FROM THE DESK OF

TINA GRAZIANO

June 20, 2017

Via Email
Honorable Kathleen H. Burgess, Secretary to the PSC
Dakin D. Lecakes, DPS Examiner
P. Nicholas Garlick, DEC Examiner

Re: Case 14-F-0490, Application of Cassadaga Wind LLC for a Certificate of Environmental Compatibility and Public Need Pursuant to Article 10 to Construct a Wind Energy Project.

Reply to: Memorandum in Support of Cassadaga Wind LLC's Motion to Exclude Testimony of Richard R James and Jerry L Punch, PhD — by Muscato & Klami, Attorneys for Cassadaga Wind LLC

Dear Sec. Burgess et al.,

I respectfully ask you to post the attached comment by Nina Pierpont, MD, PhD, as a filed document to DMM case no. 14-F-0490.

Dr. Pierpont's letter responds to the applicant's motion to dismiss testimony by Mr. James and Dr. Punch.

Tina Graziano
Party to DMM Case 14-F-0490

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NINA PIERPONT M.D. PH.D.

June 20, 2017

Via Email

Honorable Kathleen H. Burgess, Secretary to the PSC
Dakin D. Lecakes, DPS Examiner
P. Nicholas Garlick, DEC Examiner

Regarding Case No. 14-F-0490: Application of Cassadaga Wind, LLC, for a Certificate of Environmental Compatibility and Public Need to Construct a Major Electric Generating Facility in the Towns of Charlotte, Cherry Creek, Stockton, and Arkwright, New York

Reply to: Memorandum in Support of Cassadaga Wind LLC's Motion to Exclude Testimony of Richard R James and Jerry L Punch, PhD — by Muscato and Klami, Attorneys for Cassadaga Wind LLC

Dear Sec. Burgess et al.,

I am one of the sources of information cited as unreliable and unscientific in Mr. Muscato's objection to the testimony of Richard James and Jerry Punch. I published *Wind Turbine Syndrome: A Report on a Natural Experiment* in 2009.

This was a scientific study.

First, I hold two doctoral degrees that qualify me to make such a study. The first is the PhD in Population Biology from Princeton University (1986) in which I was trained over the course of six years in the study of animal populations and behavior in natural settings, and the statistical analysis and presentation of such studies. The second is the MD from the Johns Hopkins University School of Medicine (1991), in which I was trained in medicine, including anatomy, physiology, pathology, pathophysiology, neuroscience, behavioral medicine, and epidemiology, as well as direct clinical experience in diverse medical fields including otolaryngology and neurology.

My study design for *Wind Turbine Syndrome* was drawn from field ecology, which is notably flexible because of the difficulty of studying animals in natural settings without disturbing their relationships to space, resources, and social groupings. Field ecology studies commonly use comparison groups to demonstrate effects, as strict controls are not definable in natural environments.

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For *Wind Turbine Syndrome*, I studied the first 10 families I found that 1) had at least one highly symptomatic member; 2) had moved into and out of exposure several times to establish that operating wind turbines were the cause of the symptoms; and 3) had done something expensive and difficult (like buying another house to live in) to stop the exposure and symptoms. The latter is called, in epidemiology, a "revealed preference measure." Moving into and out of exposure is called a "case-crossover" design, whereby each person acts as his or her own control, exposed vs not exposed. Case-crossover designs are appropriate when the effects of exposure are evident immediately.

The purpose of the defined comparison group was not to establish whether turbines caused the symptoms—this was ascertained by the case-crossover format. The purpose of the comparison group was to examine the effects of age and pre-existing medical conditions on susceptibility to the symptom set. The comparison group was made up of everyone (38 people) in the exposed households regardless of whether they were affected. Because the sampling method was random (everyone in the exposed households) with regard to the effect of interest (effects of age and pre-existing conditions on the occurrence of symptoms in exposed persons), I was able to use statistical tests to demonstrate the significance of three risk factors: motion sensitivity, migraine disorder, and pre-existing damage to the inner ear by noise exposure or chemotherapy.

