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Design and Access Statement

Mason House Farm,
Clitheroe Road,
Lancashire, BB7 3DD.

The Turbine Choice

The Endurance E-3120 has been chosen for a number of reasons primarily due to the potential electricity requirement on farm. The main purpose of this wind turbine is to provide electricity for farm use. We have taken into consideration the local amenity, visual impact and energy requirements for the future therefore the application is not purely financially driven. Securing energy prices for farming businesses should be paramount as they will rise over the course of the next few years.

The visual impact of the turbine has been kept to a minimum and positioned so that it will not be a overbear structure on the surrounding area.

The development of turbines is inevitable if the country is going to meet the targets set by the government in reducing carbon footprints and reducing our dependency on the traditional methods of generation electricity. The position of the wind turbine should not detract from local property prices or the amenity value of the area.

Energy Prices and the future

The following is an extract from a report looking at UK energy prices and the future called Electricity Prices in the United Kingdom, Fundamental Drivers and Probable Trends 2008 to 2020 by Hugh Sarman, Incoteco and John Constable of the Renewable Energy Foundation

Examination of current system data indicates that from 2010, possibly earlier, right through to 2020, there is likely to be extended tightness of supply either caused by lack of generating capacity and or tightness in the supply of gas. The period ca, 2015 will be especially critical. Due to fragile margins and high gas prices any firm predictable non-gas generator is likely to enjoy high prices. Generation or electricity storage capacity able to enter the peaking market may be extremely well rewarded even by the standards of that sector.

While many of the risks outlined above are now unavoidable, their severity can be mitigated in the medium term if prompt and determined action is taken by government to rectify the faults of energy policy during the previous fifteen years.

Notwithstanding government expectations between now and 2015 the UK is likely to see the retirement of up to 30GW of nuclear and coal generating capacity, some 75% of the country's total capacity, in order to meet international obligations with regard to 1. Acid gas emissions and 2. Kyoto Treaty targets. To avoid protracted electricity rationing and/or rolling blackouts from 2010 onwards compensating infrastructure must be built in short order, and if this is to be diverse in fuels the cost will be in the range £50-60 billion. Given the lack of financial incentives for capacity that are offered by the electricity trading arrangements and the lack of firm carbon price signals, and the lengthy planning horizon for nuclear and clean coal plants, the default near term solution is a dramatic increase in combined cycle gas turbine plants, for which there is approximately 20GW currently in various stages of planning.

Thus the UK looks set to become even more dependent on gas. With North Sea in decline, the UK will become the world's largest sovereign gas importer, competing with the rest of Europe for gas exports, particularly from Russia.

The proposal at Mason House Farm will not solve the energy problems of the UK however with National policy supporting small scale renewable energy projects the collective can start to contribute to local requirements.

The project will generate electricity to carbon neutral the farm; the farming operation expansion will use a considerable amount of electricity. By generating electricity using the natural assets of the farm's dependence of the national grid will be omitted and energy security for the future will be secured.

The current European and national legislation is concentrating on renewable energy and it is natural for farmers and landowners to utilise natural resources to benefit both the agricultural operations through securing energy cost and potentially generate an additional income stream if they generate more electricity than needed.

Transport

The turbine comes on a 44 foot lorry and one crane. The turbine itself is in sections with the longest part being the rotor blades. The farm access is adequate and existing vehicles of this size come onto the farm. Access to the site will be via a field gate into a well drained area and will pose no problems. No main roads or access off the roads have to be altered and traffic will not be affected. Any damage to the field will be put back once the development has finished.

Environment

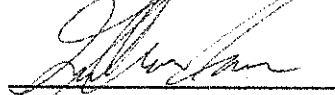
Although the site is within the Area of Outstanding Natural Beauty the size and scale of the E-3120 is not obtrusive, the farm itself is in a Entry level Scheme however no specialist ecology species or ornithological species have been found to deter the proposal progressing.

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**ACOUSTICAL
CHARACTERIZATION OF
THE ENDURANCE WIND
POWER E-3120 WIND
TURBINE**

**PRESENTED TO :
ENDURANCE WIND POWER, INC.**

WRITTEN BY:



GUILLAUME CARON, JR. ENG.



MARCH 2010

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ACOUSTICAL CHARACTERIZATION OF WIND TURBINE E-3120

Mandate

The mandate was to describe the acoustical characterization of wind turbine E-3120 to evaluate environmental impact. This study aims to obtain the apparent sound power (with A-weighted - L_{WA}) from this source and to forecast pressure levels generated depending on wind speed and distance. We also evaluated if there are pure tones in the wind turbine noise profile using FFT spectrum analysis. This document is a translation of the report prepared June 6, 2009.

Abstract

This study was based on the IEC-61400-11 standard (*Wind turbine generator systems – Part 11 Acoustic noise measurement techniques Ed 2.1*).

IEC-61400-11 standard characterizes acoustic emission of wind turbine based on wind speed. It specifies the sound power level (L_{WA}) as a function of wind speed, which allows deducing its impact for all distances.

This standard also describes the method of analysis of pure tone and precise conditions and measurement techniques such as:

- Location of measurements;
- Equipment;
- Formatting data ;
- Data analysis.

Moreover, this standard describes how to perform less detailed measurements and analysis for some cases. In the current study, some exceptions are made in relation to this standard, which does not affect the relevance of the analysis.

Instrumentation

- Precision Sound Level Meter Larson-Davis 824 (Type 1, satisfies IEC 60651-1993, IEC 60804-1993) Serial 824A2810.
- Capacitor microphone 1/2" 2551 de Larson-Davis S/N 1082.
- 1000 Hz stallion CAL200 de Larson-Davis (Type 1) SN3899.
- Third octave spectrum analyzer (Sound Level Meter. 824 de Larson-Davis).
- FFT spectrum analyzer (Sono. 824 de Larson-Davis) (with Hanning window).
- Windscreen: half sphere of 70 cm diameter to eliminate noise caused by wind.
- Anemometer.

Measurement description

This report is comprised of many sound level measurements at different wind speeds. Wind speeds are measured on *Endurance Wind Power's* anemometer located at 24.6 m height.

- The test was performed on *Endurance Wind Power's* test site located in Saint-Jean-Port-Joli, QC.
- Measurements, compilations and analysis were performed by Michel Bochud and Guillaume Caron.

Position of measurements

- The turbine is placed on level ground, located 55 meters from Highway 20. The vehicles generate a lot of noise (more than the wind). This constraint forced us to wait for a long period of time to obtain a complete absence of traffic before performing measurements. Most of the time, this constraint forced us to limit the length of measurement to approximately ten seconds instead of one minute.
- The microphone is placed at a distance of 31.4 m (less than 5° of declination). Most measurements were taken inside a van with the side door open. This configuration offers the feature to create a screen to the sounds from the highway. For some other measurements, the microphone was placed at the center of a round surface of wood of 1.2 meters in diameter, according to the IEC-61400-11 standard. The microphone is protected from the wind by a hemisphere of 70 cm (the features of this screen are defined in IEC-61400-11 page 29).

Level measurements

- A calibration is made at the beginning and at the end of each measurement session using a 1000 Hz CAL200 Larson-Davis stallion.
- The measures are *Leq* type with a variable measurement period, given the background noise of the highway.
- Noise measurements FFT spectrum are averages of 190 spectra during 10 seconds on average.
- The turbine was stopped occasionally in order to measure and correct for the background noise. The acoustic measurements are time-stamped to the second to have a correlation with wind speed compiled in the measuring station (one measurement per second).
- All measurement levels (*Leq*, 1/3 octave, FFT) were recorded and graphs are provided in appendix.

Content measurements

- Measures level of wind noise $dB_{(A)}$ with third-octave spectrum
- Measures level of background noise $dB_{(A)}$ with third-octave spectrum
- FFT analysis measurements of noise from wind turbine (0 to 2000 Hz, 5 Hz wide). All measurement files are provided in the appendix.
- All measurements were taken for wind speeds ranging from 5 to 14 m / s.

Methodology of data compilation and analysis

The methodology used is that specified in the IEC-61400-11.

All *Leqs* values (wind turbine running or off) are compiled in the same file: "Compilation_mesures acoustiques_EnduranceWindpower_1erjuin2009.xlsx".

The notes BF (background noise - *bruit de fond*) indicate that the wind turbine is turned off or that the measure was done far from the wind turbine, so the noise it produces is negligible compared to background noise.

All measurements (wind turbine running or turned off) are made in the complete absence of traffic on the highway.

Note: The background noise of the sound level meter is 16 dB, which is well below the measurements.

