HGC ENGINEERING
noise · vibration · acoustics

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February 20, 2009

Mr. Bryan Tripp
Canadian Hydro Developers, Inc.
34 Harvard Road
Guelph, ON
N1G 4V8

Re: Canadian Hydro Developers, Inc.
Melancthon EcoPower Center, Melancthon Township, Ontario
Acoustical Investigation - Lormand Residence – 335498 7th Line, Amaranth, Ontario

Dear Mr. Tripp,

As requested, Howe Gastmeier Chapnik Limited (HGC Engineering) has undertaken an acoustical investigation at the Lormand Residence in the Township of Amaranth, Ontario. This residence is situated near wind turbine generators that are part of the Melancthon EcoPower Center located in the Township of Melancthon, Dufferin County, Ontario. The Melancthon EcoPower Center consists of one hundred and thirty-three General Electric Wind Energy 1.5 megawatt model sle wind turbine generators. This acoustical investigation initially arose from a complaint received from the Lormand Residence on December 9, 2008.

The Lormand Residence is located at 335498 7th Line, Amaranth, Ontario. Figure 1 shows the Lormand Residence in relation to the surrounding roads and wind turbines. There are several wind turbines surrounding this property. The closest wind turbine (WT71) is approximately 460m west of the residence. The master bedroom of the Lormand residence is on the west side of the dwelling.

This acoustical investigation was completed in accordance with the Melancthon Wind Plant, Noise Complaint Management Protocol prepared by Aercoustics Engineering Limited, dated February 14, 2008. The criteria used in this investigation are based on the MOE's publication "*Interpretation for Applying MOE NPC Technical Publications to Wind Turbine Generators*".

This investigation utilized a series of attended and unattended sound level measurements recorded both inside and outside the Lormand Residence and in close proximity the nearest wind turbine generator. These sound level measurements were conducted over a two monitoring periods, from December 18 until December 24, 2008 and from January 16 until January 26, 2009.

Weather conditions, including wind speed and direction, were monitored and recorded during both measurement periods at ground level. This data was supplemented with electric power production records and wind data obtained from Canadian Hydro as recorded through their turbine monitoring system.

It should be noted that the sound level limits of the MOE apply only to the sound level contribution of the sound source under assessment, in this case the sound from the wind turbine generators. Thus, where a sound level measured at a receptor includes significant sound due to the relevant sound source and unrelated background sound sources (i.e., road vehicles, air traffic, farming machinery, wind, etc.), some form of evaluation must be made to determine the sound level contribution of the source under assessment in the absence of the background sounds.

Consequently, a central challenge with any investigation of environmental noise emissions is the evaluation of measured sound levels and the removal of significant effects of background sound. This challenge is particularly acute in the audit of wind plants, due to the typically large source-to-receiver distances, the significance of wind and wind-induced noises, and the spatially diffuse layout of the wind turbine generators within a wind plant.

1.0 Sound Level Limits

MOE technical publication NPC-232, *Sound Level Limits for Stationary Sources in Class 3 Areas (Rural),* provides general assessment guidelines for stationary industrial noise impacting a sensitive land use such as a residence in an acoustically rural area. The sound level limits of the MOE guidelines are presented in terms of hourly energy equivalent average sound levels designated L_{EQ}, in units of A-weighted decibels, dBA. Thus, where sound levels vary in loudness over an hour, it is the average sound level rather than the maximum or minimum sound levels which is relevant. The measured L_{EQ} represents the overall sound level, which includes contribution from the wind turbine generators, among other sources.

NPC-232 indicates that the applicable sound level limit for a stationary source of sound is the local ambient sound level in the area, unaffected by sound from the stationary sound source. However, where these ambient sound levels are low, exclusionary minimum limits apply. Under NPC-232 the exclusionary minimum limits are 40 dBA for quiet nighttime periods and 45 dBA for quiet daytime periods.

Sound levels are sometimes usefully quantified by determining the ninetieth percentile (L_{90}) sound level. An L_{90} sound level represents the level which was exceeded 90% of the time during a measurement. Technical publication NPC-232 indicates that it is appropriate to using the background one hour ninetieth percentile sound level (L_{90}) plus 10 dB if it results in a more stringent sound level limit than that obtained by considering the background one hour equivalent sound level (L_{EQ}). L_{90} sound levels are useful as they allow some separation of steady sound from an overall, aggregate measured sound level. That is: when a continuous sound such as the sound of an operating wind turbine generator is masked at times by a louder transient sound such as those caused by wind gusts, birds, vehicles, and animals, the L_{90} sound level tends to more accurately reflect the sound level contribution of the steady sound by itself than does the L_{EQ} sound level.

It is important to note that the MOE guidelines do not require or imply that inaudibility of a sound source at a point of reception should be expected. In fact, even when the sound levels from a source are less than the numeric guideline limits, spectral and temporal characteristics of a sound regularly result in audibility at points of reception.

The MOE has recognized wind turbine generator noise as unique among other industrial sounds, because wind turbine generators generate more sound as wind speeds increase and because increasing wind speeds generally result in increasing levels of background sound. Consequently, the MOE has provided supplementary guidance for the modelling of wind turbine generator noise in the *Interpretation for Applying MOE NPC Technical Publications to Wind Turbine Generators* (the *Interpretation*).

The *Interpretation*, while based upon technical publications NPC-232 and NPC-205, provides specific criteria for the combined contribution of all wind turbine generators in a wind plant as a function the wind speed as measured by an anemometer located 10 metres above the ground. The *Interpretation* is intended to be applied when designing a wind plant to assess the predicted contribution of a new wind plant. The numeric limits of the *Interpretation* are presented in A-weighted decibels and summarized in Table 1.

Table 1: MOE Sound Level (L_{EQ}) Criteria for Wind Turbine Generators

10 metre Wind Speed (m/s)	4	5	6	7	8	9	10
Rural Wind Turbine Noise Limits, NPC-232 (dBA)	40	40	40	43	45	49	51

The MOE guidelines indicate that sound level measurements should generally not be conducted during periods with high wind speeds. Specifically, technical publication NPC-102 indicates that measurements of low sound levels should not be undertaken when winds exceed 15 km/h (4.2 m/s). Typically, the noise output of industrial sound sources is independent of wind speed. This is not the case for wind plants and there is an intrinsic relationship between wind speed (and therefore ambient noise) and increased sound power levels associated with the wind turbine generators. Complicating matters, there is a large degree of variability related to environmental factors within the wind plant area including, among others, local ground level wind speeds, wind speeds affecting the wind turbine generator blades, the associated wind shear, and the sound power of the wind turbine generators, all of which affect the measured sound levels. Thus, it is not realistic to expect that in practice a single repeatable sound level can or will be measured for a given wind speed at a given setback distance; a simple comparison of single numbers is not sufficient or possible.

The modelling methodology prescribed by the MOE provides typical environmental factors (including wind shear), based on internationally recognized standards. The predictive modelling methodology does not ensure that there will be no incidents or conditions during which the numeric guidelines are exceeded. While sound level measurements made during specific real-world meteorological conditions can be compared against the numeric limits, for the wind turbines, of the MOE guidelines to provide a guide to suitability, a measured sound level which exceeds the numeric limits of the *Interpretation* under a particular condition does not necessarily imply that the design or the performance of the wind plant is out of compliance with the MOE guidelines.

2.0 Measurement Methodology

Two unattended sound level meters were deployed and configured to record L_{EQ} and L_{90} sound levels in 10-minute intervals over two monitoring periods from Thursday, December 18 until Wednesday, December 24, 2008 and from Friday, January 16 until Monday, January 26, 2009. One meter was placed approximately 15 m from the Lormand Residence, on the southwest side of the dwelling. The monitoring location was selected in conjunction with the resident and was generally near the house itself, with little to no acoustic screening from the wind turbine generators to represent the same exposure the home experienced. The second sound level meter was deployed approximately 80 m southeast of WT71. At this location WT71 was audible and dominant. The sound level meter located 80 m southeast of WT71 was damaged due to the extreme winter weather conditions and did not record data from January 16 until January 22, 2009. The meter was replaced with a different meter on January 22, 2009 and data was successfully recorded for the remainder of the measurement period.

To analyze the data four principal strategies were used: i) the analysis examined L_{90} sound levels, which tend to minimize the effects of intermittent background sound such as traffic, in addition to L_{EQ} sound levels; ii) measured sound levels were correlated with power production data from the closest wind turbine generator; iii) measured sound levels were considered with regard for the ambient weather conditions present at the time of the measurement; and iv) sound level records made at the Lormand Residence were compared to similar records made at two locations near a wind turbine generator where background sound was less significant relative to the contribution of the wind turbine generator noise.

An automatic meteorological station was deployed on December 18, 2008 and January 16, 2009 by HGC Engineering to record temperature, humidity, and ground level wind speed and direction at a height of 2 m. Canadian Hydro provided hub-height (80m) wind speed and electric power production data from individual wind turbine generators to assist the analysis. To determine the approximate criteria, 10m wind speed data was calculated using calculated wind shear values based on the wind speeds measured at hub-height and ground level. An anemometer at 10 m was not available.

