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REVIEW OF NOISE STUDIES AND RELATED MATERIAL REGARDING DRAFT ENVIRONMENTAL IMPACT STATEMENT (EIS)/ENVIRONMENTAL IMPACT REPORT (EIR) FOR THE OCOTILLO WIND ENERGY FACILITY (OWEF), IMPERIAL COUNTY, CALIFORNIA

DATE: OCTOBER 5, 2011

Introduction

This review was conducted on behalf of The Protect Our Communities Foundation and Backcountry against Dumps, Inc.[1] as part of their public comments on the BLM EIS/EIR for the proposed Imperial County, Ocotillo Wind Energy Facility, (referred to here as "OWEF" or the "Project"). Additional references are Case File Number: CACA051552 and Document Number: CA-670-2010-032. The focus of this review is on the Draft EIS/EIR Sections relating to noise and its impact on people and wildlife in the region of impact. My work with local communities and citizens groups around the U.S. and Ontario, Canada has focused on the question of how to integrate industrial wind turbines into rural communities. Please see the attached biographic information for my background and experience in wind energy noise and health. In this review I would like to share my understanding of siting criteria for modern industrial scale wind turbines and the impact of the wind turbine noise on people and wildlife.

I have visited sites throughout the Midwest from western Iowa to the coast of Maine, and Ontario to West Virginia where wind turbines were either operating or proposed. I have also reviewed the noise criteria and setbacks proposed by States, Provinces and local government bodies for wind farms. This has given me broad exposure to a number of different situations each with their own requirements. Based on this I find three issues that have a particular importance for my report.

I would like to focus on these points:

First, setbacks, from property lines to the nearest turbine of less than 2 kilometers (1.25 miles) are clearly inadequate for extremely quiet rural communities. The presence of nearby highways will not mask or otherwise offset the noise from wind turbines.[2] Wind turbine noise is distinctively annoying and is not addressed when criteria using dBA weighting and long averaging times are used.[3] [4] [5] The reports and documents submitted on behalf of the Project do not correctly or adequately describe the impact of the proposed project on the host community, or its residents whose homes and properties are close to the footprint of the project. Further, they do not apply the appropriate normalization factors to either the L_{dn} or CNEL land-use compatibility evaluations used by BLM, Imperial County, and the State of California. A separation distance of over one mile may seem

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[1] The Protect Our Communities Foundation, Dennis Trafecanty, President, PO Box 305, Santa Ysabel, CA 92070 and Backcountry Against Dumps, Donna Tisdale, President, P.O. Box 1275, Boulevard, CA 91905

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

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

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

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

extreme but is needed based on the experiences of communities with other wind turbine projects and is alluded to in the EIS/EIR. People living at distances of a mile or more from wind turbines on flat land are experiencing adverse health effects from sleep disturbance at night from audible turbine noise. Other aspects of wind turbine sound emissions, especially amplitude modulated infra and low frequency sounds, even those that may not be reach the threshold of audibility, are currently believed to be caused by disturbances to our organs of balance from the energy in the rapid modulations of the infra and low frequency sound.[6] [7]

Second, background sound levels submitted on behalf of the Project's developers and/or operators are described as ambient sounds which include the effects of short term events and insects, birds, and 'wind noise'. The selected measurement locations are too close to traffic routes or other local noise sources such that they do not reflect the quiet nature of the rural wilderness community. The measurements used to collect this information do not meet any recognized national or international standard[8]. The end result is a biased assessment of background sound levels that overstates the characteristic soundscape of the community as experienced by the local population and wildlife by as much as 10 to 15 dBA. Use of this data to evaluate the potential for negative impacts of the people living near the project as required in the BLM and CEQA Guidelines leads to a conclusion that the wind turbine noise will not be a source of noise pollution at the homes and properties near the project[9]. Had background noise been properly measured the conclusion would be that the Project will have a significant, continuing impact on the adjacent communities and wilderness areas.

The four test locations identified in the EIS/EIR (L1 through L4, Figure 3.10-3) are all located near traffic arteries which will significantly inflate the measured L_{eq} sound levels. The EIS/EIR uses these measurements as the basis for asserting that other areas distant from the traffic routes will have similar high sound levels. Nothing could be further from the truth. Background sound levels in communities of this type are routinely in the mid 30 dBA L_{eq} class during daytime and, at night after traffic and man-made activities begin to drop off, the levels drop to the low 20 dBA Leq range. Had the proper background readings been used for the decision making presented in the EIS/EIR the increase in sound level caused by the wind turbines would be 10 to 20 dBA near residential properties. An increase of this amount will result in the new sounds being considered highly objectionable and likely a source of sleep disturbance. In the wilderness area the sounds will increase by 20 to 30 dBA near or within the footprint of the proposed turbines. As will be shown later, this will have a deleterious impact on wildlife because it will reduce the listening area for mating calls and for predator avoidance.[10]

Third, computer model estimates of operational sound levels from the proposed projects understate the impact of the turbines on the community. The computer model estimates do not include confidence limits as is appropriate for any scientific or engineering study (conservatively this would add 3.6 dB to all predicted values and contour lines) nor does the model reflect operation of the

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

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

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

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

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

turbines during nighttime during periods of stable atmospheric conditions and other times when in-flow turbulence or high wind shear increase the noise emissions by 6 dBA or more. [11]