Synchronisation

The 824 sound level meter and the anemometer are synchronized to the second. The *Leqs*, FFTs and wind speed are the average values taken at exactly the same moment. These correlations are shown in the files "Vitesse du vent_2009-6-1.xlsx". These files give a value per second.

Wind speed

The wind speed, measured by the anemometer, is standardized according to the procedure 8.1 of standard IEC-61400-11.

For this calculation, the following parameters were used:

Z: The height of the anemometer - 25 m

H: Hub height- 25 m

z₀: Roughness length – 0.05 m

z_{0ref}: Reference roughness length – 0.05 m

z_{ref}: Reference height for wind speed - 10 m

$$V_s = V_z \left[\frac{\ln\left(\frac{z_{ref}}{z_{0ref}}\right) \ln\left(\frac{H}{z_0}\right)}{\ln\left(\frac{H}{z_{0ref}}\right) \ln\left(\frac{Z}{z_0}\right)} \right]$$

$$V_s = V_z \left[\frac{\ln\left(\frac{10}{0,05}\right) \ln\left(\frac{25}{0,05}\right)}{\ln\left(\frac{25}{0,05}\right) \ln\left(\frac{25}{0,05}\right)} \right] = V_z \times 0,8525$$

Standardized measurements are 0.853 times the speed measured.

Background noise correction

The turbine is very quiet; the noise is barely above the background noise. The average difference is only 4 dB. By implementing the recommendations of the IEC-61400-11, when the difference is between 3 and 6 dB, 1.3 dB is subtracted to the level measured. If it's higher to 6 dB, we apply the adjustment as the difference of sound power. Less than 3 dB, no correction is made.

Third octave spectrum

Third octave spectra (wind turbine running or off - see Appendix) measured and presented already include the filter (A). For some spectra, there is a slight peak for the 160Hz band, however, this peak is also in some other background noise spectra.

Analysis of pure tones (tonality)

FFT spectra (0 - 2000 Hz, 5 Hz wide, flat weighting, Hanning time window) are obtained for different wind strengths, ranging from 5 to 12 m / s, with the wind turbine in motion and stopped to have the spectrum of background noise.

Again, the FFT spectra of the wind turbine do not show significant difference compared to background noise. There are no lines that correspond to the identification of a "tone", as specified in the standard IEC-61400-11 (*local max isn't more than 6 dB above masking noise level*). We note peaks at 675 Hz, 925 Hz and 1550 Hz, but the level is below the level of background noise and they are not even audible from a distance of 31.4 meters.

Apparent sound power level

As mentioned in the methodology of IEC-61400-11 (p. 20), we can calculate the apparent sound power level $L_{W(A)}$. At least, this means that the sound power is equal to or lower than this value.

Therefore,

$$L_{W(A)} = Leq_{(A)} + 10 \log \left(\frac{4\pi R_1^2}{S_0} \right)$$

Where:

$Leq_{(A)}$ is the sound power level with background noise correction ;

R_1 is the distance between sound level meter and the center of the rotor

S_0 is reference area of 1 m².

The noise level generated by the turbine is fairly constant and if we rely on the average level ($Leq_{(A)} = 51.2$ dB), we obtain:

For: $Leq_{(A)} = 51,2$ dB

$$R_1 = \sqrt{(R_0^2 + H^2)} = \sqrt{(31,4^2 + 24,6^2)} = 38,9 \text{ m}$$

Where

R_0 is the distance at which the measurement was taken;

H is the height of the nacelle.

We obtain:

$$L_{W(A)} = 51,2 + 10\text{Log}(4\pi 38,9^2) = 94 \text{ dB}$$

Let the equation of sound power:

$$L_{W(A)} = L_{eq(A)} + 10\text{Log}\left(\frac{4\pi R_1^2}{S_0}\right)$$

For a distance R_0 of 100 m:

$$L_{eq(A)} = L_{W(A)} - 10\text{Log}(4\pi(R_0^2 + H^2)) = 94 - 10\text{Log}(4\pi(100^2 + 24,6^2)) = 42,8 \text{ dB}$$

This is about 4.5 dB lower than background noise, so imperceptible.

Moreover, a relation of the apparent acoustical power versus standardized wind speed has been obtained from measures taken on site:

$$L_{W(A)} = 0,5413V_s + 89,407$$

Where V_s is the wind velocity standardized according to procedure 8.1 of the standard IEC-61400-11.

Conclusion

The actual sound power level is about 94 dB and depends slightly on wind speed.

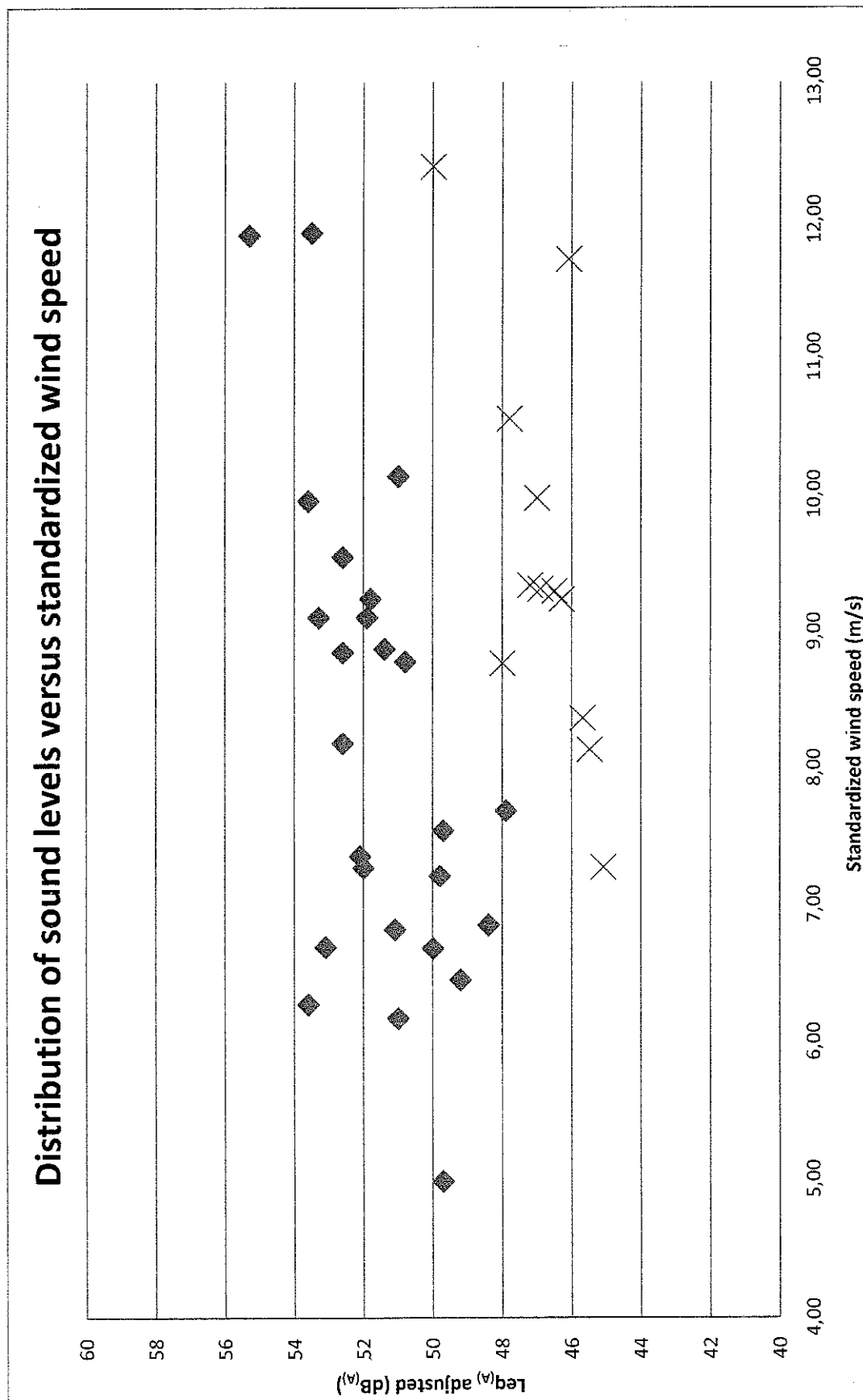
Note that this power level guarantees a sound level of around 43 dB for a distance of 100 m. At this distance, the background noise is higher than the noise of the turbine.

No trace of pure sound (tone) is audible at 100 feet. The FFT analysis shows the presence of several frequencies, but the level is too low according to background noise so they are hardly audible even to 31 meters.