In a presentation to a committee of the New York State Assembly in March 2006, I described the curious phenomenon of vibration or pulsation felt in the chest during exposure to operating wind turbines. This symptom was of interest to the National Academy of Sciences and mentioned in its 2007 report to Congress, *Environmental Impacts of Wind-Energy* Projects (see attached). The authors asked to learn more about this effect of low frequency noise, which proved to be common among the highly affected participants in my study.

My paper was read and commented on by scientists and physicians in the fields of population biology, epidemiology, basic neuroscience, neurology, neurotology, sleep medicine, and public health. I revised and incorporated material in response to their commentary, and published seven lengthy comments ("peer reviews") in the book.

The book was then deliberately designed for full access to data and findings by scientists and non-scientists alike.

The test of scientific validity is *reproducibility.* As Malcolm Swinbanks, PhD (Cambridge), a noise engineer and affected susceptible, has remarked, "*Pierpont's conclusions have predictive power, the true test of science.*"

The simple experiment I studied is repeated (albeit unethically) every time wind turbines are erected: people with migraine disorder or motion sensitivity (15-20% of the population with a 3:1 female-to-male ratio) become exposed in their homes to operating turbines. How easy it would be to study these people—to take their experiences beyond the thousands of Internet accounts of the same symptom set in the same circumstances—if turbine proponents did not block such study with lease-holder gag clauses, so-called Neighbor Agreements, and other legal mechanisms.

Since 2009, there have been several studies of even smaller groups of affected, sensitive people, these done by acousticians in conjunction with noise measurements:

> Paul Schomer, PhD, and others (Shirley Wisconsin Wind Study, 2013, cover page attached) established the occurrence of the same symptom set and proposed the same mechanism (effects of infrasonic/low frequency air pressure pulsations on the otolith organs) as I did in 2009. Dr. Schomer is the Director of Standards for the Acoustical Society of America.
>
> Steven Cooper (Australia, 2014, cover page and Executive Summary attached) was able in 2014 to study 6 sensitive people in three homes with the full cooperation (and indeed funding) of the wind energy company. In diaries in which the residents rated, at many time points, how much they were bothered by hearing noise, feeling vibration, or feeling other "sensations," it was "sensation" that disturbed them the most, much more than hearing noise. Disturbance is not related to perception of noise or to measured A-weighted or even 1/3 octave-band analyzed noise. Disturbance due to "sensation," including "headache, pressure in the head, ears or chest, ringing in the ears, heart racing, or a sensation of heaviness" is correlated with aspects of turbine function that increase turbulence around the blades and thus the potential for stronger low-frequency or infrasonic pulsations. The disturbance was often severe enough to compel participants to leave their homes to get relief. Indeed, one of the three couples in Cooper's study had moved out of their home because of the sensations and accompanying sleep disturbance.

These authors and others have definitively established that turbines produce rhythmic, abrupt air pressure pulsations at the blade-passing frequency and its first 6 harmonics (multiples of the blade-passing frequency). These pulsations distinguish operating turbines from background noise, and may be measurable up to 10 km from turbines.

I suggest that Mr. Muscato does not have a good grasp of scientific thought or reasoning, but for reasons of financial or other gain is attempting, on behalf of his client, to obscure and derail the process of scientific and clinical discovery of wind turbine health effects. Muscato's commentary should probably be excluded from the process of discerning what is known about the risks of placing wind turbines near homes, since his commentary is clearly biased in favor of a commercial enterprise.