Had the background studies met the procedural and protocol requirements of the American National Standards Institute's (ANSI) S12.9 and S12.18 standards for measuring the residual background outdoor sounds the study would have reported much lower background sound levels. The Project would have a "significant impact" under the rules of the BLM, Imperial, and CEQA Guidelines (Appendix G). Had the modeling properly addressed the increased sound power emitted by wind turbines from atmospheric conditions, desert topography with ridges to the north, west, and south of the project, high temperature gradients that produce high wind shear and turbulence, and small inter-turbine spacing, the dBA sound levels, L_{dn} and CNEL values predicted for the sensitive receiving locations would have been much higher. These conditions include those of:

- nighttime atmosphere with a stable boundary layer (temperature inversion) and high wind shear above that boundary layer (e. g. high wind shear),
- periods of atmospheric turbulence, as is likely for turbines mounted on high locations with rough terrain, and
- inter-turbine wake-induced turbulence created when turbines are located in rows with inter-turbine spacing of less than 5 to 7 rotor diameters (new information indicates this may need to be more like 10 to 15 rotor diameters)[12] to prevent inter-turbine wake turbulence. Turbines in the current layout are as close as 3 rotor diameters or less.

The BLM/CEQA rules that define when an impact is significant that would not be met if the background noise study, computer modeling, and L_{dn} and CNEL normalization process had been conducted according to the practices identified in this report are:

- Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies;
- A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project;

Information used in the EIS/EIR provided by representatives of the Project developer and their experts for the Project, on topic of health risks, infra and low frequency noise, noise limits and setbacks, background sounds in rural communities and computer modeling studies are incorrect, incomplete or otherwise misleading. Any implied or stated assertions that there is no research supporting a concern that wind turbine sound emissions at receiving properties and homes or that they cannot result in adverse health effects do not reflect current understanding of independent medical and acoustical research. [13] [14]

The combination of the above negative factors in the reports prepared as submittals regarding the Project's wind turbine noise emissions/pollution will result in sleep disturbance for a significant

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

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

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

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

fraction of those who live a mile or more away. Chronic sleep disturbance results in serious health effects.

For a smaller portion of the community, there will be a risk of the adverse health effects currently described as Wind Turbine Syndrome mediated through the body's organs of balance (vestibular) and proprioception. This is a different set of symptoms and causes than what would be expected of higher levels of infra and low frequency sound and are not related to the audibility of the ILFN. The reports and other documents described in the EIS/EIR on infra and low frequency sound (3.3.5) address adverse health effects that occur when the sound pressure level of the noise source exceeds the Threshold of Perception. The adverse health effects of concern are not related only to those associated with audible levels of infra and low frequency sound. There are also adverse health effects associated with modulated infra and low frequency sounds at levels below the threshold of audibility. Dr. Pierpont's peer-reviewed study reported in "Wind Turbine Syndrome" (published in 2009) is now supported by the work of others, such as, Dr. Alec Salt and his colleagues at the Washington School of Medicine in St. Louis, MO and the Lerner Research Institute/Head and Neck Institute in Cleveland, OH. A reference to one of the peer reviewed papers was provided earlier and others published on this topic are available through on-line Journals.

The result of these technical flaws and an outdated understanding of how the human body responds to acoustical energy below the threshold of audible perception leads to a conclusion that if the Project, as proposed, is approved, it will, with a high degree of certainty, have negative noise health impacts that are "significant." Given that these health effects are first noticed by people with pre-existing medical conditions and that many residents of Ocotillo are retired veterans of the Vietnam War who have such conditions the likelihood that these effects will be more prevalent than in other communities must be considered.

Review

The Draft Environmental Impact Statement provided by the BLM is the subject of this review. I have also had the opportunity to review many similar documents prepared for other wind turbine projects by other acoustical consulting groups that work for the wind turbine project developers.

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

The review will address a number of topics. Those topics include:

- Discussion of terms and standards,
- Discussion of weather and its effect on turbines
- Discussion of spacing and its effects on turbine noise
- Limits on noise to protect residential properties and residents:
    - Imperial County sets a CNEL of 60 (Entry in Table 7 for residential, page 21) as the level permitted outside a home. Proper use of this procedure to assess land use

compatibility for a new noise source requires that the CNEL be normalized to account for the difference between urban/suburban communities with prior noise exposure (the land use for which CNEL 60 applies) and the nature of the community that will have the new noise source. In this case the host community will be a rural residential community with no prior exposure to noise from the new source. This normalization process was not applied to the predicted CNEL in the report resulting in EIS/EIR tables and conclusions suitable for land use compatibility decisions in urban/suburban communities where industrial sounds are common. But, they are not correct for rural communities with no prior noise experience with a new noise source having impulsive sound characteristics.

- BLM uses the EPA's 1974 Levels documents recommendation for of 55 L_{dn} as its guide. Proper use of this procedure requires that the L_{dn} be normalized to account for the difference between urban/suburban communities with prior noise exposure (the land use for which CNEL 60 applies) and the nature of the community that will have the new noise source (rural residential with no prior exposure to noise from the new source). This normalization process was also not used in the EIS/EIR.
- BLM noise guidelines (Wind Energy Development, Chapter 4, page 9) also notes that an increase of 10 dB in the background sound level "…almost certainly causes an adverse community response." It also notes that Harris reports a 35 dB Ldn for rural communities. A 35 L_{dn} implies that nighttime sound levels are below 30 dBA.
- The World Health Organization's 2009 Nighttime Noise Guidelines states that levels above 40 dBA (Leq night-outside cause adverse health effects.

