer as demonstrated in Figure 6 shows that this claim is not supported by evidence. It is the days and nights when the amplitude modulation is at its worst, not the 2-3 dB of a summer afternoon, but the 6-9 dB of a late evening or the 10 -14 dB during weather conditions common in winter months and during weather that creates significant vertical and horizontal turbulence in other seasons." E-Coustics Report at pp. 6-9.

Amplitude modulation is the sound level fluctuation from wind turbines that occurs approximately once per second relative to the passage rate of the wind turbine blades. The Maine DEP regulates amplitude modulation under provisions for short duration repetitive sounds (SDRS). These are defined as a sequence of sound events each clearly discernible that causes an increase of 6 dBA or more in the sound level observed before and after the event. Analysis for SDRS requires determining the difference between the maximum and minimum fast-weighted sound levels that occur for each blade passage event.

RSE's findings related to amplitude modulation and SDRS events are based on extensive testing in Maine during all hours of the day and night and all seasons of the year. RSE observed the sound level fluctuations or amplitude modulation to typically range from 2 to 4 dBA. This range is similar to amplitude modulation graphs provided by Kamperman and James in the *"How To" Siting Guide* and by G.P. van den Berg in *The Sounds of High Winds*. However, Kamperman/James claim that Figure 6 of the Siting Guide demonstrates amplitude modulation occurs with sound levels varying over 9 dBA. This claim is incorrect in regards to amplitude modulation and SDRS. Closer examination of Figure 6 shows that the 9 dBA variation is based on the minimum and maximum sound levels that occurred 13 seconds apart, and not at the one second interval that defines amplitude modulation. In fact, the sound level variation for the one-second events in Figure 6 ranges from 2 to 5 dBA for all events except one where the difference reaches 6 dBA. Evidence in the Siting Guide is consistent with RSE findings that nearly all amplitude modulation or SDRS events are less than 6 dBA.

RSE is familiar with studies that find greater fluctuations and recognize that there is potential for this to occur; however, our measurements of wind projects operating in Maine under a variety of site and weather conditions (including evening, nighttime and stable atmosphere) indicate that fluctuation at or above 6 dBA are very infrequent and do not occur on a routine basis at the levels suggested by Mr. James. The measurement data provided by the James Report in Figure 6 (pg. 8) shows sound level fluctuations inside an entry vestibule to a home with amplitude modulation ranging from 6 to 11 dBA. The graph indicates that the data was measured over a ten second period shortly after midnight. RSE does not accept the results presented and views this as extremely limited, undocumented, unreferenced data particularly when compared to the hundreds of hours of measurements of GE 1.5 sle turbines in Maine that clearly indicated the SDRS events exceeding 6 dBA are very infrequent. Further, James' Figure 6 does not reference any specific measurement method; identify site or meteorological conditions during measurements; discuss the source; identify the presence or absence of other extraneous ambient sources such as wind around the building and conditions inside the house during the measurements. He also does not provide a citation for his Figure 6 referenced to a publicly available report prepared by a qualified acoustical professional. (For more discussion on Amplitude Modulation and SDRS see Appendix 7)

Finally, the Wind Turbine Sound Compliance Assessment protocol that will be utilized for the Oakfield project will require sound level measurements at 50 millisecond intervals to identify and quantify SDRS events that may occur and will require appropriate adjustments, including application of the 5 dBA penalty, if appropriate, to measured sound levels in accordance with Maine DEP 375.10 to determine compliance. The suggestion by James that the convention is to add 5 dBA to model estimates to account for SDRS events is neither supported by the literature nor the applicable regulations in the State of Maine.

7. E-Coustics challenges the assumption that the predictions represent "worst-case" conditions and argues that actual levels will be significantly higher than the predicted levels, particularly in certain meteorological conditions. R. James states "Consultants for wind utility developers often claim that wind turbine sound emissions inside and adjacent to the project footprint estimated by the sound propagation model's represent "worst-case" conditions.... Weather can introduce additional deviations from model results through independent of the effect of weather

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and wind on the turbine's noise emissions, ANSI standards for outdoor noise caution that turbulence in the air can increase the downwind sound levels by 6-7 dB or more. It should be clear that any assertions by the acoustical modeler that the models represent "worst case" sound level estimates rely on careful phrasing and ignorance of the underlying standards and methods by the reviewers." E-Coustics Report at pp. 8-9.

RSE appreciates the need to predict sound levels that reflect the high end of the range of what will occur during actual operation. The Oakfield model applies factors for uncertainty and methods accuracy as previously discussed. The attenuation estimates of the model have been verified from actual measurements of operating wind turbines in similar environments at Stetson and Mars Hill. This empirical verification accounts for sound levels in operating and weather conditions most favorable to sound propagation that are reflected in RSE's *Sound Level Assessment* for Oakfield (i.e., 5 dBA higher than the GE 1.5 sle specifications (109 dBA), simultaneously moderately downwind direction, and other conservative factors). Additional model details were provided during the Oakfield Committee Review process (see RSE presentation of July 22, 2009 in Appendix 8).

It is important to recognize that the measurements and model estimates are applied at distances of the nearest protected locations to the wind turbines. Predicted sound levels for Oakfield at these locations are in the 40-45 dBA range. The purpose of the post-construction monitoring protocol is to ensure that compliance is assessed in conditions most favorable to sound propagation, i.e. low surface winds so no masking, and higher winds aloft sufficient to ensure maximum sound power output, which are also the conditions most likely to result in the highest levels of amplitude modulation and be most noticeable.

8. E-Coustics argues that there should be a 5 dBA penalty added to the modeled results to account for amplitude modulation. E-Coustics Report at p. 9. The Rufus Brown submission also suggests that the sound assessment for Oakfield did not take into account SDRS events. Brown Submission at pp. 6-7.

As discussed in item 6, above, the Sound Level Assessment by RSE, as well as the local and state peer reviews, takes into account the potential for SDRS events to occur. The SDRS penalty applies 5 dBA to the measured sound levels of SDR events (i.e., not across the board). Compliance measurement protocols have been developed between First Wind, the Maine DEP and the Town of Oakfield that establish the conditions under which operations testing will occur and the measurement data required to identify and quantify SDRS events (Oakfield Committee Report and RSE Workshop Presentation). The intent of the operations test protocols is to identify potential SDRS events and apply the appropriate penalty if and when they occur. Measurement results by RSE indicate that SDRS events are unlikely to occur frequently and do not occur at levels that Mr. James asserts would result from operation of GE 1.5 sle turbines at Oakfield. Operations compliance will be determined in conditions most favorable to SDRS events occurring and, if they occur, the appropriate penalty will be applied.

9. E-Coustics asserts that the conditions favorable to sound propagation occur over 47% of the time and most often at night. E-Coustics Report at pp. 9-10.

First Wind, the DEP and the Town of Oakfield recognize the need to evaluate sound impacts during conditions most favorable to sound propagation and therefore the post-construction monitoring protocol is specifically designed to test in those types of conditions. These are stable atmospheric conditions during which winds aloft are sufficient for full sound emissions from the wind turbines and surface winds at the compliance positions are light. During these periods, sound from the wind turbines will be most noticeable and the contribution of ambient sound levels from wind will be low. As previously noted, these are the exact conditions that RSE was looking for in order to perform operations testing at Mars Hill and Stetson. Test schedules for both projects were delayed by weeks and months trying to meet the required test conditions. RSE experience and evaluation of meteorological data suggest that these simultaneous conditions occur significantly less than 47% of the time.

IV. Background Sound Levels [pages 13-15 of the E-Coustics report]

10. E-Coustics criticizes the failure to obtain background ambient sound levels, although the report acknowledges that it is not required by the applicable regulations. E-Coustics Report at pp. 13-14.

The Maine DEP does not require measurement of ambient sound levels in cases such as this where the developer elects to accept the lowest DEP limits, quiet area limits of 55 dBA daytime and 45 dBA nighttime.

11. E-Coustics asserts that recent WHO guidelines demonstrate that sound levels above 40 Lnight-outside pose a public health risk. E-Coustics Report at 14-15.

As acknowledged by the Powers Trust and reflected in the preamble to Chapter 375, the Board of Environmental Protection specifically recognized the potential adverse effects of noise, including nighttime noise, when it established the noise limits that govern this project. See Powers Trust Objections at 7 (quoting from preamble). The Chapter 375 noise regulations establish a comprehensive program for regulating sound from developments and set daytime and nighttime limits designed to ensure the protection of the public health and welfare. The rulemaking for Chapter 375 included two public hearings, eight public workshop sessions, several draft rules, and substantial public comment. See Basis statement for Chapter 375 Section 10. As recently as January, 2008, the Department evaluated the sufficiency of its noise regulations to address the noise effects of wind turbines and found the existing regulations to be appropriate and consistent with the best practices of the National Research Council's 2007 report on the Environmental Impacts of Wind-Energy Projects.

The Town of Oakfield, working with an outside sound expert, evaluated the same concerns being raised now by the Powers Trust and James Report. See Oakfield Committee Report. Specifically, the Town and its outside experts engaged in a comprehensive process that involved multiple public hearings and the exchange of technical information among experts, with a particular focus on health and sound issues. Their final report discusses a recent study of the acoustic impact of wind turbine farms on residents. That study found that the only health effect was sleep disturbance, *which occurred at a statistically significant level above 45 dBA outside the home.* (Oakfield Committee Report at 13). This is a level that exceeds the DEP quiet nighttime limits that apply to this project. The Final Report also noted that "after a literature review, the Committee did not find any peer-reviewed medical or public health reports or journal articles that concluded sound and noise from modern wind turbines in a well-designed, properly sited, operated, and maintained wind energy facility can cause adverse health effects." Id. at 14.

While a simplistic numeric comparison makes it appear the WHO guideline is lower, looking at the detail behind those numbers makes it is clear that the $L_{night, outside}$ metric cannot be compared directly to Maine DEP limits as Mr. James alleges. The WHO Nighttime Noise Guidelines For Europe (2009) state that an outside nighttime sound level ($L_{night, outside}$) of 40 dBA should be the target to protect the public including the most vulnerable groups (elderly, children and chronically ill). $L_{night, outside}$ is defined by the WHO as the "equivalent outdoor sound pressure level associated with a particular type of noise source during the nighttime (at least eight hours), calculated over a period of a year" (WHO Appendix I). The sound pressure level is measured at the most exposed façade of a dwelling and at a fixed height of 4 meters. At eight hours per night, the $L_{night, outside}$ would represent the equivalent sound level averaged over a period of 2,920 hours in one year.

By contrast, the Maine DEP hourly sound level limit of 45 dBA applies each and every hour of routine nighttime operation of the wind project. The nighttime limit also applies for a longer 12-hour period (7 am to 7 pm) instead of the 8 hour minimum established by the WHO. Moreover, the Maine DEP limit applies at locations that are up to 500 feet closer to the noise source/wind turbines than the WHO guideline for locations just outside the dwelling.

Acoustic model estimates prepared for Oakfield Wind yield the high end of the sound level range expected from periods of full sound operations. It is well known that wind turbines do not operate continuously at full sound power during an entire year.. Therefore for some portion of time, sound levels will be significantly less than the high-end predictions based on full sound output. Calculating the $L_{night, outside}$ from wind turbine operations over a one-year period would require determining the percentage of time that the wind project would operate at various levels (electric power and sound). The results of such an analysis may indicate that the Oakfield Wind Project would be at or near the WHO guideline given the amount of time that wind turbines will inevitably operate below the high range of sound levels predicted by the RSE model. Mr. James' contention that based on the 2009 WHO [New] Nighttime Noise Guidelines for Europe, the sound levels from operation of the Oakfield Wind Project will create an adverse impact are simply incorrect and misleading.

V. Comments Regarding Use of the Model [pages 15-18 of the E-Coustics report]

12. E-Coustics argues that models used to predict sound levels associated with wind turbines are not sufficiently accurate to be relied upon and underestimate actual sound levels. E-Coustics Report at pp. 16-18. Likewise, in its submission the Powers Trust objects to use of the ISO 9613-2 methodology in RSE's sound assessment. Powers Trust Submission at pp. 3-5.

See responses in **Sound modeling and review**, above.

13. E-Coustics asserts that the predicted levels reflect an average of the yearly estimates of sound at a protected location. E-Coustics at p. 16.

RSE's sound model predicts the highest equivalent hourly sound level expected from operation of the Oakfield Wind farm and not a yearly average. This metric was chosen for comparison to DEP limits. As noted in response to item 11 above, there will be periods of time when the project operates at less than full sound output and therefore a yearly average will necessarily be less than the equivalent hourly predictions reflected in the *Sound Level Assessment.*

14. E-Coustics states that the measured levels at Mars Hill constitute evidence that the model used in Oakfield under predicts sound levels. E-Coustics Report at 17.

As discussed above, the results at Mars Hill were used to calibrate the model and resulted in 5 dBA being added. The recent Q1 and Q2 results at Stetson have validated the calibrated model that was used for Oakfield.

15. E-Coustics suggests that data from Mars Hill was selectively presented to skew the difference between modeled and measured sound levels. E-Coustics Report at 17 states – "Note that the sound levels range from a low of about 35 dBA to a high of just over 52 dBA. All of these represent wind turbine sounds and not wind or other artifacts. The initial model estimated that the sound levels at this site would be 47.5 dBA. This is about 5 dBA lower than the highest level in the MDEP chart and 12 dB over the lowest level which was identified as wind turbine sound."

Mr. James fails to recognize that the measured sound levels represent a range of turbine operation levels from approximately 7% (100 kW) to slightly over 100% of electric power (1500 kW or 1.5 MW). RSE's ***Compilation of Ambient & Quarterly Operations Sound Testing Report*** for Mars Hill dated October 15, 2008 shows measured sound levels in relation to model estimates for the actual electric power generation. All the measured sound levels at referenced Mars Hill position MP-8 are shown on graphs contained in RSE's ***Compilation*** report as shown below. Measurements that included a large contribution from ambient sound sources were clearly indicated by black outline symbols and include sound levels ranging from 38 to 57 dBA. The most common source of ambient sound was from surface winds acting on vegetation and terrain. Mr. James is incorrect in his assertion that these measurements were precluded by wind speeds at the microphone exceeding the limits of the wind screen. In fact, enlarged foam windscreens designed for high wind conditions were used at several test locations, including MP-8, with consistent results.