Attended measurements were conducted on December 18, December 23 and December 24, 2008, as well as January 16, January 20 and January 26, 2009. Observations of the sound level characteristics and sound level measurements were made by qualified HGC Engineering field staff.

3.0 Instrumentation

MOE technical publication NPC-102, "Instrumentation" provides specifications for sound level measurement instrumentation. All equipment used in the investigation meets these requirements.

Three Bruel & Kjaer Integrating Sound Level Meters were used for the unattended monitoring. The instruments are described in Table 3 and Table 4 below.

Table 3: Instrumentation Used For Unattended Sound Level Measurements (December)

Measurement Location	Instrument Make and Model	Instrument Serial Number
Lormand Residence	Bruel and Kjaer Type 2238	2448501
WT71	Bruel and Kjaer Type 2238	2342948

Table 4: Instrumentation Used For Unattended Sound Level Measurements (January)

Measurement Location	Instrument Make and Model	Instrument Serial Number
Lormand Residence	Bruel and Kjaer Type 2238	2342948
WT71	Bruel and Kjaer Type 2236	2039554

Both of the Bruel and Kjaer 2236 and 2238 sound level meters meet the specifications contained in technical publication NPC-102. The clocks of all instruments were synchronized before being deployed.

Hewlett Packard Type 3569A Real Time Frequency Analyzers (SN 3222A00134, 322A00199), in conjunction with Bruel & Kjaer Microphones, a Larson Davis Integrating Sound Level Meter (SN 1724), and a Rion Sound Level Meter (NL-22) were used for the attended measurements.

Correct calibration of all the acoustic instrumentation was verified using Bruel and Kjaer and Rion acoustic calibrators. Wind screens were used on all microphones, consistent with the requirements of technical publication NPC-103, "Procedures".

4.0 Assessment and Discussion

4.1 Unattended Acoustic Measurements

The overall sound level data gathered by the automatic monitor at the Lormand Residence is shown on Figures 2 through 4. The figure illustrates the 10-minute L_{EQ} (energy equivalent average) and L_{90} (90^{th} percentile) sound levels measured at each location, together with the numeric limits derived in accordance with the *Interpretation*, based on the calculated 10-metre height wind speed data. The following is an explanation of the data presented in the figures.

"L_{EQ} (Energy Equivalent Average Sound Level)" – The first dataset is the energy equivalent average L_{EQ} sound level, recorded at the Lormand Residence, in 10 minute intervals, shown in red. The corresponding amplitude information, in units of A-weighted decibels, is provided on the left hand side vertical axis.

"L_{90} (90th Percentile Sound Level)" – The second dataset is the 90th percentile sound level, L_{90}, recorded at the Lormand Residence, in 10 minute intervals, shown in black. The corresponding amplitude information, in units of A-weighted decibels, is provided on the left hand side vertical axis.

"MOE Limits for Contribution of Wind Turbine Noise" – The third dataset is shown on the chart in green, and represents the wind speed-dependant criteria, for the sound level contribution of wind turbines, derived under the *Interpretation*. It is shown as a green line and the corresponding amplitude information, in terms of dBA, is shown on the left hand vertical axis. These limits were derived using 10 m wind speed data that was determined using calculated wind shear values based on the wind speeds measured at hub height and ground level.

"Ground Level Wind Speed" - The fourth dataset is the ground level wind speed, and is shown in grey. The corresponding scale, displaying wind speed in units of m/s, is shown on the right hand side vertical axis.

"Ground Level Wind Direction" - The approximate wind direction is also shown on this data series with black arrows. The direction the arrow is pointing in represents the direction that the wind is coming from, with north represented by an arrow pointing towards the top of the page. For example, a wind coming from the east is represented by an arrow pointing to the right side of the graph.

"Wind Speed at 80m (Measured at WT71)" – The fifth dataset is the wind speed information measured by an anemometer at the 80 metre hub height of the wind turbine generator closest to the point of reception. This dataset is shown in Figures 2 through 4 in orange, and the corresponding amplitude information, displaying wind speed in units of m/s, is shown on the right hand side vertical axis.

"Power Generated by WT71" – The sixth dataset is the power generated by the wind turbine generator closest to the point of reception, shown in blue. The corresponding amplitude information, displaying power in units of 100kW, is shown on the right hand side vertical axis.

With increasing wind speed the sound power levels generated by wind turbine generators also increase. However higher wind speeds also tend to increase ambient sound levels by rustling grasses, trees, etc. This fact is the basis of the wind speed dependant numeric limits of the *Interpretation*. In general, the measured sound levels presented in Figures 2 though 4 follow the trend in ground level wind speed reasonably well.

As noted in Section 1.0, the L_{90} sound level is often a better descriptor of the sound level contribution of a steady sound source than the L_{EQ} sound level. Where a steady sound is not masked by short duration events, such as vehicle pass-bys, the L_{EQ} and L_{90} sound level will be close to one another. Conversely, when short-duration or variable background sounds are the dominant noise source, and strongly mask any quieter steady industrial sounds, the difference between the L_{EQ} sound level and the L_{90} sound level will be large.

Considering these facts in the analysis of the data in Figures 2 though 4, it can be seen that in general the L_{90} sound level (which represents steady sound from all sources, including, the wind turbine generator sounds and any other steady background sound sources) is generally 5 to 10 dB above the numeric limits of the MOE criteria derived based on wind speed during many time periods when the wind turbines were operational. This result is consistent in both the December and January measured sound level data. As discussed earlier, a measured sound level in excess of the numeric limits of the *Interpretation* does not necessarily imply that the performance of the wind plant is out of compliance with the MOE guidelines. Further analysis of the data is required to determine the contribution from the wind turbines themselves.

Figures 2 through 4 show several operating conditions with differences due to both weather and a variation in which neighbouring turbines were operating. The operating wind turbines have been indicated on the figures and changes in the operating conditions have been indicated by vertical lines. It should be noted that WT70 went offline several times during the measurement period. The recorded sound levels at the Lormand residence showed no difference in magnitude with WT70 on and off. Two intervals have been indicated for further discussion.

As indicated on Figure 3, at approximately 6:00am on January 21, 2009 WT71 (the closest wind turbine) shutdown, leaving only WT72 and WT76 in operation, this time period has been labelled Interval A. During this interval the L_{90} sound levels were consistently above the numeric limits of the MOE criteria derived based on wind speed. These excesses are due to the combined contribution of the sound levels due to WT72 and WT76 and the weather conditions (i.e. ground level wind speeds on the order of 5 m/s).

Interval B, shown on Figure 3, is a period of relatively low wind speeds. During this interval none of the neighbouring turbines were operating due to a combination of the extreme cold temperatures and low wind speeds. The L_{90} sound levels were consistently below the criteria during this interval.

Figures 5 and 6 shows the 10-minute L_{90} sound level data recorded by the automatic monitor at the Lormand Residence and the 10-minute L_{EQ} sound level data recorded by the automatic monitor approximately 80 m from WT71, from December 18 until December 24, 2008 and from January 22 until January 26, 2009. The sound levels recorded at the Lormand Residence are generally less than the levels recorded in close proximity to WT71. During Interval B, highlighted on Figure 6, the sound levels recorded at the Lormand Residence are generally the same as the levels recorded in close proximity to WT71. This trend was expected because during Interval B the neighbouring wind turbines were not operational and therefore the sound levels were dominated by the environment.

4.2 Attended Acoustic Measurements

Several attended measurements were conducted on December 18, December 23 and December 24, 2008, as well as January 16, January 20 and January 26, 2009. The observations and results of the attended measurements confirm that the wind turbines are audible at the Lormand Residence. These measurements were conducted in close proximity to the southwest corner of the dwelling itself with a direct line of sight to WT71 to represent the sound level exposure at the plane of the bedroom window. The sound levels recorded during the attended measurements are generally less than the levels recorded by the unattended sound level meters because the unattended sound level meter had a greater exposure to the surrounding turbines and the weather conditions. The measured L_{EQ} and L_{90} values are summarized in Table 4. Measurements were conducted under a variety of weather conditions and the measured wind speeds have also been included in Table 4.

Table 4: Summary of Attended Measurements at the Lormand Residence

Date and Time	L_{EQ} [dBA]	L_{90} [dBA]	2m Wind Speed	80m Wind Speed	Criteria [dBA]	Comments
Dec 18, 2008 10:30am	36	33	3	5	40	Wind turbines clearly audible and dominant, west wind
Dec 23, 2008 4:00pm	44	41	1.5	8.5	40	Wind turbines clearly audible and dominant, southeast wind
Dec 24, 2008 11:00am	43	39	3.5	5.5	40	Wind turbines clearly audible and dominant, southwest wind
Jan 16, 2009 3:00pm	36	31	2	4	40	Wind turbines clearly audible, some traffic noise, west wind
Jan 20, 2009 7:45am	35	31	0.5	6	40	Wind turbines clearly audible, distant dog, north wind
Jan 26, 2009 2:10pm	43	39	4	6.5	40	Wind turbines clearly audible and dominant, west wind
Jan 26, 2009 2:45pm	40	36	4	6.5	--	Neighbouring wind turbines not operating, west wind
Jan 26, 2009 3:05pm	40	35	3.5	6.5	--	Neighbouring wind turbines not operating, west wind
Jan 26, 2009 3:40pm	43	41	3.5	6.5	40	Wind turbines clearly audible and dominant, west wind

*V represents wind speed

The first five measurements presented in Table 4 above represent a brief sample of the sound levels experiences at the Lormand residence. Two of the L_{EQ} measurements exceeded the MOE criteria and one of the L_{90} measurements exceeded the criteria.

