Alabama Ledge Wind Farm
Environmental Noise Assessment
Genesee County, New York

FINAL

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1.0 INTRODUCTION

Alabama Ledge Wind Farm, LLC (the Applicant) is proposing to construct a 52 unit wind energy conversion (WEC) project (the Project) on 3,663 acres of private land in the Town of Alabama, Genesee County, New York. Total capacity of the Project is estimated to be within the range of 85.8 to 104 megawatts (MW) with each individual turbine rated at 1.65 to 2.0 MW. The objective of this environmental noise assessment is to determine the feasibility of the Project to operate in compliance with existing noise state and local noise regulations, ordinances, and guidelines. The following report provides an introduction to the basic acoustic engineering terms used in this environmental assessment. Applicable noise impact criteria are identified and discussed in Section 2. Baseline sound measurement procedures used to document the existing acoustic environment and the measurement results are presented in Section 3. Reference sound source data, acoustic modeling methodology and a description of the modeling scenarios considered are discussed in Section 4. Calculated offsite sound levels at both the critical operating conditions and under maximum Wind Turbine Generator (WTG) rotational speed, regulatory compliance determination, and overall report conclusions and are provided in Section 5.

1.1 Acoustic Terminology

The standard unit of sound measurement is the decibel (dB). The decibel scale compresses the full range of acoustic energy by comparing logarithms of the level in interest with respect to 20 micropascals, the approximate threshold of human perception to sound at the frequency of 1000 Hz (0 dB). The acoustic energy range varies from 20 micropascals (0 dB) to over 20 million micropascals (120 dB), the threshold for pain. The decibel scale is logarithmic to accommodate the wide range of sound intensities to which the human ear is subjected. A property of the decibel scale is that the sound pressure levels of two separate sounds are not directly additive. For example, if a sound of 70 dB is added to another sound of 70 dB, the total is only a 3-decibel increase (or 73 dB), not a doubling to 140 dB. Table 1 presents sound levels from common interior and exterior sound sources and acoustic environments.

Environmental sound is typically composed of acoustic energy at different frequencies. However, the human ear does not interpret the sound level from each frequency as equally loud. To compensate for the hearing response of the human ear, an A-weighting filter is commonly used for describing environmental sound levels. A weighting filters the frequency spectrum of sound levels as the human ear naturally does (attenuating low and high frequency energy similar to the way people hear sound). Sound levels that are A weighted to reflect human response are presented as dBA in this report.

Sound levels can be measured and presented in various forms. The most common sound metrics used in community sound surveys are the equivalent sound level (Leq), the maximum sound level (Lmax), and percentile distributions of sound levels (L%). Sound level data are presented in statistical terms to describe time varying sound and are commonly used for establishing exceedance thresholds. The percentile sound levels (L%) provide the sound level exceeded for that percentage of time over the given measurement period. Table 2 presents additional information on terminology as presented in the Project noise assessment.

Table 1. Various Indoor and Outdoor Sound Levels

Outdoor Sound Levels	Sound Pressure (μPa)		Sound Level (dBA)	Indoor Sound Levels
	6,324,555	-	110	Rock Band at 5 m
Jet Over-Flight at 300 m		-	105	
	2,000,000	-	100	Inside New York Subway Train
Gas Lawn Mower at 1 m		-	95	
	632,456	-	90	Food Blender at 1 m
Diesel Truck at 15 m		-	85	
Noisy Urban Area—Daytime	200,000	-	80	Garbage Disposal at 1 m
		-	75	Shouting at 1 m
Gas Lawn Mower at 30 m	63,246	-	70	Vacuum Cleaner at 3 m
Suburban Commercial Area		-	65	Normal Speech at 1 m
Air Conditioning Unit at 20 feet	20,000	-	60	
Light Auto Traffic at 100 feet		-	55	Quiet Conversation at 1m
Quiet Urban Area—Nighttime	6,325	-	50	
		-	45	
Suburban Area—Nighttime	2,000	-	40	Empty Theater or Library
		-	35	
Rural Area—Nighttime	632	-	30	Quiet Bedroom at Night
		-	25	Empty Concert Hall
Rustling Leaves	200	-	20	Average Whisper
		-	15	Broadcast and Recording Studios
	63	-	10	
		-	5	Human Breathing
Reference Pressure Level	20	-	0	Threshold of Hearing

Notes:
μPa - Micropascals describe sound pressure levels (force/area).
dBA - A-weighted decibels describe sound pressure on a logarithmic scale with respect to 20 μPa.
Data compiled in part by TtEC from multiple technical resources and from direct acoustic field measurement experience and should be used for general informational purposes only.

Table 2. Acoustic Terms and Definitions

Term	Definition
Noise	Unwanted sound based on level, character, frequency or pitch, time of day, and sensitivity and perception of the listener.
Ambient Noise Level	A relative term used to describe all encompassing noise from sources both near and far and it is defined by NYS DEC using the L_{eq} metric.
Sound Pressure Level (dB)	Pressure fluctuations in a medium (air in this case). Sound pressure is measured in decibels referenced to 20 micronewtons per square meter, the approximate threshold of human perception to sound at 1000 Hz.
Sound Power Level (dB)	The total acoustic power of a noise source measured in decibels referenced to 10^{-12} watts. Sound power is independent of the environment The wind turbine noise specification is provided by the manufacturer in these terms since sound power is independent of environment.
A-Weighted Decibel (dBA)	Environmental sound is typically composed of acoustic energy across many different frequencies. To compensate for the auditory frequency response of the human ear, an A-weighting filter is commonly used for describing environmental sound levels. Sound levels that are A weighted are presented as dBA in this report.
C-Weighted Decibel (dBC)	For impulsive sound events such as gun shots C-weighting is typically used and has a nearly flat frequency response with the extreme high and low frequencies attenuated. C weighting has been shown to have a better correlation with human response to impulsive sounds tha A-weighting.
Equivalent Noise Level (L_{eq})	The average noise level, on an energy basis, over a specific period of time. The L_{eq} integrates fluctuating sound levels over a period of time to express them as a steady state sound level.
Statistical L_n	Statistical levels help further characterize the sound environment. The percentile sound levels (L%) indicate the sound level exceeded for that percentage of the measurement period. The L_{90} level is commonly referred to as the background sound level as it excludes short term intrusive noise events and is the statistical level that is the level exceeded during 90 percent of the measurement period. In comparison, he L_{10} is referred to as the intrusive level and is the sound level that is exceeded for 10 percent of the time during the measurement.
Octave Band	The audible range of humans spans from 20 to 20,000 Hertz (cycles per second) and is divided into center frequencies (or 1/3 center frequencies) for determination of a broadband sound's frequency content.
Low Frequency Noise (LFN)	The frequency range of 10 Hz to 200 Hz is typically defined as low frequency noise. At sufficiently high levels, LFN can cause vibrations in structures and physiological effects in humans.
Infrasound	The frequency range of infrasound is normally taken to be below 20 Hz. Existing infrasound levels were documented as a part of the background sound survey.

Source: Compiled by TtEC from multiple sources

2.0 NOISE REGULATIONS AND APPLICABLE CRITERIA

There are currently no Federal noise regulations that are directly applicable to the proposed Project. The Town of Alabama has a local noise ordinance that limits maximum received decibel levels in residential areas. The New York State Department of Environmental Conservation (NYSDEC) has issued noise guidance criteria under the State Environmental Quality Review Act (SEQR) that is defined as an incremental increase criteria relative to existing conditions. This guideline was adopted for the Project environmental noise assessment to determine the potential for when adverse impacts within the Project study area may occur. The NYSDEC criteria is only a suggested guideline and is not a regulatory requirement. The Town of Alabama noise ordinance limit is considered controlling law for the Project environmental noise assessment.