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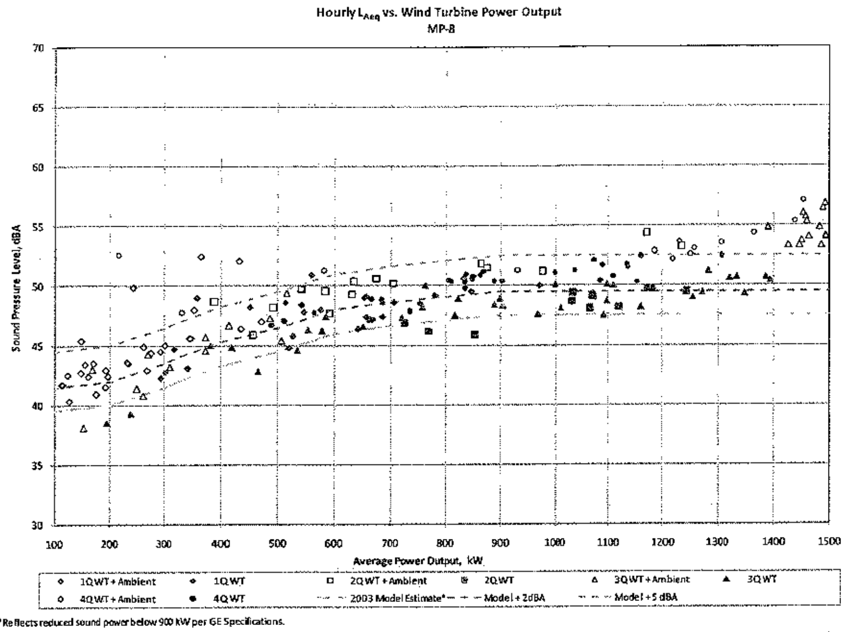

Figure 3-26. Correlation between Hourly L_{Aeq} Measurements at MP-8 and Average Power Output of Wind Turbines 1 through 5 (RSE edited 11/2/2009 to add Model +5 dBA)

At position MP-8 (Figure 3-27) the results indicate a consistent relationship between measured sound levels and electric power generation. The results that show the highest measured sound levels were 5 dBA or less above the model estimates form the basis for adjustments to the source sound power levels made in the Oakfield Wind model and evaluated by the Oakfield Wind Energy Committee and Mr. Kaliski of RSG. The model estimates for Oakfield are for simultaneous wind turbine operations at 100% of rated sound power output based on extensive testing at Mars Hill and verified for accuracy in 2009 by measurements at Stetson.

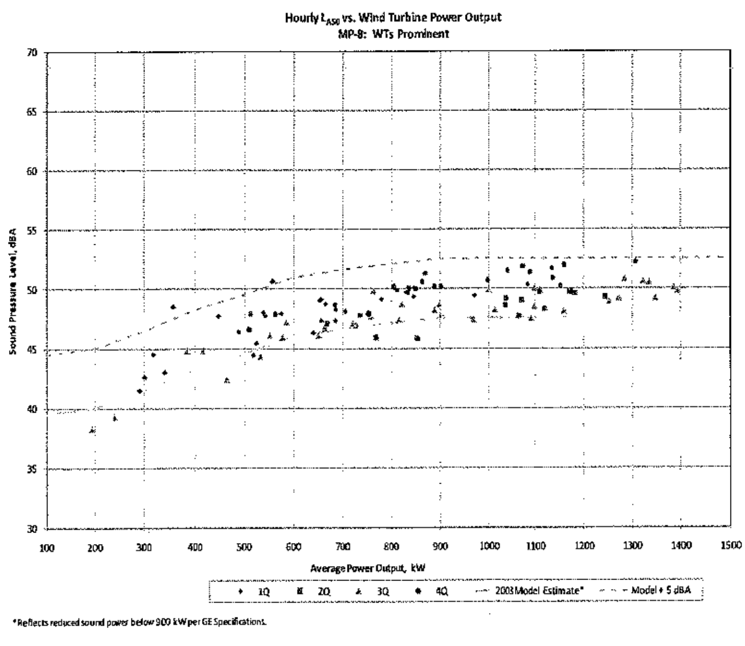

Figure 3-27. Correlation between Hourly L_{A50} Measurements at MP-8 with Wind Turbines Prominent and Average Turbine Power Output (RSE edited 11/2/2009 to add Model + 5dBA)

The results are not based on a "single series of tests" but rather a comprehensive quarterly test program with extensive hours of testing to achieve the proper test conditions for each quarter. During the Mars Hill quarterly testing program, RSE worked with Maine DEP and EnRad consulting to refine the test protocol. As a consequence, during the fourth round of quarterly testing, the wind turbines were shutdown on several occasions to quantify "real time" ambient sound levels during the compliance test period. This process was implemented and results from fourth quarter testing were consistent with the other three rounds of quarterly testing.

Again, model refinements were made for Oakfield to reflect the results of the operations testing at Mars Hill so that the model would accurately predict the high end of the test range (during full operations) and not an average of the test results. The refined sound model applied to Oakfield was independently peer reviewed by Mr. Kaliski, and verified by RSE measurements at Stetson Wind.

16. E-Coustics references studies of other wind projects to support the conclusion that the model predictions here are not reliable. E-Coustics Report at p. 17.

RSE agrees that actual measurement data is the most important means for determining validity of the model. As James states "the easiest way to establish that wind turbine models underestimate sounds at properties adjacent wind utilities is to look at existing wind projects". This is precisely what RSE and First Wind have done with extensive testing at Mars Hill and Stetson of the GE 1.5sle wind turbines over a range of operating and weather conditions in Maine. RSE has also reviewed published literature containing actual measurement data from operating wind turbines including many of the studies referenced by Mr. James. Although James references other studies, he has not provided any data from those studies and therefore there is no basis for determining their potential relevance here. Further, in relation to his use of other studies, Mr. James fails to acknowledge that different turbines will have different sound impacts and that these sound impacts are also highly dependent upon terrain (as James himself notes on pages 15-16 of his report).

Interestingly, James references a study by K. Kaliski to demonstrate that errors in wind turbine models have been shown to have errors of 5 to 10 dB or more "when studied by independent acoustical engineers" (pg. 16). This is the same independent engineer that peer reviewed and performed a sensitivity analysis of the Oakfield model constructed by RSE and concluded the "sound predictions and modeling are appropriate and may be conservative." (Committee Report at pg. 23).

17. At page 17 James states "Furthermore, studies that use models normally disclose the strengths and weaknesses of the models and also disclose the input data and other important assumptions. They give appropriate cautions and disclose error tolerances for all possible known conditions that the model does not consider. This is not done in the Evergreen Wind Power II, LLC study for Oakfield. The model is poorly documented and missing important data if the study is to be critically reviewed by others competent to do so."

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The most pertinent details of the CADNA/A model and settings were provided in RSE's ***Sound Level Assessment*** submitted to Maine DEP. Additional details concerning the model settings used by RSE were provided to the Town of Oakfield Wind Energy Review Committee on their request, and are readily available if DEP's third party expert wishes to examine them. In addition, the Oakfield CADNA/A model files were provided to the acoustical consultant to the Town of Oakfield Wind Energy Review Committee, for review and analysis. Mr. Kaliski independently evaluated various model settings, calculated sound level estimates and found that RSE's model and settings were appropriate and may be conservative. The same modeling protocol has also been evaluated by Warren Brown, acoustical consultant to Maine DEP, for the Rollins Wind Project who found the RSE modeling results were reasonable and technically correct (see Appendix 3: *Rollins Wind Project Sound Level Assessment – Peer Review*).

18. At page 17 James further states "The promises of compatibility with existing community sound levels, of no potential for nighttime sleep disturbance or low frequency 'vibrations' have been replaced with numerous complaints about noise and health to the local Boards and environmental agencies. In some cases this has escalated to threats of litigation. Given that track record, it is a safe assumption to consider the Evergreen Wind Power II, LLC models to be estimates of turbine noise under optimum operating conditions and nothing more."

RSE has fully disclosed all sources of information concerning the model estimates and their basis for comparison to Maine DEP sound level limits. The estimates represent the highest expected hourly turbine sound levels based on extensive testing under a variety of operating and site conditions. RSE reports do not contain promises of compatibility or claims of no potential for various impacts. As part of the Oakfield workshops, RSE provided comparisons of the measurement data and sound level estimates to recognized standards and guidelines.

19. At page 20 James states "RSE's conclusions that the project meets MDEP regulations are based on flawed procedures and assumptions; and cannot be accepted for the purpose of determining whether the MDEP noise regulations have been complied with. The 5 dBA penalty for short duration fluctuating sounds should be applied to the 45 dBA level permitted during night-hours on protected properties to reduce the criteria to 40 dBA for nighttime protected properties, the computer model should be redone to use line-source modeling methods for the wind turbines that are aligned in rows along the ridge; and the input data and other settings should be disclosed in the report on the results. In addition, a greater safety factor should be required by MDEP for model results based on post construction complaints that have demonstrated the unreliability of this model in prior projects."

RSE's findings and model calculations are based on extensive measurements of operating turbines at two separate projects in Maine under a wide range of site and weather conditions. Measurements and model calculations have been peer reviewed by two independent consultants working on behalf of the State of Maine and the Town of Oakfield. The actual model files and a complete set of measurement reports have been provided for peer review. RSE has worked closely with the Maine DEP and the Town of Oakfield to expand and refine measurement protocols to fully and accurately evaluate compliance including applying appropriate penalties for short duration repetitive and tonal sounds if they occur (see Appendix 2: Wind Turbine Sound Compliance Assessment Plan).

Summarizing, Mr. James is wrong in a preponderance of his ***Comments*** and discredits his own work by using flawed assumptions, incomplete and inaccurate representations of RSE's Oakfield ***Sound Level Assessment*** and a misleading mixture of fact and fiction. Consequently, the Powers Trust **Objections as to Noise** are without technical merit.

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APPENDIX 1

RESOURCE SYSTEMS ENGINEERING BACKGROUND

and RESUMES

Resource Systems Engineering (RSE) has provided broad-based environmental consulting services in Maine, New England, other US States and the Canadian Provinces for over 32 years (see: www.resourcesystemsengineering.com). All RSE projects have been completed under the direct supervision of Licensed Professional Engineers (PE). Over this period, hundreds of RSE studies and reports have been peer reviewed by other qualified professionals including PEs. The PEs at RSE have over 65 years of professional experience (see Appendix 1: Resumes). During more than four decades of individual practice, RSE senior personnel have earned credibility among our peer professionals, clients and regulators by our unwavering commitment to the application of scientific objectivity to all projects.

RSE Engineers and technical staff are qualified by training and experience to provide acoustical engineering services across for a broad spectrum of industrial, commercial and government clients for both major and minor projects. For the wind energy industry in Maine alone, RSE has a clear history of environmental acoustical engineering services including pre-feasibility siting evaluations, regulatory sound level assessments based on industry standard mathematical modeling, pre-development ambient sound level measurements, development of public and private workshops presenting the physics of sound, noise regulations and guidelines, collaborative diagnostic testing with a turbine manufacturer, operations compliance assessment measurements and noise complaint resolution.

In the past six years alone, RSE has provided this full spectrum of environmental acoustical services to six of Maine's largest wind energy projects. At least sixteen, peer reviewed, RSE reports are available to the public at state and local government offices in connection with these wind projects. Included in these public reports are hundreds of hours of pre-development ambient sound level measurement results and hundreds of hours of operations sound level measurement results. This large database was required in order to obtain measurements under specific weather and operating conditions when wind turbines were most noticeable. RSE presented the broad spectrum of collected data and selected data reflecting full sound power output with calm to low surface winds for comparison to regulatory limits. With this substantial measurement experience, RSE has refined instrumentation and methods to assess compliance in accordance with regulatory requirements, permit conditions and site specific, peer reviewed protocols. For the Rollins Wind Project, RSE also assisted with development of the most rigorous compliance assessment protocol currently applied to wind energy projects in Maine regulated under the Site Location of Development Act (SLODA). Exhibit 1 presents a summary of specific wind energy projects for which RSE has provided services.

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Resource Systems Engineering

- Established in 1977
- Full-service environmental engineering and consulting services
- Over 600 projects
  - Over 500 noise related projects
- Over 16 Wind Turbine Projects
  - From Hawaii to Maine
    - Consultation
    - Modeling
    - Sound Study

Charles F. Wallace, Jr.

- Over 40 years in the environmental engineering field
- Founder and President of RSE

R. Scott Bodwell

- Over 20 years in the environmental engineering field
- Senior Project Engineer

PROFESSIONAL RESUME

CHARLES F. WALLACE, JR., P.E.

PRESIDENT

Mr. Wallace is a Professional Engineer registered in the states of Maine, Massachusetts, New Hampshire, and North Carolina (formerly). He is a Diplomate of the American College of Forensic Examiners. He earned a B.S. in Engineering Physics in 1965 and an M.B.A. in 1972, both from the University of Maine at Orono. He has been practicing since 1965. In 1970, he began to focus his career as an environmental professional. In 1977, Mr. Wallace formed the company now known as Resource Systems Engineering. Since that time, all company activities, computer system development, computer modeling, designs, permits, and studies have been completed under his direct supervision.

Mr. Wallace has been responsible for project management, detailed designs, and preparation of comprehensive environmental impact studies on major projects in Maine, Michigan, Minnesota, Wisconsin, Massachusetts, North Carolina, and Nova Scotia, Canada. In Maine alone, he has provided environmental engineering and full permit services for more than 40 projects, including seven biomass energy projects, three major waste-to-energy projects, and three bulky waste recycling facilities. Since 1974, Mr. Wallace has worked on a variety of projects in the pulp and paper industry and has experience with lumber and composition board mills. In each project, he has been responsible for process and project designs/reviews and the preparation or coordination of environmental studies including noise and visual impact analyses, air and water quality studies, water quantity evaluations, environmental site assessments, solid waste management, and associated analysis. Mr. Wallace has been the project manager senior engineer on bulk oil storage facilities. He also was the Project Manager and Service Engineer investigating the feasibility of a wood waste composite manufacturing plant and a starch from potato waste project. In several projects, Mr. Wallace's computer models and feasibility studies were used in support of multimillion-dollar financings. In other cases, his fatal flaw analyses led to successful project sitings and project redesigns to minimize environmental impacts.

