STATE OF VERMONT

PUBLIC SERVICE BOARD

Petition of Green Mountain Power Corporation,	)	
Vermont Electric Cooperative, Inc., and Vermont	)	
Electric Power Company, Inc., for a certificate of public	)	Docket No. 7628
good, pursuant to 30 V.S.A. Section 248, to construct up	)	
to a 63 MW wind electric generation facility and	)	
associated facilities on Lowell Mountain in Lowell,	)	
Vermont, and the installation or upgrade of	)	
Approximately 16.9 miles of transmission line and	)	
Associated substations in Lowell, Westfield and Jay, Vermont	)	

REBUTTAL TESTIMONY OF ROBERT McCUNNEY ON BEHALF OF GREEN MOUNTAIN POWER CORPORATION

November 22, 2010

Summary of Testimony

Dr. McCunney responds to claims by Department of Public Service witness Mr. Kane, Albany witness Mr. James, Lowell Mountains Group witness Mr. Blomberg and others concerning the health and related impacts of sound. He also supports the Board's approved sound standard for wind projects.

REBUTTAL TESTIMONY OF

ROBERT McCUNNEY

ON BEHALF OF GREEN MOUNTAIN POWER CORPORATION

1. Q. What is your name, occupation, and business address?

A. My name is Robert McCunney. I am a medical doctor practicing in the field of occupational and environmental medicine, a research scientist at the Massachusetts Institute of Technology Department of Biological Engineering, and a co-author of a recent comprehensive review of the peer-reviewed scientific literature respecting wind turbines and human health. My business address is 245 First Avenue, 18th Floor, Cambridge, MA 02142.

2. Q. Please describe your educational background and pertinent professional experience.

A. A copy of my CV is attached as **Exh. Pet.-RJM-1**. For the past 30 years, I have practiced Occupational and Environmental Medicine from a variety of perspectives, including research, clinical and educational dimensions. I have been board certified since 1982 by the American Board of Preventive Medicine in Occupational and Environmental Medicine. I have an active clinical practice in Cambridge, Massachusetts where I evaluate and treat people exposed to potential occupational and environmental hazards. At the Massachusetts Institute of Technology ("MIT"), where I am a research scientist, I conduct environmental and occupational medical research and also co-teach a course in epidemiology. I also regularly lecture at the Harvard School of Public Health on the subject of noise and hearing.

My professional interest in the health implications of noise exposure arose as a result of my responsibilities as an occupational physician in overseeing hearing conservation programs of workers in occupational settings. Occupational exposure to noise can adversely affect hearing, a finding noted and confirmed in the medical literature for many years (Meyer and McCunney, 2007). My involvement with potential noise implications on hearing has focused on (1) publishing: I have written three book chapters for two different textbooks; (2) clinical issues: in serving as Director of Environmental Medicine at MIT from 1994 to 2001, I was responsible for reviewing, interpreting and following up the results of audiometric tests conducted on MIT employees; and (3) lecturing: for the past 10 years, I have regularly lectured at the Harvard School of Public Health to graduate students on noise and hearing, the most recent lecture was on March 12, 2010.

My involvement with wind turbines and potential human health implications dates to 2009 when I was invited to be a member of an expert panel by the American Wind Energy Association ("AWEA") and CanWEA. The purpose of the panel was to address the peer-reviewed scientific literature regarding potential health implications of wind turbines. I was a co-author of the comprehensive review "Wind Turbines and Health" (the "White Paper"), which was authored by the panel. The White Paper was released in December 2009.

3. Q. Have you previously testified before the Vermont Public Service Board ("Board")?

A. No.

4. Q. What is the purpose of your testimony?

A. I respond to claims by Department of Public Service ("DPS") witness Mr. Kane, Albany witness Mr. James, Lowell Mountains Group ("LMG") witness Blomberg and others concerning the health and related impacts of sound. I provide information from scientific studies related to the evaluation of potential sound-related health implications of living in the vicinity of wind turbines. I also support the Board's approved sound standard for wind projects.

5. Q. Please summarize your conclusions.

A. The risk of any direct adverse health effect at levels below 45 dB (A) is virtually non-existent.

Infra sound from wind turbines is not a risk to health, and low frequency sound does not usually reach levels where the sound would be detectable. There is no evidence that the audible or sub-audible sounds emitted by wind turbines have any direct adverse physiological effects.