- Description of wind turbine noise as a source of environmental noise exposure and noise pollution for humans
- Evidence that the Project noise will exceed the permitted levels,
- Comments on the potential risks to health and welfare of persons living near the footprint of the Project specifically regarding wind turbine noise. A brief discussion on the potential for the noise to adversely impact mating and prey avoidance by wildlife in the footprint of the turbines.

Review of Terms and Standards

L_{Aeq}: The equivalent energy level in dBA. A measure of the acoustic energy over some interval of time that expresses the total energy of time-varying sound as a single number. Leq is very sensitive to short duration high amplitude events. A one hour Leq measurement in a quiet rural area with sound levels of 25 dBA for 59 minutes will have an Leq of 42.3 dBA if, during that hour, a short term noise, such as a vehicle pass-by on a nearby road, raises the sound level to 60 dBA for one minute. Leq is not a good descriptor for the background sound level in a quiet community where there are extremes between the residual sound (all sounds from afar that are not short term) and short term events that have high sound levels.

L_{An}: A statistical value determined by sampling sounds for some period of time, often 10 minutes to an hour, but it could also be longer, constructing a histogram. The L_{A90} would be the sound level representing the quietest 10% of the time. It is traditionally associated with the long term background sound level or residual sound level. The L_{A10} would be the sound level representing the noisiest 10% of the time. It is traditionally used as a descriptor of noisiness. The L_{A50} would be the sound level representing the median of the distribution of sound levels. The L_{A50} is not the same as L_{Aeq}. However, the L_{A50} is less sensitive to short term events and thus is often used to represent an 'average' sound level.

Ambient sound[15]: at a specified time. the all encompassing sound associated with a given environment, being usually a composite of sound from many sources at many directions, near and far, including the specific sound source(s) of interest.

Residual sound: at a specified time, the all-encompassing sound, being usually a composite of sound from many sources from many directions, near and far, remaining at a given position in a given situation when all uniquely identifiable discrete sound sources are eliminated, rendered insignificant, or otherwise not included. Specified in S12.9, Part 1 the residual sound may be approximated by measuring the percentile sound level exceeded during 90 to95 percent of the measurement period (e.g. L_{A90}).

Background sound: all-encompassing sound associated with a given environment without the contributions from the source or sources of interest. In S12.9, Part 3, background sound is described as a combination of (one) Long-term background sound, and (two) short-term background sounds, with the durations for long and short defined according to application and situation.

Long-term background sound: background sound measured during a measurement, after excluding the contribution of short-term background sounds in accordance with one of the methods specified in the standard S12.9, Part 3. Long-term background sound is assumed to be approximately stationary in a statistical sense[16], over the measurement duration, and it is describe solely by its sound exposure per unit time (in each frequency-weighted or frequency-filtered band of interest).

Short-term background sound: background sound associated with one or more sound events which occur infrequently during the basic measurement period, the measurement interval with or without the source operating, and measured in accordance with one of the methods in the standard S12.9, Part 3.

Note: Examples of short-term background sounds include sounds from such sources as: a nearby barking dog, accelerating motor vehicle, radio music siren and aircraft flyover, wind, insects, birds, etc.

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

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

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

Standards Used in Assessing Land-Use Compatibility

EPA Levels Document (1974): In the 1970's the EPA operated an Office of Noise Abatement and Control (ONAC) that was tasked with promulgating standards for communities and other non-occupational environments. In 1974, the EPA published the 'Levels" document which provided a resource for communities that were developing local or state level

[15] Reference standards are S12.9 parts 1 and 3 for these definitions.

[16] Seasonal and weather related sounds such as insects, birds, wind rustle in dry leaves, should also be considered short term sounds for the purpose of measuring the long term background sound level. In addition, the test instruments shall not be located near roads, poles, fences, trees, walls or other reflecting surfaces or sources of local noise not representative of the larger community. This also includes streams and locations near roads.

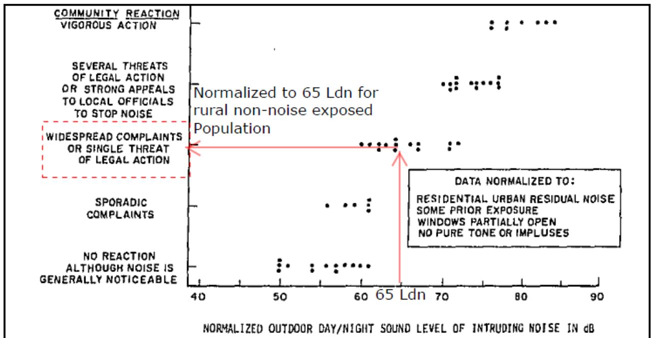

Figure D-7. Community Reaction to Intensive Noises of Many Types as a Function of the Normalized Outdoor Day Night Sound Level of the Intruding Noise D-3

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

noise ordinances. This work was primarily focused on the needs of urban and sub-urban communities with existing noise exposure. The body of the document presents information for this target audience. For communities with different soundscapes, such as rural communities the tables and graphs presented in the body of the document were not appropriate. The Levels document included an Appendix that provided the method to be used when adjusting the L_{dn} levels for a proposed project in a rural community to account for differences from the urban/suburban ones for which the 55 L_{dn} applied. Table-7 in the Figure 1 shows the adjustment factors that are to be added to predicted levels for the new noise source's L_{dn} to normalize the data to the equivalent annoyance level for a rural community. For example, an urban or suburban community with prior experience with noise might find sound levels of 55 L_{dn} to be satisfactory. An L_{dn} of 65 dB on the other hand will lead to widespread complaints (see red arrows on Figure D-7).