2.1 State Noise Policy

The NYSDEC issued a program guidance document entitled Assessing and Mitigating Noise Impacts (NYSDEC, Feb 2, 2001). This document presents general information and suggested methodology for use in performing environmental noise assessments. Within that document, the following recommendations are provided on determining the potential for adverse noise impacts:

Table 3. Effect of Increases in Noise Levels on Receptors

Increase in Existing Ambient Sound Levels (dBA)	Expected Effect on Receptors
0 – 3	No appreciable effect
3 - 6	Potential for adverse noise impact limited to cases where only the most sensitive receptors are present.
> 6	Potential noise impact. Requires a closer analysis of impact potential depending on existing SPLs and the character of sound emissions, land use and receptors.
10	Perceived as a doubling of the sound level

Based on the NYSDEC guidance presented in Table 3, this analysis has used an incremental increase of 6 dBA as the minimum threshold to assess the potential of when adverse noise impacts may begin to occur. An increase of less than 6 dBA is considered to be insignificant. Additionally, the policy indicates that the typical ambient level in rural environments is 45 dBA, where ambient noise is defined as the all encompassing noise from sources near and far and is determined by the Leq measure. Leq is the equivalent sound level that combines the time-varying sound levels over the measurement period into a single number. It can be thought of as the average noise level, but it is an energy average computed using logarithmic equations rather than the usual arithmetic method used to determine an average of a group of values. The Leq is always higher than the arithmetic average due to the effect of how higher levels of sound energy during short term events are accounted for. As guidelines, the NYSDEC criteria are not regulations and should be used for planning purposes only. In areas that are not sensitive to noise or undeveloped areas, use of the NYSDEC criteria is clearly not appropriate.

2.2 Local Standard

The Town of Alabama noise ordinance limits sound to a not to exceed maximum of 50dBA at any time.

3.0 EXISTING ACOUSTIC CONDITIONS

To determine existing sound levels in the study area, sound monitoring was completed on two separate occasions. The purpose of these measurements is to: (1) document existing conditions (2) assess compliance with the NYSDEC incremental increase environmental noise guideline.

3.1 Measurement Locations

The Project study area is predominantly open farmland with small areas of woodlands and an active mining quarry located in the southwest Project quadrant. The topography is gentle sloping with no significant changes in elevation. The majority of noise sensitive areas (NSA) are single-family residences. No schools, hospitals, or nursing homes were identified within the Project study area. The sound survey was completed in support of the environmental noise assessment and was conducted at four discrete residential locations (Locations 1 – 4) with start dates of either October 18 or October 31, 2006 depending on measurement location. All measurements commenced on November 20, 2006. Noise monitoring stations are shown in Figure 1.

Overall, the study area is relatively homogenous acoustically, with residences exposed to both similar noise sources and overall residual background sound levels. Variation in sound levels were determined to be primarily dependant on distance to area roadways and to mature tree stands. The objective of this survey was to document existing sound levels at residential receptor locations within the Project study area. To accomplish this, monitoring equipment was deployed within 200 feet of existing residential structures, but away from any vertical reflecting surfaces as required under (ANSI Standard S12.18-1994). The sound analyzers were positioned in locations facing the general direction of the proposed WEC facility.

The four monitoring locations from the first survey are described below and include distance to closest road:

- Location 1: backyard at the residence at the address of 2879 Batavia-Oakfield Townline Road.
  Distance to road - 200 feet.

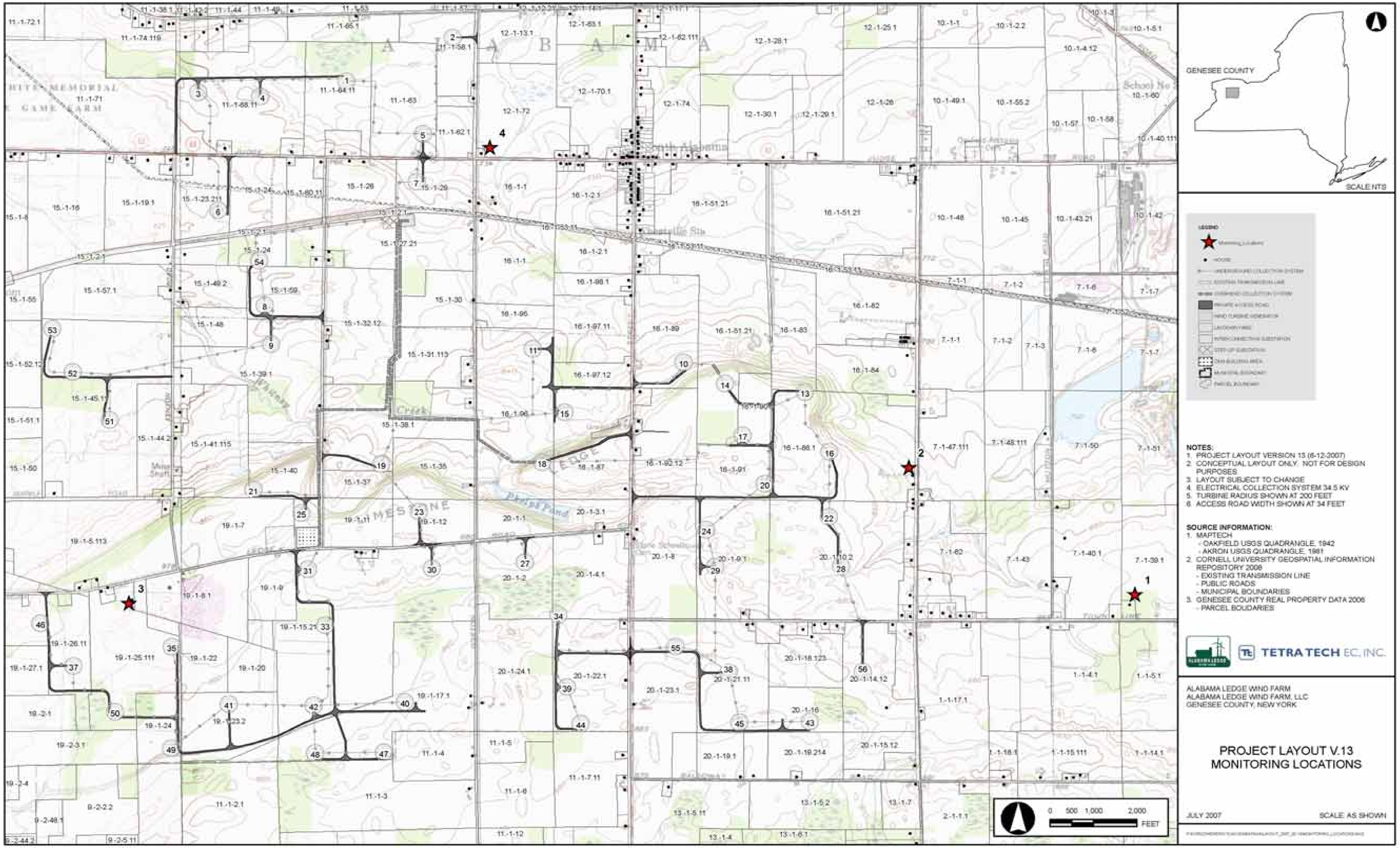
- Location 2: backyard of the residence at the address of 7380 Macomber Road.
  Distance to road - 160 feet.

- Location 3: west side yard of the residence at the address of 1554 Ledge Road.
  Distance to road - 630 feet.

- Location 4: east side yard of the residence at the address of 2007 Judge Road.
  Distance to road - 150 feet.

The principal source of manmade noise at locations 1 through 4 was intermittent traffic on the nearby roadways. Wind and the interaction of wind with terrain and foliage was the dominant source of natural noise. Microphones were deployed at a height of approximately 5 feet above the ground and were equipped with foam windscreens to reduce the effects of wind-generated self noise across the microphone diaphragms. The use of the L90 statistical descriptor which filters out short term extraneous noise events and the selection of monitoring locations that were relatively shielded from wind will further reduce microphone wind noise effects.

Figure 1 Noise Monitoring Locations



3.2 Instrumentation

All sound level measurements were taken with Larson Davis Model 820 and Norsonic Model 118 real-time sound level analyzers which were equipped with precision condenser microphones having an operating range of 5 dB to 140 dB, and an overall frequency range of 3.5 to 20,000 Hz. These meters meet or exceed all requirements set forth in the American National Standards Institute (ANSI) Standards for Type 1 for quality and accuracy (ANSI Standard S1.4-1983). Prior to survey start, midway through the measurement, and immediately following the end of the measurement sessions, the sound analyzers were calibrated with an ANSI Type 1 calibrator which has an accuracy traceable to the National Institute of Standards and Technology (NIST). Over the course of the measurement, no manual level adjustments were required and a maximum drift of 0.3 dBA was noted between calibration checks.