Respectfully,

Nina Pierpont

Nina Pierpont, MD, PhD

PREPUBLICATION COPY

Environmental Impacts of Wind-Energy Projects

Committee on Environmental Impacts of Wind Energy Projects

Board on Environmental Studies and Toxicology

Division on Earth and Life Studies

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

Report to Congress 2007

THE NATIONAL ACADEMIES PRESS
Washington, D.C.
www.nap.edu

insufficient to pose a health hazard (BWEA 2005). Nevertheless, a recent study by van den Berg (2004, 2006) suggests that, especially at night during stable atmospheric conditions, low-frequency modulation (at around 4 Hz) of higher frequency swishing sounds is possible. Note that this is not infrasound, but van den Berg (2006) states that it is not known to what degree this modulated fluctuating sound causes annoyance and deterioration in sleep quality to people living nearby.

Low-frequency vibration and its effects on humans are not well understood. Sensitivity to such vibration resulting from wind-turbine noise is highly variable among humans. Although there are opposing views on the subject, it has recently been stated (Pierpont 2006) that "some people feel disturbing amounts of vibration or pulsation from wind turbines, and can count in their bodies, especially their chests, the beats of the blades passing the towers, even when they can't hear or see them." More needs to be understood regarding the effects of low-frequency noise on humans.

Assessment

Guidelines for measuring noise produced by wind turbines are provided in the standard, IEC 61400-11: Acoustic Noise Measurement Techniques for Wind Turbines (IEC 2002), which specifies the instrumentation, methods, and locations for noise measurements. Wind-energy developers are required to meet local standards for acceptable sound levels; for example, in Germany, this level is 35 dB(A) for rural nighttime environments. Noise levels in the vicinity of wind-energy projects can be estimated during the design phase using available computational models (DWEA 2003a). Generally, noise levels are only computed at low wind speeds (7-8 m/s), because at higher speeds, noise produced by turbines can be (but is not always) masked by ambient noise.

Noise-emission measurements potentially are subject to problems, however. A 1999 study involving noise-measurement laboratories from seven European countries found, in measuring noise emission from the same 500 kW wind turbine on a flat terrain, that while apparent sound power levels and wind speed dependence could be measured reasonably reliably, tonality measurements were much more variable (Kragh et al. 1999.) In addition, methods for assessing noise levels produced by wind turbines located in various terrains, such as mountainous regions, need further development.

Mitigation Measures and Standards

Noise produced by wind turbines generally is not a major concern for humans beyond a half mile or so because various measures to reduce noise have been implemented in the design of modern turbines. The mechanical sound emanating from rotating machinery can be controlled by sound-isolating techniques. Furthermore, different types of wind turbines have different noise characteristics. As mentioned earlier, modern upwind turbines are less noisy than downwind turbines. Variable-speed turbines (where rotor speeds are lower at low wind speeds) create less noise at lower wind speeds when ambient noise is also low, compared with constant-speed turbines. Direct-drive machines, which have no gearbox or high speed mechanical components, are much quieter.

Acceptability standards for noise vary by nation, state, and locality. They can also vary depending on time of day—nighttime standards are generally stricter. In the United States, the U.S. Environmental Protection Agency (EPA) only provides noise guidelines. Many state governments issue their own regulations (e.g., Oregon Department of Environmental Quality 2006), and local governments often enact noise ordinances. Standards of acceptability need to be understood in the context of ambient (background) noise resulting from all other nearby and distant sources.

PSC REF#:178200

Public Service Commission of Wisconsin
RECEIVED: 12/27/12, 11:02:02 AM

BEFORE THE

PUBLIC SERVICE COMMISSION OF WISCONSIN

Application of Highland Wind Farm, LLC, for a Certificate of Public Convenience and Necessity To Construct a 102.5 Megawatt Wind Electric Generation Facility and Associated Electric Facilities, to be Located In the Towns of Forest and Cylon, St. Croix County, Wisconsin	Docket No. 2535-CE-100

Ex.-Clean Wisconsin-Hessler-6

Please enter the attached report titled “A Cooperative Measurement Survey and Analysis of Low Frequency and Infrasound at the Shirley Wind Farm in Brown County, Wisconsin” into the record as Ex.-Clean Wisconsin-Hessler-6.