In order to determine the sound level contribution of the neighbouring wind turbines several measurements were conducted on January 26, 2009 with all the neighbouring turbines on and off. It should be noted that only WT71 and WT76 were included in this measurement. Figure 7 shows the average sound levels recorded at the Lormand Residence when the wind turbines are on and when the wind turbines are off. The measured frequency profiles demonstrate a broadband increase in sound in the frequency range from 250 to 1250 Hz and it also indicates that the sound level due to the wind turbines is tonal[1] at 160 Hz under certain weather conditions. This observation is consistent with several of the other measurements conducted at the Lormand Residence. An analysis of the measured frequency profiles and corresponding weather conditions indicates that the tone is particularly evident when the hub height wind speeds are at least 6.5 m/s.

A statistical analysis of the sound levels measured on January 26, 2009 was completed. The sound levels were recorded in 10-second intervals over four periods of twenty minutes; first with the turbines on, two periods with the turbines off and then again for a period with them on. The mean and standard deviation were calculated for each period. Figure 8 shows the difference between the mean sound levels measured when the wind turbines were on and off, in units of the group standard deviation. It can be seen that the measured levels at 160 Hz are different by 2.6 standard deviations and the overall A-weighted sound level is different by 1.4 standard deviations. A statistical analysis of these sound levels indicates that, at a high level of confidence, the sound level at 160 Hz is 5 dB higher when the wind turbines are operating and the overall A-weighted sound level is 3 dB higher when the wind turbines are operating. This indicates that under the weather conditions present in the afternoon on January 26, 2009 the measured sound level, including the wind turbine generators, was approximately 3 dB higher than the measured background sound with a significant contribution in the 160 Hz frequency band from the neighbouring wind turbine generators.

On January 26, 2009 sound level measurements were also conducted inside the Lormand Residence bedroom, which is on the west side the dwelling with a direct line of sight to WT71. The results of these measurements are not presented herein but they confirm that the sound levels inside the residence increase when the wind turbines are on, particularly at 160 Hz.

A Tascam digital audio tape (DAT) recorder and a Bruel and Kjaer 2236 sound level meter were installed in the Lormand bedroom so that they could record the sound levels during a time they found the acoustic impact of the neighbouring wind turbines to be objectionable. Figure 9 shows the A-weighted sound levels recorded over a two-minute period during the evening of January 16, 2009, and analysed using a Hewlett Packard Type 3569A Real Time Frequency Analyzer. As indicated on the figure, there is a significant tone at 160 Hz that is accentuated inside the bedroom. This accentuation is typical for the performance of windows which reduce higher frequency sounds better than lower frequency sounds.

The sound from modern wind turbine generators is generally broadband in nature, demonstrating the characteristic aerodynamic "swoosh" with no substantial low-frequency tones. Thus, this tone is not characteristic of normal turbine sound and may be an indication of a mechanical deficiency.

Appendix A describes measurements of noise at infrasonic frequencies made at the receptor location. Infrasound is not relevant to the MOE guidelines, and in most industrial contexts is

[1] Tonality: A "tone" or a "tonal sound" is any sound which can be distinctly identified through the sensation of pitch. In measured sound data, when presented as a function of frequency, a tone would typically show up as an elevated level at a certain frequency where the levels at the neighboring frequencies on both sides are less. Tonality increases the subjective annoyance of the sound and under MOE guidelines would indicate a 5 dB penalty.

rarely an issue. However, it has been the subject of interest for wind plants in recent media reports. The conclusion of the data summarized in Appendix A is that the infrasound levels at the Lormand Residence are well below the threshold of human perception.

5.0 Summary and Conclusions

HGC Engineering conducted an acoustical investigation of the wind turbine generators surrounding the Lormand Residence. This investigation involved automatic continuously recorded sound level measurements at two monitoring locations, near the residence and near the closest wind turbine, from December 18 through December 24, 2008 and from January 16 through January 26, 2009. A number of attended acoustic measurements were also conducted, including spectral sound measurements. Meteorological and power production data was also obtained for this measurement period.

The results of the investigation indicate that the sound of the operating wind turbine generators surrounding the Lormand Residence is routinely audible. The automated sound level monitor data shows that the L_{EQ} (energy equivalent average) and L_{90} (90^{th} percentile) sound levels recorded at the Lormand Residence were generally greater than the numeric limits specified by the Ontario Ministry of the Environment's (MOE's) sound level criteria derived by the *Interpretation* by a margin sufficient to suggest that sound levels from the turbines themselves may be exceeding the MOE sound level criteria more frequently than anticipated by the MOE model.

The sound level contribution of the wind turbines was found, on occasion, to be tonal at a frequency of 160 Hz, which is not typical of this class of wind turbines. Such a tone would increase the subjective annoyance of the sound, and under MOE guidelines would necessitate a 5 dB penalty to be added to the overall A-weighted level. Accordingly, it is recommended that further acoustic investigations be undertaken to identify the specific turbine that is the source of the tonal sound. Based on the measured frequency profiles, it is anticipated that removal of the 160 Hz tonal sound will result in a reduction in the overall sound level at the Lormand Residence as well as a less intrusive sound characteristic.

We trust that this information is sufficient for your current needs. Please let us know if you have any further questions or concerns.

Yours truly,
Howe Gastmeier Chapnik Limited

Megan Munro, BASc, EIT

LICENSED PROFESSIONAL ENGINEER R. B. HOWE PROVINCE OF ONTARIO

Brian Howe, MEng, MBA, PEng

Figure 1: Site Plan showing Lormand Residence and Neighbouring Wind Turbines

Melancthon II Turbine	Lot Lines	Abandoned Railway
Melancthon I Turbine	ESR Study Area	Existing Gravel Road
Receptor	Watercourse	Existing Paved Road

Melancthon Wind Project: Phase I and II Layouts

Canadian Hydro Developers, Inc.

0 450 900 1,350 1,800 2,250 Metres

MB.06.271

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Figure 2: Sound Levels Measured at the Lormand Residence.
Comparison to Wind Speeds and Criteria. Canadian Hydro, Melancthon EcoPower Center.