Since 1973, Mr. Wallace has been responsible for the preparation of Oil Spill Prevention, Control, and Countermeasures (SPCC) Plans; Stormwater Pollution Prevention Plans; Integrated Spill Contingency Plans; and Facility Emergency Response Plans designed to protect human health and the environment from accidental releases of oil or chemicals. Mr. Wallace has completed hazard analyses and capability assessments for electric power generating facilities, waste management and disposal facilities, and hazardous waste treatment and storage facilities. Clients have included both private industry and government agencies. He has developed comprehensive environmental compliance programs and conducted compliance audits of major and minor facilities. These programs are designed to protect clients from untoward litigation and demonstrate good engineering practices applied to oil and chemical management. Mr. Wallace has also conducted several environmental site assessments for industrial and commercial properties including many underground storage tank removals. In some cases, these assessments lead to subsurface investigations of soil and groundwater contamination, site remediation, and recovery of eligible costs from Maine's Groundwater Protection Fund. He prepared Site Safety and Health Plans for this work. Mr. Wallace presented a seminar on SPCC planning at a workshop co-hosted by the Maine Department of Environmental Protection. He has conducted professional seminars on environmental noise control regulations and instructed training classes in hazardous waste operations and emergency response and pollution prevention in accordance with Occupational Safety and Health Administration and U.S. Environmental Protection Agency standards (40-hour and 8-hour HAZWOPER).

Mr. Wallace was responsible for site location, permits, and detailed design of a wood waste-to-fuel facility in Lewiston, Maine; three phases of a comprehensive, regional-scale, solid waste recycling facility targeted for Mexico, Maine; the Regional Waste Systems bulky waste recycling facility to serve at least 27 communities in the Greater Portland, Maine, area; and a 1,500 ton-per-day construction and demolition material recycling facility in Brockton, Massachusetts. The Regional Waste Systems facility was the first of its kind in Maine to integrate bulky waste and urban wood processing, composting, and landfilling all on one site. Although not constructed. It was also the first to be licensed under Maine's complex solid waste laws. He has also prepared visual impact assessments and alternative design and routing evaluations for a 5.5-mile, 115-kva transmission line in Stratton, Maine and a 5-mile, 115-kva transmission line in West Rockport, Maine. He was directly responsible for development of the Aroostook Valley Electric Company (formerly Fairfield Energy Venture) Ash Utilization Program, touted by the Maine Department of Environmental Protection as the best in Maine.

Mr. Wallace has assisted private individuals with the complex permit process of rebuilding residential structures in shore land zones, within 100-year floodplains, and on coastal sand dunes on substandard lots.

Mr. Wallace was retained as an expert witness in the field of environmental licenses on a major case involving development of a wind energy project in northwestern Maine. The case was settled out of court. Mr. Wallace has testified before the Maine legislature on environmental laws and worked with the Maine Department of Environmental Protection on a wide variety of environmental rules and regulations, including air quality, noise, solid waste, and licensing procedures. Mr. Wallace has also been retained by clients as an expert witness during arbitration proceedings and litigation involving project permits and after the fact impacts of substandard erosion and sediment controls associated with large scale subdivisions.

Mr. Wallace has attended courses, seminars, and workshops on stormwater and erosion control design, DEP Best Management Practices for Stormwater Management, water rights/allocation/and resource management, ethics for environmental professionals, above ground and underground storage tank technology, remediation of petroleum-contaminated sites, implementing the 1990 Clean Air Act, environmental liability, atmospheric dispersion modeling, and asbestos management.

Mr. Wallace is a lifetime member of Sigma Pi Sigma, a national physics honor society and served on the executive and legislative review committees of the Maine Association of Planners. He is a member of the Maine Resource Recovery Association; Air & Waste Management Association; American Consulting Engineers Council; American College of Forensic Examiners and Consulting Engineers of Maine. He served on the Maine Air Quality Advisory Committee as the Consulting Engineers of Maine representative to the Maine Department of Environmental Protection. He also served on the Maine Chamber & Business Alliance Environmental Committee. Other memberships include the Maine Chamber and Business Alliance, Natural Resources Council of Maine, and Friends of Casco Bay. Civic activities include commissioner of the Brunswick Parks and Recreation Department (two terms), Board of Directors of the Brunswick Golf Club (two terms, Chair of the Physical Plant Committee, Member of the Finance Committee), and coach and Boards of Directors of Brunswick's Youth Soccer and Youth Hockey Leagues where he was instrumental in finding and developing new soccer fields and construction of an outside ice arena. He served on the Executive Board of the Coastal Conservation Commission. He is also serving on the Brunswick Town Council's Citizens Advisory Board for an all-tide Public boat launch located in an economically sensitive coastal area. He was instrumental in focusing attention on good engineering practices applied to this premier coastal access project and prepared/presented testimony at several public workshops and regulatory hearings.

PROFESSIONAL RESUME
R. SCOTT BODWELL, P.E.
Sr. PROJECT ENGINEER

Mr. Bodwell is a Professional Engineer registered in the State of Maine. He is an Engineering graduate of Dartmouth College and has completed several graduate courses and professional services in various engineering disciplines such as environmental, acoustics and ocean engineering. He has been practicing since 1982, combining professional experience in systems analysis with environmental engineering disciplines. Mr. Bodwell has been with Resource Systems Engineering since 1987, and has served as the senior project engineer on a variety of projects.

Mr. Bodwell is a specialist in the areas of noise impact and acoustical engineering, stormwater management, erosion control, site design, solid waste, hazardous materials, environmental audits and site assessments, and computer modeling. Mr. Bodwell conducted noise impact studies and provided acoustical engineering services for many projects, including wind farms, natural gas transmission facilities, shipbuilding operations, electrical power plants and waste-to-energy facilities, material recovery, a major limerock quarry expansion, a rail-to-barge aggregate transfer facility, a peat-mining operation, lumber mills, chipping plants, and numerous gravel-mining operations. He has developed sound level prediction models for analysis of outdoor sound propagation from numerous development projects. Mr. Bodwell has conducted professional seminars and field training covering environmental noise measurement and control.

Mr. Bodwell has developed site designs, erosion control, and stormwater management plans for industrial and commercial facilities including power plants, hazardous material storage facilities, mining operations, and solid waste facilities. He developed computer models for ash and sludge utilization programs, financial feasibility analysis, and air emissions. He also developed an innovative agronomic residual utilization model, working closely with the University of Maine. This model forms the basis for one of the most successful wood-ash landspreading programs in the state of Maine.

Mr. Bodwell has extensive experience in environmental regulation and permitting involving energy facilities, solid waste facilities, hazardous materials programs, natural resource protection, pollution prevention, stormwater, and noise, and has a working knowledge of environmental regulations involving air emissions and water quality. He developed innovative and systematic approaches for management and auditing of environmental compliance programs at industrial facilities. He prepared integrated oil spill, chemical emergency response, and stormwater pollution prevention plans and conducted environmental reviews and audits at manufacturing and power-generating facilities.

Mr. Bodwell has completed several environmental site assessments of industrial and commercial properties including subsurface investigation and remediation of underground storage tank and hazardous waste facilities.

Mr. Bodwell has completed a 40-hour course in Hazardous Waste Operations and Emergency Response and attended courses and seminars on computer-aided engineering, acoustic modeling, stormwater and erosion control design, blasting, confined space entry, trenching and excavation safety, underground storage tank technology, hazardous materials transportation, hazardous waste management, stormwater pollution prevention, oil remediation, and bulky waste management.

Mr. Bodwell has served on the Brunswick Planning Board and Comprehensive Planning Committee, and the Advisory Board of the Brunswick-Topsham Land Trust. He conducts citizen water quality monitoring for the Friends of Casco Bay and is affiliated with several professional organizations. He has volunteered in numerous youth development activities including Career Day at local high schools.

RESOURCE SYSTEMS Engineering

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Exhibit 1

Resource Systems Engineering

Sound Level Assessments for Major Wind Energy Projects in Maine

(All Reports are Publically Available at Maine Department of Environmental Protection and Local Municipal Offices)

<u>Evergreen Wind Power, LLC; Mars Hill Wind Farm</u>

- *Preliminary Sound Level Analysis* dated December 26, 2003
- *Sound Level Study; Ambient and Operations Sound Level Monitoring* (1st Quarter) dated June 21, 2007 included:
    - December 2006
        - Ambient Sound Level Monitoring
        - 6 fixed monitoring positions
        - 47 hours of measurements
        - Short term measurements and observations at multiple locations
        - Local weather provided by wunderground.com Presque Isle
        - Fixed Data Base - 282 position hours
    - May 2007
        - Operations Sound Level Monitoring
        - 9 fixed monitoring positions
        - 96 hours of measurements
        - Short term measurements and observations at multiple locations
        - Weather provided by RSE's portable met station (approx 2 m above ground) at one position, wunderground.com (Presque Isle) and Hub Height wind speed and direction from WT1 though WT28 (provided by First Wind)
        - Fixed Data Base - 864 position hours

- *Sound Level Study; Ambient and Operations Sound Level Monitoring; 2nd Quarterly Report* dated November 2, 2007 included:
    - September 2007
        - Operations Sound Level Monitoring
        - 7 fixed monitoring positions
        - 26 hours of measurements
        - Short term measurements and observations at multiple locations
        - Weather provided by RSE's portable met station (approx 2 m above ground)at one position, wunderground.com (Presque Isle) and Hub Height wind speed and direction from WT1 though WT28 (provided by First Wind)
        - Fixed Data Base - 182 position hours

- *Sound Level Study; Ambient and Operations Sound Level Monitoring; 3rd Quarterly Report* dated April 11, 2008 included:
    - January 2008
        - Operations Sound Level Monitoring

- 8 fixed monitoring positions
- 86 hours of measurements
- Short term measurements and observations at multiple locations
- Weather provided by RSE's portable met station (approx 2 m above ground) at one positions, First Wind's portable met stations (approx 2 m above ground) at four positions, wunderground.com (Presque Isle) and Hub Height wind speed and direction from WT1 though WT28 (provided by First Wind)
- Fixed Data Base - 688 position hours

- *Sound Level Study; Ambient and Operations Sound Level Monitoring; 4th Quarterly Report* dated September 5, 2008 included:
  - May 2008
    - Operations Sound Level Monitoring
    - 7 fixed monitoring positions
    - 46 hours of measurements
    - Short term measurements and observations at multiple locations
    - Weather provided by First Wind's portable met stations (approx 2 m above ground) at four positions, wunderground.com (Presque Isle) and Hub Height wind speed and direction from WT1 though WT28 (provided by First Wind)
    - Fixed Data Base - 322 position hours

- Total Measurement Data Base for fixed positions: 2,338 hours

- *Sound Level Study; Compilation of Ambient & Quarterly Operations Sound Testing* dated October 15, 2008

<u>Evergreen Wind power II, LLC; Oakfield Wind Project</u>

- *Sound Level Assessment* dated April 2, 2009
- Town Meeting, RSE presentation on Sound and the Oakfield Sound Level Prediction Model, May 20, 2009
- Workshop with the Town presenting the Sound Level Prediction Model, Post Construction Monitoring Protocol, and Infrasound and Low Frequency Noise, July 22, 2009
- RSE PowerPoint presentation (Appendix 6)

<u>Evergreen Wind Power V, LLC; Stetson Wind Project</u>

- *Sound Level Assessment* dated March 1, 2007
- *Sound Level Assessment (Supplement for Nighttime Construction)* dated November 2007
- *Ambient Sound Level Measurements* dated October 16, 2008 included:
  - April 2008
    - Ambient Sound Level Monitoring
    - 4 fixed monitoring positions
    - 24 hours of measurements

    - Weather provided by wunderground.com (Houlton)
    - Fixed Data Base – 96 position hours

- *Operations Compliance Sound Level Study* (1st Quarter) dated July 27, 2009
  - May 2009
    - Operations Sound Level Monitoring
    - 4 fixed monitoring positions
    - 59 hours of measurements
    - Short term measurements and observations at multiple locations
    - Weather provided by RSE portable met stations (approx 2 m and 10 m above ground) at three positions, wunderground.com (Danforth) and Hub Height wind speed and direction from WT1 though WT18 (provided by First Wind)
    - Fixed Data Base – 236 position hours

- *Operations Compliance Sound Level Study Second Quarter Summary* dated October 22, 2009
  - September 2009
    - Operations Sound Level Monitoring
    - 2 fixed monitoring positions
    - 7 hours of measurements
    - Weather provided by RSE portable met stations (approx 2 m and 10 m above ground) at two positions and Hub Height wind speed and direction from WT1 though WT38 (provided by First Wind)
    - Fixed Data Base – 14 position hours

- Total Measurement Data Base for fixed positions: 346 hours

<u>Stetson Wind II, LLC; Stetson II Wind Project</u>

- *Sound Assessment* dated October 22, 2008 included:
  - April 2008
    - Ambient Sound Level Monitoring
    - 3 fixed monitoring positions
    - 24 hours of measurements
    - Weather provided by wunderground.com (Houlton)

- Total Measurement Data Base for fixed positions: 72 hours

<u>Evergreen Wind Power III, LLC; Rollins Wind Project</u>

- *Sound Level Assessment* dated October 30, 2008
- SLOD Permit Appeal – Supplemental Information Dated April 2, 2009

Record Hill Wind, LLC; Record Hill Wind Project

- Town Meeting (public informational), RSE Presentation on Sound, June 24, 2008
- Public Informational DEP meeting, RSE Presentation on Sound, Noise Modeling and Noise Monitoring, November 20, 2008
- *Sound Level Assessment* (including Pre-Development Ambient Monitoring results) dated December 1, 2008 included:
    - July 2008
        - Ambient Sound Level Monitoring
        - 5 fixed monitoring positions
        - 72 hours of measurements
        - Weather provided by RSE's portable met station (approx 2 m above ground) at three positions, Hub height wind speed and direction calculated and provided by Wagner Forest
        - Fixed Data Base – 360 position hours
    - August 2008
        - Ambient Sound Level Monitoring
        - 5 fixed monitoring positions
        - 178 hours of measurements
        - Weather provided by Stantec's portable met station (approx 2 m and 10 m above ground) at two positions (1/2 time at one then the other), Hub height wind speed and direction calculated and provided by Wagner Forest
        - Fixed Data Base – 890 position hours

- Total Measurement Data Base for fixed positions: 1,250 hours

- *Sound Level Assessment* (does not include PDA) dated January 20, 2009
- *Supplement to: Sound Level Assessment* dated June 16, 2009

Total measurement database of all fixed sound level meters: 5,000 position hours.

(consisting of 1,778 positions hours of ambient and 3,222 position hours of operations measurements).

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APPENDIX 2

ROLLINS WIND PROJECT

WIND TURBINE SOUND COMPLIANCE ASSESSMENT PLAN

APRIL 6, 2009

Rollins Wind Project
Wind Turbine Sound Compliance Assessment Plan

Submitted by
Evergreen Wind Power III, LLC

Final Revised April 6, 2009

This wind turbine sound compliance assessment plan was developed jointly by Evergreen and Maine DEP with the advice and guidance of their respective acoustical consultants. Recommendations for testing protocols were drafted by EnRad Consulting of Old Town, Maine on behalf of Maine DEP, and further refined in consultation with Evergreen and Resource Systems Engineering (RSE) of Brunswick, Maine.