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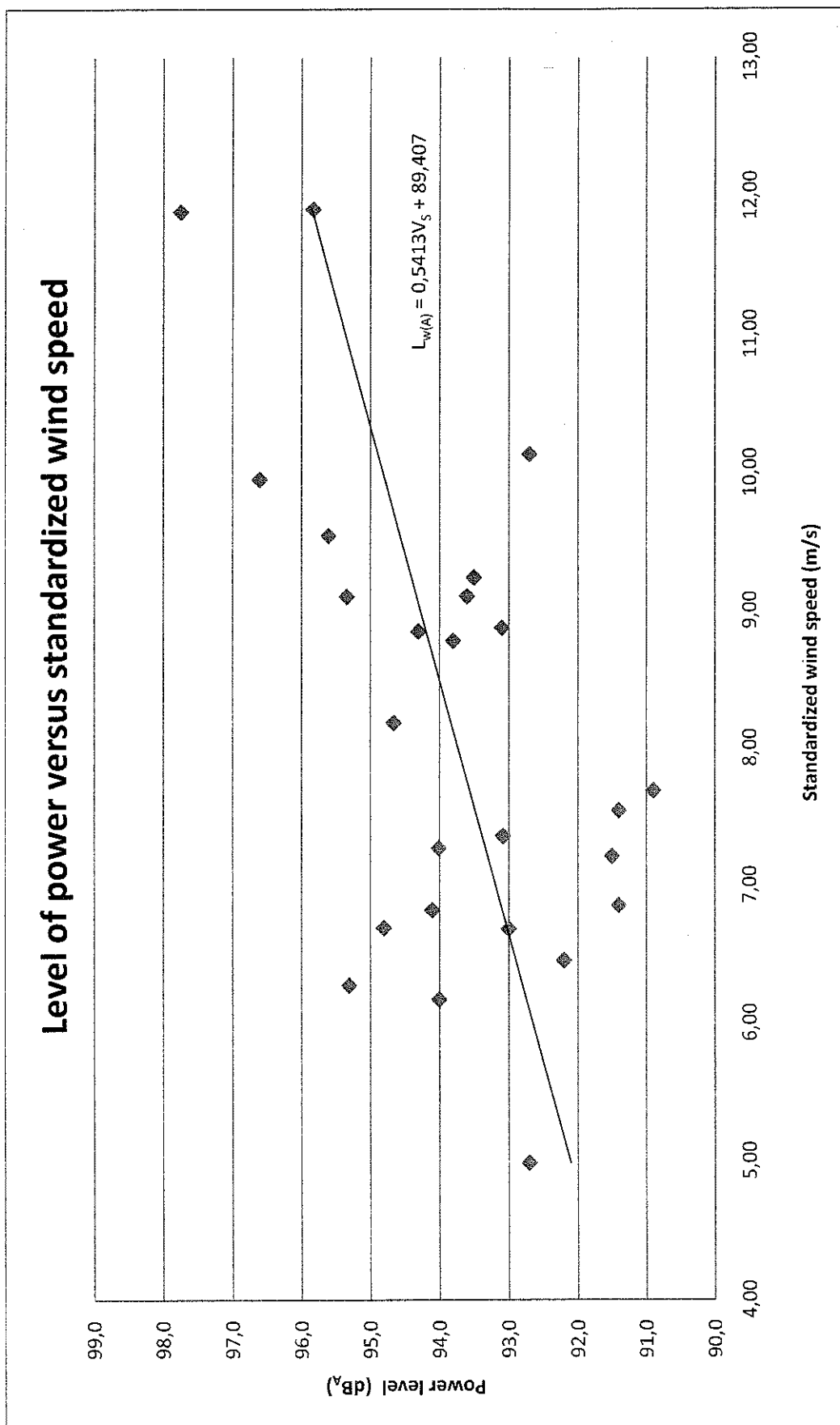
APPENDIXES

Graph of distribution of apparent sound levels versus standardized wind speed



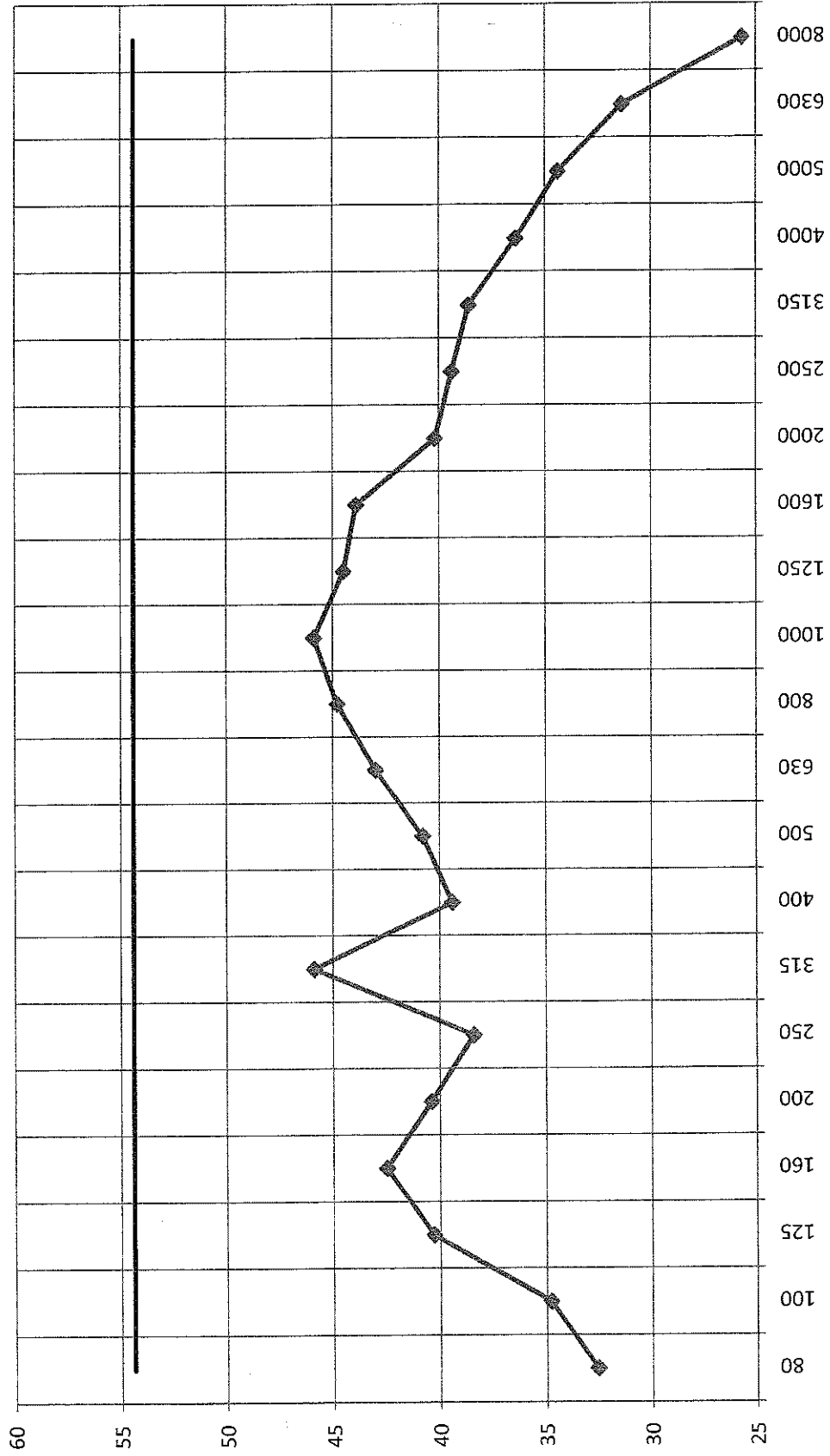
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Graph of level of power versus standardized wind speed.



Third octave spectrum of wind turbine's noise (SP33).