Noise levels associated with sleep disturbances tend to be higher than 45 dB (A). The ground-borne vibrations from wind turbines are too weak to be detected by, or to affect, humans.

Some people may be annoyed at the presence of sound from wind turbines, or its fluctuating nature, depending primarily on personal characteristics as opposed to the intensity of the sound level. Annoyance, however, is not a pathological condition, *per se*; so-called "Wind Turbine Syndrome" is not a recognized medical disorder, and the array of symptoms identified by one author (Pierpont, 2009) is most likely a reflection of annoyance to noise.

The World Health Organization ("WHO") guidelines on noise represent a consensus view of international expert opinion on the lowest noise levels below which the occurrence rates of particular effects can be assumed to be negligible. Exceedances of the WHO guideline values do not necessarily imply significant noise impact and indeed, it may be that significant impacts do not occur until much higher degrees of noise exposure are reached.

The Board's approved sound standard of 45 dBA (exterior) (Leq) (1hr) is sufficient to protect human health and avoid sleep disturbance.

6. Q. Please describe briefly the testimony to which you are responding.

A. DPS witness Mr. Kane states that the lack of any comprehensive analysis of infrasound and low-frequency noise is a "glaring omission." Kane Prefiled Direct Testimony ("Pf.") at 14. He also cites a study by Salt and Hullar stating that infrasound may have an impact on inner ear physiology. Exh. DPS-MK-2 at 20. Mr. James cites a study finding that long-term exposure to sound levels of 90 dBA increased hearing loss, and a so-called Wind Turbine Syndrome report relating to the health effects of sound. James Pf. at 12, 14. Mr. Blomberg cites a WHO report that referred to sleep disturbance at sound levels between 30 dBA and 40 dBA. Blomberg Pf. at 4. Other witnesses, such as Mr. Brooks, express concern about noise impacts.

7. Q. Please discuss the minimum level of sound that has been associated with adverse health effects on humans.

A. The risk of any direct adverse health effect at levels below 45dB (A) is virtually non-existent (Miedema, Passchier-Vermeer and Vos 2003, Elements for a position paper on night time transportation noise and sleep disturbance TNO Inro, Delft, 2002-59).

8. Q. Please address the effects on humans of infra sound or low frequency sound.

A. Infrasound occurs at frequencies less than 20 Hz. Table 1 shows the sound pressure level of the corresponding frequency of infrasound and low frequency sound necessary for the sound to be heard by the average person (Leventhall *et al*., 2003). In essence, the lower the frequency of a sound, the higher the sound pressure needed for the sound to be heard by the average person. There are, however, different levels of hearing sensitivity that may allow some people to hear infrasound

TABLE 1

Hearing Thresholds in the Infrasonic and Low Frequency Range

Hz	4	8	10	16	20	25	50	100	200
SPL	107	100	97	88	79	69	44	27	14

At low frequencies, a much higher level of sound is necessary for it to be heard in comparison to higher frequencies. For example, at 10 Hz, the sound must be at 97 dB to be audible. (See Table 1 above). If this level occurred at the mid to high frequencies, which the ear detects effectively, it would be roughly equivalent to standing without hearing protection directly next to a power saw.

It has been claimed that sounds that contain low frequency noise, most notably within the infrasonic level, can adversely affect health even when the levels are below the average person's ability to detect them (Alves-Pereira and Branco, 2007; Salt *et al.* 2010). Low frequency sounds may be irritating to some people and, in fact, some low frequency sound complaints prove impossible to resolve (Leventhall *et al*., 2003).

Comprehensive reviews of low frequency sound, its sources and measurement have been published (Berglund and Lindvall, 1996), including infrasound from wind turbines (Leventhall 2006). Studies conducted to assess wind turbine low frequency noise have shown that wind turbine sound near residences is not audible below about 50 Hz (Hayes 2006). Recent work on evaluating a large number of noise sources between 10 Hz and 160 Hz suggests that wind turbine noise heard indoors at typical separation distances is modest (Pedersen 2008). The low levels of infrasound and low frequency sound from wind turbine operations have been confirmed by others (Jakobsen 2004; van den Berg 2004). Low frequency noise at 26 Hz was inaudible. In general terms, acousticians have reached consensus that infrasound from wind turbines is not a health problem (Leventhall 2006).