The sound compliance assessment for the Rollins Wind Project requires carefully specified measurement conditions, monitoring specifications and reporting requirements to characterize and consistently quantify wind turbine sound levels. RSE has developed this compliance assessment plan in consultation with the Department and development compliance for the project will be demonstrated when the following outlined conditions have been met for 12, 10-minute measurement intervals per monitoring location meeting 06-096 CMR 375.10 requirements.

Extraneous sounds could potentially or do complicate routine operation compliance assessment. If the applicant must adjust for such sounds, background ambient monitoring will be necessary. If background ambient monitoring is proposed, locations and times will be determined with concurrence from the MEDEP.

a. Compliance will be demonstrated when the required operating/test conditions have been met for twelve 10-minute measurement intervals at each monitoring location.

b. Measurements will be obtained during weather conditions when wind turbine sound is most clearly noticeable, i.e. when the measurement location is downwind of the development and maximum surface wind speeds ≤6 mph with concurrent turbine hub-elevation wind speeds sufficient to generate the maximum continuous rated sound power from the five nearest wind turbines to the measurement location. [Note: These conditions occur during inversion periods usually between 11pm-5am.] Measurement intervals affected by increased biological activities, leaf rustling, traffic, high water flow or other extraneous ambient noise sources that affect the ability to demonstrate compliance will be excluded from reported data. The intent is to obtain 10-minute measurement intervals that entirely meet the specified criteria. A downwind location is defined as within 45° of the direction between a specific measurement location and the acoustic center of the five nearest wind turbines.

c. Sensitive receiver sound monitoring locations will be positioned to most closely reflect the representative protected locations for purposes of demonstrating compliance with applicable sound level limits, subject to permission from the respective property owner(s). Selection of monitoring locations will require concurrence from Maine DEP.

d. Meteorological measurements of wind speed and direction will be collected using anemometers at a 10-meter height above ground at the center of large unobstructed areas and generally correlated with sound level measurement locations. Results will be reported, based on 1-second integration intervals, and be reported synchronously with hub level and sound level measurements at 10 minute intervals. The wind speed average and maximum will be reported from surface stations. Maine DEP concurrence on meteorological site selection is required.

e. Sound level parameters reported for each 10-minute measurement period will include A-weighted equivalent sound level, 10/90% exceedance levels and ten 1-minute 1/3 octave band linear equivalent sound levels (dB). Short duration repetitive events will be characterized by event duration and amplitude. Event frequency is defined as the average event frequency +/- 1SD and amplitude is defined as the peak event amplitude minus the average minima sound levels immediately before and after the event, as measured at an interval of 50 ms or less, A-weighted and fast time response, i.e. 125 ms. For each 10-minute measurement period short duration repetitive sound events will be reported by percentage of 50 ms or less intervals for each observed amplitude integer above 4 dBA. Reported measurement results will be confirmed to be free of extraneous noise in the respective measurement intervals to the extent possible and in accordance with (b.).

f. Compliance locations will be determined in consultation with the Department.

g. Compliance data collected in accordance with the assessment methods outlined above for representative locations selected in accordance with this protocol will be submitted to the Department for review and approval prior to the end of the first year of facility operation. Compliance data for each location will be gathered and submitted to the Department at the earliest possible opportunity after the commencement of operation, with consideration for the required weather, operations, and seasonal constraints.

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APPENDIX 3

ROLLINS WIND PROJECT

SOUND LEVEL ASSESSMENT – PEER REVIEW

ENRAD CONSULTING

APRIL 6, 2009

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Rollins Wind Project Sound Level Assessment -- Peer Review

LINCOLN, MAINE

Warren L. Brown

April 6, 2009

Submitted by:

EnRad Consulting
516 Main Street
Old Town, Maine 04468

Submitted to:

Becky Maddox
Maine Department of Environmental Protection
Augusta ME 04433

Rollins Wind Project Sound Level Assessment
Peer Review

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Review Basis

Evergreen Wind Power III, LLC proposes to operate a 60 MW wind energy facility on North and South Rollins Mountains in Penobscot County, Maine. At the request of the Maine Department of Environmental Protection (MDEP) a peer review is undertaken to determine if the noise study is reasonable and technically correct according to standard engineering practices and the Department Regulations on Control of Noise (06-096 CMR 375.10).

The proposed wind farm noise assessment report will be generally critiqued unless detailed criticism is given.

1.0 Introduction

The stated objective of the sound assessment was to determine the expected sound levels from routine operation of the wind project and compare them with the relevant environmental noise standards. Sound levels from the construction activity, and operation of the substation and other electrical transmission facilities are briefly discussed

The routine operation sound level estimates are compared to the Maine DEP sound level limits to demonstrate that Rollins Wind Project will meet applicable sound level limits.

2.0 Sound and Decibels

Informational

3.0 Site Description

The wind turbine portion of the project consists of 40 General Electric 1.5 MW turbines located a top Rollins North and South in the Lincoln, Lee, Winn and Burlington (Penobscot County). Operation of the substation and transmission line is not expected to generate significant sound levels. Sound level estimates for the wind project to not include these facilities.

The turbines will generally run North-South along various ridges with base elevations of the turbines ranging from approximately 700 -- 1260 feet above sea level. In addition to the turbine structures, the project will include construction of an operations and maintenance facility at the south end and the substation near the north end of Rollins North.

The report indicates nearest protected locations lie between Rollins North and South within the towns of Lincoln and Lee. Numerous seasonal residences surround this project site, which is largely undeveloped forestry land.

Evergreen Wind Power III (Evergreen III) has purchased property or obtained leases with local landowners to install and operate wind turbines at the proposed locations. Evergreen III has also obtained agreements with landowners who may experience sound levels from the project that have the potential to exceed applicable sound level limits (MDEP Chap 375.10)

Parcels for which Evergreen III has a lease, easement or other arrangement are indicated in the assessment.

4.0. Noise Control Standards

Land-use ordinances for Burlington, Lee, Lincoln and Winn indicate that no quantitative noise standards are enacted in these municipalities, consequently Maine DEP Chap 375.10 regulations apply.

5.0 Existing Sound Levels

Evergreen III proposes to not confirm predevelopment ambient sound levels, but rather, in recognition of the rural nature of the site accept the most conservative regulation levels of 55 dBA daytime and 45 dBA nighttime. Mention is made of elevated wind effects on ambient noise during wind speeds required for turbine operation.

6.0 Sound Level Limits

Sound level limits were determined at protected locations and property lines based on land owner agreements and land uses. As previously mentioned, Evergreen has obtained leases or agreements with many local landowners to exempt the project from sound level limits at those sites.

Five nearby sensitive receiver points (protected locations) are listed with proposed measurement locations respective to residences/property boundaries and estimated development impact.

7.0 Future Sound Levels

7.1 Construction

Standard discussion

7.2 Proposed Operation

Operation sound level estimates were based on an acoustic model employing CADNA/A software utilizing area topography and wind turbine locations as provided by Stantec.

Wind turbine operation and sound power output relative to wind speed are discussed and plotted. Sound level estimates are based on full turbine sound power output plus and an uncertainty factor of ± 5 dBA to allow for wind turbine sound power specification (IEC 61400-11) and outdoor propagation prediction (ISO 9613-2) uncertainties Attenuation factors were intentionally omitted from the estimate model, which may have lessened resulting estimates further.

Selected sensitive receiver position sound level estimates from routine wind turbine operation range from 39-45 dBA. Actual measured sound levels will vary substantially with wind speeds/directions, subsequent to microphone interference and numerous wind generated noise sources (ambient + operation).

Wind speed generally varies with the elevation and may contain both horizontal and vertical components. Sound level measurements taken during turbine operation levels at or near maximum power will occur under a wide range and type of increased wind speeds. These measurement periods will be characterized by times when wind turbines are completely inaudible due to high ambient noise and other times when surface level operation noise is more prominent.

Accurate, measurement-derived operation sound levels can only be made when conditions permit, a clear separation between operation and background noise. Forested receiver locations may not allow separation of operation and ambient noise sources under windy conditions.

Tonal and short duration repetitive sounds are not expected based on manufacturer specifications and prior experience, but short duration repetitive sounds may occur as a result of amplitude modulation during some conditions -- to be specified in recommendations.

8.0 Conclusions and Recommendations

Maine DEP sound level limits based on land use and land owner agreements were conservatively set at "quiet limits -- 45 dBA nighttime./55 dBA daytime" (within 500 feet of residence).

The proposed sensitive receiver sites, R-1 through R-5, are appropriate in number and general location to assess wind turbine operation compliance for nearby protected locations. Operations of the substation and transmission lines generally do not generate significant sound levels.

The wind project prediction model based on CADNA/A software with incorporation of an uncertainty factor of ± 5 dBA and intentional omission of possible attenuating factors may yield a reasonable if not conservative estimate, if short duration repetitive sounds are not problematic.

I will further recommend specifications for RSE's recommendations to measure predevelopment ambient sound levels at respective protected locations under conditions representative of operations with subsequent project operation compliance testing.

Conclusion - (Peer Review)

It's my opinion the Rollins Wind Project noise assessment is essentially reasonable and technically correct according to standard engineering practices and the Department Regulations on Control of Noise (06-096 CMR 375.10) with a possible omission involving excessive amplitude modulation and the resulting penalty for short duration repetitive sound.

The wind project prediction model based on CADNA/A software with incorporation of an uncertainty factor of + 5 dBA and intentional omission of possible attenuating factors yields an estimate that does not account for potential excessive amplitude modulation under stable atmospheric conditions, which would invoke a 5 dB penalty for short duration repetitive sounds, potentially resulting in borderline protected locations (greater than or equal to 43 dBA) receiving greater than predicted sound levels, even potentially in excess of 45 dBA. The 2 possible locations are measurement locations R2 and R3 along RT 6.

Infrasound, sonic frequencies <20 Hz, have been widely accepted to be of no concern below the common human perception threshold of 85-90 dBG for non-pure tone sounds. There is insufficient, broadly accepted evidence to conclude otherwise. Numerous national infrasound standards limit industrial facilities, impact equipment and jet engines, but wind turbine infrasound levels fall far below these standards.

Wind turbines, rotating, under conditions necessary for power production produce a measurable broadband (lower frequencies) amplitude modulation of sound ("swoosh" and/or "thump") at ±1 Hz, which should not be confused with infrasound.

The A-weighting scale is widely used in noise ordinances, equipment specification and sound control regulation. The introduction of C-weighting for the assessment of wind turbine sound is preliminary and unrefined on a broad basis. Current international wind turbine acoustic output standards do not require dBC or dBG rating.

I recommend a required routine operation noise compliance assessment methodology for wind turbine projects based on very selective meteorological, background sound conditions and careful specified sound measurement parameters which will require compliance measurements under most favorable conditions for sound propagation, during periods of significant maximum amplitude modulation and appropriate measurement parameters.

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Compliance sound assessment of wind turbines require carefully specified measurement conditions, monitoring specifications and reporting requirements. Compliance should be demonstrated, based on following outlined conditions for 12, 10-minute measurement intervals per monitoring location meeting 06-096 CMR 375.10 requirements.

Extraneous sounds could potentially or do complicate routine operation compliance assessment. If the applicant must adjust for such sounds, background ambient monitoring will be necessary. If background ambient monitoring is proposed, locations and times should be determined with concurrence from the MDEP.

a. Compliance will be demonstrated when the required operating/test conditions have been met for twelve 10-minute measurement intervals at each monitoring location.

b. Measurements will be obtained during weather conditions when wind turbine sound is most clearly noticeable, i.e. when the measurement location is downwind of the development and maximum surface wind speeds ≤6 mph with concurrent turbine hub-elevation wind speeds sufficient to generate the maximum continuous rated sound power from the five nearest wind turbines to the measurement location. [Note: These conditions occur during inversion periods usually between 11pm-5am.] Measurement intervals affected by increased biological activities, leaf rustling, traffic, high water flow or other extraneous ambient noise sources that affect the ability to demonstrate compliance will be excluded from reported data. The intent is to obtain 10-minute measurement intervals that entirely meet the specified criteria. A downwind location is defined as within 45° of the direction between a specific measurement location and the acoustic center of the five nearest wind turbines.

c. Sensitive receiver sound monitoring locations should be positioned to most closely reflect the representative protected locations for purposes of demonstrating compliance with applicable sound level limits, subject to permission from the respective property owner(s). Selection of monitoring locations should require concurrence from MDEP.

d. Meteorological measurements of wind speed and direction should be collected using anemometers at a 10-meter height above ground at the center of large unobstructed areas and generally correlated with sound level measurement locations. Results should be reported, based on 1-second integration intervals, and be reported synchronously with hub level and sound level measurements at 10 minute intervals. The wind speed average and maximum should be reported from surface stations. MDEP concurrence on meteorological site selection is required.

e. Sound level parameters reported for each 10-minute measurement period, should include A-weighted equivalent sound level, 10/90% exceedance levels and ten 1-minute 1/3 octave band linear equivalent sound levels (dB). Short duration repetitive events should be characterized by event duration and amplitude. Event frequency is defined as the average event frequency +/- 1SD and amplitude is defined as the peak event amplitude minus the average minima sound levels immediately before and after the event, as measured at an interval of 50 ms or less, A-weighted and fast time response, i.e. 125 ms. For each 10-minute measurement period short duration repetitive sound events should be reported by percentage of 50 ms or less intervals for each observed amplitude integer above 4 dBA. Reported

f. Compliance locations should be determined in consultation with the Department.

Compliance data collected in accordance with the assessment methods outlined above for representative locations selected in accordance with this protocol should be submitted to the Department for review and approval prior to the end of the first year of facility operation. Compliance data for each location should be gathered and submitted to the Department at the earliest possible opportunity after the commencement of operation, with consideration for the required weather, operations, and seasonal constraints.

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APPENDIX 5

IEC 61400-11 WIND TURBINE GENERATOR SYSTEMS – PART 11:

ACOUSTIC NOISE MEASUREMENT TECHNIQUES,

EDITION 2.1 2006-11 and AMENDMENT 1 2006-05

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INTERNATIONAL STANDARD

IEC 61400-11

Edition 2.1

2006-11

Edition 2:2002 consolidated with amendment 1:2006

Wind turbine generator systems –

Part 11: Acoustic noise measurement techniques

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IEC

Reference number
IEC 61400-11:2002+A1:2006(E)

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INTERNATIONAL STANDARD

IEC 61400-11

2002

AMENDMENT 1
2006-05

Amendment 1

Wind turbine generator systems –

Part 11:
Acoustic noise measurement techniques

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APPENDIX 6

RESOURCE SYSTEMS ENGINEERING'S REPONSE TO

KENNETH KALISKI, RSG, INC

INFORMATION REQUEST NO.1 – ITEM 2

JULY 22, 2009

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Resource Systems Engineering

080130/2.5.2
July 22, 2009

Resource Systems Group, Inc
55 Railroad Row
White River Junction, VT 05001

ATTENTION: Ken Kaliski, P.E.