The sound analyzers were programmed to measure and data log broadband A-weighted sound levels including hourly equivalent (Leq) and background (L90) sound levels. Data collected at Locations 1 and 4 included both broadband A-weighted and 1/1 full octave frequency data spanning 8 Hz to 20 kHz. Immediately following the field survey program, all data were downloaded to a computer for the purposes of storage and subsequent analysis.

3.3 Sound Survey Results

Sound data were collected for a sufficient period of time to encompass the entire range of future WTG operational wind speeds, ranging from cut-in to the maximum rotor speed of WTG rated power. Wind speeds as measured at the onsite meteorological tower ranged from 0.35 to 19.04 m/s. Data points known to contain extraneous events, data collected during periods of rain, and data from the extreme ends of the range of wind speeds including data below typical WTG cut-in speed were systematically removed from the data set to avoid biasing.

The wind speed data was then scaled from the met station height to the reference 100 meter hub height wind speed using site specific roughness length coefficient as assigned to the site by AWS Truewind, the Project's wind engineering consultant. The baseline sound measurement data were then plotted against the corresponding wind speed data. This plot was used to determine the relationship of the background sound level (dBA) correlated to wind speed (m/s) at the reference hub height. Figure 2 presents the results regression analysis, data points, and the best fit correlation coefficient using a linear equation. A similar plot was completed using the Leq descriptor identified in the NYSDEC guidance document for use in development and siting assessments. The Leq levels consistently ranged from 5 to 15 dBA higher than the L90 levels. Overall, the baseline sound data were representative of a quiet rural environment. When cricket noise frequency data were removed from data collected during overnight periods, there were only minor differences in diurnal L90 sound levels.

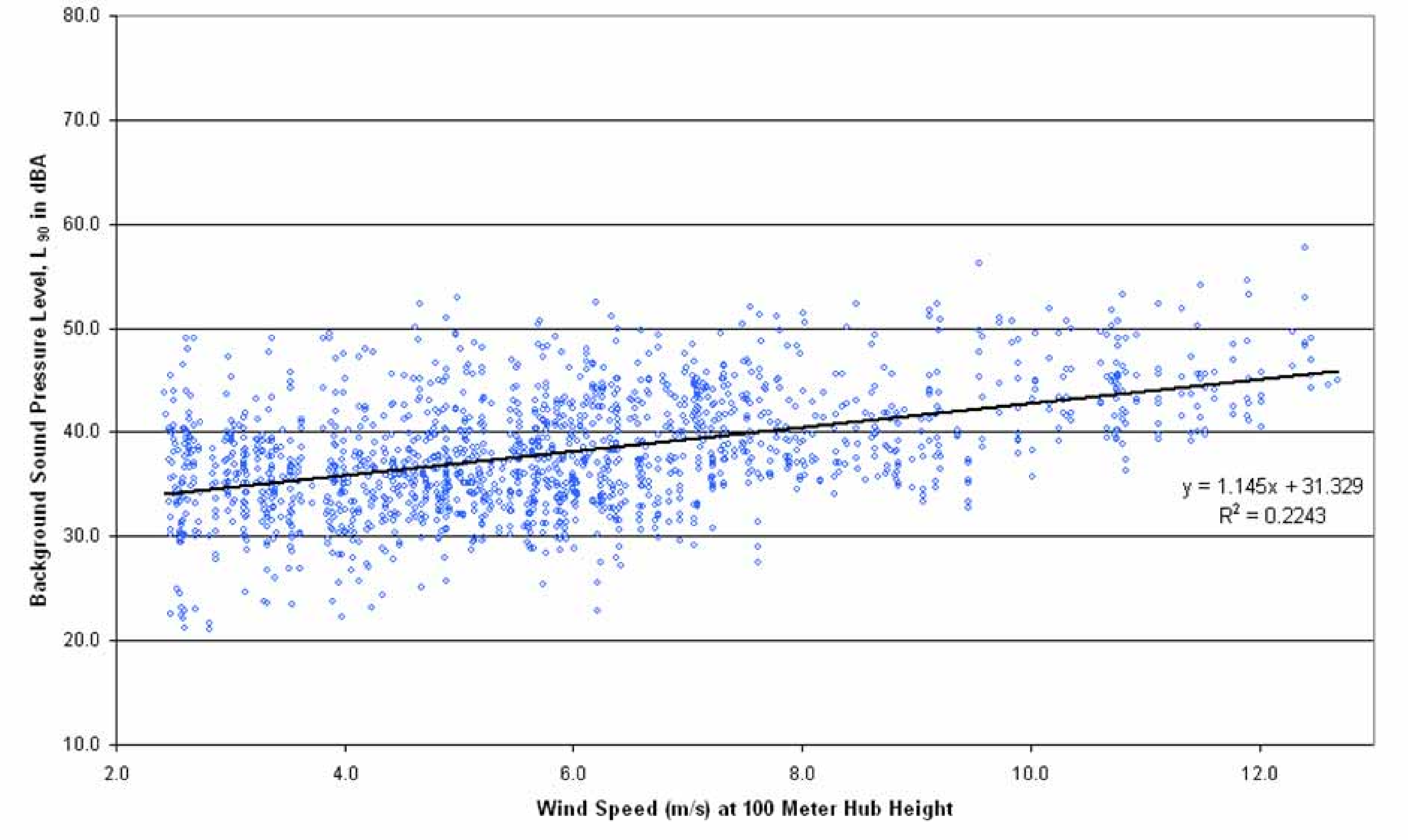
The results of the regression analysis reveal that during future WTG operation, baseline sound levels will range from a minimum of 34.8 dBA at 3 m/s representative of the approximate WTG cut-in wind speed and increase to 42.8 dBA at 10 m/s representative of WTG full rotational speed. At wind speeds higher than 10 m/s, background sound levels continue to increase, but the WTG sound emissions will remain relatively constant (or decrease slightly) until it reaches cut-out wind speeds. A summary of background sound levels at reference wind speeds is shown in Table 4.

Table 4. Measured L_{90} Background Sound Levels at Reference Wind Speed

Monitoring Location	**L_{90} Baseline Level at WTG Load Level**							
100-meter Wind Speed	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Measured (L_{90}) dBA	34.8	35.9	37.1	38.2	39.4	40.5	41.7	42.8

These measured L90 data will provide the basis for determining the net increase in background sound levels during WTG operation over the entire range of the WTG rotation speeds. The purpose of this type of analysis is to avoid invalid comparisons of turbine noise with background noise. In example, it would incorrect to compare the maximum turbine noise level which occurs at elevated wind speeds with the minimum background noise level which occurs during calm winds when the turbine is not operational. It is also possible that the greatest increases above background could occur at some operating level below full load since both the turbine noise and background noise are reduced, but not necessarily in direct proportion to each other. Use of the L_{eq} levels is the method for establishing baseline, as stated under the NYSDEC guideline. The use of the L_{90} for determining the incremental increase will result in a much more conservative analysis approach, and was the method employed in the Project environmental noise impact assessment.

Figure 2: Regression Analysis of Brackground L_{90} Sound Pressure Levels and Wind Speed Data From WTG Cut-In To Full Rotational Speed



4.0 ACOUSTIC MODELING METHODOLOGY

This report section discusses the modeling procedure used in the Project environmental noise analysis procedures used to determine the potential for adverse impacts and compliance with applicable regulatory criteria and guidelines.

4.1 Wind Turbine Source Data

A somewhat unique acoustic characteristic of WEC projects is that the noise generated by each individual WTG will increase as the wind speed across the site increases. In order to assist project developers and acousticians, WTG manufacturers report WTG sound power data at each integer wind speed referenced to a height of 10 meters above grade, ranging from cut in to full rated power. The WTG sound source data used in the analysis are the guaranteed maximum WTG sound levels per the IEC 614100-11 acoustic measurement standards. This internationally accepted standard was specifically developed to ensure consistent and comparable sound emission data of utility-scale wind turbines between manufacturers and models. The Applicant has reviewed several WTG options and has selected four turbines that are among the quietest WTGs commercially available. These four are the Gamesa G87, Vestas V82, Suzlon S88 and the Vestas V90.