For a rural community with no prior noise exposure these levels would not be appropriate. Applying the +10 dB normalizing factor to Figure-7 results in an L_{dn} of 65 dB. Because Ocotillo has no prior experience with wind turbine noise (as opposed to say, traffic noise) there is another correction factor of +5. The EIS in Table 4.9-3 reports that the range of L_{dn}'s for the four scenarios is from 45.8 to 49.5 L_{dn} at Location L1 and 39.9 to 44.2 at Location L4 with the other locations being between these two bounds. However these L_{dn}'s are not normalized. The normalized values, which must be used for this method to work, show the land-use compatibility impact is 15 dB higher that the tables report. Thus, the normalized L_{dn} range is 60.8 to 64.5 L_{dn} at Location L1 and 54.9 to 59.2 at Location L4. The reported L_{dn}'s imply there will be little or no negative community response from an urban/suburban population with prior noise exposure but, the normalized levels indicate the wind turbine noise will result in widespread complaints and threats of legal action in a rural community.

Normalized L_{dn}/CNEL For Rural Residential w/o prior noise exposure experience		
Location	**Scenario 1**	**Scenario 4**
L1	60.8/65.8	64.5/69.5
L4	54.9/59.9	59.4/64.4
BLM/Imperial limits for L_{dn} and CNEL to maintain equivalent levels of annoyance to experienced urban/suburban community	55 L_{dn}/60 CNEL	

The CNEL method has a similar normalization process. The table for CNEL normalization (next page) adds an extra correction of +5 dB for sounds that may be impulsive or produces tones. The Table of Normalized Ldn/CNEL for Rural Residential (left) shows that once the EIS/EIR sound levels are normalized the project is at or above the recommended guidelines at all locations.

CNEL Calculation and Normalization Methods Page 1

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

Table of correction factors used to normalize CNEL values (after U.S. Environmental Protection Agency document NTID300.3, *Community Noise*, 1971).

Figure 2 Table of CNEL Normalization adjustments

ANSI S12.9 Part 4 (R_2005): Noise Assessment and Prediction of Long-term Community Response

In 1980 the ONAC was defunded by the administration and has remained unfunded since that time. To cover the loss of the EPA the Acoustical Society of America (ASA) and the American National Institute (ANSI) promulgated a standard that incorporated the same basic concepts as the EPA Levels document and the normalizing process of Table and Figure D-7. This standard can be applied to assess a community's response to a new noise source. It will result in the same recommendations for a rural community as the EPA document. For a non-noise exposed rural community ANSI S12.9 Part 4 sets the nighttime sound level at 30 dBA (Leq) and the daytime to 40 dBA (Leq).

Standards for Computer Modeling of Sound Propagation

ISO 9613-2: Acoustics-Attenuation of Sound during propagation outdoors, Part 2: General Method of Calculation: This standard specifies engineering methods for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of noise sources. The method is applicable, in practice, to a great variety of noise sources environments. It is applicable, directly or indirectly, to most situations concerning road or rail traffic, industrial noise sources, construction activities, and many other ground based noise sources. It does not apply to sound from aircraft in flight, or to blast waves from mining, military, or similar operations. It is validated only for noise sources that are located close to the ground (approximately 30 m difference between the source and receiver height). It is also limited to noise sources that are within 1000 m of the receiving location. Meteorological conditions are limited to wind speeds of approximately 1 m/s and 5 m/s when measured at a height of 3 m to 11 m above the ground. When all constraints, including these, are met by the situation being modeled the procedure is accurate within a +/- 3 dB range. Its use has not been validated by any independent peer-reviewed process for use in siting wind turbines. However, it became the practice in the mid-1990s to use commercial software packages for modeling. A general-purpose industrial and traffic noise such as the commercial software package SoundPLAN 7.0 which is based upon this ISO standard for thei EIS/EIR. This practice was promoted by the British Wind Energy Association (BWEA) and trade associations in other countries. This practice was not followed by many of the countries in the European Union because of their concern about the limitations of the method and its use for predicting wind turbine sound propagation. For example, there are alternate models that have been developed specifically for wind turbines in the Nordic countries. These models, have been validated by peer-reviewed independent studies and used in those countries.

The Swedish EPA has recently investigated a new modeling algorithm for wind turbines that applies both for onshore and offshore turbines. This model incorporates enhancements to the iso-9613 part 2 algorithms that address the specific characteristic of wind turbine sound infra and low frequency sound emissions to propagate at a decay rate of 3 dB per doubling of distance at distances of several hundred meters away from the turbine. The ISO-Standard assumes propagation occurs at the decay rate of 6 dB per doubling of distance. Although it may be argued that the ISO-Standard is commonly used for wind turbine projects, it must be noted that there are many wind turbine projects where the initial models indicated there would be no problems that, once operation started, exhibit problems. Use of a model that understates real-world operational sound levels is a very likely cause of this problem.