REFERENCE: Oakfield Wind Project
Request for Information
Letter from RSG to Eaton Peabody June 21, 2009

SUBJECT: Response to Information Request No. 1 – Item 2

Dear Ken,

The following is provided in response to item no. 2 of your request for information.

Request:

2. Low frequency sound analysis – We would request of the applicant an analysis of low frequency sound and infrasound at the worst-case receiver(s). Compare impacts with appropriate health and structural vibration criteria and justification for these criteria.

Response:

Low frequency sounds range from 0 to 200 Hz. Infrasound is the term used to describe low frequency sound at or below 20 Hz. RSE recently measured sound levels of operating GE 1.5sle wind turbines at frequencies ranging from 6 to 20,000 Hz at the Stetson Wind Project in Washington County, Maine in 2009. These measurements can be used to assess the potential impacts of low frequency sounds by comparison with recognized standards and technical criteria. The GE 1.5sle wind turbines at Stetson are the same make and model turbine and have the same rotor blades that are being proposed for the Oakfield Wind Project.

Exhibit 1 provides typical one-third octave band sound level measurements at two positions in close proximity to wind turbines. Position CP-1 is approximately 850 feet south of the southern-most wind turbine and position CP-4 is approximately 1,250 feet east of the closest wind turbine and perpendicular to the string of wind turbines. Exhibit 2 and Exhibit 3 present the location of measurement positions relative to the Stetson Mountain wind turbine array.

30 Parkers Way
Brunswick, Maine 04011
207 725-7896

The measurements presented at CP-1 show equivalent sound levels measured continuously for an hour beginning at midnight (12 am) on May 22 when the nearest wind turbine was shut down. The next nearest wind turbine is approximately 2,000 feet north of CP-1. Results indicate that these measurements at CP-1 include significantly lower wind turbine sound mixed with sound level contributions from ambient sources.

Measurements at CP-4 show sound levels for the two hours when all nearby turbines were operating at or near full power generation and surface winds were at their lowest levels, 2 am and 10 pm on May 21. When these atmospheric conditions occur, extraneous sound from wind in trees is significantly reduced and sound levels from wind turbines are most noticeable. The hour beginning at 2:00 am on May 21 had the lowest surface winds at or below 5 mph except for two 3-second periods when the wind reached 7 mph. The hour beginning at 10:00 pm also had light surface winds but with several 3-second gusts in the 6 to 8 mph range. During the shutdown period at CP-1 winds were typically from 4 to 8 mph with several 3-second gusts reaching 12 mph.

Among the three measurement periods, the highest one-third octave sound levels at frequencies below 20 Hz and above 4,000 Hz occurred at CP-1 when the nearest turbine was shut down. Surface wind speeds (10 meter) were also higher at CP-1 than at CP-4 during these hours. This indicates that the higher sound levels at low and high frequencies were from ambient (non-wind turbine) sources such as wind acting on trees. Exhibit 1 graphs show lower sound levels at these frequencies, as well as frequencies between 20 and 125 Hz, when the surface winds at CP-4 were lowest (hour beginning 2 am). Overall, the hourly sound levels at CP-4 for the hour beginning at 2:00 am on May 21 are most representative of wind turbine sound levels at full sound output. The hourly equivalent sound level at CP-4 for this period was 46.3 dBA at a distance of approximately 1,250 feet from the closest turbine of the Stetson array.

Exhibit 1 also shows low frequency and infrasound levels relative to the threshold of hearing for 1/3 octave bands from 6.3 Hz to 500 Hz. Ambient sound as represented by measurements at CP-1 with the nearest wind turbine shut down is below the hearing threshold in the infrasound region. Measurements at CP-4 clearly show infrasound levels more than 20 dB below the hearing threshold. Because the nearest protected location at Oakfield is approximately 600 feet farther away than the nearest turbine at Stetson CP-4, infrasound levels at Oakfield protected locations are also expected to be more than 20 dB below the hearing threshold. Measured sound levels at both CP-1 and CP-4 cross the hearing threshold at approximately 50 Hz.

In addition, Exhibit 1 presents the average threshold of sensation (feeling) from infrasound and low frequency noise (ILFN) developed after Yamada 1983. The average threshold of feeling is 20 dB or more higher than the hearing threshold and 40 dB or more above wind turbine sound levels at CP-4. Further, Exhibit 1 compares measured sound levels at CP-4 with a sound level of 85 dB on the G-weighted scale used for infrasound measurements per ISO 7196. The Environmental Protection Agency in Denmark has established criteria for infrasound of 85 dBG (Infrasound Emission from Wind Turbines, J. Jakobsen, Danish EPA, 2005). Wind turbine sound levels at Stetson position CP-4 are approximately 15 dB or more below the 85 dBG infrasound criteria. Similar results can be expected at Oakfield.

From measurement results at CP-4, RSE calculated hourly whole (1/1) octave band sound levels for comparison with criteria for room noise as contained in American National Standards Institute (ANSI) S12.2-2008 "Criteria for Evaluating Room Noise". Exhibit 4 presents graphs that compare the outdoor sound levels from Stetson Wind with ANSI room criteria guidelines and limiting levels for low frequency sound levels for acoustically induced vibration of lightweight wall and ceiling structures. ANSI noise criteria (NC) curves are widely used for evaluating background sound in buildings.

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ANSI 12.2 Annex C recommends criteria of NC-25 to NC-30 for bedrooms of private residences. RSE selected the lower NC-25 (indoor) for evaluation of sound levels from operation of the proposed Oakfield Wind Project. No reduction from transmission loss of the building structure for attenuation of outdoor sound levels to indoors has been taken for these graphical comparisons. In reality, a minimum transmission loss of 5 dB at 63 Hz and 10 dB at frequencies of 125 Hz would be expected. The expected sound levels at the highest modeled receiver position at Oakfield would also be approximately 1.5 dBA below the measured wind turbine sound levels at Stetson position CP-4.

Exhibit 4 shows that the measured sound levels at CP-4 in low surface wind (high upper wind) conditions are 6 dB or more below the ANSI guidelines for inducing structural vibration and at or below the NC-25 room criterion guidelines at frequencies at and below 63 Hz. As expected, the outdoor sound levels measured at Stetson are above the indoor room criteria at other frequencies including near ambient conditions during the shutdown at CP-1. However, accounting for the transmission loss of the structure will reduce measured outdoor sound levels to be at or below the quiet room criteria at frequencies between 125 and 4,000 Hz. An additional 1.5 dB or higher reduction would also be required to reflect the model estimates for Oakfield based on the hourly L_{Aeq} of 46.3 dBA.

Comparisons of measured sound levels from Stetson with relevant ANSI health and vibration standards demonstrate that there will not be adverse impacts due to sound levels from operation of the proposed Oakfield Wind Project.

In its review of potential issues associated with low frequency and infrasound from operation of utility-scale wind energy projects, the Maine DEP consulted with the Maine Center for Disease Control. The Maine DEP and Dora Anne Mills, MD, MCDC Director, reviewed a considerable body of scientific, peer-reviewed evidence and concluded that low frequency and infrasound from wind turbines does not pose a measurable health risk for projects that comply with Maine DEP limits. Exhibit 5 provides examples of literature that RSE understands was reviewed by Maine DEP and Dr. Mills.

Response to item 3 is pending.

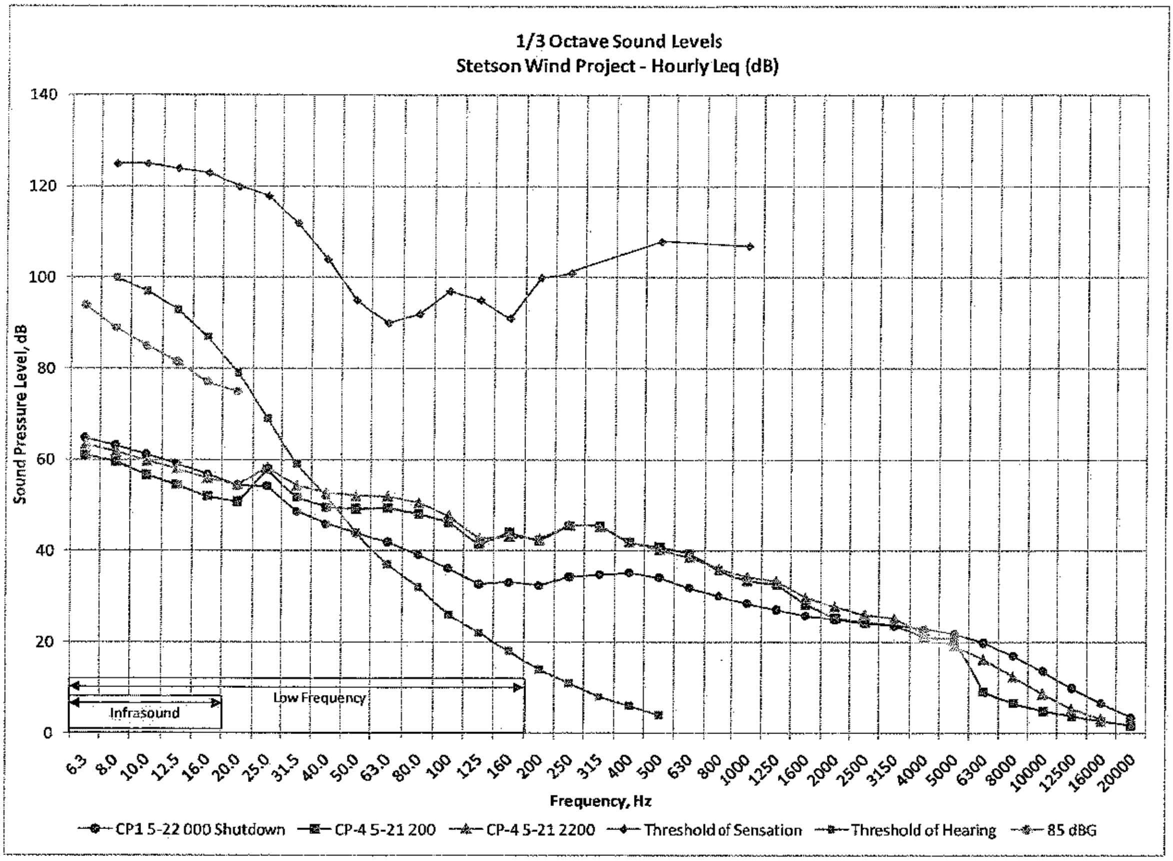
Sincerely,
Resource Systems Engineering

Charles F. Wallace, Jr., P.E.
President
Enclosures

R. Scott Bodwell, P.E.
Sr. Project Engineer

cc: D. Morris, Town of Oakfield
A. Hamilton, Eaton Peabody
J. Browne, Verrill Dana

Oakfield Wind Project
Exhibit 1



Source: Threshold of Hearing. Hayes, Malcolm. Low Frequency and Infrasound Noise Immissions from Wind Farms and the Potential for Vibroacoustic Disease. 2006.
Threshold of Sensation. Shinji, Yamada. Body Sensation of Low Frequency Noise of Ordinary persons and Profoundly Deaf Persons. 1983.

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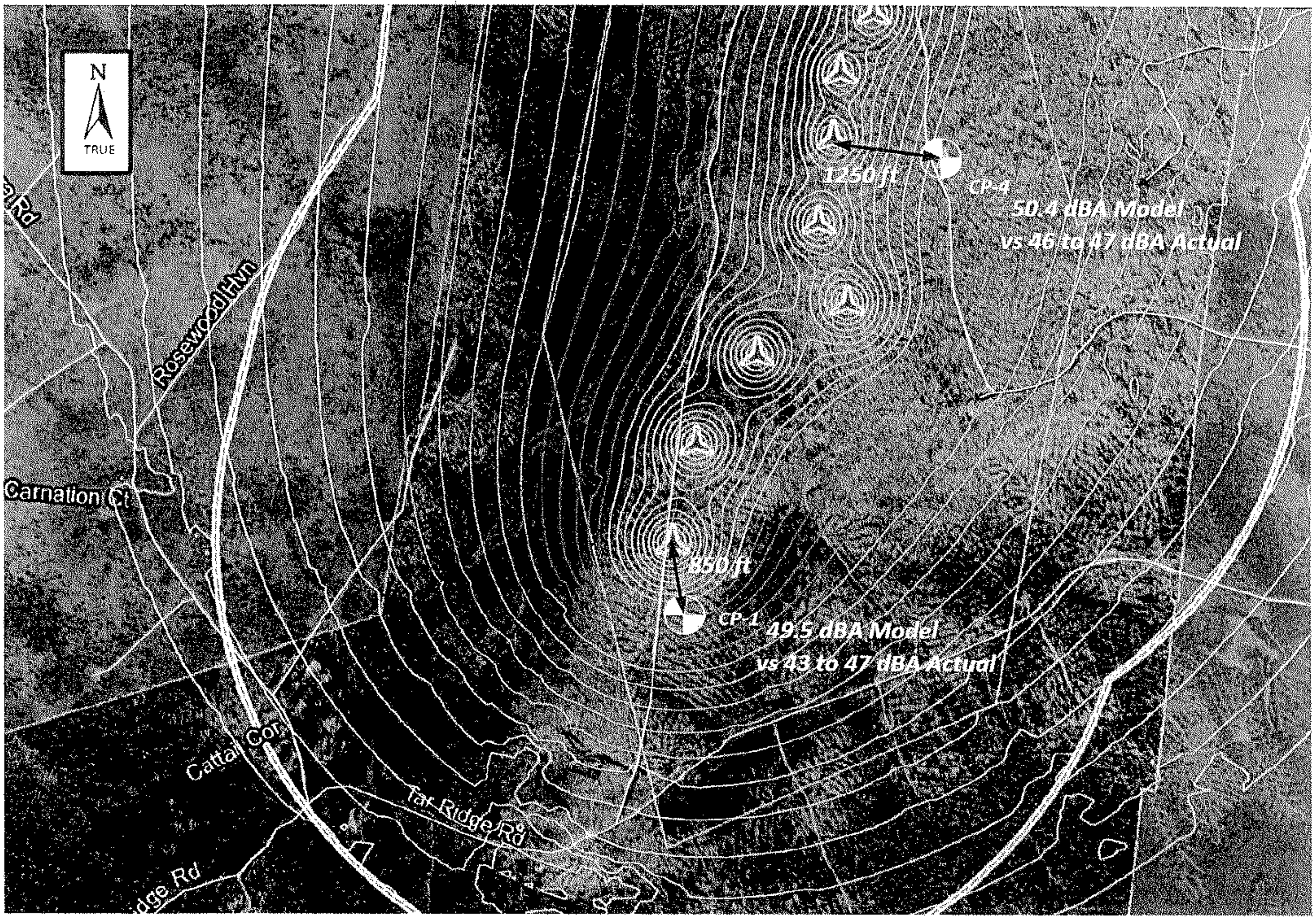
Oakfield Wind Project
Exhibit 2