The manufacturers' sound power source data were scaled up to the proposed 100 meter hub height accounting for site-specific roughness length and incorporating uncertainty factors as reported in the manufacturers' specifications and test reports. A summary of sound power data used in the analysis are presented in Table 5.

Table 5. Turbine Manufacturer Sound Power Levels (dBA) Correlated with Wind Speed

Monitoring Location	WTG L_{max} Sound Power Level at Reference Wind Speed							
100-meter Wind Speed	3 m/s	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Gamesa G87	101.8	101.9	102.7	105.8	107.0	107.0	106.8	106.8
Vestas V82	101.1	101.4	101.7	102.5	103.2	103.3	103.3	103.3
Suzlon S88	101.1	103.3	104.2	105.3	106.6	107.3	107.4	107.4
Vestas V90	NA	98.0	102.9	105.0	105.9	105.5	105.3	105.3

4.2 Defining WTG Worst Case Operational Acoustic Condition

To determine the WTG operational condition that will result in the worst case incremental increase in measured background sound levels, a comparison of net change in background L90 sound levels by reference wind speed was completed for each turbine model. Although not initially intuitive, the worst case operational noise condition in terms of incremental increase does not occur at full rated power when the WTG is at its maximum noise emission level. For the Gamesa G87, the worst case operation condition occurs at a reference wind speed of 6 m/s. The Vestas V82 maximum delta occurs at cut-in wind speed of 3 m/s. The Suzlon S88 worst case operational condition is at a reference wind speed of 4 m/s. The Vestas V90 worst case operational condition occurs at a reference wind speed of 6 m/s. Subsequent acoustical modeling was focused on these four WTG operational design speeds to determine the maximum number of receptors that would receive sound levels above NYSDEC incremental increase guidance. This approach is conservative as incremental increases and therefore the number of potentially impacted receptors under all other WTG operating conditions will be lower, as shown in Tables 6, 7, 8, and 9 by the “net change” row.

Table 6. Gamesa G87 Worst Case WTG Operational Condition

Monitoring Location	**Comparison of WTG L_{max} Sound Power Data to L_{90} Background**							
100-meter Wind Speed	3 m/s	4 m/s	5 m/s	**6 m/s**	7 m/s	8 m/s	9 m/s	10 m/s
Gamesa G87	101.8	101.9	102.7	105.8	107	107	106.8	106.8
Representative at 1200 ft	36.2	36.3	37.1	40.2	41.4	41.4	41.2	41.2
Background L_{90}	34.8	35.9	37.1	38.2	39.4	40.5	41.7	42.8
Net Change	1.4	0.4	0.0	2.0	2.0	0.9	-0.5	-1.6

* **Bold** type indicates worst case design wind speed

Table 7. Vestas V82 Worst Case WTG Operational Condition (Lmax)

Monitoring Location	**WTG L_{max} Sound Power Level at Reference Wind Speed**							
100-meter Wind Speed	**3 m/s**	4 m/s	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Vestas V82	**101.1**	101.4	101.7	102.5	103.2	103.3	103.3	103.3
Representative at 1200 ft	**35.5**	35.8	36.1	36.9	37.6	37.7	37.7	37.7
Background L_{90}	**34.8**	35.9	37.1	38.2	39.4	40.5	41.7	42.8
Net Change	**0.7**	-0.1	-1.0	-1.3	-1.8	-2.8	-4.0	-5.1

* **Bold** type indicates worst case design wind speed

Table 8. Suzlon S88 Worst Case WTG Operational Condition

Monitoring Location	WTG L_{max} Sound Power Level at Reference Wind Speed							
100-meter Wind Speed	3 m/s	**4 m/s**	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Suzlon S88	101.1	**103.3**	104.2	105.3	106.6	107.3	107.4	107.4
Representative at 1200 ft	35.5	**37.7**	38.6	39.7	41	41.7	41.8	41.8
Background L_{90}	34.8	**35.9**	37.1	38.2	39.4	40.5	41.7	42.8
Net Change	0.7	**1.8**	1.5	1.5	1.6	1.2	0.1	-1.0

* **Bold** type indicates worst case design wind speed

Table 9. Vestas Worst Case WTG Operational Condition

Monitoring Location	WTG L_{max} Sound Power Level at Reference Wind Speed							
100-meter Wind Speed	3 m/s	4 m/s	5 m/s	**6 m/s**	7 m/s	8 m/s	9 m/s	10 m/s
Vestas V90	N/A	98.0	102.9	**105.0**	105.9	105.5	105.3	105.3
Representative at 1200 ft	N/A	32.4	37.3	**39.4**	40.3	39.9	39.7	39.7
Background L_{90}	N/A	35.9	37.1	**38.2**	39.4	40.5	41.7	42.8
Net Change	N/A	-3.5	0.2	**1.2**	0.9	-0.6	-2.0	-3.1

* **Bold** type indicates worst case design wind speed

4.3 Acoustic Modeling Software

The operational noise impact assessment was performed using the most recent Project design layout as of August 1, 2007 and the latest version of the using Datakustic GmbH’s CadnaA, the computer aided noise abatement program. CadnaA is a comprehensive 3-dimsional acoustic software model that conforms to ISO 9613.2 “Attenuation of Sound During Propagation Outdoors”. The engineering methods specified in this standard consist of 1/1 octave band algorithms that incorporate the following:

- Geometrical wave divergence
- Reflection from surfaces
- Atmospheric absorption
- Screening by topography and obstacles
- Terrain and ground effects
- Source directivity factors
- Height of sources and receptors
- Seasonal foliage effects
- Meteorological conditions including the effects of wind and atmospheric inversions

The CadnaA acoustic modeling software has been shown to be a highly accurate and effective acoustic modeling tool for WEC projects sited in both E.U. and the USA when appropriate WTG modeling techniques and site specific conditions are properly incorporated. For the Project's environmental noise assessment, adjustments were made to account for site ground conditions and topography using official USGS digital elevation data set. Ground attenuation rates for existing and onsite roadways as well as for the turbine lay down areas were defined as hard reflective ground, to ensure highest degree of calculation accuracy. Sound attenuation through foliage and diffraction around and over existing structures were conservatively ignored under all modeling scenarios.

Source emission heights were modeled at the design hub height of 100 meters above grade. Received sound level calculations were completed at a height of 1.52 meters above grade, the approximate height of the ears of a standing person. The acoustic model assumes all WTGs operating continuously and concurrently at their maximum manufacturer rated sound level at a given design wind speed. The ISO9613.2 standard calculates received sound pressure levels for meteorological conditions favorable to propagation, i.e. downwind sound propagation or what might occur typically during a moderate atmospheric ground level inversion. Though a physical impracticality, the model assumes that wind is blowing in all directions simultaneously resulting in the maximum possible sound level at all receptor locations. For receptors located between discrete WTG locations, the model will actually over-predict received sound levels. Considering these factors, the acoustic modeling analysis presented in the Project noise assessment is representative of a worst-case acoustic condition for each of the wind turbine models under consideration.

5.0 MODELING RESULTS AND REGULATORY COMPLIANCE DETERMINATION

5.1 Acoustic Modeling Results

Results from the acoustic model are presented in two ways. The first is a map of noise contours projected on digital orthophotos of the Project study area at the critical operating condition, resulting incremental increases in macro background sound levels at the reference wind conditions, and the maximum sound levels during worst case operational conditions (see Appendix A for Noise Contour Plots). The second is a summary of results in tabular format.

(see Appendix B for Acoustic Model Output). Acoustic modeling was completed for three different scenarios to accurately quantify sound levels from the Project:

Scenario 1. Operational sound levels at the worst case noise emission levels for each of the four turbine models are provided in Plots 1A, 1B, 1C, and 1D. The highest sound power levels are 107 dBA for the Gamesa G87, 103.3 dBA for the Vestas V82, 107.4 dBA for the Suzlon S88, and 106.0 dBA for the Vestas V90. Rated sound powers include manufacturers' stated margin of accuracy. These results are used to assess compliance with the Town of Alabama noise ordinance maximum limit of 50 dBA.

Scenario 2. Operational sound levels for the four turbine models at their worst case operation design wind speeds. Contour plots for the Gamesa G87, Vestas V82, Suzlon S88, and Vestas V90 are presented in Plots 2A, 2B, 2C, and 2D. The plots are independent of the existing acoustic environment, i.e. are project generated sound levels only. The results of this scenario were used to determine worst case incremental increases in received sound levels as discussed in Scenario 3.