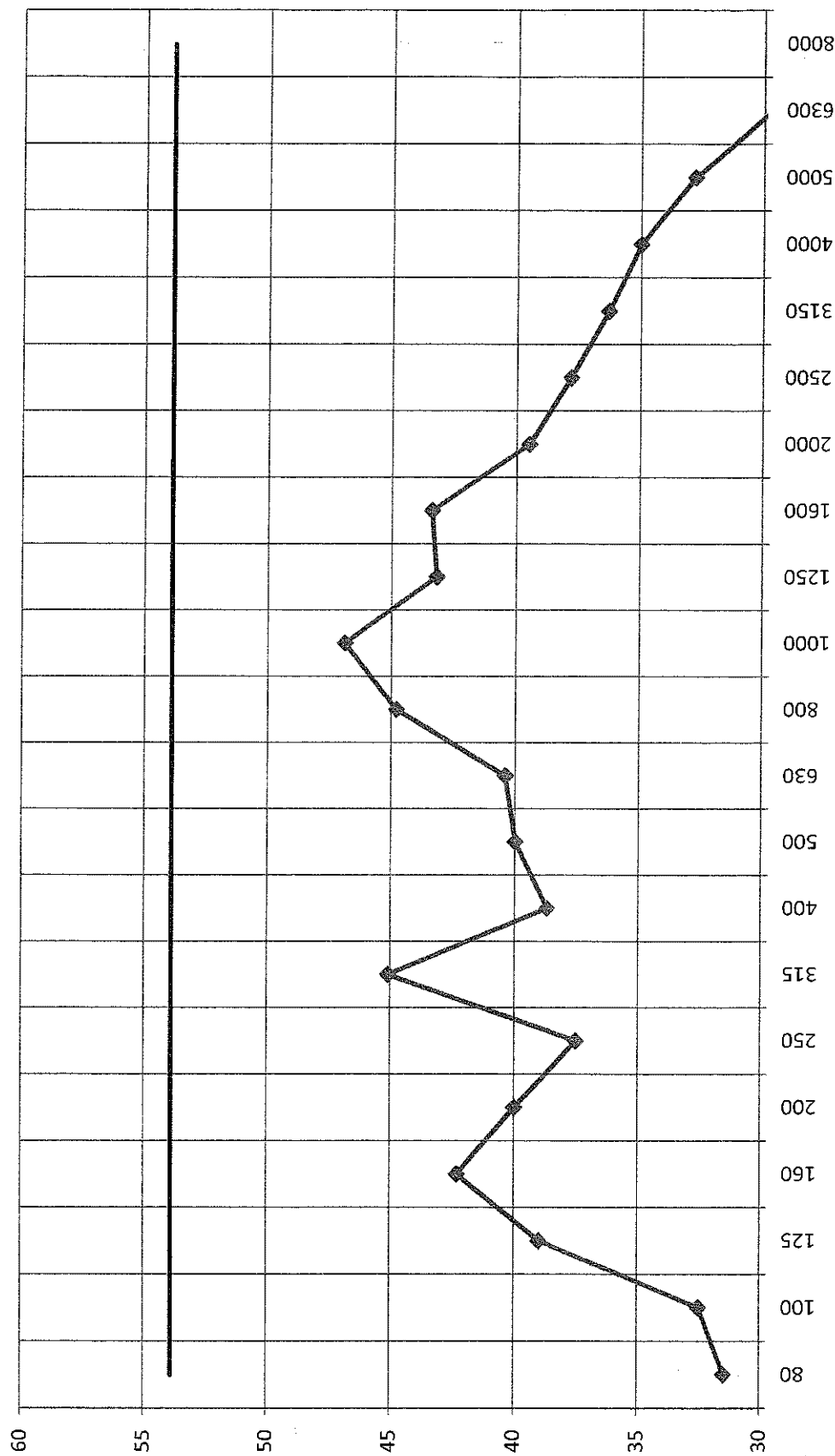
SP33 54,4 dBA 6,85 m/s



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Third-octave spectrum of wind turbine's noise (SP34).

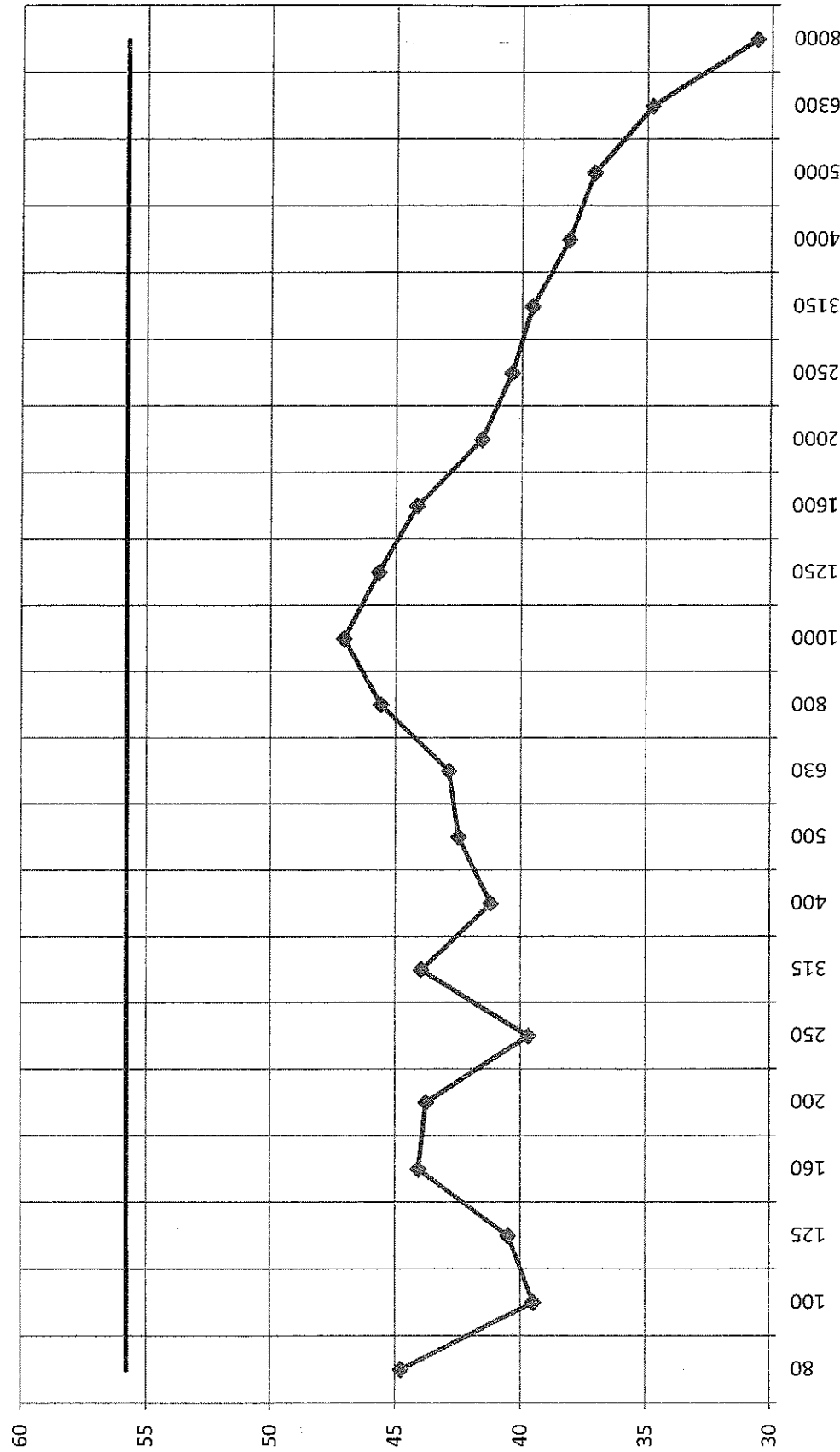
SP34 53,9 dBA 7,21 m/s



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Third octave spectrum of wind turbine's noise (SP35).