The Acoustic Group
CONSULTING ACOUSTICAL & VIBRATION ENGINEERING

THE RESULTS OF AN ACOUSTIC TESTING PROGRAM
CAPE BRIDGEWATER WIND FARM
44.5100.R7:MSC

Prepared for: *Energy Pacific (Vic) Pty Ltd*
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Date: 26th November, *2014*

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CONTENTS

APPENDICES

ACKNOWLEDGEMENT

The material set out in this report relates to a study conducted at three houses in proximity to the Cape Bridgewater Wind Farm in SW Victoria.

The Study was requested by Pacific Hydro to investigate the noise complaints from the occupants of the three houses, without any restrictions to the investigation. Pacific Hydro identified the objective of the noise and vibration monitoring was to determine whether certain wind conditions or certain sound levels give rise to disturbance experienced by specific local residents at Cape Bridgewater.

The residents involved in the study provided unrestricted access to their properties for nine weeks of monitoring (both internal and external locations) and vacated their properties for a number of nights to permit attended monitoring in their homes.

The residents provided diary observations and comments during the study and made themselves available for consultation and discussions re their observations throughout the study.

Pacific Hydro provided unlimited access to the wind farm to undertake measurements that could assist in the study.

The study appears to be the first of its kind in Australia to be a joint exercise between a wind farm operator and residents, and therefore provides information not normally available in a one sided acoustic assessment of a wind farm. Information, findings and recommendations are provided to assist others involved in the investigation of wind farm “noise”.

Without the assistance of the six residents, the wind farm manager (who provided essential data and assistance on site) and Pacific Hydro (who initiated and funded the study) the study could not have occurred. All of these people need to be acknowledged for their participation in the study.

EXECUTIVE SUMMARY

The Cape Bridgewater Wind Farm is an existing facility located in the south-west corner of Victoria and has been operational for approximately six years.

The wind farm has been the subject of acoustic compliance testing in accordance with the consent conditions imposed on the permit for the wind farm [1] that nominates compliance with the criteria and methodology identified in New Zealand Standard 6808: 1998 *Acoustics – The Assessment and Measurement of Sound from Wind Turbine Generators* [2].

Despite the wind farm satisfying the acoustic criteria nominated on the permit [9] the operator of the wind farm (Pacific Hydro) is in receipt of noise complaints from residents in proximity to the wind farm.

To address the issue of complaints from residents Pacific Hydro requested the conduct of an acoustic study at three residential properties to ascertain any identifiable noise impacts of the wind farm operations or certain wind conditions that could relate to the complaints that had been received. The study was to incorporate three houses that are located between 650 m to 1600 m from the nearest turbine.

Following discussions with the residents in late 2013 permission was given by the residents for access to their properties to undertake acoustic testing both inside and external to the dwellings, in addition to Pacific Hydro permitting measurements on the wind farm to investigate noise and vibration emissions from turbines and the substation.

In addition to unrestricted access to the wind farm and to the residential properties, wind farm operating data was provided. The study included a period in which the wind farm was shut down for the purpose of high-voltage cabling that permitted measurements to be obtained of the natural environment (without the operation of the wind farm) for direct comparison of the wind farm under different weather scenarios.

The acoustic investigation was not restricted to the general A-weighted level specified on the permit.

Following consultation with residents, residents were asked to record (using severity rankings) perceived noise impacts, vibration impacts and other disturbances which, for the purposes of this study, have been labelled “sensation.” “Sensation” includes headache, pressure in the head, ears or chest, ringing in the ears, heart racing, or a sensation of heaviness.

A diary format for the study was developed based upon that used by the South Australian EPA in relation to the Waterloo Wind Farm [3], with the modification to include vibration and sensation, and alteration of the severity ranking to be user-friendly for the residents. Following a trial of the diary format amendments were proposed so that as far as possible, the residents were asked to provide diary entries on a one to two hourly basis with a view to the diary entries reflecting a continuous record.