Scenario 3. Net change in existing ambient conditions during operation of the four models relative to the existing L90 sound level for the given wind speed are presented in Plots 3A, 3B, 3C, and 3D using the results from scenario 2. According to the NYSDEC environmental noise guidelines, operations resulting in incremental increases of 6 dBA and greater should be minimized whenever possible.

The acoustic modeling Plots for scenario 1 clearly demonstrate that all candidate WTG models will fully comply with the Alabama Noise Ordinance limit of 50 dBA at all residential receptor locations. Reviewing the Projects performance with regards to the NYSDEC incremental increase guideline, indicates that exceedances were identified for each of the WTGs under consideration. The Gamesa G87 has a total of 44 receptors with predicted exceedances of the NYSDEC criteria under the worst case operational condition of a wind speed of 6 m/s, the Vestas V82 has 8 exceedances which occur at WTG cut-in, The Suzlon S88 has 38 exceedances at a wind speed of 4 m/s, and the Vestas V90 has 20 at a wind speed of 6 m/s. It's important to note that majority of the NYSDEC exceedances are at receptors that are located between two or more WTGs and are likely mathematical over predictions due to the omnidirectional downwind propagation component as performed under ISO 9613. A summary of results of the maximum Project related incremental increases in background sound levels are presented in Table 10. In reference, increases ranging from 3 to 6 dBA, the NYSDEC guidelines presented in Table 3 show that there is a "potential for adverse noise impact only in cases where the most sensitive receptors are present." Increases greater than 6 dBA are identified as potential noise impacts requiring further analysis.

Table 10. Comparison Acoustic Modeling Results to NYSDEC Guideline Criteria by WTG

Incremental Increase in L_{90} Background* (dBA)	Gamesa G87 No. of Receptors	Vestas V82 No. of Receptors	Suzlon S88 No. of Receptors	Vestas V90 No. of Receptors
0 – 3	20	65	23	43
3 - 6	118	109	121	119
> 6	**44**	**8**	**38**	**20**

* NYSDEC guideline criteria recommends on using the L_{eq} for establishing background. THE PROJECT substituted L_{90} data resulting in a much more conservative impacts assessment.

If a sound is audible, it does not necessarily mean it is annoying. However, the higher incremental increase over existing baseline levels, the greater the possibility for future Project related noise complaints. Response to any increase in background sound levels is largely subjective and will vary from person to person depending on several factors including predetermined perceptions of the project and economic incentives. Project participants are less likely to be effected by noise than non-participants.

5.2 Secondary Assessment of the Potential for Adverse Impacts

The modified Composite Noise Rating Method (CNR) was used to assess potential noise impacts of worst case operational condition at the noise sensitive locations where exceedances of the SEQR broadband criteria were identified. This methodology incorporates many factors including the expected sound levels from a WTG project, the existing background sound levels, character of the noise (e.g., tonal, impulsive), duration, and subjective factors such as community attitude or history of previous exposure. This method, which is based on case histories of reaction to new sources, dates back to 1955 and with minor modifications has been used by a number of federal agencies including the NYS DEC and US EPA.

The procedure involves the following four steps:

1. Obtain a baseline rating classification, letter grade, from the predicted sound pressure level spectrum of the new noise source.
2. Determine a background (masking noise) correction based on the average measured background sound level spectrum.
3. Apply a number of other correction factors related to when the source is in operation, the character of the noise and the general attitude of the receiver.
4. Determine a final rating classification after application of all corrections and adjustments.

A description and graph of final rating classifications and expected responses are provided in Table 11. In developing the Project layout, the Applicant's goal was to achieve a mCNR rating of "C" at all sensitive receptor locations corresponding to "no reaction although noise is noticeable."

The first step in the modified CNR method first plots the octave band sound pressure level spectrum of the Project on a family of curves to determine the initial Noise Level Rank, a lower-case letter. The initial Noise Level Rank is the lower case letter designating the highest zone into which the spectrum protrudes. The plots for each of the four WTGs under consideration are provided in Figures 3, 4, 5, and 6 with results summarized in Table 12.

Table 11. Final Modified CNR Noise Level Rankings and a Description of Anticipated Subjective Responses

Final mCNR Ranking	Anticipated Subjective Responses
A	No Complaints
B	
C	No Reaction though Noise is Generally Audible
D	
E	Widespread Complaints or Single Threat of Legal Action
F	
G	Several Threats of Legal Action and Appeals to Local Officials to Stop Noise
H	
I	Vigorous Action

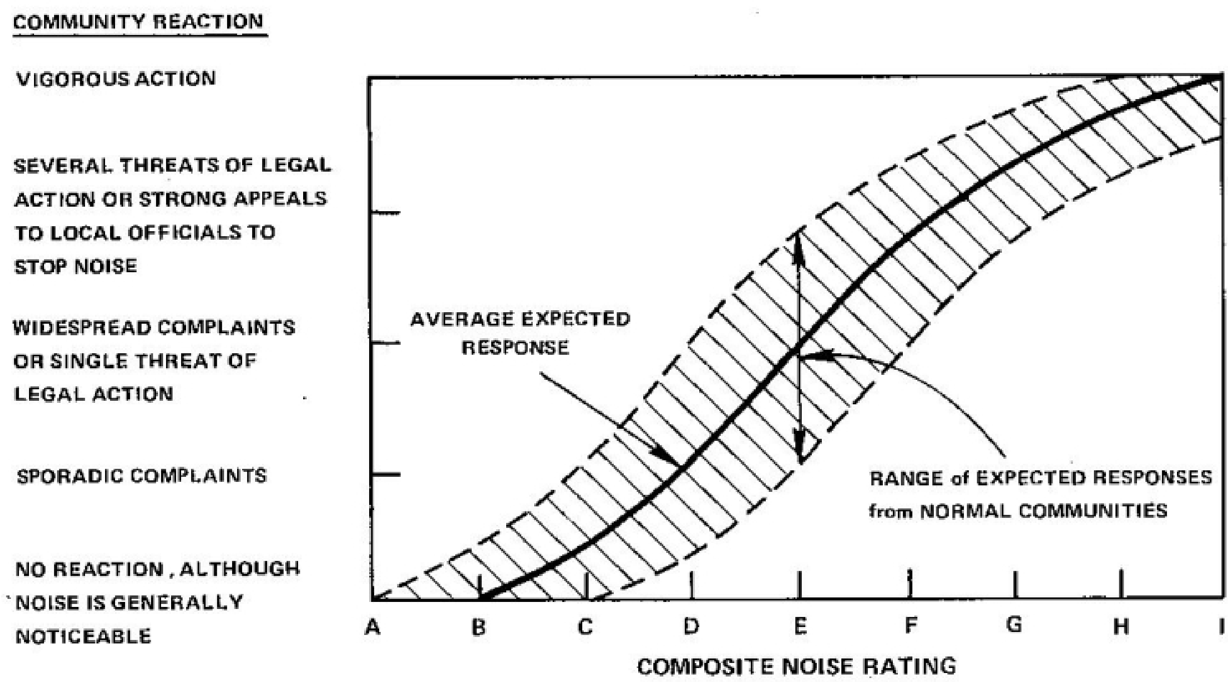


Figure 3: Plot Of Sound Pressure Frequency Spectra Of The Gamesa G87 WTG at the Worst Case Operational 6 M/S Design Wind Speed at Multiple Received Broadband dBA Levels