MEASUREMENT LOCATIONS – STETSON WIND PROJECT

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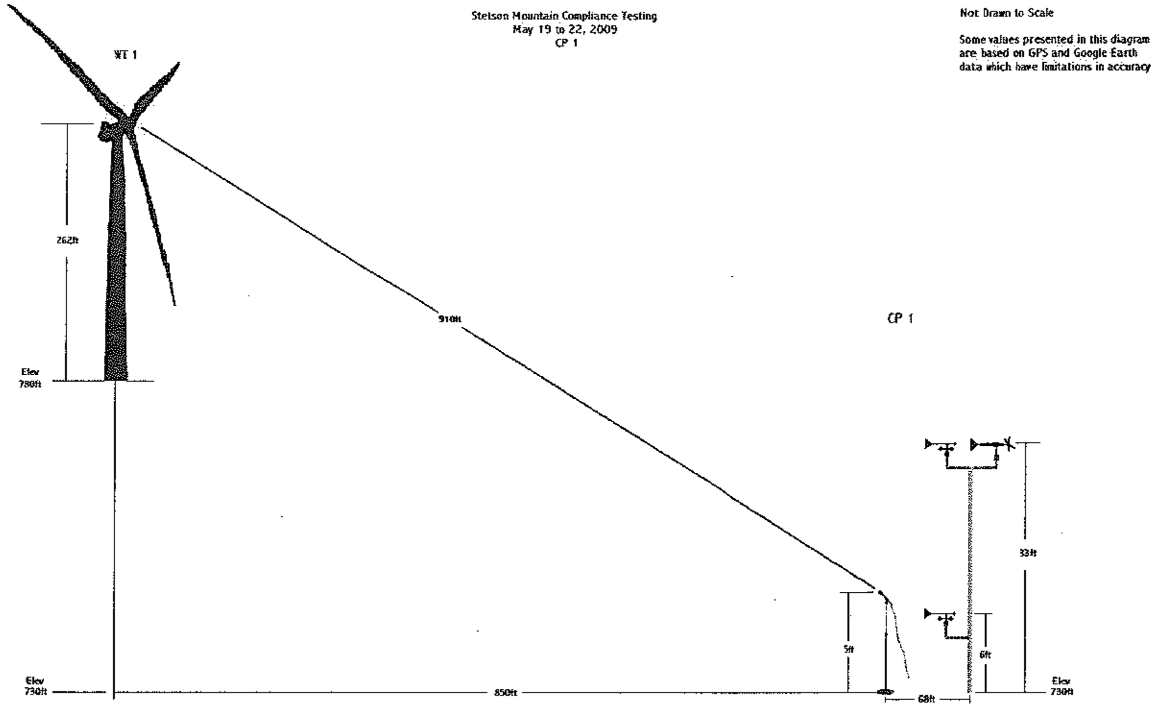
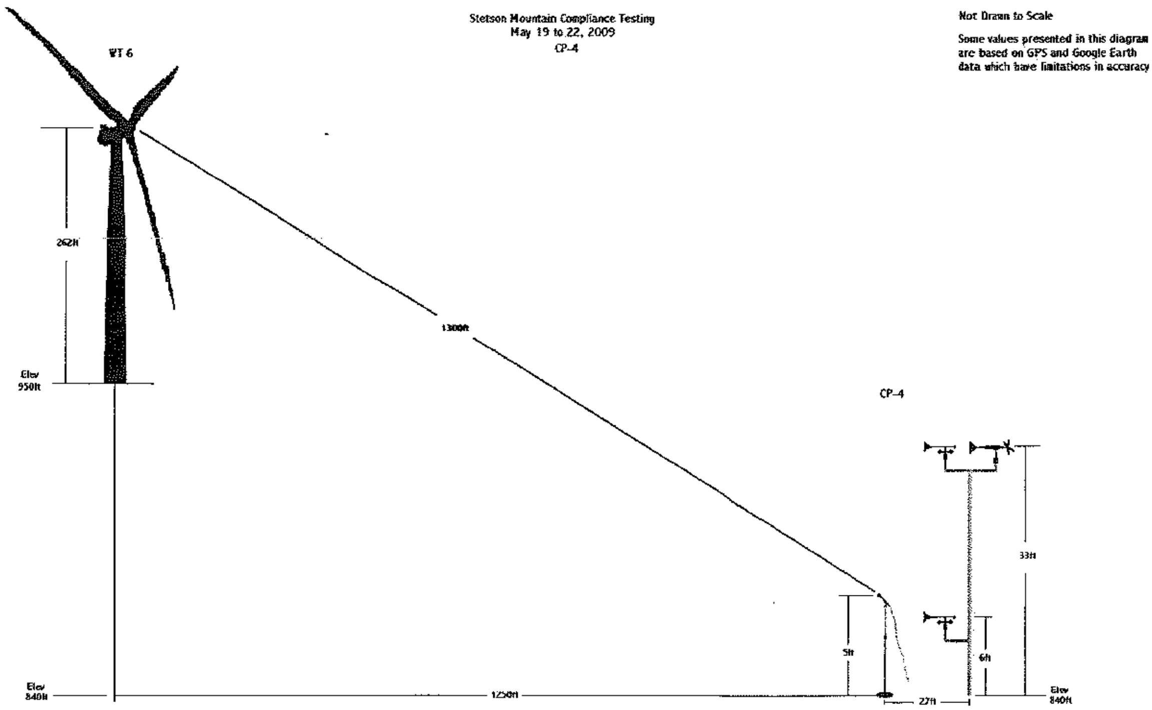
Exhibit 3





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Oakfield Wind Project
Exhibit 4

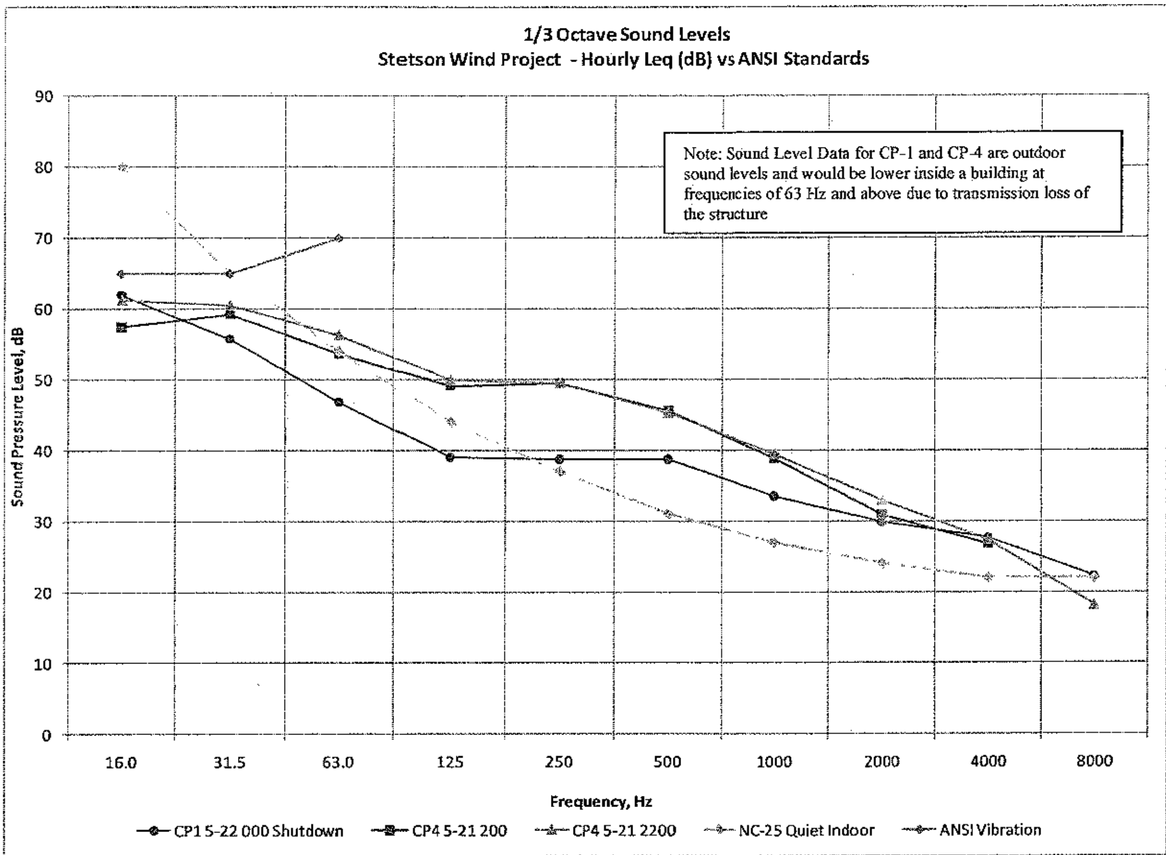

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Exhibit 5

Published literature reviewed by Maine DEP and Maine Center for Disease Control (reference Wind Turbine Neuro-Acoustical Issues, D.A. Mills, MD, MPH Maine CDC/DHHS, March 2009):

- Eja Pedersen, Noise Annoyance from Wind Turbines, Swedish Environmental Protection Agency (2003) ("There is no scientific evidence that noise at levels created by wind turbines could cause health problems other than annoyance.")
- Health Assessment Section, Bureau of Environmental Health, Ohio Department of Health, Literature Search on the Potential Impacts Associated with Wind-to-Energy Turbine Operations, (2008) ("No evidence was found to indicate adverse health impacts in humans caused by infrasound levels generated by modern wind turbines")
- Danish Electronics, Light and Acoustics, Low Frequency Noise from Large Wind Turbines: A Procedure for Evaluation of the Audibility for Low Frequency Sound and Literature Study (2008) ("Low frequency is one of the two lowest ranking sound characteristic descriptors in relation to annoyance.")
- Geoff Leventhall, Infrasound from Wind Turbines – Fact, Fiction or Deception, Canadian Acoustics, Vol. 34 No. 2, at 29 (2006) ("[T]here is insignificant infrasound from wind turbines and . . . there is normally little low frequency noise.")

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APPENDIX 7

WIND TURBINE SOUND AMPLITUDE MODULATION vs. SHORT DURATION REPETITIVE SOUND

RESOURCE SYSTEMS ENGINEERING

OCTOBER 29, 2009

Wind Turbine Sound Amplitude Modulation versus Short Duration Repetitive Sound

Reference Maine Department of Environmental Protection Chapter 375.10

Prepared by: Resource Systems Engineering
Charles F. Wallace, Jr., PE

First Edition: April 14, 2009
Second Edition: October 29, 2009

The terms "low frequency sound" used by laymen to describe wind turbine "swish-swish" or "blade thump" is a misuse of acoustical terminology. "They might not be aware that the term 'low frequency sound' makes acousticians think of frequencies below 100 to 200 Hz, and in that range the sound is not considered to be problematic"[Ref: ***The sounds of high winds*** by G.P. van den Berg, 12 May 2006, pg 5]. Also, "...turbulent flow is the dominant cause of [audible] sound for modern wind turbines. It is broad band noise with no tonal components and only a little variation, known as blade swish. ... TE [trailing edge] sound level, the dominant audible sound source in a modern turbine, therefore increases steeply with blade speed and is highest at the high velocity blade tips." [Ref: ibid pg 35] "Atmospheric stability is not only relevant for wind turbine sound *levels,* as we saw in the preceding chapter, but also for the *character* of the sound. In conditions where the atmosphere is stable, distant wind turbines can produce a beating or thumping sound that is not apparent in daytime." [Ref: ibid pg 61] The frequency of amplitude modulation (AM) is not an audible sound by itself but rather changes the character of the dominant higher audible frequencies to make them more noticeable.

Short duration repetitive sounds (SDRS) are regulated by the Maine DEP under Chapter 375.10 C. (1) (e). SDRS is: *"A sequence of repetitive sounds which occur more than once within an hour, each clearly discernible as an event and causing an increase in the sound level of at least 6 dBA on the fast meter response above the sound level observed immediately before and after the event, each typically less than ten seconds in duration, and which are inherent to the process or operation of the development and are foreseeable"* (ref. Chapter 375.10 G. (19)).

According to various publications and RSE measurements, amplitude modulation (AM) of wind turbines does occur. Resource Systems Engineering (RSE) measurements show that the sound pressure level range is very similar to the amplitude modulation of a common, oscillating household fan with a modulating frequency as a function of the oscillation speed (see Figure 1). Wind turbine amplitude modulation is reported to be a function of the rotor blade down or up stroke and the frequency of the turbine blades passing the tower. Both result in a modulation of the most audible frequencies (250 -1200 Hz) of WT sounds (ref: Richarz et.al. pg 6-7). This results in the "whoosh" or "thump" sounds that are mistakenly described by some as low frequency and infrasound. Also, while AM has the potential to exceed 6 dBA, as required to be an SDRS per DEP regulations, RSE is unaware of any observed or measured wind projects in Maine that frequently exceed this 6 dBA threshold using GE 1.5 sle turbines or for turbines whose layouts are linear along ridge tops and mountainous terrain. Even when AM has been found to exceed DEP's 6 dBA SDRS threshold by other credible researchers such as Dr. G.P. van den Berg, it did not occur very frequently and required synchronicity and coherence of pulses to have an additive effect at far field receiver positions.