It is noted that the study utilises persons who have lodged complaints concerning the subject wind farm and thereby provides an opportunity to specifically to investigate a possible relationship to the observations and the wind farm that may not be apparent with a larger sample of people around a wind farm, in that it is acknowledged not all people complain about the turbines.

The study found that the diarized resident's observations identified "sensation" as the major form of disturbance from the wind farm.

For one resident sensation, noise and vibration were observed with the wind farm shutdown.

While the study found for the six residents that there was no direct correlation between the power output of the turbines and residents' diary observations with respect to noise, it found a trend between high levels of disturbance (severity of "sensation") and changes in the operating power of the wind farm.

The study found a pattern of high severity of disturbance to be associated with four different operating scenarios of the wind farm being:

- when the turbines were seeking to start (and therefore could drop in and out of generation)
- an increase in power output of the wind farm in the order of 20%
- a decrease in the power output of the wind farm in the order of 20%, and
- the situation when the turbines were operating at maximum power and the wind increased above 12 m/s.

There were at times other instances of high severity of disturbance not fitting the above four scenarios.

Noise data was first examined in terms of dB(A) and then1/3 octave bands.

When noise data was assessed in terms of 1/3 octave bands for calculation of various acoustic parameters, it was found that the dB(Z), dB(G), 0.8Hz 1/3 octave band and the dB(A) followed the power output of the wind farm. Those curves also followed the increase in the wind speed, there being a direct correlation between the power output of the turbine and the prevailing wind speed.

Use of the shut-down testing identified that the extraction of the noise contribution from the wind farm could not be carried out by way of one third octave band analysis, either by use of an L90/L95 level or an Leq level in view of the significant variation in the ambient noise at high wind speeds, as a result of the fluctuating wind.

Examining the noise data with respect to 1/3 octave band data to obtain generalised acoustic parameters failed to reveal any significant difference between the operation of the wind farm and the natural environment that would support the concept that there is no difference between the natural acoustic environment and that of a wind farm. The analysis of the shutdown testing indicates the permitted noise emission on the permit (as a contribution) cannot be determined.

Examination of the acoustic environment in terms of narrowband analysis however, confirmed the results of previous investigations. It demonstrated that there is a unique signature attributed to wind farms that involves a peak at the blade pass frequency and the first five harmonics of that frequency. This unique infrasound pattern has been labelled by the author in other investigations as the "Wind Turbine Signature".

The shut-down testing confirmed that the Wind Turbine Signature is present when the turbines are operating but does not occur in the natural environment (i.e. wind farm shut down).

The investigation identified for the turbines used at Cape Bridgewater that when the turbines were operational there is a distinct frequency generated at 31.5 Hz that exhibits side bands on either side of that frequency (at multiples of the blade pass frequency). This pattern confirms the presence of an amplitude modulated signal which is not present in the acoustic environment when the turbines are not operating.

Superimposing narrowband signals onto 1/3 octave band results clearly shows that the natural infrasound environment in proximity to a wind farm when NOT operating is significantly different to that for the same locations with the wind farm operating.

By including narrowband analysis in the description of the acoustic environment, the study confirms that the infrasound obtained in a wind farm affected environment is different to that in a natural acoustic environment.

Clarification as to the mechanism of amplitude modulation and the wording used in some cases to describe that phenomena associated with turbines has been explored with a suggestion for clarification of such wording.

The Danish dB(A) LF method [4] has been used for low-frequency noise annoyance, based on sources other than wind turbines [5] [6]. It was not found to have sufficient correlation to be used for wind farms by reason of the internal noise that can be generated during the presence of high winds.

Using 1/3 octave band information and noise annoyance as a general descriptor, the analysis for the three houses was unable to separate the wind farm contribution from the ambient.