IEC 61400-Part 11: acoustic noise measurement techniques: The purpose of this standard is to provide a uniform methodology that will ensure consistency and accuracy in the measurement and analysis of acoustical emissions by wind turbine generator systems. The standard was prepared for application to wind turbine manufacturers trying to meet well-defined acoustical emission performance requirements, and the purchaser in specifying such requirements. This standard is used to determine the sound power level emitted by wind turbines under conditions defined as normal operation. Normal operation is specified as weather conditions that are not severe and represent operation with low wind shear. Such conditions are normally defined as a "neutral" or "unstable" atmosphere where the windshear will generally be in the range of 0.15 or less and in general under 0.20. This weather condition is commonly observed during daytime of warm seasons and in particular can be described as a warm sunny afternoon in the temperate zone. Under low wind shear conditions the wind speed does not increase significantly between the height where the blade is lowest in this rotation and the top where it is at its highest peak. This allows the anemometer located on the turbine's hub to calculate the optimum angle of attack of the blades and RPM of the hub for maximum efficiency in extracting energy. Because inefficiency in extracting energy results in increased noise, heat, turbulence, and additional stresses on the blades the lowest noise immission condition for wind turbine occurs is when it is most efficiently extracting energy from the wind. In a paper by William Palmer, P.ENG., the effect of varying wind shears on wind turbine noise is explored[17]. Figure 3 shows an example of the optimal weather conditions for a windshear of 0.14 with no stability layer (temperature inversion boundary). The IEC test uses this weather condition to measure the sound power levels emitted by the turbines. The EIS/EIR used that data for its model. The problematic situation is when there is high-level windshear, such as 0.44, without a stable boundary layer. Because there will be a significant difference in the wind speed at the bottom and at

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

the top of the blades rotation path the windshear of 0.44 will be more difficult for the turbine to find the optimum operating mode then for the 0.14 windshear. The low wind shear condition follows a logarithmic relationship described as the Power Law which permits the estimation of a wind speed at some arbitrary height such as the hub from the wind speed at a lower height such as a 10 m meteorological tower. The higher wind shear conditions are much more complex and depend on the height of the stable boundary layer.

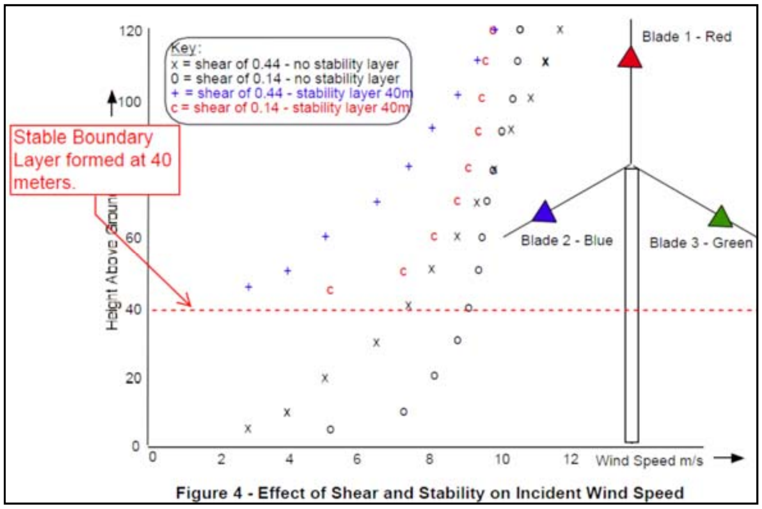

Figure 3- Example of wind shear in neutral and stable atmospheres

At night, after the sun's heating of the ground stops, the ground cools. The convection currents present in the daytime that cause the warmed air next the ground to rise upwards mixing with the upper level winds in a smooth gradient also stop. A cool layer of air forms at the ground and extends upwards to the boundary layer which will form at altitudes often between 20 m to 100 m or more above the ground. This boundary layer causes a complete disconnect between the wind speeds below it and above it. Below the boundary layer winds are often calm or even still. There is insufficient wind to cause leaf rustle or other sounds associated with surface level winds. Figure 3 which is extracted from Mr. Palmer's paper shows the stable boundary at 40 m by stopping the "+" and "c" markers for windshear at that height. These are the two curves on the left side of the figure. It is important to understand, that when a stable boundary layer forms the winds above the boundary layer are often moving at a very high rate and that rate increases rapidly with height. It is not uncommon to see wind shear coefficients of 0.7 to 1.0 or higher when these conditions form.

To compound the situation, if the stable boundary layer forms at an elevation higher than the bottom of the blades rotation path the blade will descend into it. Under these conditions the turbine blades which are under wind load above the stable boundary layer lose that load when they enter the still air below the boundary layer. This is situation that the turbine operating system which depends upon hub level anemometers cannot detect nor can it adjust the blades to account for this change. Is this condition that Mr. Palmer believes produces the maximum sound power from the turbine blades and is responsible for the deep blade whoosh that is the source of complaints during nighttime. Measurements of turbines operating this condition have shown blade whoosh (amplitude modulation) of 8 to 15 dBA above the normal sound levels. For the situation of high wind shear without the stable boundary layer blade whoosh (amplitude modulation) normally ranges from 5 to 8 dBA.

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

To further complicate the assessment of a wind turbines sound power under real world situations the atmospheric condition of a stable atmosphere is a very common feature of warm season nights.