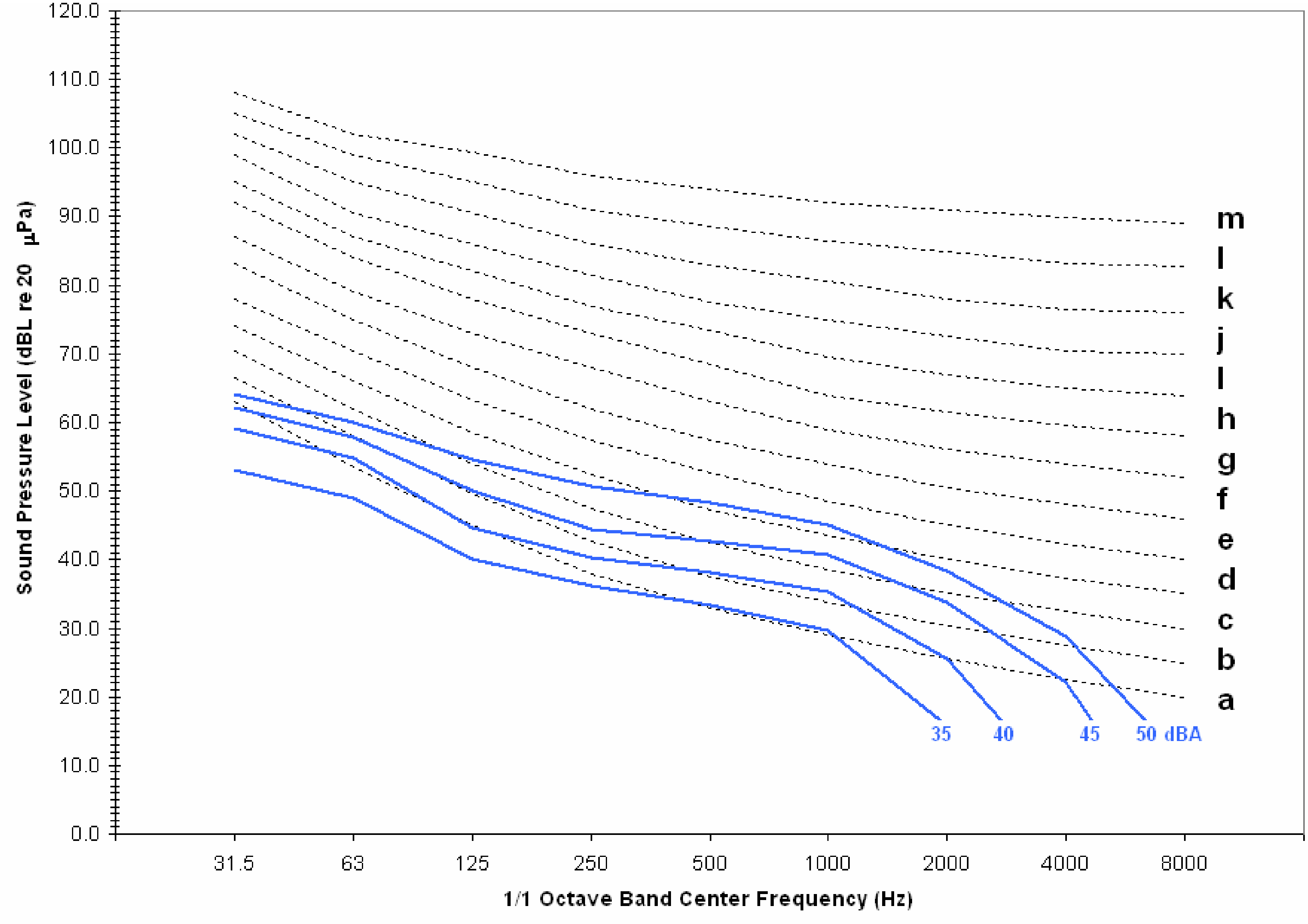


Figure 4: Plot of Sound Pressure Frequency Spectra of the VESTAS V82 WTG at the Worst Case Operational Cut In Design Wind Speed at Multiple Received Broadband dBA LEVELS

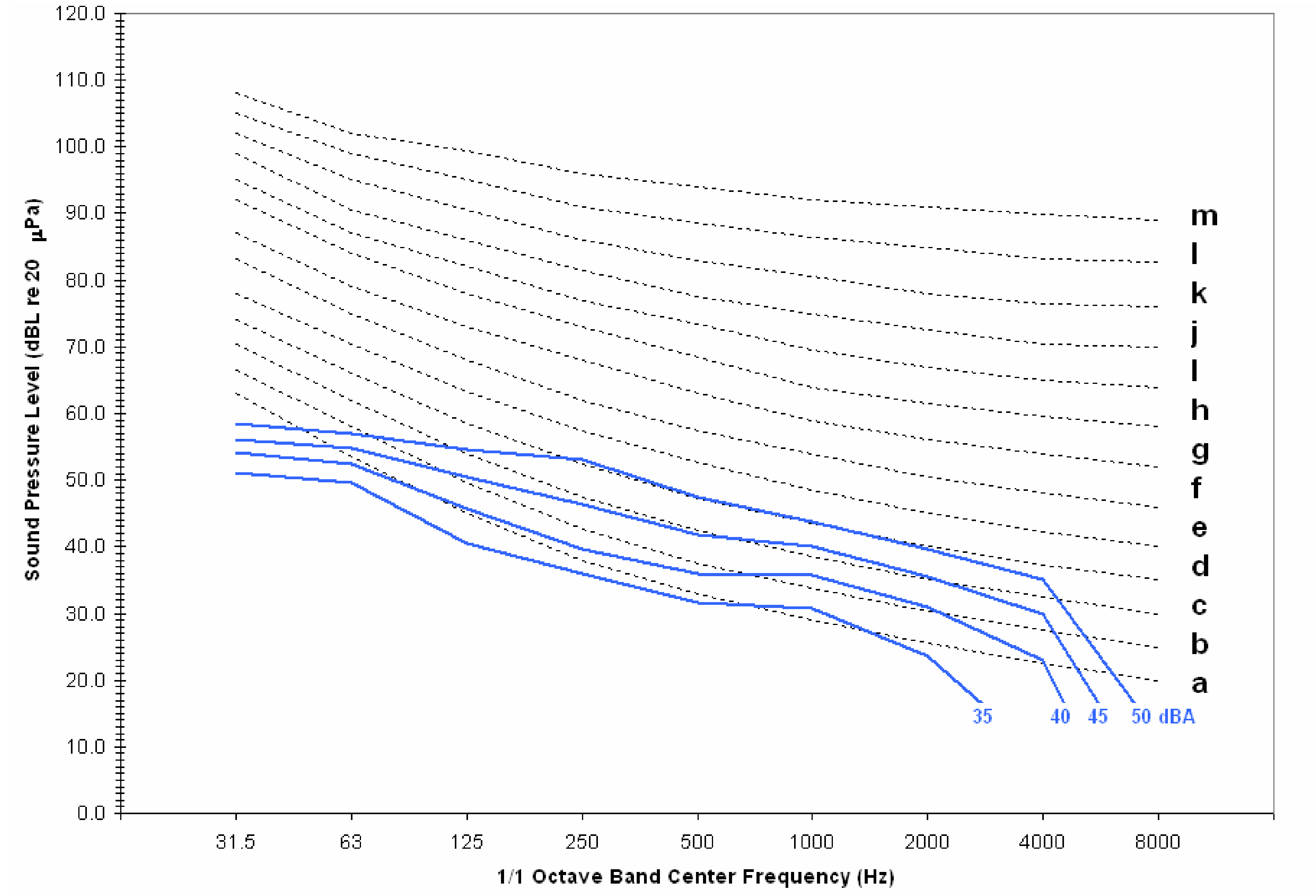


Figure 5: Plot of Sound Pressure Frequency SPECTRA of the SUZLON S88 WTG at the Worst Case Operational 4 M/S Design Wind Speed at Multiple Received Broadband dBA Levels