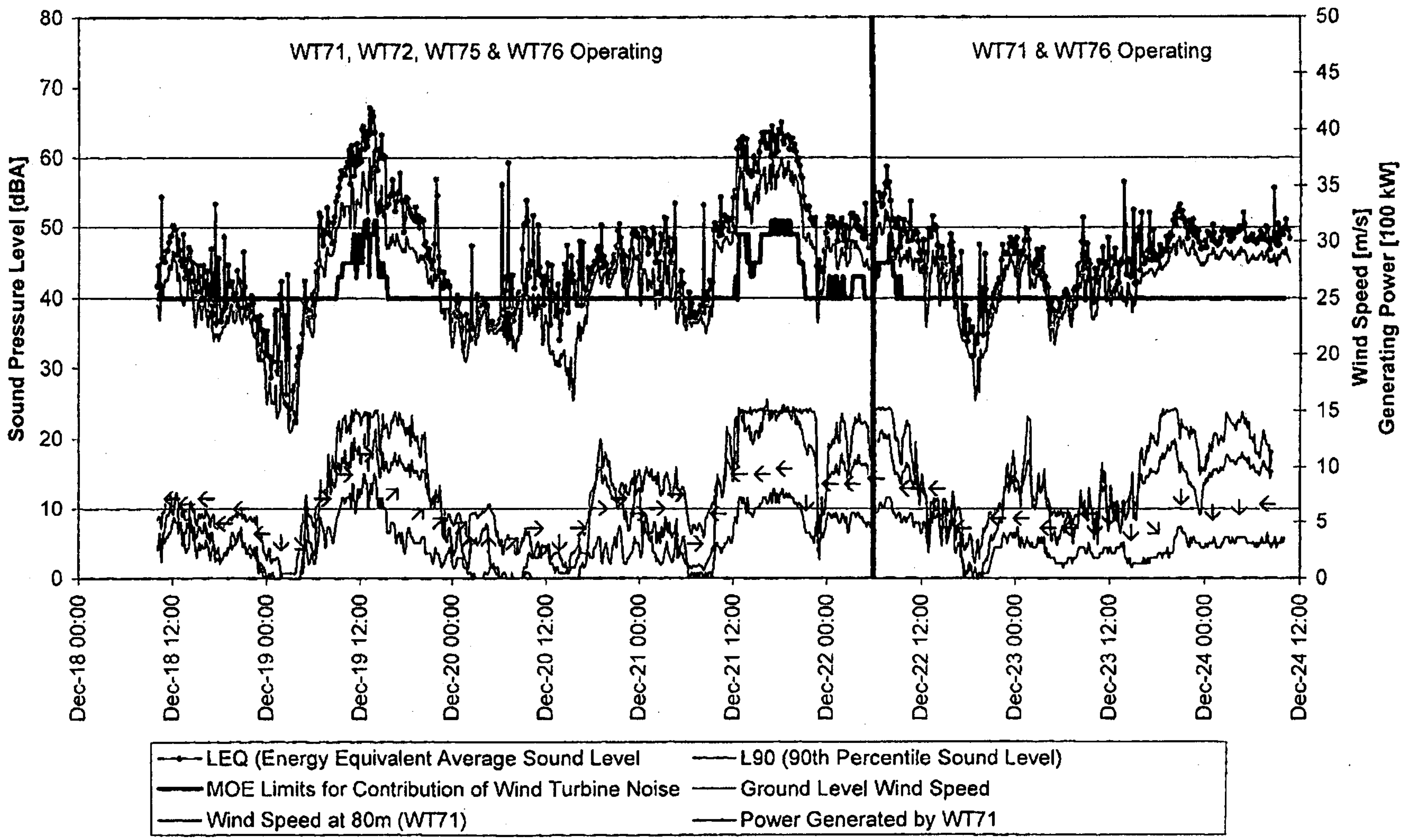


Figure 3: Sound Levels Measured at the Lormand Residence. Comparison to Wind Speeds and Criteria. Canadian Hydro, Melancthon EcoPower Center.

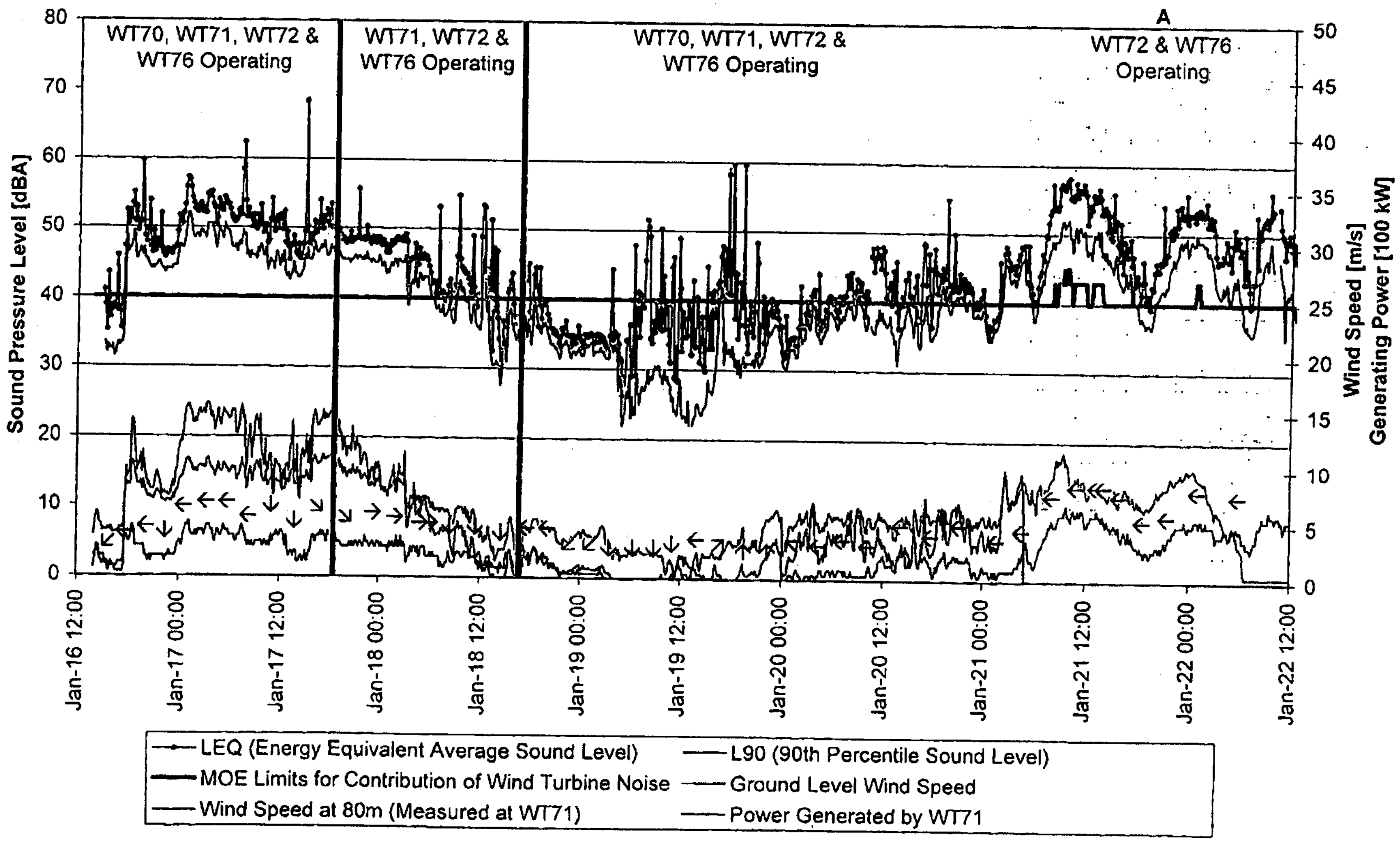


Figure 4: Sound Levels Measured at the Lormand Residence. Comparison to Wind Speeds and Criteria. Canadian Hydro, Melancthon EcoPower Center.

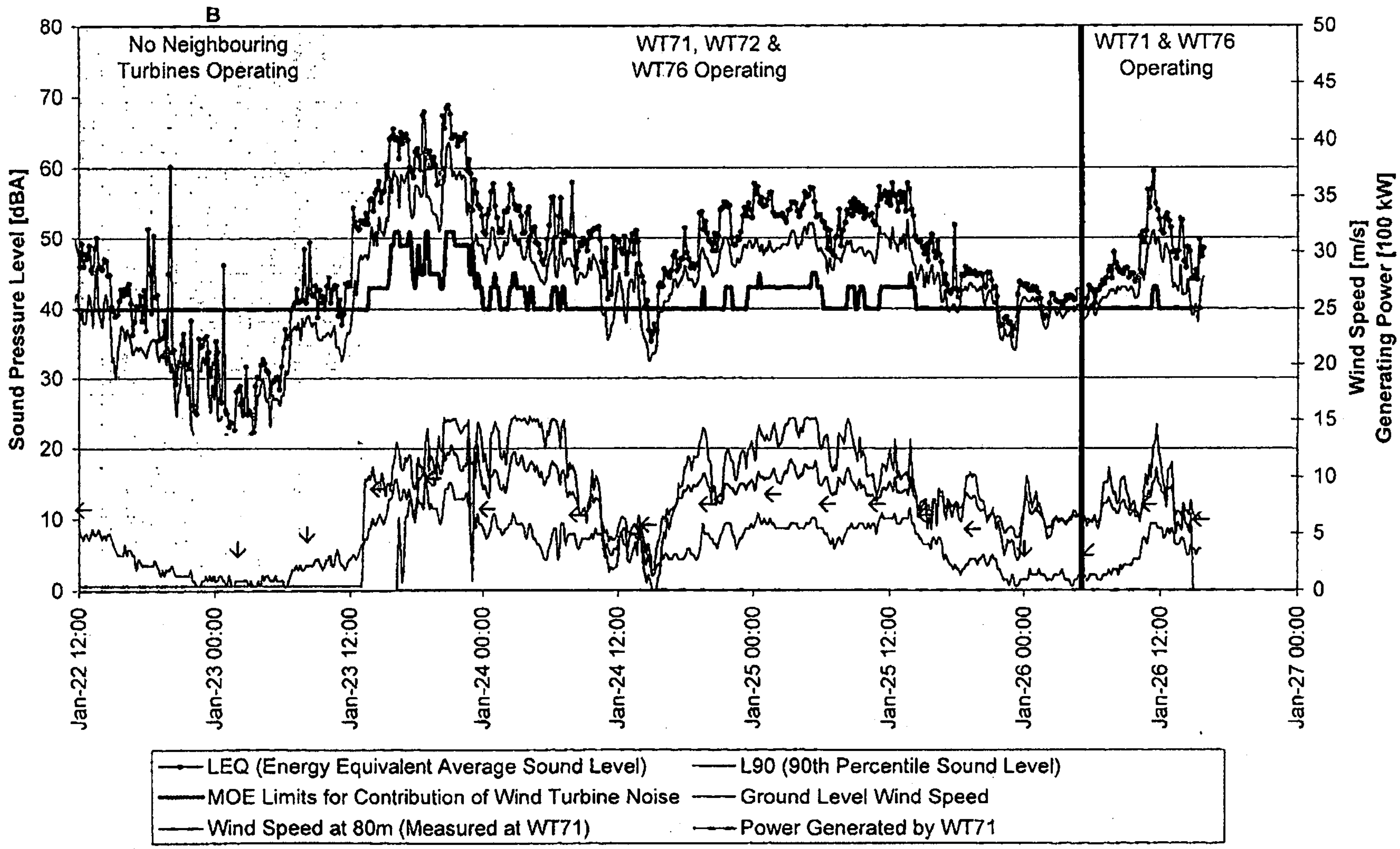


Figure 5: Comparison of Sound Levels Measured at the Lormand Residence (L_{90}) and 80 m from WT71 (L_{EQ}). Canadian Hydro, Melancthon EcoPower Center.