A few recent field studies exemplify these conclusions. Low frequency sound was assessed in the vicinity of Danish wind turbines (Low frequency noise from large wind turbines; DELTA, April 30, 2008). This study, conducted at the request of the Danish Energy Authority, concluded:

a. Wind turbines do not emit audible infra sound.

b. Other noise sources, such as road traffic, emit low frequency sounds at higher levels.

c. There is an approximate 5-15 dB attenuation in individual 1/3 octave bands of low frequency noise from outdoors to indoors.

d. The percentage of people annoyed by wind turbine noise at < 40dB (A) is about 5%.

A study by the British Wind Energy Association concluded: "low frequency noise has been below accepted thresholds and is therefore not considered a problem" (Hayes McKenzie partnership; The measurement of low frequency noise at three UK wind farms; Dept of Trade and Industry, URN number 06/1412, 2006). The authors of this report describe the results of noise assessments conducted in 2004 at three wind farms in the UK. They concluded:

a. "Low frequency noise associated with road traffic was greater than sound from neighbouring wind farms.

b. Infrasound associated with modern wind turbines will not be injurious to the health of a wind farm neighbour.

c. Measurements of infrasound of modern wind farms at distances of 200 meters were between 25 and 40 dB below perception thresholds. The authors also referred to a World Health Organization report that stated:

'There is no reliable evidence that infra sounds below the hearing threshold produce physiological or psychological effects.' (Community Noise: Berglund *et al*., Archives of the Centre for Sensory Research Vol 2 (1) 1995: Section 7.1.4: page 41).

d. The common cause of complaint was not associated with low frequency noise but with occasional audible modulation of aerodynamic noise, mostly at night.

e. Of the 126 wind farms operating in the UK, 5 reported low frequency noise problems. Therefore such complaints are the exception rather than a general problem for wind farms (Hayes McKenzie, 2006)."

A study in Texas earlier this year (2010) addressed noise levels and frequency of sound distribution in the vicinity of wind turbines (O'Neal RD *et al.*, Low frequency sound and infrasound from wind turbines, Noise-Con, April 19-21, 2010, Baltimore, MD). The results indicated that infrasound is inaudible to even the most sensitive people 305 meters (1,000 feet) from the wind turbines with the windows open or closed: low frequency sound above 40 Hz may be audible depending on background sound levels.

In experiments related to the Apollo space program, subjects were exposed to between 120 and 140 dB without known harmful effects. Early attention to low frequency sound in the U.S. space program led to studies which suggested that 24-hour exposures to 120 to 130 dB are tolerable below 20 Hz, the upper limit of infrasound. Modern wind turbines produce sound that is assessed as infrasound at typical levels of 50 to 70 dB, below the hearing threshold at those frequencies (Jakobsen 2004). In fact, Jakobsen concluded that infrasound from wind turbines does not present a health concern.

The sound levels associated with infra or low frequency sound are also addressed in criteria of the American National Standards Institute /Acoustical Society of America. For instance, the threshold for moderate acoustically induced vibration and rattles for the 31.5 and 63 Hz octave bands is 65 dB, and for the 63 Hz octave band, it is 70 dB inside the room. ANSI/ASA S12.2-2008.

There have also been studies assessing the physiological impact of low level sounds on the human body. Low-level sounds from outside the body do not cause a high enough excitation within the body, however, to exceed the internal body sounds. When measuring chest resonant vibration caused by external sounds, the internal vibration masks resonance for external sounds below 80 dB excitation level (Leventhall, 2006). Investigations at very low frequencies show a reduction of about 30 dB from external to internal sound in the body of a sheep (Peters *et al*. 1993). Similar findings have been noted in the protective effect of the uterus in attenuating noise exposure to the fetus at about 30 dB(A).