Utilising the wind turbine signature and the aforementioned discrete low-frequency amplitude modulated signal when compared with the severity observations provided by the six residents reveals that as the magnitude of those discrete frequency signatures increase so does the level of severity.

From the resident's subjective observations a wind turbine signature rating curve has been derived that indicates an unacceptable presence of sensation inside a dwelling (for those 6 residents) occurs at an level of 51 dB(WTS) – when assessed as rms values 400 lines for analysis range of 25 Hz. Utilising PSD values (400 line 25 Hz range) the unacceptable level for the 6 residents occurs at 61 dB(WTS).

It is noted that the participants involved in the study have experienced the impact of the wind farm for a period of in excess of six years and would appear to have a heightened sensitivity to such impacts, although the threshold levels of perception generally agrees with similar observations made during measurements undertaken by TAG at residential properties in proximity to the Waterloo Wind Farm (in South Australia), the Waubra Wind Farm (Victoria), the Capital Wind Farm and the Cullerin Wind Farm (both in NSW).

Being the first study to document or to identify "sensation" associated with the wind farm and the wind turbine signature, it is noted that the sample data is small and has persons already affected by the "noise". The findings must be considered as **preliminary** and warrant further detailed studies of the scientific rigour necessary for the purpose of confirming/verifying the suggestions for the use of the nominated dB(WTS) thresholds.

It is however noted that when placed in the concept of a dB(WTS) curve there is agreement with the infrasound components of the turbine perception concept nominated by Kelley in 1982 [7].

The observations from the residents with respect to sleep disturbance indicate that for the rural setting of Cape Bridgewater, where the ambient noise levels at night inside dwellings are typically below 15 dB(A) (in the absence of any activity in the household), then the concept of a 30 dB(A) Leq threshold level identified in the New Zealand Standard (that in the main is based upon road traffic noise [8]), would appear to be an inappropriate threshold for the assessment of internal noise levels associated with wind farms.

Other findings concerning the emission of vibration and the relationship to general acoustic measures identified during the course of the study are summarised in the conclusion.

During the course of the study there were significant issues in terms of instrumentation that requires for other researchers in this area identification of problems and the **essential** need for persons involved in the measurements of noise, and particular infrasound, in proximity to wind farm affected environments to utilise calibrated instrumentation covering the entire signal chain from the microphone (or pressure sensor) through to the read out. Reliance upon manufacturer's data does not always cover the entire spectrum of concern, with an entire section of this study report addressing instrumentation issues that have been identified during this study.

On the basis of a limited number of affected residents for the study, it is suggested that:

- **for these residents the presence of "sensation" is the major impact;**
- **surveys of residents near other wind farms should utilise the Cape Bridgewater Wind Farm survey method so as to include "sensation" in any investigations;**
- **the use of dB(A) or dB(C) for internal measurements of the wind farm does not separate the results from that generated by the wind – for residences that are directly exposed to the wind.**

There is not enough data from this study to justify any change in regulation. However, the following matters are suggested for further investigation:

- **the validity of the dB(WTS) and the appropriate threshold levels be the subject of further studies to provide the necessary scientific rigour for a threshold to protect against adverse impacts;**

- **examination of the use of the dB(WTS) index (both external and internal) to supplement the external dB(A) index currently used for wind farms;**

- **the use of the internal dB(WTS) method can assist in medical studies in that the internal dB(WTS) identifies the presence of energy from the operation of a wind farm. The dB(A) level measured inside dwellings is of no assistance in such studies;**

- **the use of an external dB(WTS) can overcome the limitations of the dB(A) method that can be influenced by extraneous sources (i.e. wind); and**

- **the issues of directivity and identification of the noise emission sources of a turbine relative to sound power testing at ground level be examined. Whilst there are significant costs involved, further investigations are required (by the use of a crane or similar) to measure noise levels at the hub height and the top and bottom of the swept path for say 150 metres from the tower, including directivity testing at those heights around the turbine.**