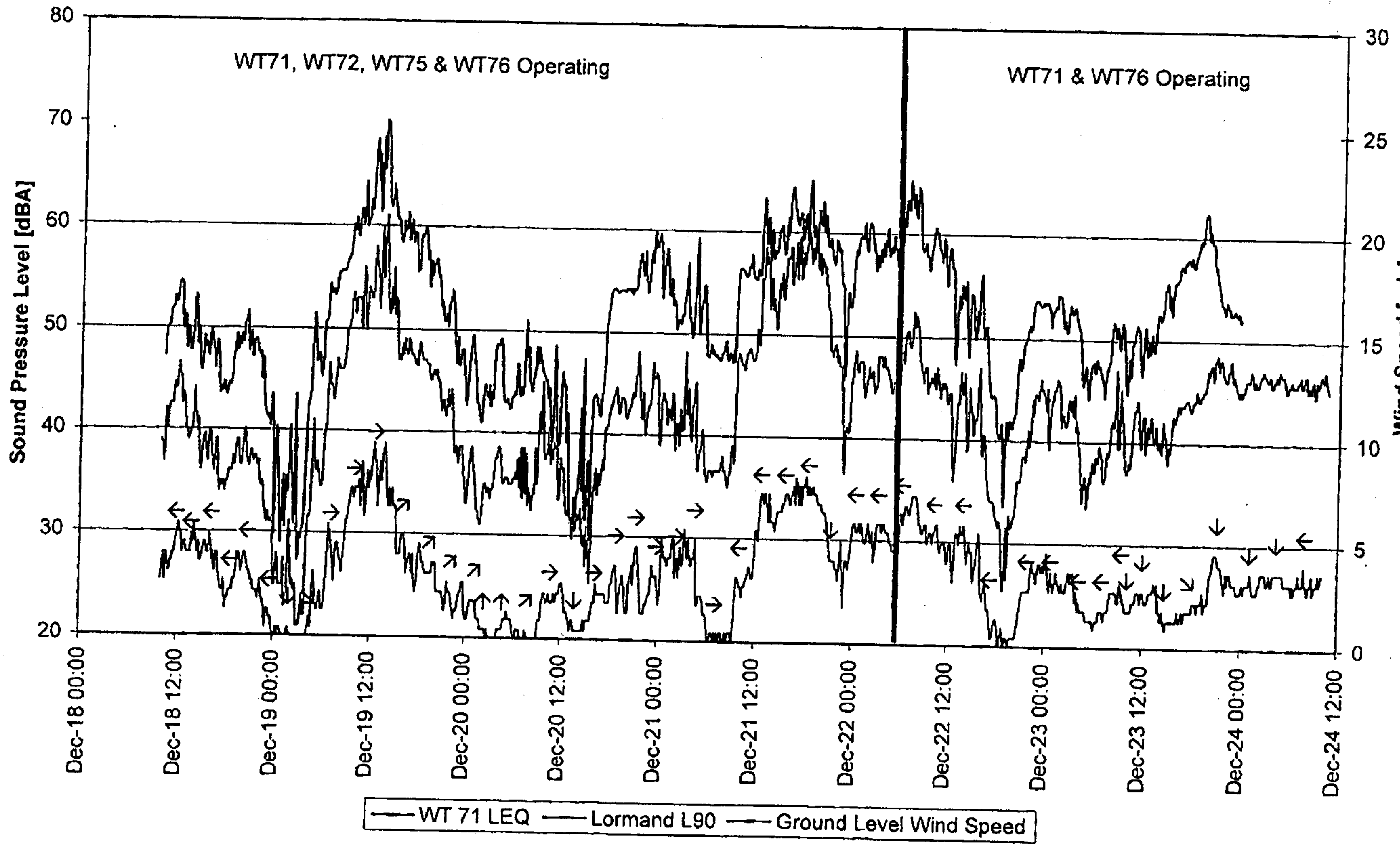


Figure 6: Comparison of Sound Levels Measured at the Lormand Residence (L_{90}) and 80 m from WT71 (L_{EQ}). Canadian Hydro, Melancthon EcoPower Center.

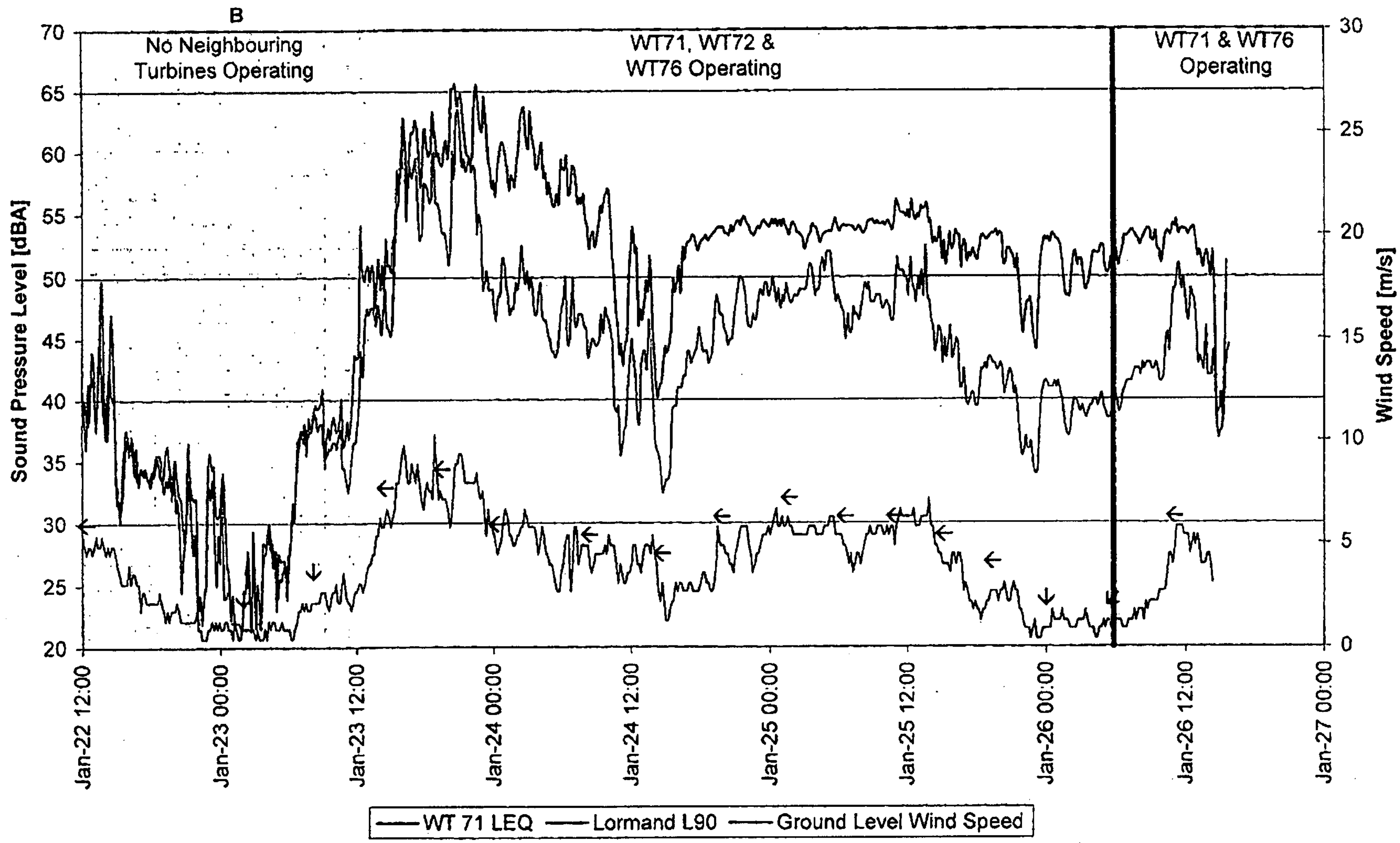


Figure 7: Average Sound Levels Measured outside the Lormand Residence Conducted when the Wind Turbines were On and Off - January 26, 2009, 2:00 - 4:00pm