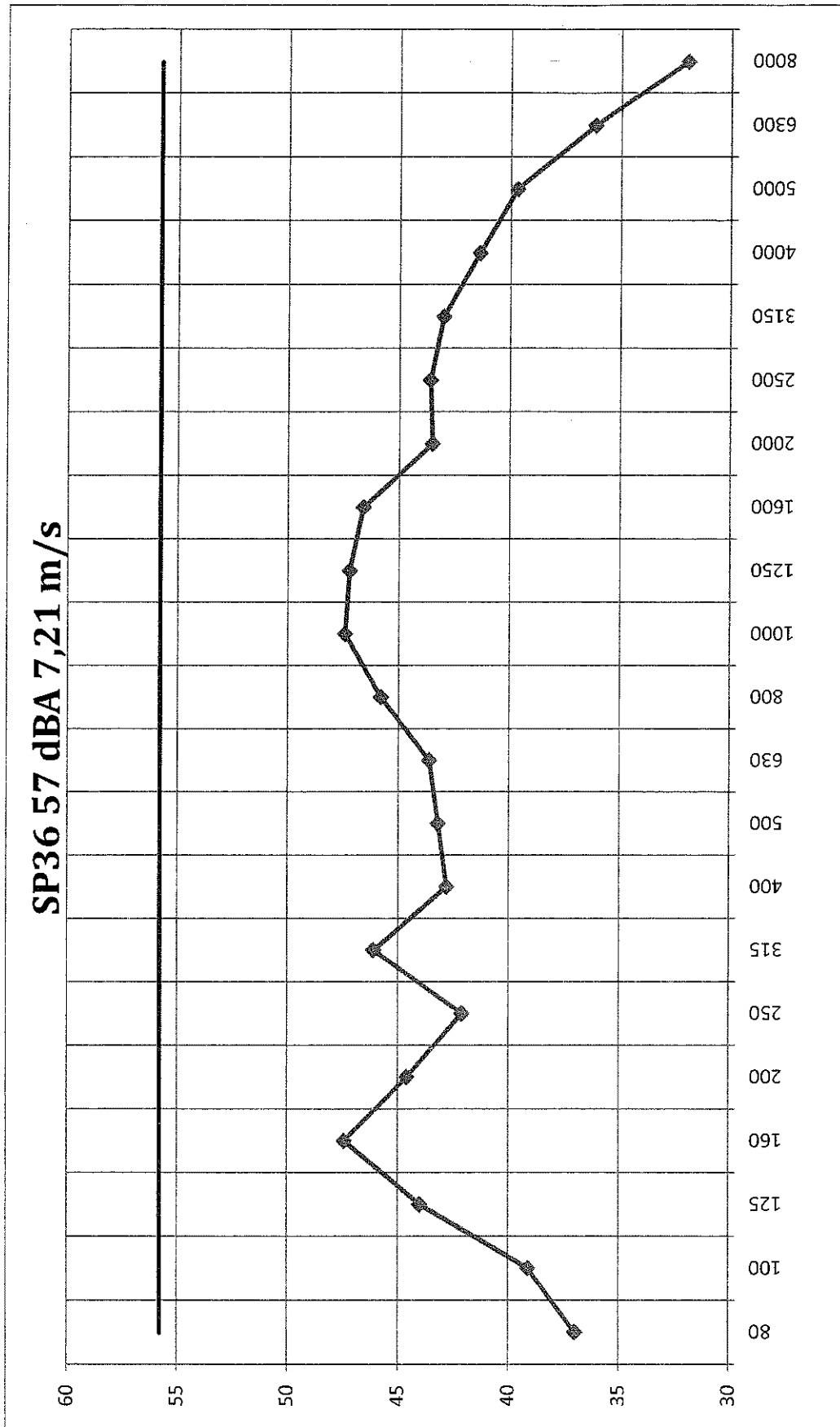
SP35 57 dBA 7,21 m/s



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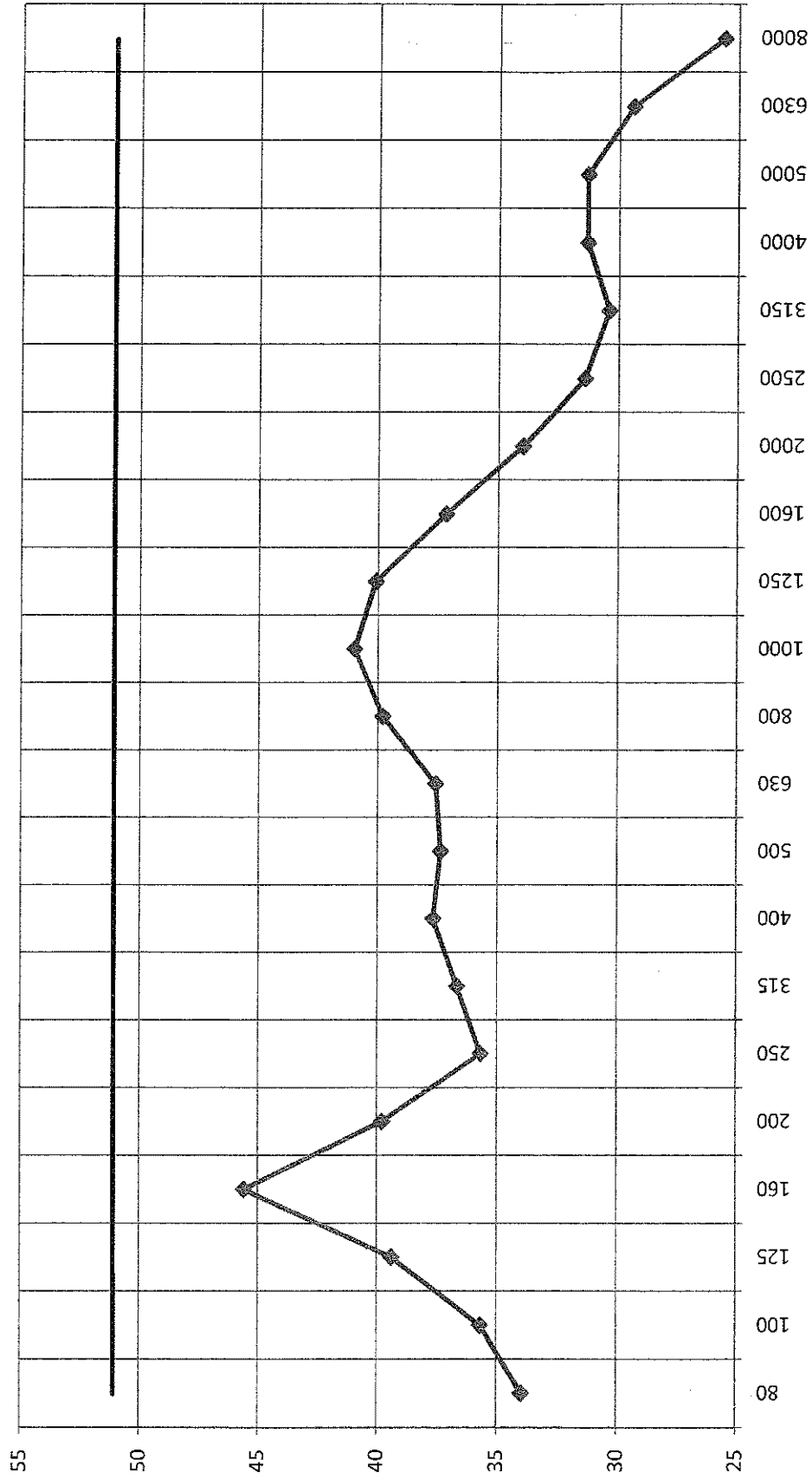
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Third octave spectrum of wind turbine's noise (SP36).



Third octave spectrum of background noise (SP37).