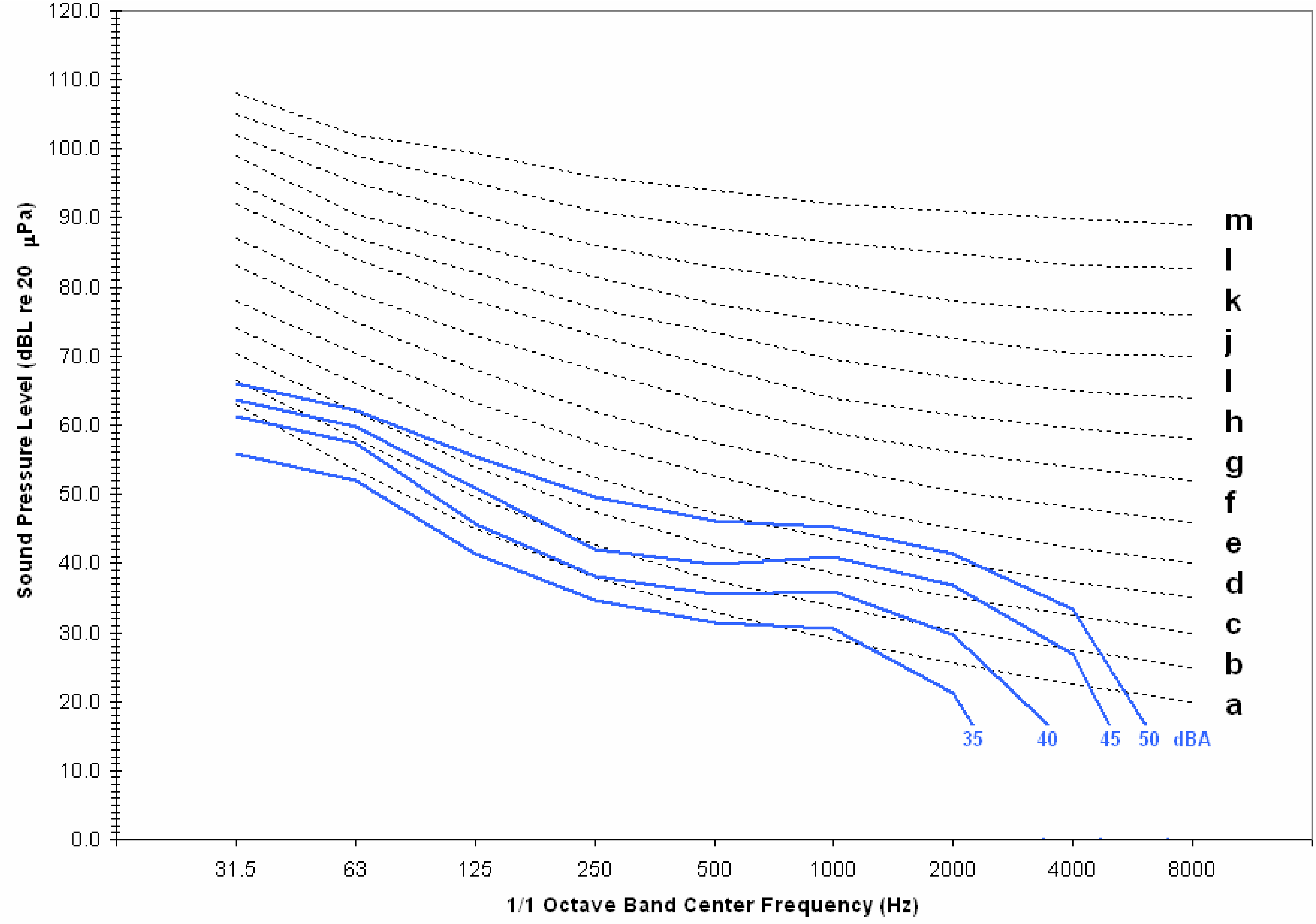


Figure 6: Plot of Sound Pressure Frequency SPECTRA of the VESTAS V90 WTG at the Worst Case Operational 6 M/S Design Wind Speed at Multiple Received Broadband dBA Levels

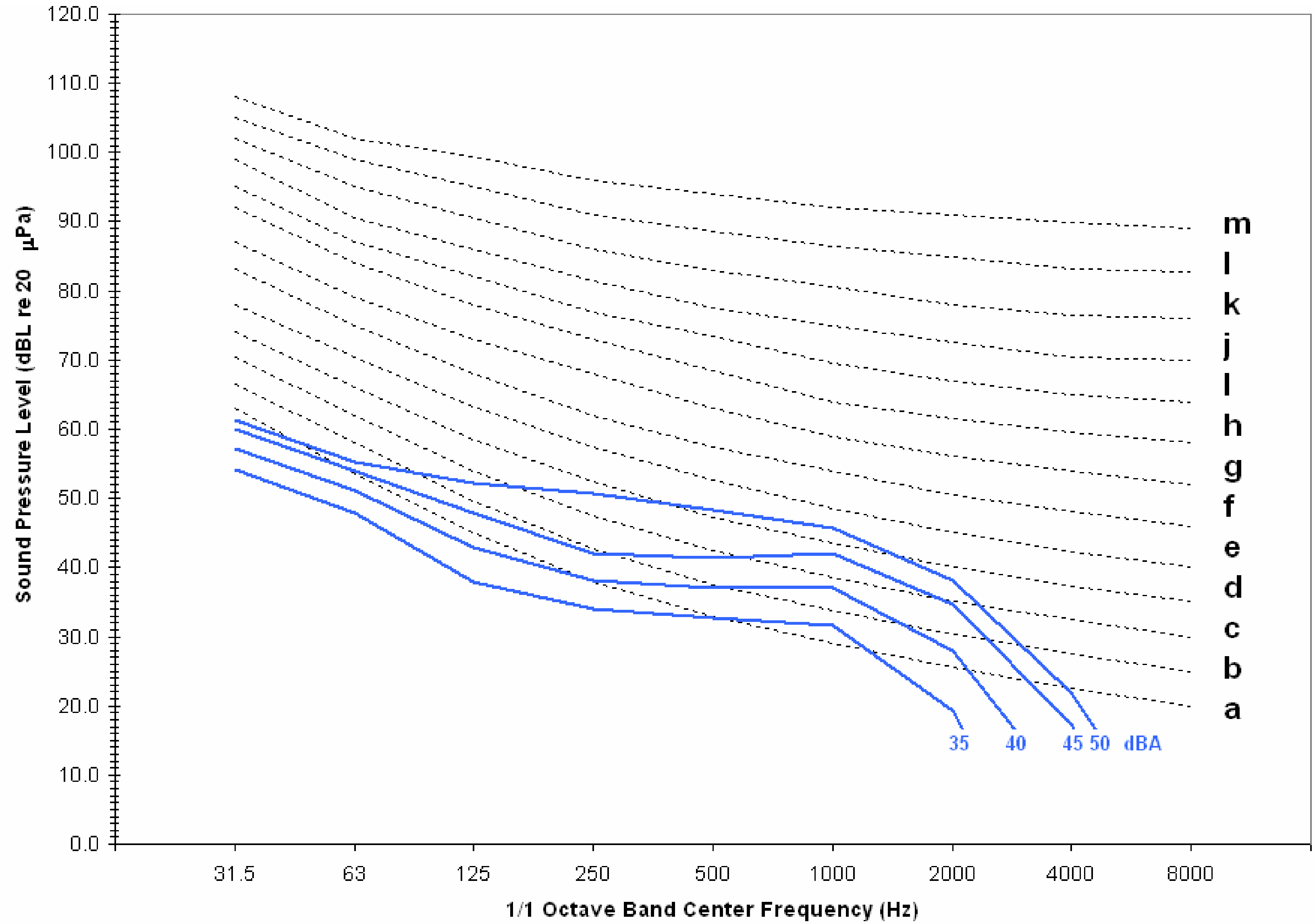


Table 12. Summary of Initial modified CNR Noise Level Rank by WTG Design Alternative

WTG Operational Sound Level (dBA)	Gamesa G87	Vestas V82	Suzlon S88	Vestas V90
35	a	a	a	a
36	a	a	a	a
37	a	a	b	a
38	a	a	b	b
39	b	b	b	b
40	b	b	b	b
41	b	b	b	b
42	b	b	c	b
43	c	b	c	c
44	c	c	c	c
45	c	c	c	c
46	c	c	c	c
47	c	c	c	c
48	c	c	d	c
49	d	c	d	d
50	d	d	d	d