For example, G. P. van den Berg published his work as a PhD dissertation and also in a book referenced above. In **Chapter V: The Beat is Getting Stronger** van den Berg discusses AM from a single turbine and the effects of atmospheric stability, coherence and synchronicity of several turbines combined. Figure V.3 (pg 74) presents amplitude modulation from a single turbine at the Rhede Wind Park in Germany. The Rhede Wind Park consists of 17 Enercon E-66 1.8 MW turbines with a hub height of 98 meters, 3-blade propellers with 35 meter blade length arranged in a double row manufactured circa 2000 – 2001 (ref: van den Berg at pgs 39, 40, 45). Figure V.3 shows AM near turbine 16 and then close to a dwelling. The full range of AM in these graphs is < 5 dBA. Subsection **V.2.4: Beats caused by interaction of several turbines** also presents figures of AM that show how AM increases with coherence and synchronicity. Figure V.4 (pg 75) shows that AM near the residence increases as a result of the interaction of several turbines and also shows that the AM is < 6 dBA. **Table V.2: level variation in wind turbine sound due to blade swish, in dB** (pg 79) compares calculated results to measured results. In the **Measured results** portion, the variation in AM from a single turbine is 5.9 dB [possibly what is meant based on earlier charts is dBA] and the ***most frequent*** variation from multiple turbines is equal or less than 5.5 dB[A]. The maximum variation is

9.5 dB[A]. In ***Wind Turbine Noise Diagnostics,*** Richarz states: "Predicted amplitude modulation ranges from 1 dB to 6 dB." (ref: Richarz pg 1).

In reviewing van den Berg and other relevant work, it must be remembered that those measurements were from wind parks with significantly different terrain, ground cover (some with relatively open farm fields) and different turbine arrays (somewhat more closely spaced and more rectangular layouts) than found at the Mars Hill, Stetson, Rollins and Oakfield Wind Energy projects. These Maine projects all have or plan to install similar GE 1.5 sle wind turbines. Figure 2 shows a sound clip from van den Berg as presented in ***Effects of the wind profile at night on wind turbine sound***. Figure 3 and Figure 4 present examples from the Kamperman and James "How to Guide". Figure 5 is from Richarz, Wind ***Turbine Noise Diagnostics***, 2009. And Figure 6 is a clip from RSE's May 2009 measurements at Stetson Mountain presented at the Oakfield Workshops. Individually and collectively, these examples all demonstrate that the preponderance of AM shown in these clips is below the DEP 6 dBA threshold required for regulation as SDRS. Most importantly, the only example of AM from a wind farm consisting of GE 1.5 sle turbines in a ridge top "string" array routinely operating in Maine and measured under stable atmospheric conditions is Figure 6 by RSE.

The attached references are provided and discuss AM and its causes. While there is no question that AM from wind turbines can occur at some level, according to van den Berg, the *most frequent variation* even from multiple turbines in relatively close proximity on relatively flat terrain is less than the 6 dBA threshold required for the AM to be regulated by DEP as SDRS per Chapter 375.10. As a result of RSE 2009 measurements at Stetson Mountain and based on the referenced literature, RSE does not expect Stetson, Rollins or Oakfield Wind to generate significant AM above the DEP 6 dBA SDRS threshold.

References

Bowdler, Bullmore, Davis, Hayes, Jiggins, Leventhall, McKenzi. (2009). Prediction and assessment of wind turbine noise. Acoustics Bulletin. March/April 2009. p. 35-37.

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Richarz, Werner and Richarz, Harrison. (2009). Wind Turbine Noise Diagnostics. WTN2009.

Plovsing, Birger and Sondergaard, Bo. DELTA (2008). EFP-06 Project: Low frequency Noise from Large Wind Turbines: A procedure for evaluation of the audibility for low frequency sound a literature study. Prepared for the Danish Energy Authority by Danish Electronics Light & Acoustics, Horsholm, Denmark. 78 pp + app.

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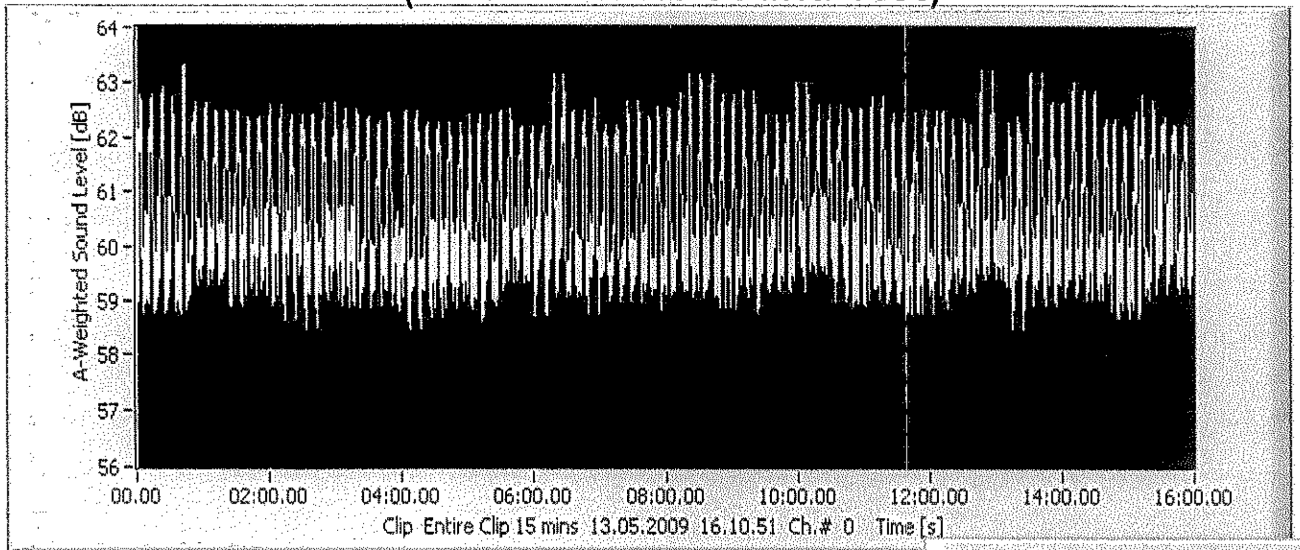
van den Berg, G.P. (2006). The Sound of High Winds. The effect of atmospheric stability on wind turbine sound and microphone noise.

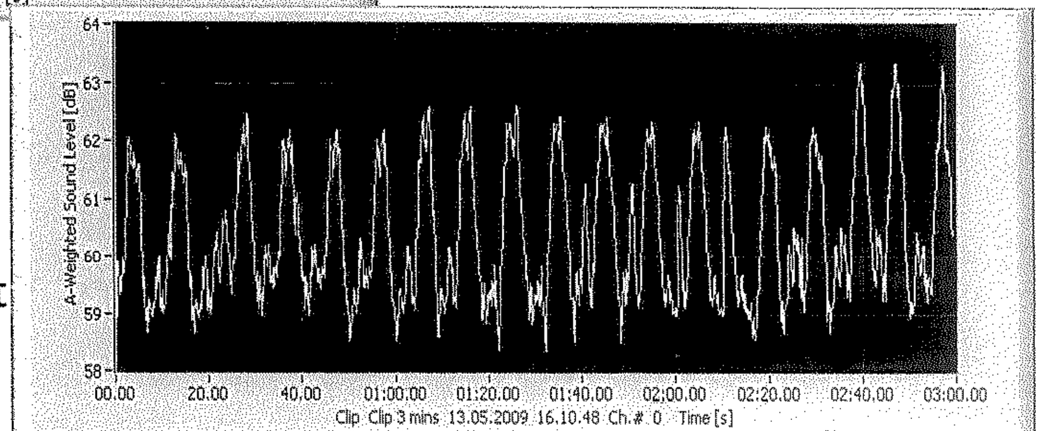
Common Household Pedestal Oscillating Fan (15.58 minute Sound Test)

Figure 1



Measurements were recorded at RSE's office on May 13, 2009 with a Larson Davis Type 1 Sound Level Meter Model 831, 10 minute intervals, fast time weighted. The wave file was imported and analyzed using noiseLab analytical software. noiseLab analyzes 125 ms data.

3 minute Clip of Sound Test



14 second Clip of Sound Test

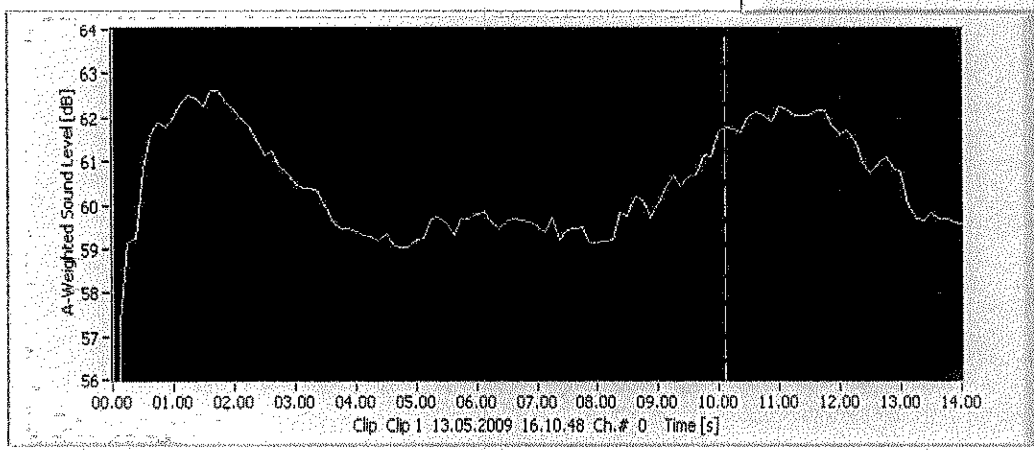


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Figure 2

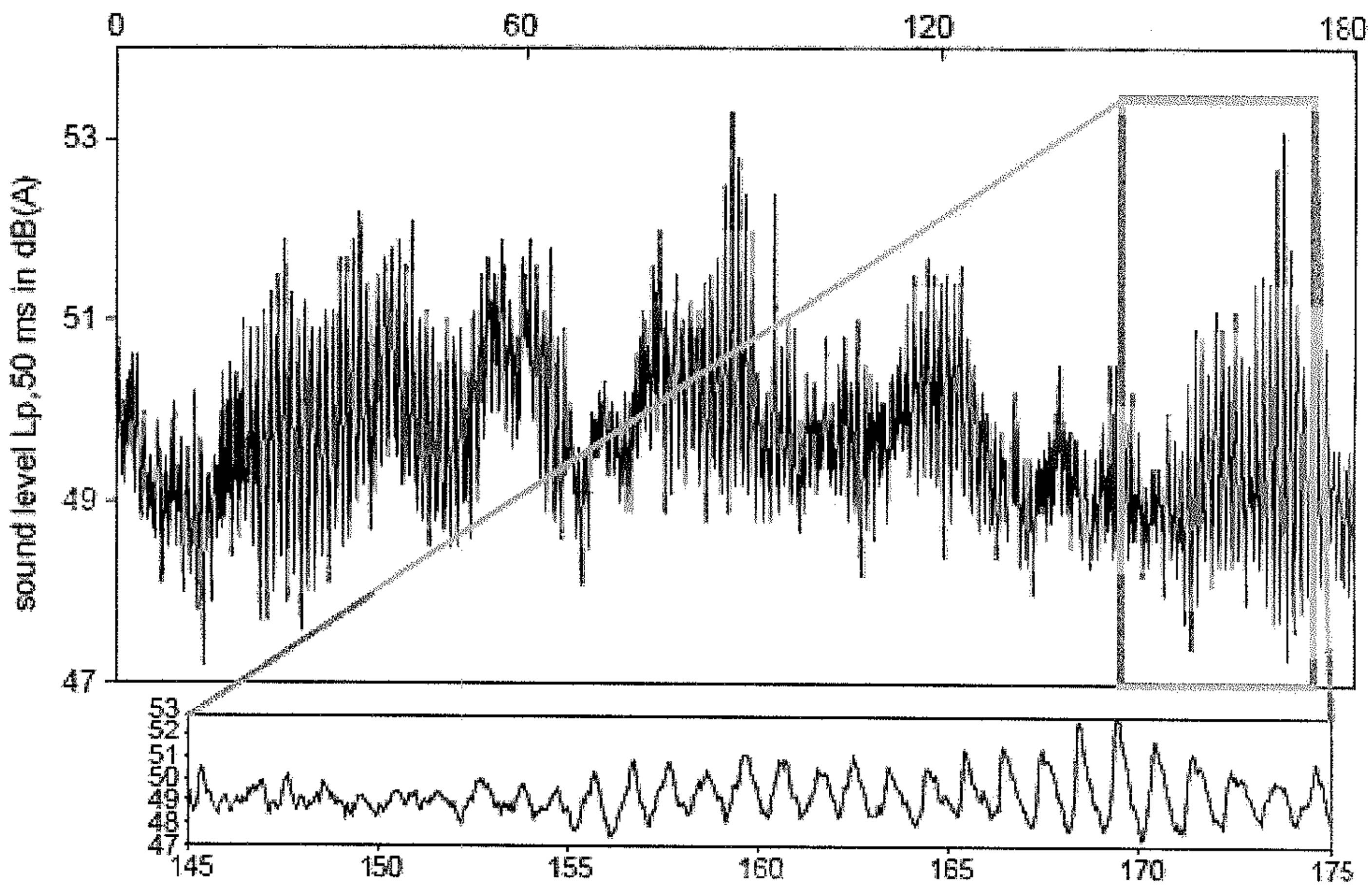

Fig. 8. Sound pressure level caused by wind turbines per 50 ms near dwelling at 750 m from nearest turbine (including reflection at façade at 2 m) over a 3 min period; part of the sequence is amplified below.

Effects of the wind profile at night on wind turbine sound. G.P. van den Berg. Journal of Sound and Vibration, 2003.