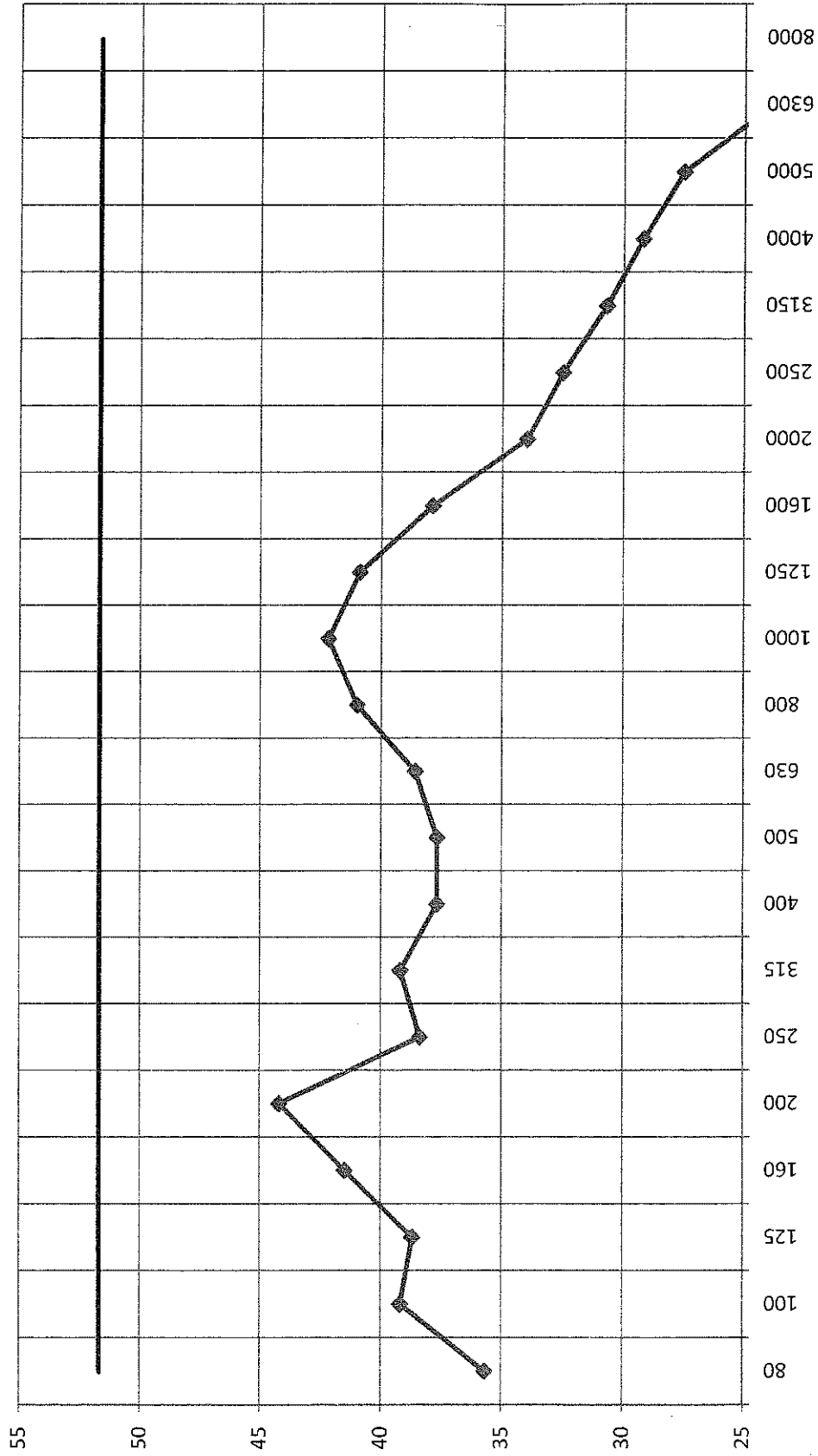
SP37 51,1 dBA BF 8,54 m/s



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Third-octave spectrum of background noise (SP39).

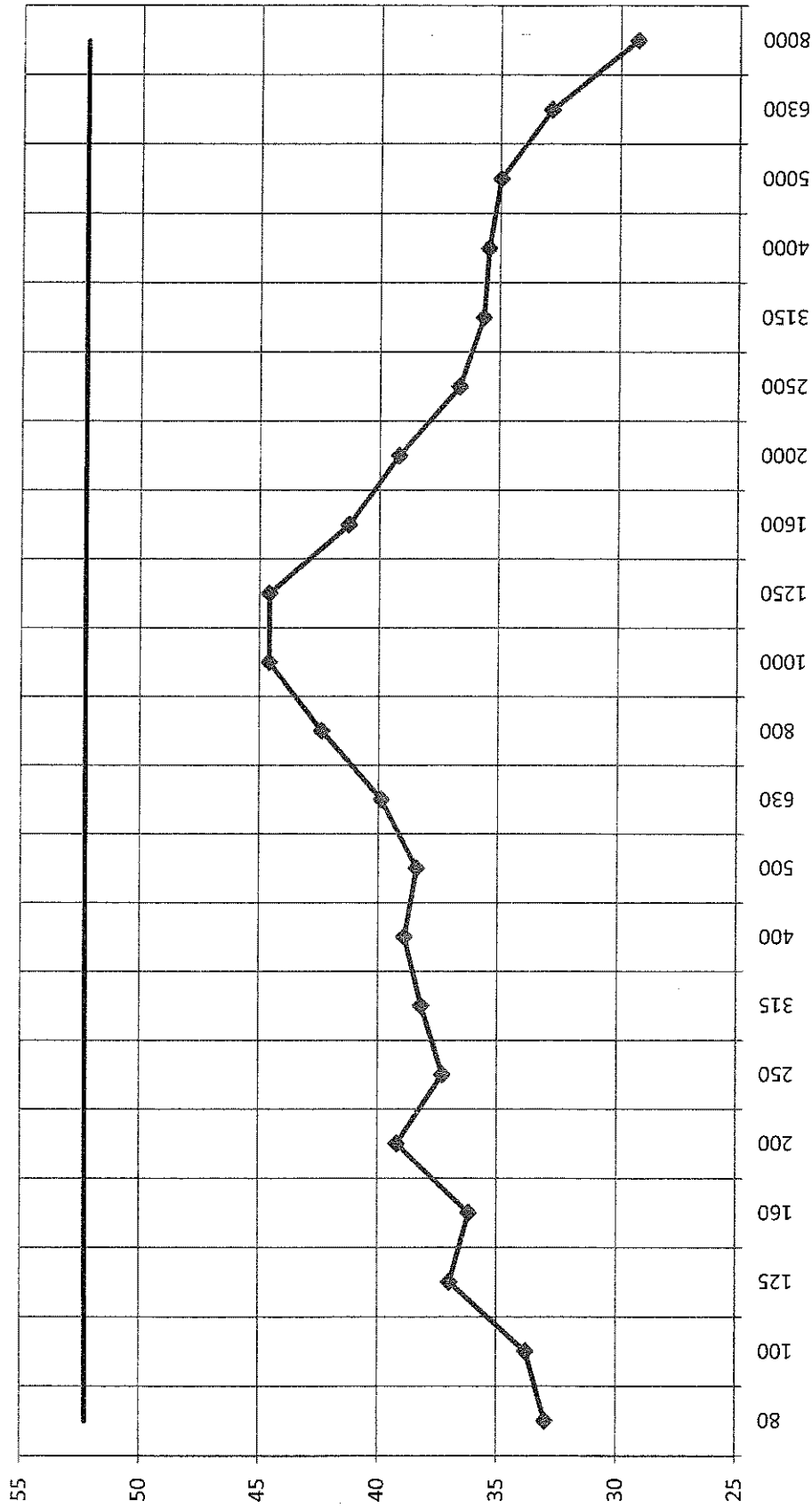
SP39 51,7 dBA BF 9,82 m/s



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Third-octave spectrum of background noise (SP41).