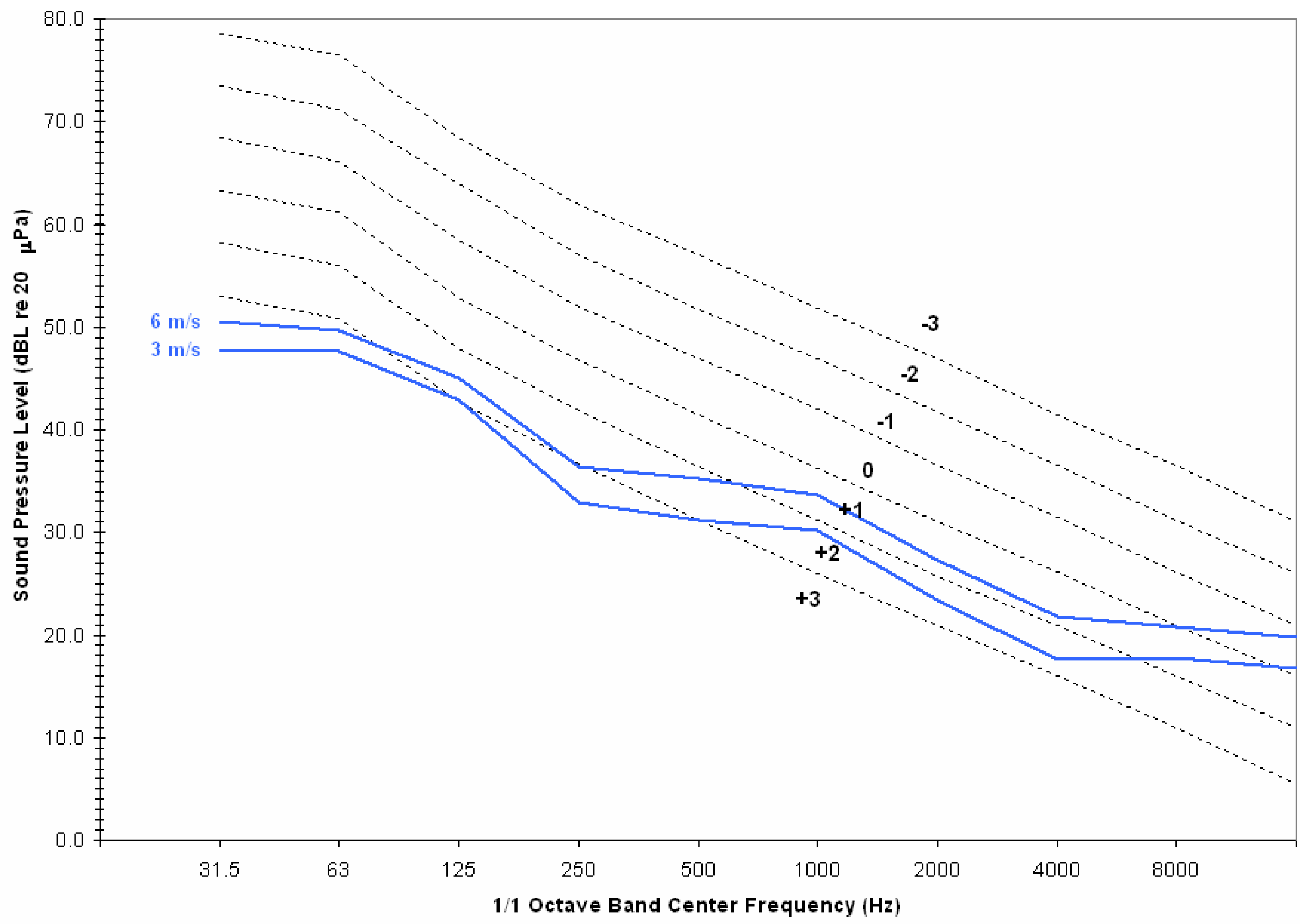
The next step in the mCNR procedure, the Noise Level Rank is adjusted for existing baseline sound levels. Adjustment for the existing baseline sound levels is done by plotting the background (L90) octave band sound pressure level spectra at the critical operational WTG design wind speeds on a set of curves for the operational WTG wind speed to select the Background Correction Number as shown in Figure 7. This correction factor determines the effectiveness of the existing acoustic environment to “mask” the intruding noise source, conservatively using the minimal L90 background sound levels which are exceeded more than 90% over a given time period. For all operational wind speeds identified in the modeling assessments (3 m/s to 5 m/s) an adjustment factor of +1 was applied and for a wind speed of 6 m/s, no adjustment was applied. At wind speeds greater than 6 m/s, higher ambient noise levels will further mask sound generated by the WTGs. Finally, adjustments accounting for the operating schedule of the noise source, the character of the new noise, previous exposure of the community to noise similar to that being added, and the community’s attitude toward the noise source. Receptors known or thought to be opposed to the Project on principal are assigned an adjustment factor of +1 and project participants or receptors known to be favorable towards the project are assigned an adjustment factor of -1. The remaining receptor locations are assumed to be neutral and no adjustments were applied.

The complete summary of the relevant correction factors is provided in Appendix C of this report. The method is completed by adding all correction factors, and using the sum to adjust the Noise Level Rank to the final Composite Noise Rating, an upper-case letter. The results of the mCNR analysis are summarized below in Table 13, and demonstrate that although exceedances of the broadband criteria may occur under certain conditions, the actual number of receptors expected that will have a Final Composite Noise Rating lower than “C” is significantly lower.

Table 13. Number of Receptors with Exceedances of the NYSDEC Guideline Criteria with a Final mCNR Rating of C or Lower

Final Composite Noise Rating	Gamesa G87 No. of Receptors	Vestas V82 No. of Receptors	Suzlon S88 No. of Receptors	Vestas V90 No. of Receptors
C	10	2	13	5
D	5	0	9	3
E	0	0	1	0
F	0	0	0	0

Figure 7: Plot of the L_{90} Background Sound Pressure Frequency SPECTRA Across the Range of Critical Wind Speeds To Determine to Determine Applicable mCNR Correction Factor



5.3 Conclusions and Regulatory Compliance Determination

In conclusion, the Project has been purposely designed to minimize environmental noise by siting WTGs as far away from existing residential receptor locations as feasible. However, operation of the Project will result in periodically audible sound within the adjacent community under certain operational and meteorological conditions. Specifically, the Project will be audible at the closest residential areas in relation to the Project footprint when four conditions occur concurrently: 1) residences in these abutting areas are directly downwind, 2) ambient sound levels are low, 3) wind speeds are high enough for wind turbine operation, 4) residents are outside with a direct line of sight to an operating WTG. Under these conditions, the "swishing" sound characteristic of wind turbines will likely be present. While audible, sound from the Project will likely not be deemed excessive, uncharacteristic, or unusually loud and will be consistent with sound generated at similar WTG projects successfully sited throughout the upstate New York area.

The modified Composite Noise Rating Method (mCNR) assessed potential noise impacts at all noise sensitive locations that exceed the NYDEC 6 dBA incremental increase criteria. The results of this secondary analysis demonstrate that though periodically audible, the project will not result in a noise nuisance for people with normal sensitivities. The goal of "C" or better is achieved at the majority of "potentially impacted receptors"; therefore no large scale noise complaints from the community are expected.

The Project will not exceed the Town of Alabama noise ordinance limit of 50 dBA at any existing residential receptor location.

Technical References:

1. DataKustik GmbH, 2005. Computer Aided Noise Abatement Model CadnaA, Version 3.5. Munich, Germany.
2. ISO, 1989. International Organization for Standardization. Standard ISO 9613-2 Acoustics – Attenuation of Sound During Propagation Outdoors. Geneva, Switzerland.
3. New York State Department of Environmental Conservation (NYS DEC). February 2, 2001. Assessing and Mitigating Noise Impacts, Program Policy. Albany, NY
4. International Standard, ISO 9613-2, Acoustics – Attenuation of Sound During Propagation Outdoors, Part 2 General Method of Calculation.
5. American National Standards Institute, ANSI S1.26-1995, American National Standard Method for the Calculation of the Absorption of Sound by the Atmosphere, 1995.
6. International Electromechanical Commission (IEC) 61400-11:2002(E) Wind Turbine Generator Systems – Part 11: Acoustic Noise Measurement Techniques, Second Edition 2002-12.
7. Stevens, K.N., Rosenblith, W.A., and Bolt, R.H., "A Community's Reaction to Noise: Can it be Forecast?" Noise Control, Vol. 1, No. 1, 1955
8. EPA, Community Noise, Publication NT1D300.3, Washington, D.C., 1971.
9. EPA, Information on Levels of Environmental Noise Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety, Publication EPA-550/9-74-004, March, 1974.
10. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), 1989 ASHRAE Handbook—Fundamentals, Atlanta, Georgia, 1989.

APPENDIX A

NOISE CONTOUR PLOTS

APPENDIX B

SUMMARY OF ACOUSTIC MODEL OUTPUT

APPENDIX C

MODIFIED CNR CALCULATION SUMMARY OUTPUT