The Sound Power data (L_w)used in the sound propagation models does not represent the noise produced by wind turbines during nighttime operations with high wind shear and stable atmospheric conditions. The IEC 61400.11 test standard collects data under neutral atmospheric conditions that do not cause these louder "thumping" or "whooshing" type of noise emissions.

In "*Effects of the wind profile at night on wind turbine sound*" G.P. van den Berg states:

> "....measurements show that the wind speed at hub height at night is up to 2.6 times higher than expected, causing a higher rotational speed of the wind turbines and consequentially up to 15 dB higher sound levels, relative to the same reference wind speed in daytime. Moreover, especially at high rotational speeds the turbines produce a 'thumping', impulsive sound, increasing annoyance further. It is concluded that prediction of noise immission at night from (tall) wind turbines is underestimated when measurement data are used (implicitly) assuming a wind profile valid in daytime."[18]

The "thumping" referred to in the Van den Berg paper occurs in synchronization with blade rotation (about one "thump" or "whoosh" per second assuming the hub is rotating at 20 rpm). "Thumping" does not referring to the blade "swish" of 1-3 dBA present when the turbine is operating in a neutral atmosphere. This "swish" is included as part of the wind turbine sound power ratings provided by the manufacturer. The "thumping" of concern is the much louder noise that is not accounted for in the manufacturer's test data. This occurs typically at night under a stable atmosphere where there is high wind shear. This "thumping" can modulate by 5 to 10 dBA or more and is a result of increased sound power emissions from the wind turbine's blades.

Based on this reviewer's experience the nighttime noise is increased by at least 5 dBA over what is observed for similar hub level wind speeds during the day under a neutral atmosphere and the noise takes on an impulsive character due to the blade swish/thump. If the increased sound power caused by the nighttime atmospheric conditions had been added to the manufacturer's sound power for neutral atmospheric conditions the predicted values in the EIS/EIR would be 5 dBA or more higher than what is shown in the report tables and contour map.

In temperate zone climates it can occur as often as 60% of summer evenings. In a desert environment, where the solar heating and nighttime cooling can be even more extreme a stable atmosphere may be even more common. Since the IEC 61400 – 11 measurement procedure only provides information for the sound power under the neutral atmosphere and low windshear use of the data from that standard will consistently under predict the sound levels of wind turbines during these, nighttime conditions. This affects the predicted sound levels in the EIS/EIR. If the model is to represent the predictable worst case situation then, at minimum, 5 dB would need to be added to all predicted sound levels.

This review identified another significant deficiency in the computer model. The model fails to disclose and include the tolerances (confidence limits) for instrumentation error of the IEC 61400-11 test procedures of ± 2 dB and also did not include the tolerances for the ISO 9613-2 modeling procedure of ± 3 dB. If the model had included proper adjustments for the confidence limits the results shown on the contour maps and tables of their report would be 3.6 dB higher than stated[19].

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

[19] sqrt(3^2 + 2^2)=3.6

The sound propagation modeling software used for the sound models is a general purpose model designed for modeling noise from common urban noise sources like industrial plants, roads, and railways. The ISO Standard limits use of its methods to noise sources that are no more than 30 meters above the receiving locations. A wind turbine with a hub height of 80 meters exceeds this ISO limitation by 50 meters. The EIS/EIR report did not disclose this limitation or make any effort to account for the errors that may accrue from the noise source exceeding the source height limits. SoundPLAN 7.0 is based on the ISO standard and thus limitations to the standard apply equally to the EIS/EIR model results. The deviations from the assumptions of the ISO standard mean that the stated confidence limits of +/- 3 dB are likely exceeded.

The result of these two failings, (understated L_w and not including known tolerances) is that the reported EIS/EIR model results are likely 8 dB or more lower (3.6 dB for confidence limits and another 5 for high wind shear conditions) than what will occur on a predictable worst case night. The model does not address the types of audible noise from wind turbines that occur during nighttime periods after high daytime solar heating. The effects the night time wind speed profile on noise emissions also results in impulsive sound which people find most objectionable. This increase would have expanded the boundary of the 40 dBA threshold to include many of the homes around the perimeter of the Project even for the most conservative scenario.

Properly modeled and normalized, this project would not comply with Imperial County's 60 dB CNEL limit at sensitive receiving properties. If the additional issues of confidence limits and higher noise was included with the normalization process the predicted Ldn/CNEL levels exceed both BLM and Imperial County criteria.

Infra and Low Frequency Sounds and their Impact on People

Both the Imperial County and BLM noise guidelines/criteria focus on audible sound and rely on A-weighted sound levels for decision making. However, wind turbine noise emissions are heavily weighted to the infra and low frequency end of the acoustic spectrum. The level of annoyance produced by wind turbine noise also increases substantially for low frequency sound, once it exceeds a person's threshold of perception. There are also more ways the sound can be perceived than just as audible sound. Perception mediated by the vestibular organs does not involve 'hearing' the sound. (see Salt, Pierpont and others) For audible sounds in the infra and low frequency range the annoyance and the sense of loudness increases more rapidly than the more readily audible mid-frequency sounds. Sound measured as dBA is biased toward 1,000 Hz, the center of the most audible frequency range of sound pressure. Low frequency sound is in the range below 200 Hz and is more appropriately measured as dBC for low frequency sound or in dBG for infrasound. As a result use of dBA criteria misses an important aspect of wind turbine noise.