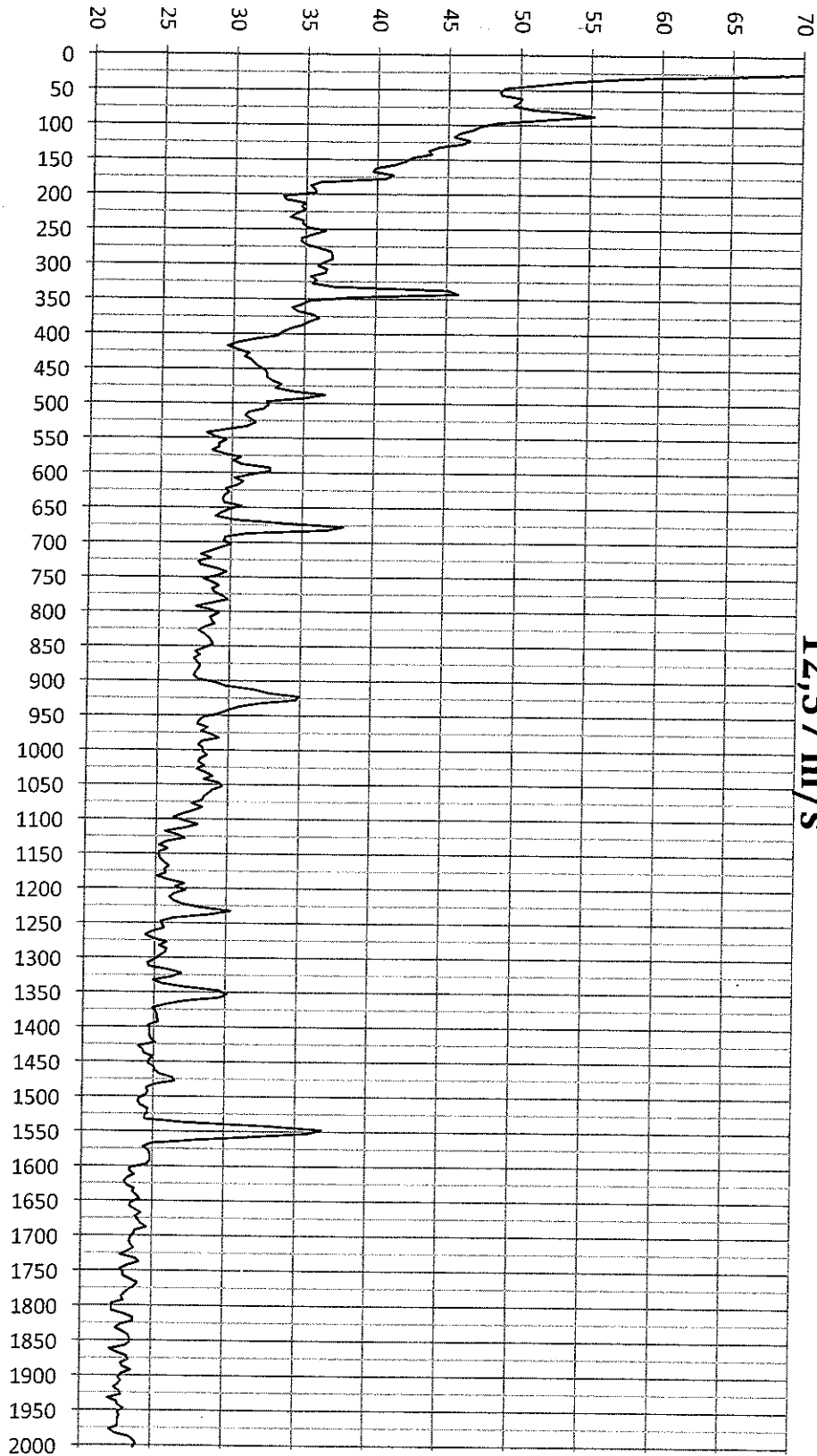
SP41 52,3 dBA BF 10,84 m/s



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Wind turbine noise FFT analysis (SP11).

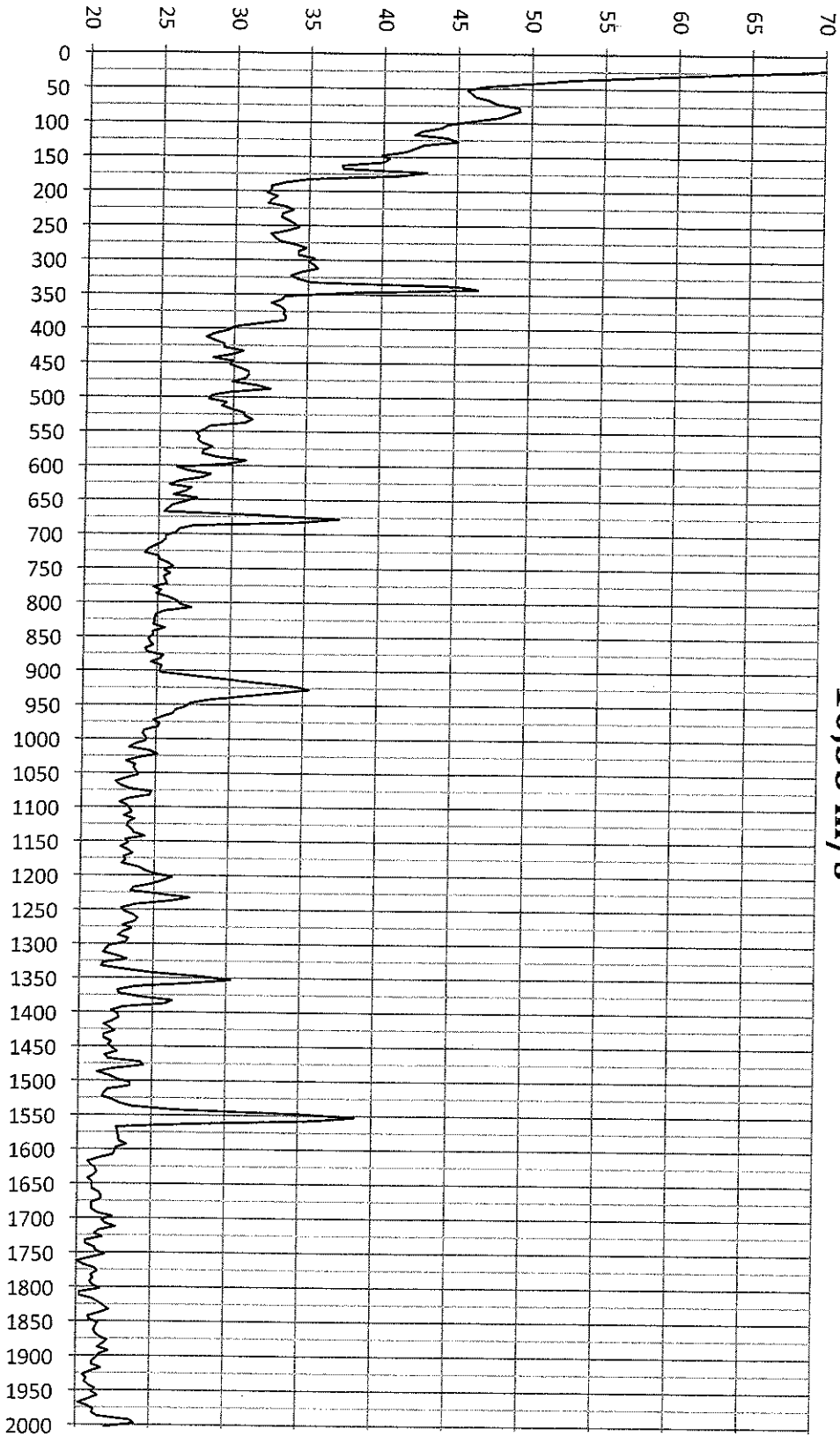
FFT Spectrum #11
12,57 m/s



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Wind turbine noise FFT analysis (SP14).

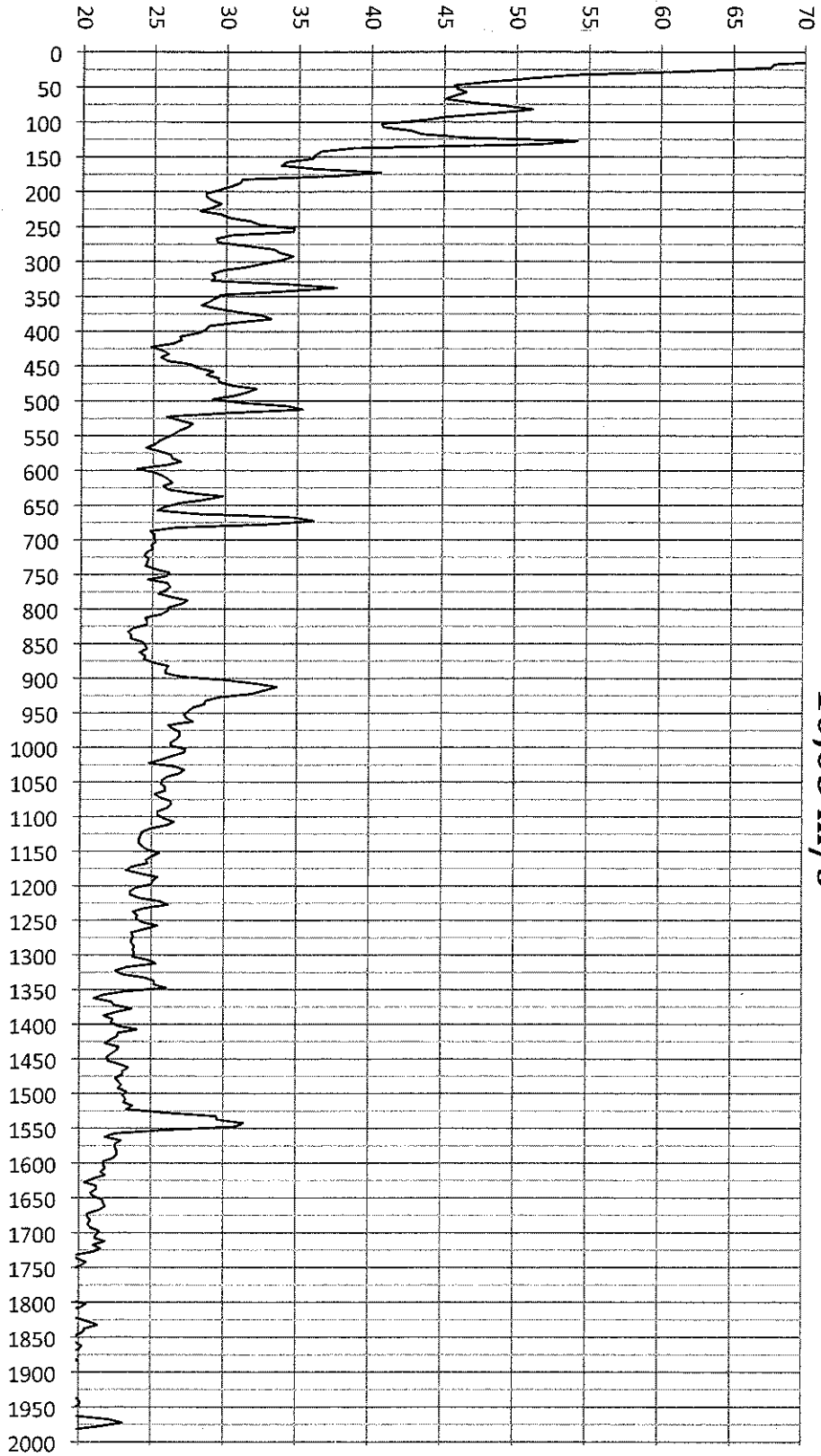
FFT Spectrum # 14
10,35 m/s



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Wind turbine noise FFT analysis (SP15).