Measurements Conducted over two 20-minute Periods

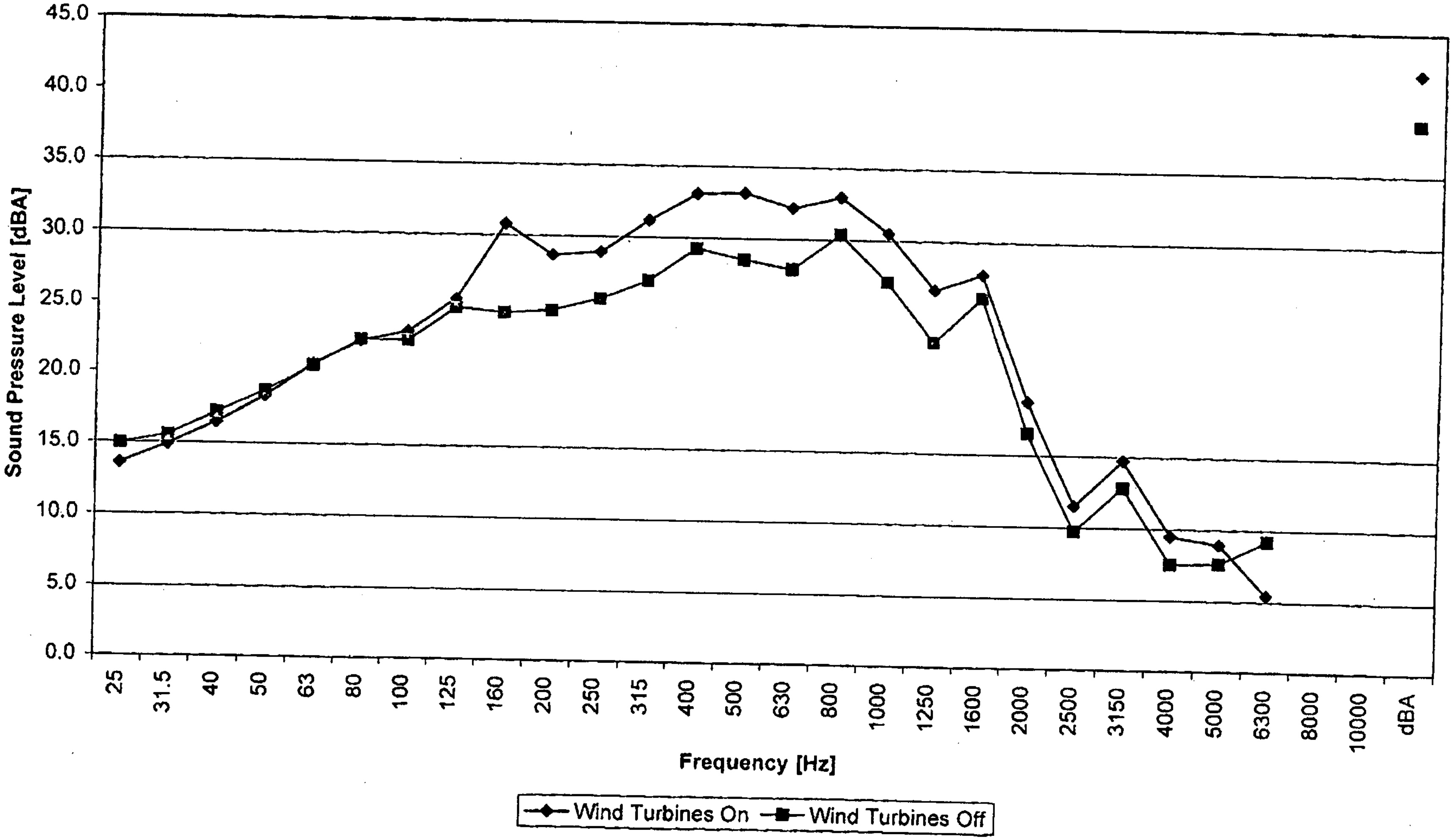


Figure 8: Difference Between Mean Sound Levels in Units of the Group Standard Deviation Conducted when the Wind Turbines were On and Off - January 26, 2009, 2:00 - 4:00pm

Measurements Conducted over two 20-minute Periods

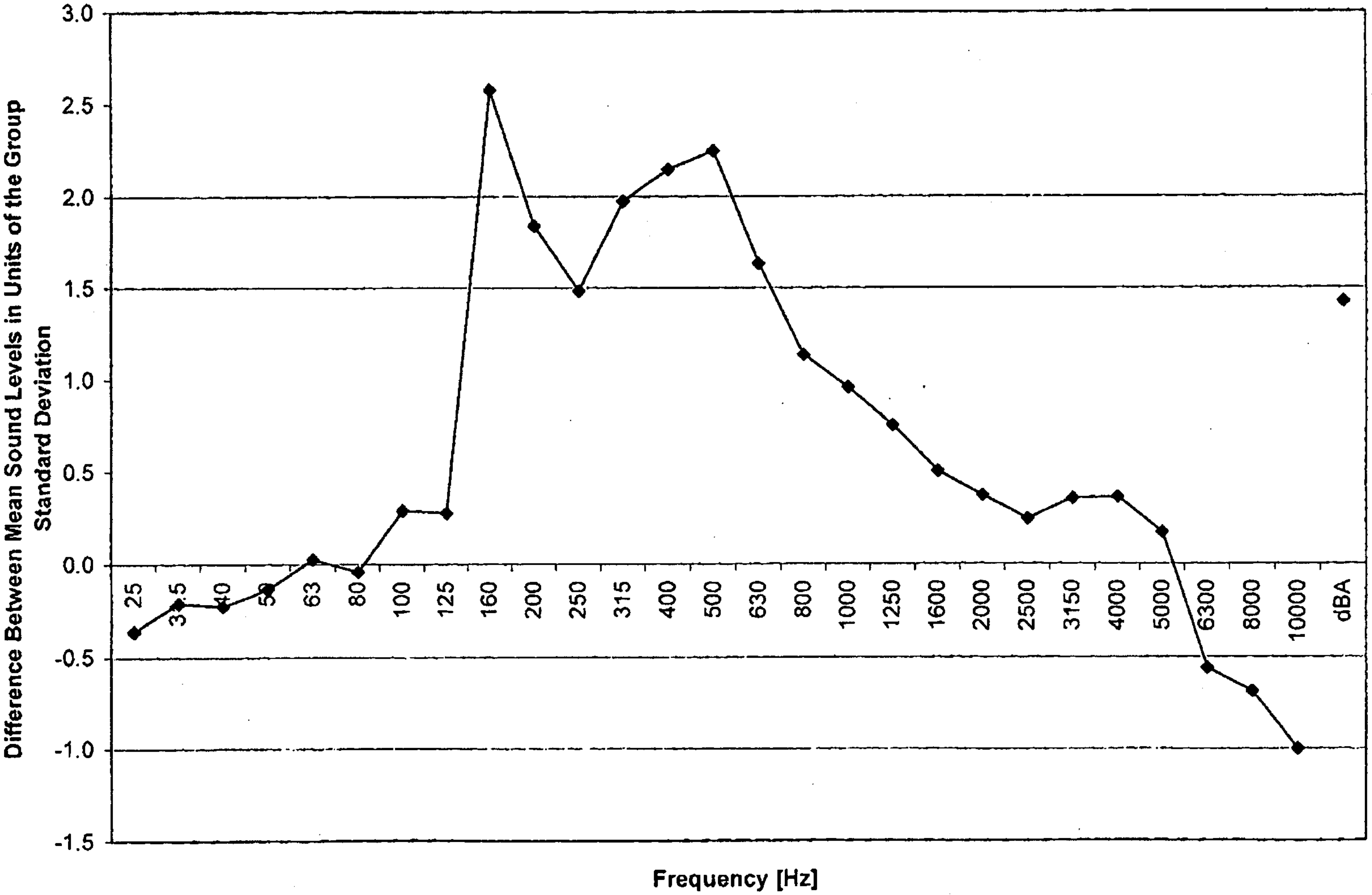
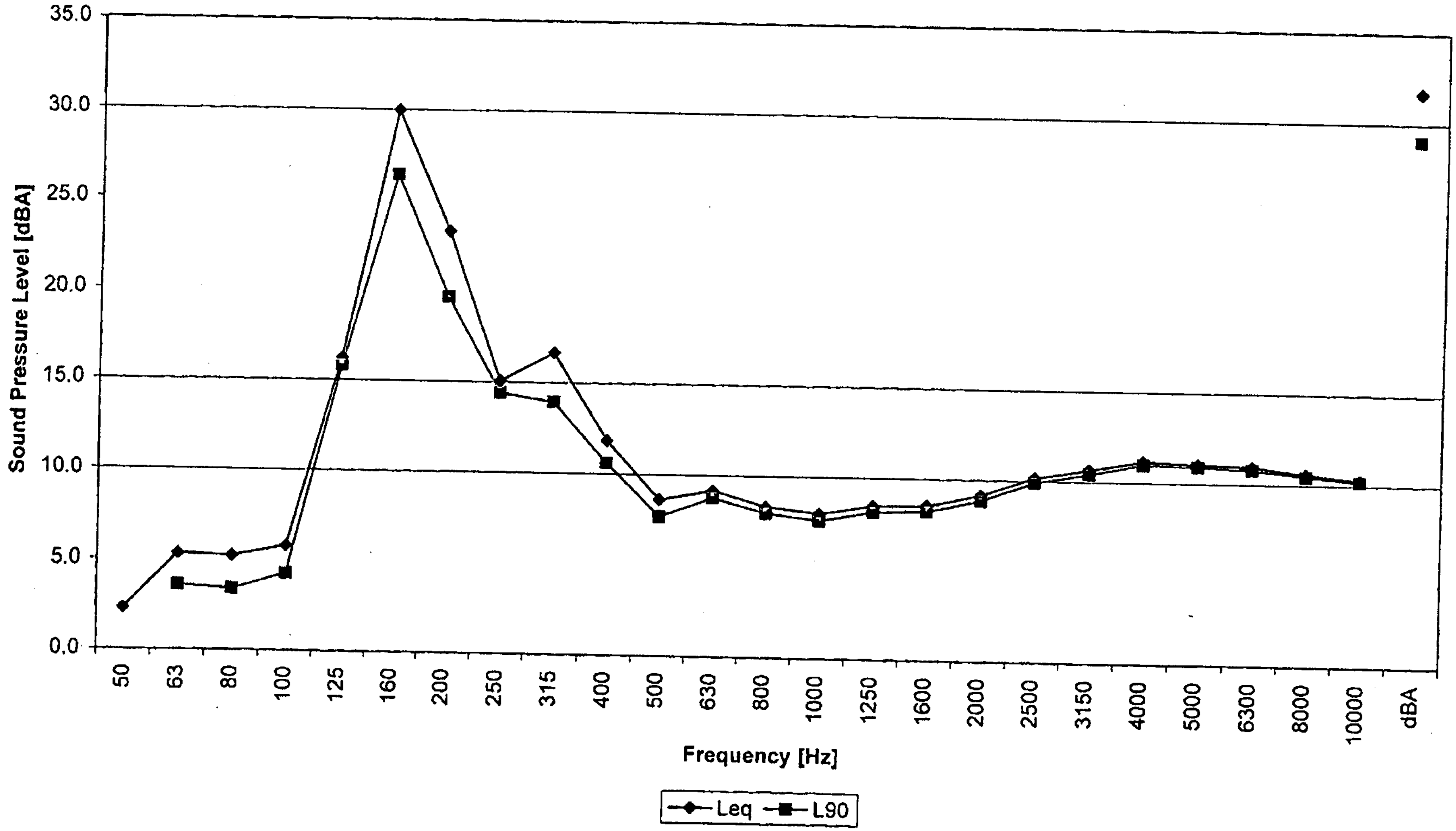