Figure 3

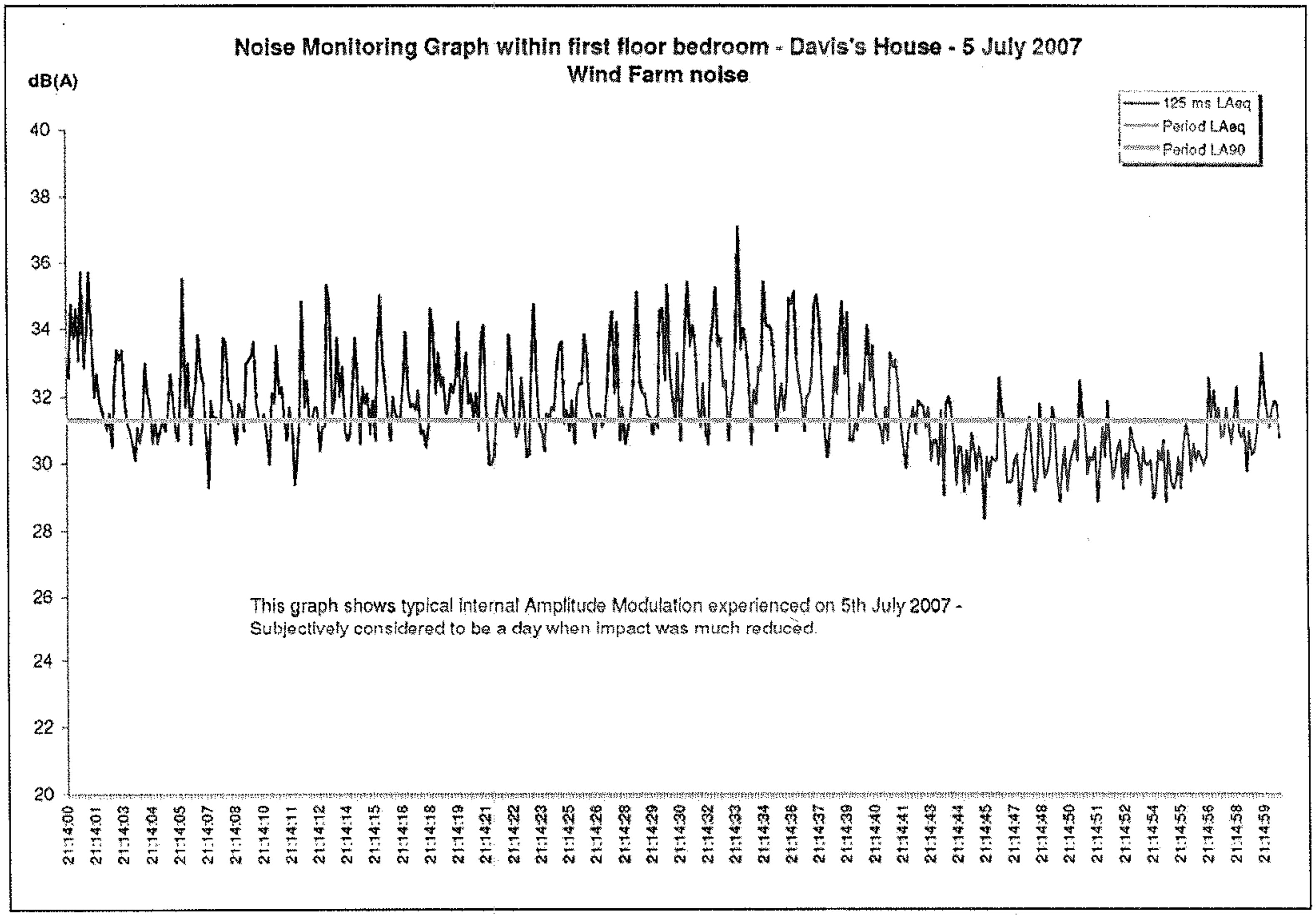

Figure 5- Amplitude modulation in a home 930 meters (3000 feet) from the nearest turbine.[19]

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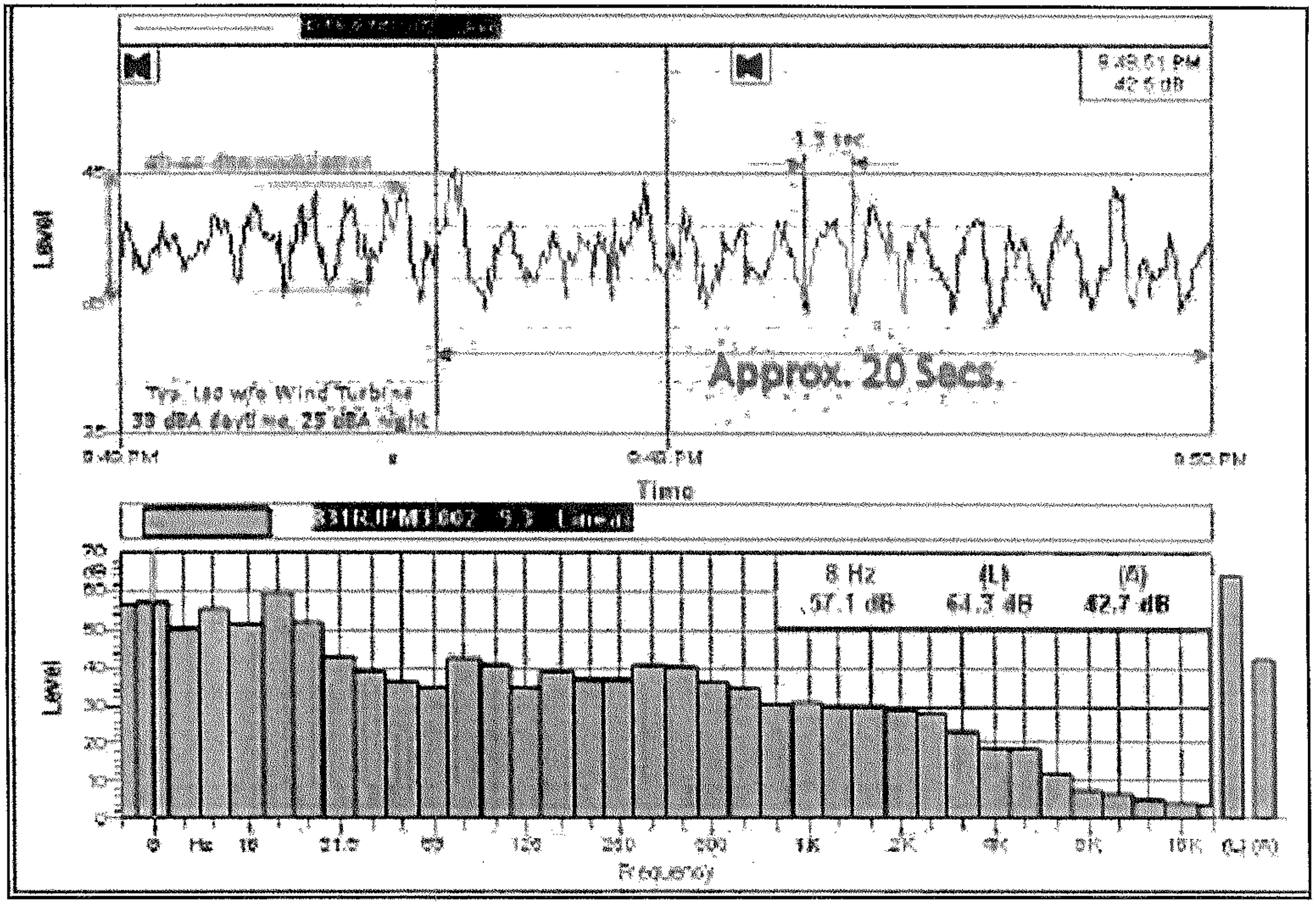
Figure 4



The "How To" Guide to Siting Wind Turbines To Prevent Health Risks From Sound. Kamperman and James. 2008.

Figure 5

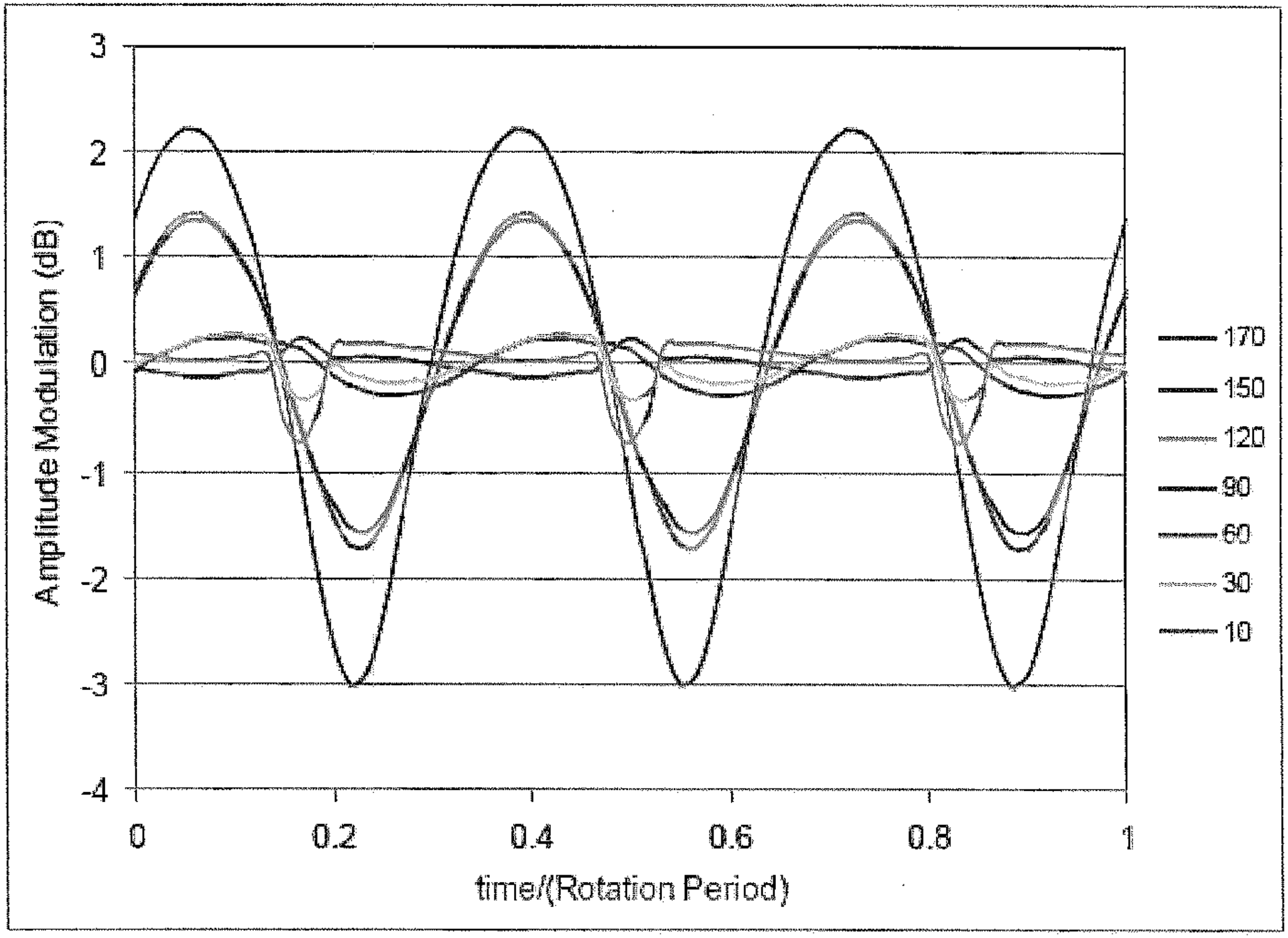


Figure 9 Amplitude modulation of radiated sound for a complete three bladed rotor.

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Wind Turbine Noise Diagnostics. Richarz and Richarz. 2009.

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Figure 6
(as presented at the Oakfield Workshops)

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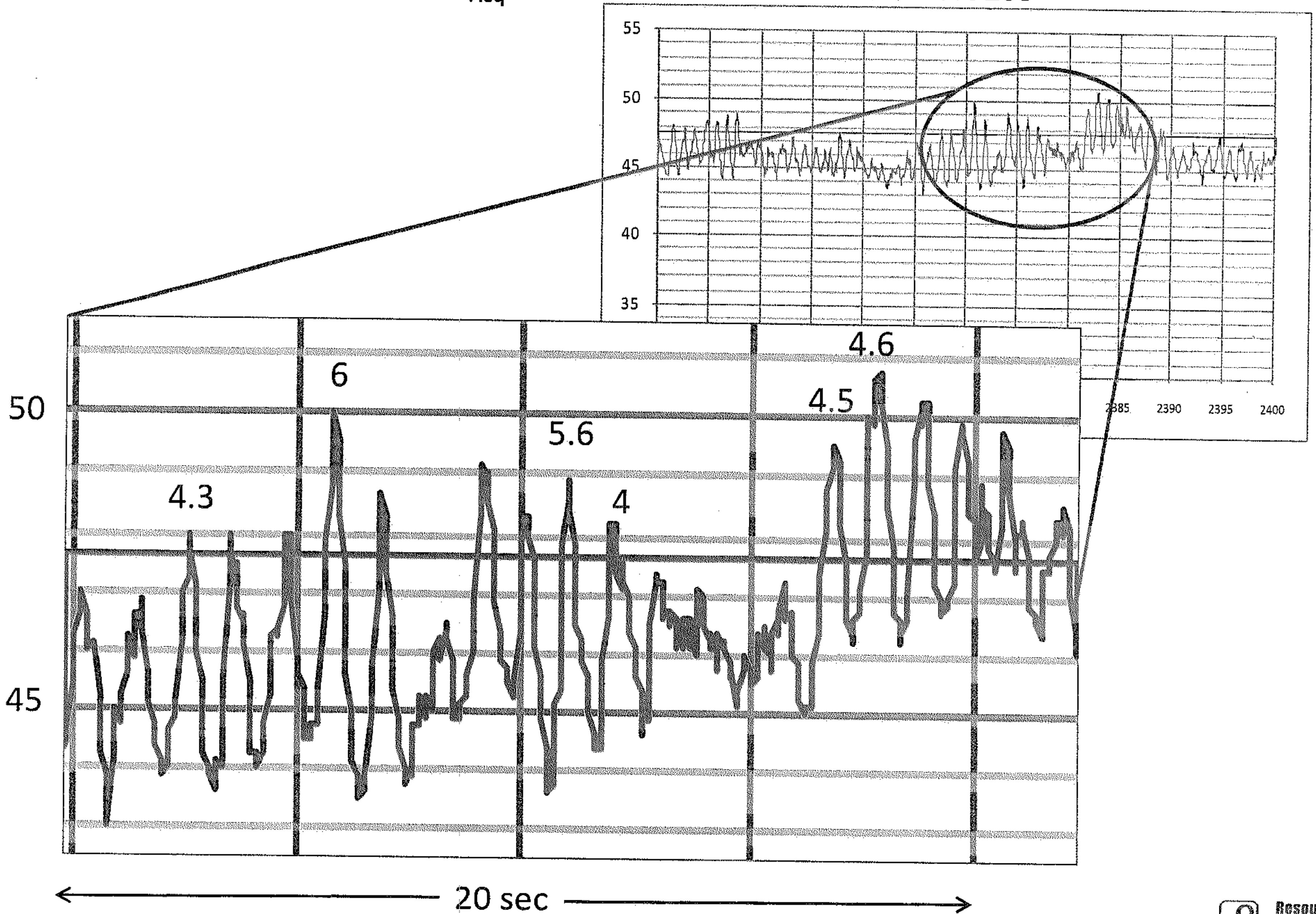
Stetson Wind CP-4
50 ms L_{Aeq} Measurements from 5-21-09 Start 200



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