A recent review article addressed potential health implications of infrasound (Salt *et al*. 2010). The authors stated: “In most cases, the inner ear’s responses (that is, of the outer hair cells of guinea pigs) to infrasound can be considered normal, but they **could be** associated with unfamiliar sensations or subtle changes in physiology. This raises the **possibility** that exposure to the infrasound component of wind turbine noise **could** influence the physiology of the ear." As noted by the bold emphases added by this author, Salt *et al.* are appropriately tentative about their hypotheses. Their review article does not make any firm conclusions about health implications of exposure to infrasound and low frequency sound. In fact, the authors make clear that they have simply introduced concepts about responses of the outer hair cells of the inner ear (which do not send signals to the brain) to exposure to infrasound. A response, however, of outer hair cells does not necessarily mean that the response is harmful. The results, cited by Salt *et al.* and upon which they base their hypotheses, are from investigations involving guinea pigs. These laboratory animals, however, have a strikingly different anatomy of the inner ear in comparison to humans, and, as a result, the corresponding implications of these animal studies to humans are dubious. Moreover, the outer hair cells are not connected to the brain. Salt *et al.* make no mention of background infrasound in their review article. Moreover, in all mammals, one of the limits of low-frequency hearing is the helicotrema (the gap in the basilar membrane that connects the scala tympani and scala vestibuli). The helicotrema acts as a high-pass filter; the larger the helicotrema, the greater low-frequency sound is shunted away from hair cells. The guinea pig has a very small helicotrema (only 7% of the area of the human helicotrema) and therefore unusually good low-frequency hearing. This review article is not persuasive of a risk of adverse health effects from infrasound. Scientific data are not available to confirm their hypotheses and the concepts proposed remain speculative.

9. Q. Please discuss the relationship between sound and sleep disturbance.

A. Environmental noise levels associated with sleep disturbances tend to be higher than 45 dB (A). (Miedema *et al.* 2003) The prevalence of chronic insomnia in the U.S. has been estimated to be about 10%; in fact, about 50-70 million Americans suffer from chronic sleep problems. (Institute of Medicine, Committee on Sleep Medicine and Research; "Sleep disorders and sleep deprivation: an unmet public health problem," National Academies Press, 2006). Sound can adversely affect sleep, but such effects are highly individualized. Research has also shown that people can become habituated to sounds so that they no longer are affected by the sounds.

10. Q. Please discuss the issue of annoyance and claimed symptoms relating to annoyance?

A. Annoyance is not a recognized clinical diagnosis and its manifestations and definition vary considerably. Some people may be annoyed at the presence of sound from wind turbines, or its fluctuating nature, depending primarily on personal characteristics. The annoyance of a sound also tends to increase as loudness increases and there is also a more rapid growth of annoyance at low frequencies. Studies have shown that as environmental noise levels increase, especially beyond 45 dB(A), regardless of the source (transpiration, industrial or wind turbines), more people report being annoyed.

11. Q. Is the Board's currently approved noise level standard sufficient to protect human health?

A. Yes. The standard set in the Board's recent wind decisions is 45 dBA (exterior) (Leq) (1hr) and 30 dBA (interior) (Leq) (1hr). As Kenneth Kaliski indicates, the 45 dBA standard is equivalent to, if not more stringent than, the 2009 WHO guideline for nighttime noise in Europe, which is 40 dB (Leq) (night) averaged on an annual basis. The WHO guidelines on noise represent a consensus view of international expert opinion on the lowest noise levels below which the occurrence rates of particular effects can be assumed to be negligible. Exceedances of the WHO guideline values do not necessarily imply significant noise impact and indeed, it may be that significant impacts do not occur until much higher degrees of noise exposure are reached. See Miedema, Passchier-Vermeer and Vos 2003, Elements for a position paper on nighttime transportation noise and sleep disturbance TNO Inro, Delft, 2002-59. This report reviews eight environmental noise studies and concludes that exposures to noise < 45 dB (A) do not adversely affect sleep. This paper was also cited in the 2009 WHO report on night time noise.

The Board's standard is also support by studies undertaken in the states of Wisconsin and Maine, and the province of Ontario. See **Exhs. Pet.-RJM-2, 3, 4**. The Wisconsin and Maine studies support a standard of 45 dBA (night), and the Ontario study refers approvingly to the WHO standard which, as noted above, is more lenient than the Board's standard.

12. Q. Does this conclude your testimony?

A. Yes.