Figure 9: L_{EQ} and L_{90} Sound Pressure Levels Measured inside the Lormand Residence Bedroom using a DAT Recorder - January 16, 2009, 9:00pm

2-Minute Data Sample



Appendix A – Infrasound Measurements

Infrasound is sound at low frequencies and is not otherwise different from common higher-frequency sound. ISO defines infrasound as "sound or noise whose frequency spectrum lies mainly in the band from 1 Hz to 20 Hz." The MOE guidelines do not contain specific assessment or measurement methodologies for noise at infrasonic frequencies as acoustic problems involving infrasound are not common.

Natural sources of infrasound include wind and breaking waves; people are continually subject to sound at infrasonic frequencies. However, the human ear is not particularly sensitive to sound at these frequencies and humans are not generally subject to levels of infrasound sufficiently high enough to be able to detect its presence.

Various papers and reports dealing with low frequency noise in general, and investigations of low frequency noise produced by wind turbine generators in particular, have been published in recent years. Perception thresholds, below which infrasound is generally not discerned, have been suggested by various papers including the definitive research by Watanabe and Møller[1]. The assessment of the infrasound near the Melancthon wind turbine generators and receptors has been based on this paper.

A Hewlett Packard Type 3569A Real Time Frequency Analyzer (serial number 3222A00134), equipped with a Larson Davis type 2570 one inch Free Field microphone (serial number 1020D), was used in conjunction with a compact infrasound windscreen for the attended infrasound measurements.

As noted above, wind and the action of waves generate infrasonic noise. Infrasound is thus present throughout the environment, and can generally be measured anywhere. This observation is significant as it indicates that in the absence of the wind turbine generators, sound at infrasonic frequencies would still be present in the Melancthon area.

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[1] Watanabe and Møller, "Low frequency hearing thresholds in pressure field and free field", Journal of Low Frequency Noise and Vibration, 1990b

Measurements of sound at infrasonic frequencies were conducted inside and outside of the Lormand residence on December 23, 2009. The measured sound spectra are illustrated in Figure A1 and A2. The measurement at each location was conducted over a two-minute period.

The measurements show that the infrasound measured inside the Lormand residence was approximately 10-20 decibels less than the infrasound measured outside the Lormand residence. This is because the pressure of wind gusts significantly increases the sound level measured at the receptors, and wind pressure is likely setting the measured level of infrasound.

As shown in Figure A1 and A2, the infrasound measured both inside and outside the Lormand residence was below the threshold of perception suggested by Watanabe and Møller, even with the significant influence from the pressure caused by wind at the outside measurement location.

This finding supports the conclusions of a recent paper[2] published in the journal of the Canadian Acoustical Association, which concluded that "infrasound from wind turbine generators is below the audible threshold and of no consequence".

[2] Leventhall, "Infrasound from Wind Turbines – Fact, Fiction or Deception," Journal of the Canadian Acoustical Association, 2006

Figure A1: Infrasound Measurements outside the Lormand Residence
December 23, 2008 - 3:15pm