Because infra and low frequency sounds from wind turbines include significant dynamic modulation in the frequency range from the blade passage frequency of from 1 Hz or less, up to about 10 Hz, standard acoustical instruments such as 1/3 octave band analyzers and FFT analyzers using band filtering cannot be used to measure the short duration pulsations. This is covered in detail in the Bray/James paper. Instrumentation with 1/3 octave band resolution of the spectrum sound pressure levels can only be used for assessing relatively long periods of the infrasound (minutes or hours, not seconds or milliseconds), and even then, the readings may understate the total acoustic energy and the maximum sound pressure levels during those pulsations[20].

Sound below 20 Hz, is generally presumed to not be audible. However, when considering the most sensitive people, the thresholds drop approximately 6-12 dB. Further, the Thresholds of Perception are for a single, steady, pure tone under laboratory conditions. Wind turbine sounds are a complex mix of tones, all within the same critical band. It is possible that for many people they will be audible at levels lower than what is required for a single, steady, pure tone.

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

For many years it has been presumed that only infra and low frequency sounds that reached the threshold of audibility for people posed any health risks. Many acoustical engineers were taught that if you cannot hear a sound, it cannot harm you. Recent research has shown that the human body and auditory system is more sensitive to infra and low frequency noise (ILFN) than previously believed. This perception is not one that is 'heard' but rather it is one that involves the organs of balance (vestibular systems). The vestibular portion of our auditory system can respond to levels of infra and low frequency sound at pressures significantly lower (as much as 40 dB) than what is needed to reach the thresholds of audibility.[21]

Dr. Nina Pierpont has conducted a study of the effects of infra and low frequency sound on the organs of balance that establishes the causal link between wind turbine ILFN and medical pathologies. This research is discounted by the wind industry as not meeting standards for epidemiology and that it is not 'peer-reviewed.' Neither accusation is correct. The type of epidemiological study conducted by Dr. Pierpont is termed a case-crossover study. Dr. Carl Philips, a highly respected epidemiologist not associated with the wind industry has said: [22]

> "*In particular, my scientific analysis is based on the following points, which are expanded upon below:*
>
> "*1. Health effects from the turbine noise are biologically plausible based on what is known of the physics and from other exposures.*
>
> "*2. There is substantial evidence that suggests that some people exposed to wind turbines are suffering psychological distress and related harm from their exposure. These outcomes warrant the label "health effects" or "disease" by most accepted definitions, though arguments about this are merely a matter of semantics and cannot change the degree of harm suffered.*
>
> "*3. The various attempts to dismiss the evidence that supports point 2 appears to be based on a combination of misunderstanding of epidemiologic science and semantic games. Multiple*

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

[21] Salt et. al.

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

components of this point appear below. " Also,

"There is ample scientific evidence to conclude that wind turbines cause serious health problems for some people living nearby." And,

"The reports that claim that there is no evidence of health effects are based on a very simplistic understanding of epidemiology and self-serving definitions of what does not count as evidence. Though those reports probably seem convincing prima facie, they do not represent proper scientific reasoning, and in some cases the conclusions of those reports do not even match their own analysis."

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

The new research is not from the traditional fields that have provided guidance for acoustical engineers and others when assessing compatibility of new noise sources and existing communities. Instead it comes from the field of research into auditory and vestibular function. A recent peer reviewed paper by NIDCD/NIH researcher Dr. Alec Salt, reported that the cochlea responds to infrasound at levels 40 dB below the threshold of audibility.[23] These studies show how the body responds to extremely low levels of energy not as an auditory response, but instead as a vestibular response.

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

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

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

During the summer of 2009, this reviewer conducted a study of homes in Ontario where people had reported adverse health effects that they associated with the operation of wind turbines in their communities[24]. The study involved collecting sound level data at the homes and properties of these people, many of who had abandoned their homes due to their problems. This study found that sound levels in the 1/3 octave bands below 20 Hz were often above 60 dB and in many cases above

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

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

70 dB. Since the shape of the spectrum for wind turbine sound emissions is greatest at the blade passage frequency which was below the threshold for the instruments used it can be assumed that the sound pressure levels in the range of 0 to 10 Hz exceeded 70 dBA. Given the statement by Dr. Salt that vestibular responses would start at levels of 60 dBG or higher this data supports the hypothesis that there reason to consider the potential for a link between the dynamically modulated infra sound produced by wind turbines and reported adverse health effects. Since the time of that study at least five (5) homes have been purchased by the utility operators because of health effects on the owners and many others have been abandoned because the owners did not have the economic resources to hire an attorney to fight for a buy-out.

Adverse health effects related to inaudible low frequency and infra sound have been encountered before. Acoustical engineers in the Heating, Cooling and Air Conditioning (ASHRAE) field have suspected since the 1980's and confirmed in the late 1990's that dynamically modulated, but inaudible, low frequency sound from poor HVAC designs or installations can cause a host of symptoms in workers in large open offices[25]. The ASHRAE handbook devotes considerable attention to the design of systems to avoid these problems and has developed methods to rate building interiors (RC Mark II) to assess them for these low frequency problems[26]. The report on Ontario by this reviewer includes an Appendix that provides more detail on this aspect of how inaudible infra and low frequency sound can cause adverse health effects.