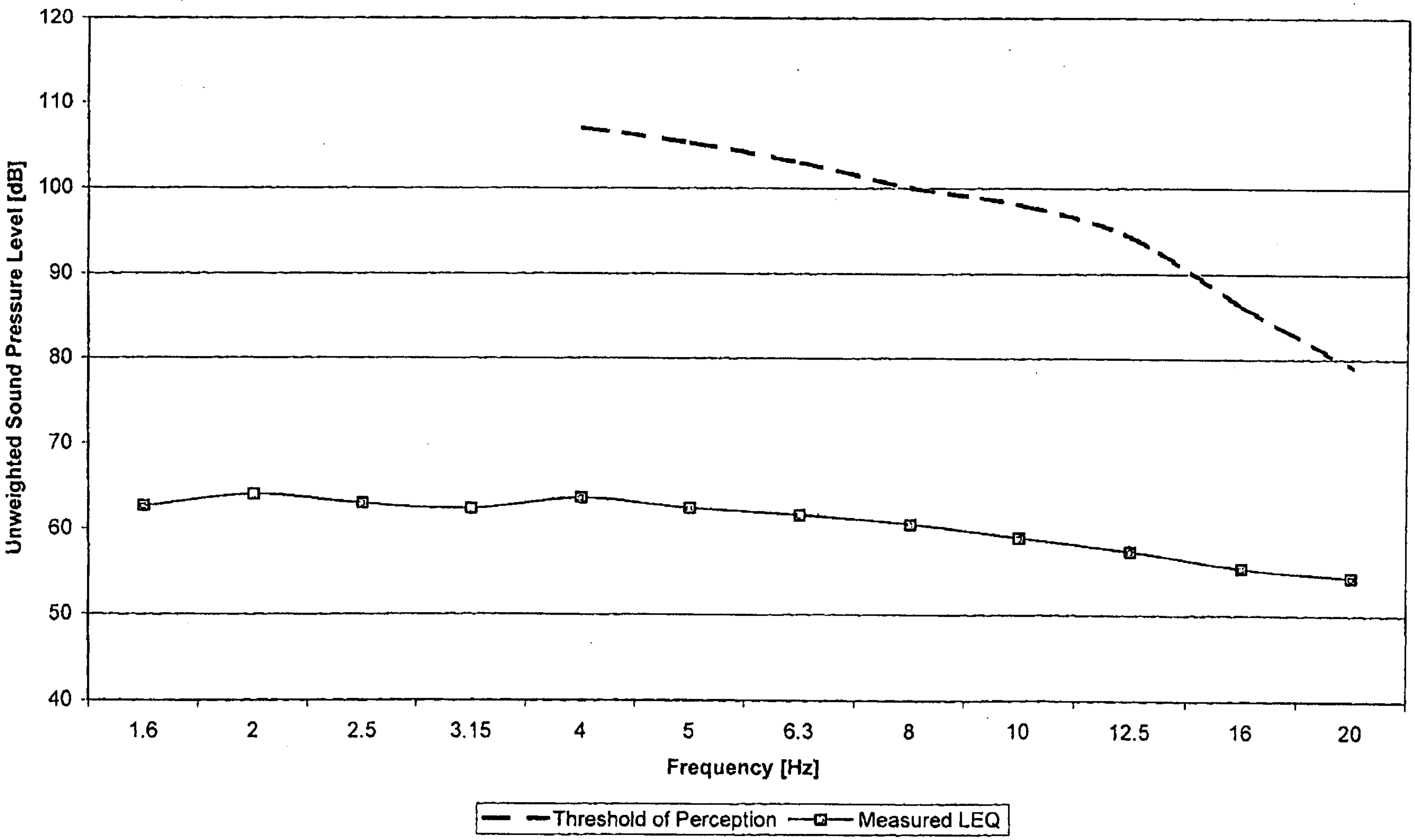
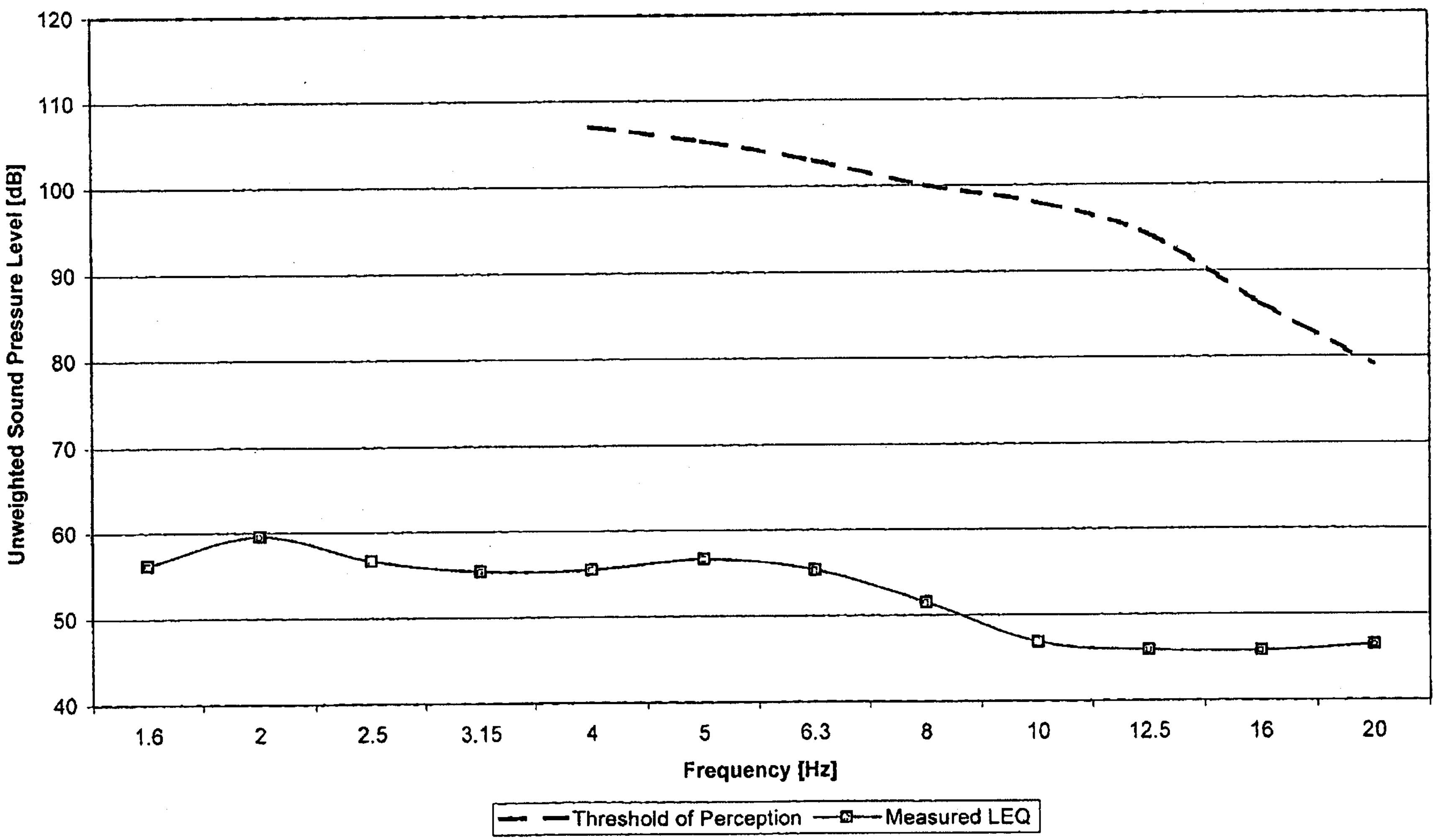


Figure A2: Infrasound Measurements inside the Lormand Residence Bedroom
December 23, 2008 - 3:45pm



1, 7, 8, 9, 10, 11, 12

13, 14, 15, 16, 17, 19, 20

21, 22, 23, 27, 28, 31,

50, 52, 54, 55, 56, 57

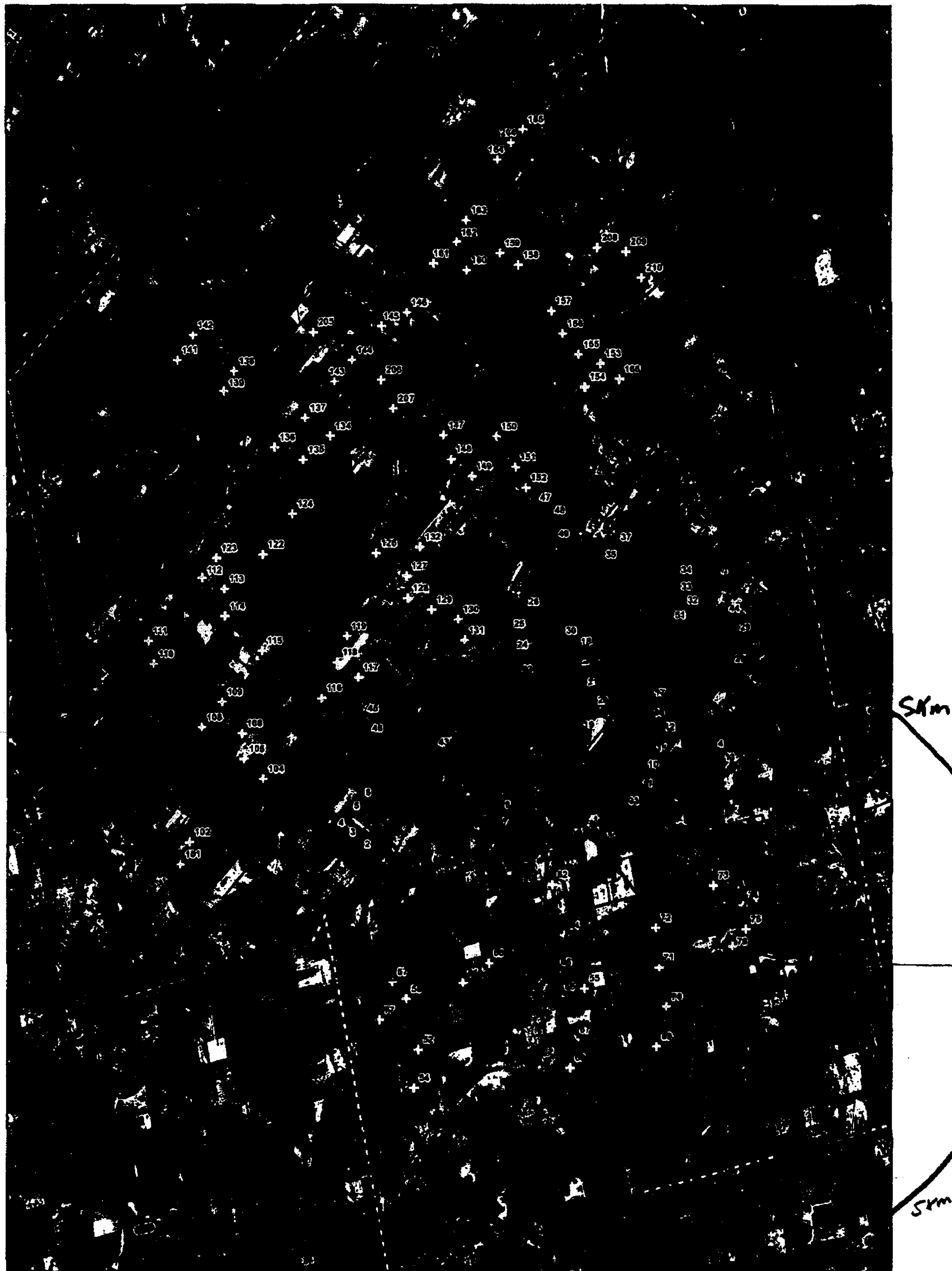
60, 61, 62, 64, 65, 66, 67

68, 69, 70, 71, 72, 73

74, 75, 76, 77

43 Turbines

Skim Plan



Melancthon II Turbine	Lot Lines	Abandoned Railway
+ Melancthon I Turbine	ESR Study Area	Existing Gravel Road
● Receptor	Watercourse	Existing Paved Road

Melancthon Wind Project: Phase I and II Layouts

Canadian Hydro Developers, Inc.

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