When infra and low frequency sound is in the less-audible or inaudible range, it is often <u>felt</u> rather than <u>heard</u>. Unlike the A-weighted component, the low-frequency component of wind turbine noise "*can penetrate the home's walls and roof with very little low frequency noise reduction*.[27]" Further, as discussed in the 1990 NASA study the inside of homes receiving this energy can resonate and cause an increase of the low frequency energy over and above what was outside the home. Acoustic modeling for low frequency sound emissions of ten 2.5 MW turbines indicated "*that the one mile low frequency results are only 6.3 dB below the 1,000 foot one turbine example*.[28]" This makes the infra and low frequency sound immissions from wind turbines a potential problem over an even larger area than the audible sounds, such as blade swish and other wind turbine noises in the mid to high frequency range.

The acoustical consultant that does not practice in this field may not be as aware of the problems of amplitude modulated, in-audible low frequency sound identified by the ASHRAE engineers. Many have not integrated these new understandings of how infra and low frequency sound can affect the vestibular organs into their work on community noise. These levels were only a few years ago considered too low to cause <u>any</u> physical response. Today, there is a renewed interest in these effects. A paper titled: Infrasound, The Hidden Annoyance of Industrial Wind Turbines, by Prof. Claude Renard of the Naval College and Military School of the Fleet (France) concludes:

> "*The information given above is enough to understand that it is better not to be exposed to infrasound which propagates far from its point of origin and against which it is impossible to protect oneself due to the long wavelengths.*

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

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

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

[28] Id., p. 12

> "*Those most affected by exposure to infrasound are rural inhabitants living in proximity to wind turbines, and those working in air-conditioned offices.*
>
> "*The people in the former category are exposed to the infrasound 24 hours a day, whereas people in the latter category are only exposed to infrasound 6 hours a day.*
>
> "*The most important issue is therefore to know what intensity of infrasound can be tolerated without inconvenience over these periods of time.*
>
> "*We do not have the answer to this question.*"

Impact on Wildlife

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

There is an equivalent issue with wildlife. Reference 10, "The costs of chronic noise exposure for terrestrial organisms" presents the similar problems increased noise in the habitat makes for wildlife. While the focus of this review is on the effects of noise on the human population it must be understood that there will be a wider effect throughout the foot print of the project and extending into the wilderness areas of the Anza-Borrego Desert State Park. This effect will extend out to distances of 2 km or more from the boundary of the Project but will be most severe inside that boundary where sound levels from turbines may be as high as 60 dBA or more. The listening radius for wildlife that use sound for mating calls and predator avoidance shrinks by half for every 6 dB increase in the background sound level. For wildlife that are close to turbines this may have a dramatic effect on reproduction rates and kills. Decreasing the listening radius so dramatically may potentially make some of the wildlife an "endangered species" for this region.

Evidence of wind farm noise exceeding certificate of approval levels

In the 2008 manuscript by George Kamperman, Bd. Cert. INCE, P.E. and myself we set criteria designed to protect the public health. We stated that a setback of at least 1.25 miles was needed to achieve this goal[29]. In this community, an even larger setback distance is warranted. The population of Ocotillo with pre-existing medical conditions may be susceptible to adverse health effects at levels lower than the general population. Given that the World Health Organization's 2009 Nighttime Noise Guidelines find that the Threshold for Adverse Health Effects is 40 dBA at night outside a home, the results shown in the tables and contour maps of the EIS/EIR, once adjusted for confidence limits and high wind shear conditions, show that 40 dBA will be exceed under all four scenarios in Ocotillo.

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[29] Kamperman, G.W., Bd.Cert. INCE, P.E., James, R.R. INCE, "The 'How To' Guide to Siting Wind Turbines To Prevent Health Risks Fro Sound, 2008.

Conclusion

It is the opinion of this reviewer, based on his personal experience and the review described in this document that a properly conducted study would identify higher sound levels and higher annoyance levels than presented in the EIS/EIR. More homes will have sound levels that exceed 40 dBA, some by as much as 8 dBA or more. When adjusted for known tolerances of algorithms and measurements used to construct the model, the increased sound power emitted by wind turbines at night under conditions of high wind shear, and normalized to account for the quiet rural community and impulsive character of the wind turbines both the BLM's L_{dn} and Imperial's CNEL criteria will be exceeded. The WHO nighttime limits of 40 dBA for safe sleep and avoidance of adverse health effects will also be exceeded.

The soundscape in non-residential areas used for campgrounds and outdoor recreation in the adjacent State Park will no longer be the natural sounds of nature but instead the industrial sounds of wind turbines. The belief that the noise from the highways will somehow 'mask' the wind turbine sounds is not supported by current research. Further, there is reason to be concerned that for a sub-set of the people in the community the infrasound and low frequency content of the wind turbine noise will pose additional health risks due to interactions with their organs of balance.

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

This project should be rejected based on the concerns raised in this report. None of the alternative scenarios are compatible with the community and current land use.

In the opinion of this reviewer the Project will result in the exposure of persons to or generation of noise levels in excess of BLM Guideline, standards established in the Imperial County noise ordinance, and also exceed the WHO 2009 nighttime guidelines setting of 40 dBA (Leq) at night as the threshold for adverse health effects. It will also result in a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project.

The Project, as currently proposed should be rejected.

End of Review

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October 5, 2011

References
Submitted Separately