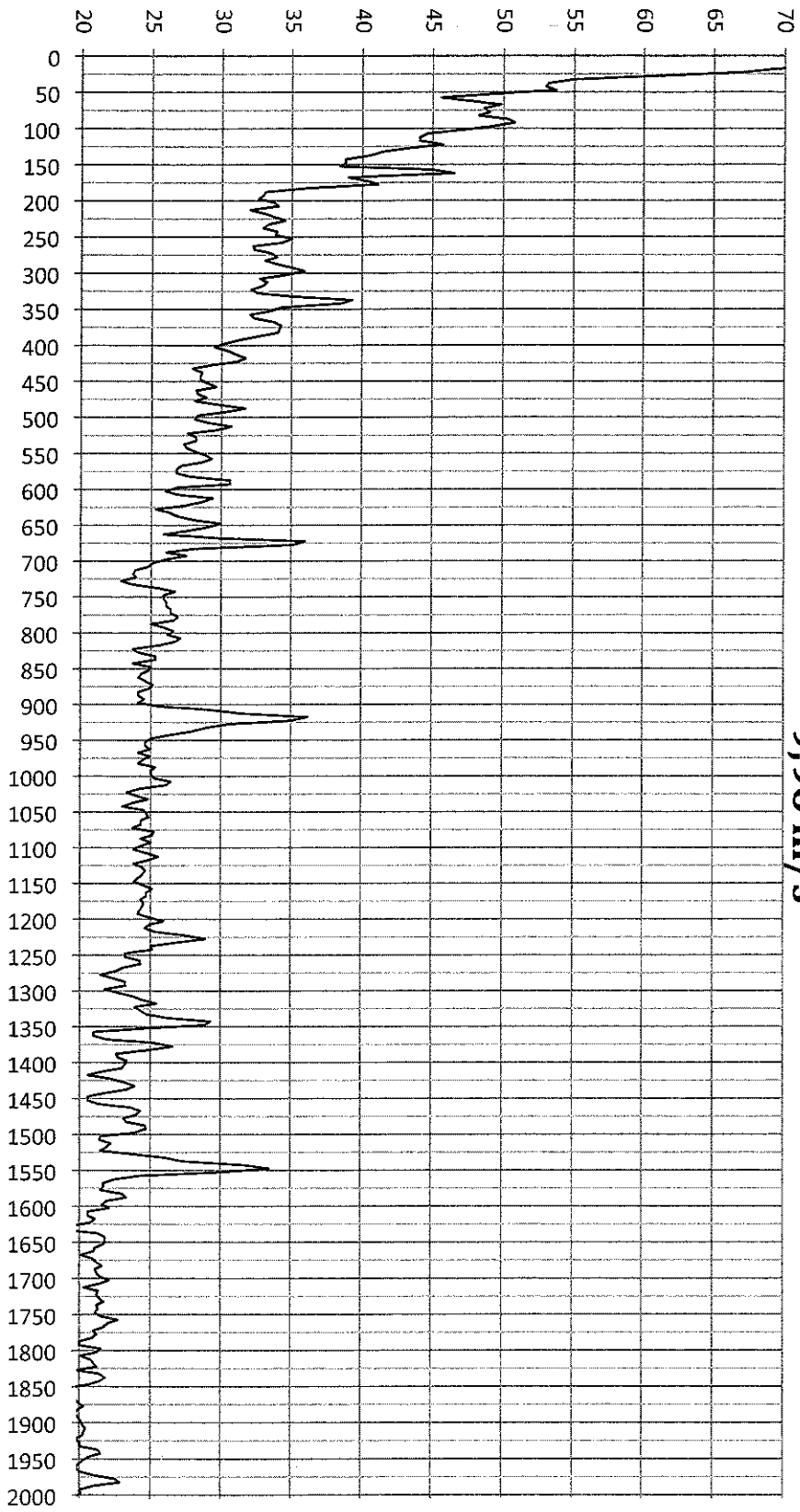
FFT Spectrum # 15
10,03 m/s



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Background noise FFT analysis (SP28).

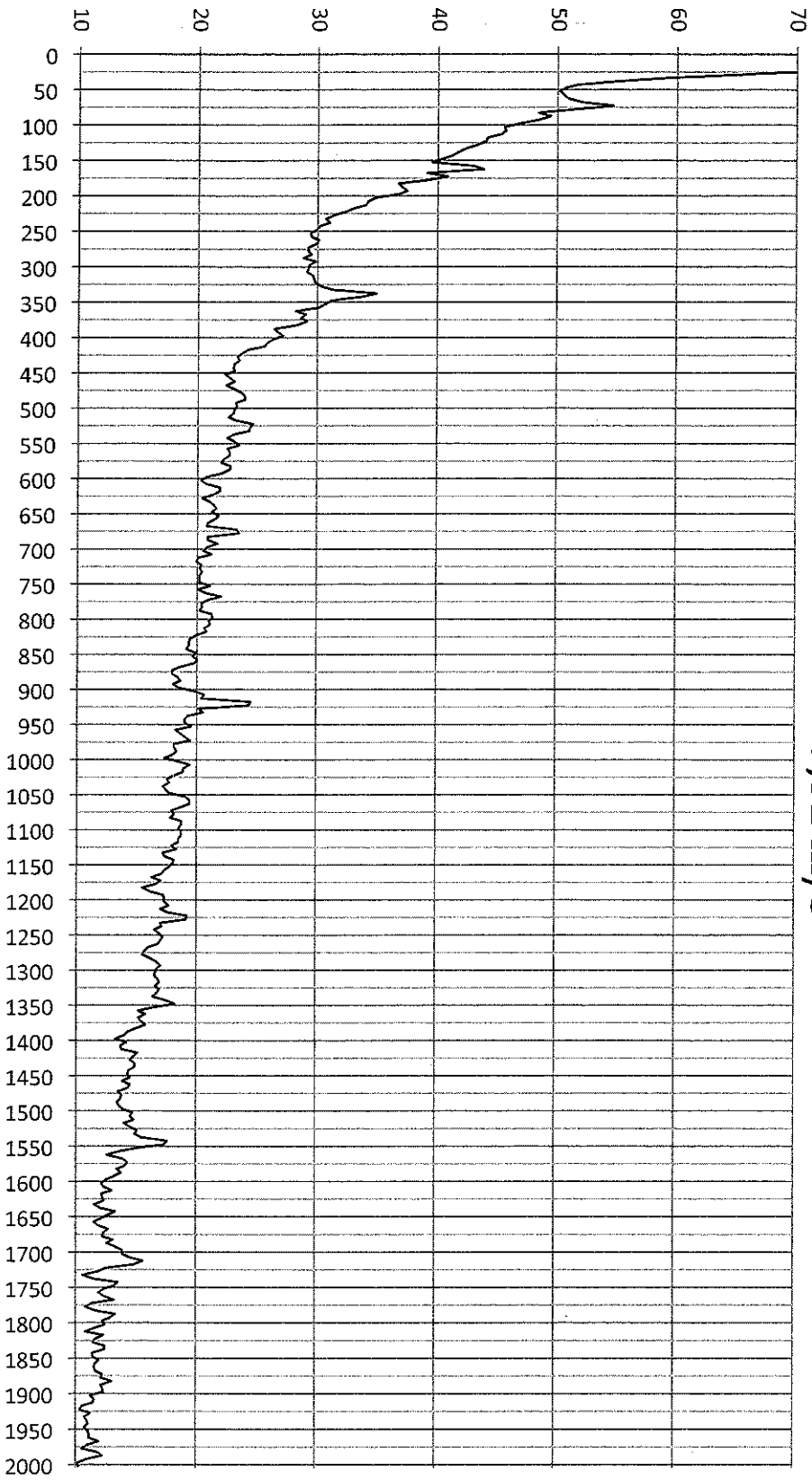
FFT Spectrum # 28 9,98 m/s



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Background noise FFT analysis (SP16).

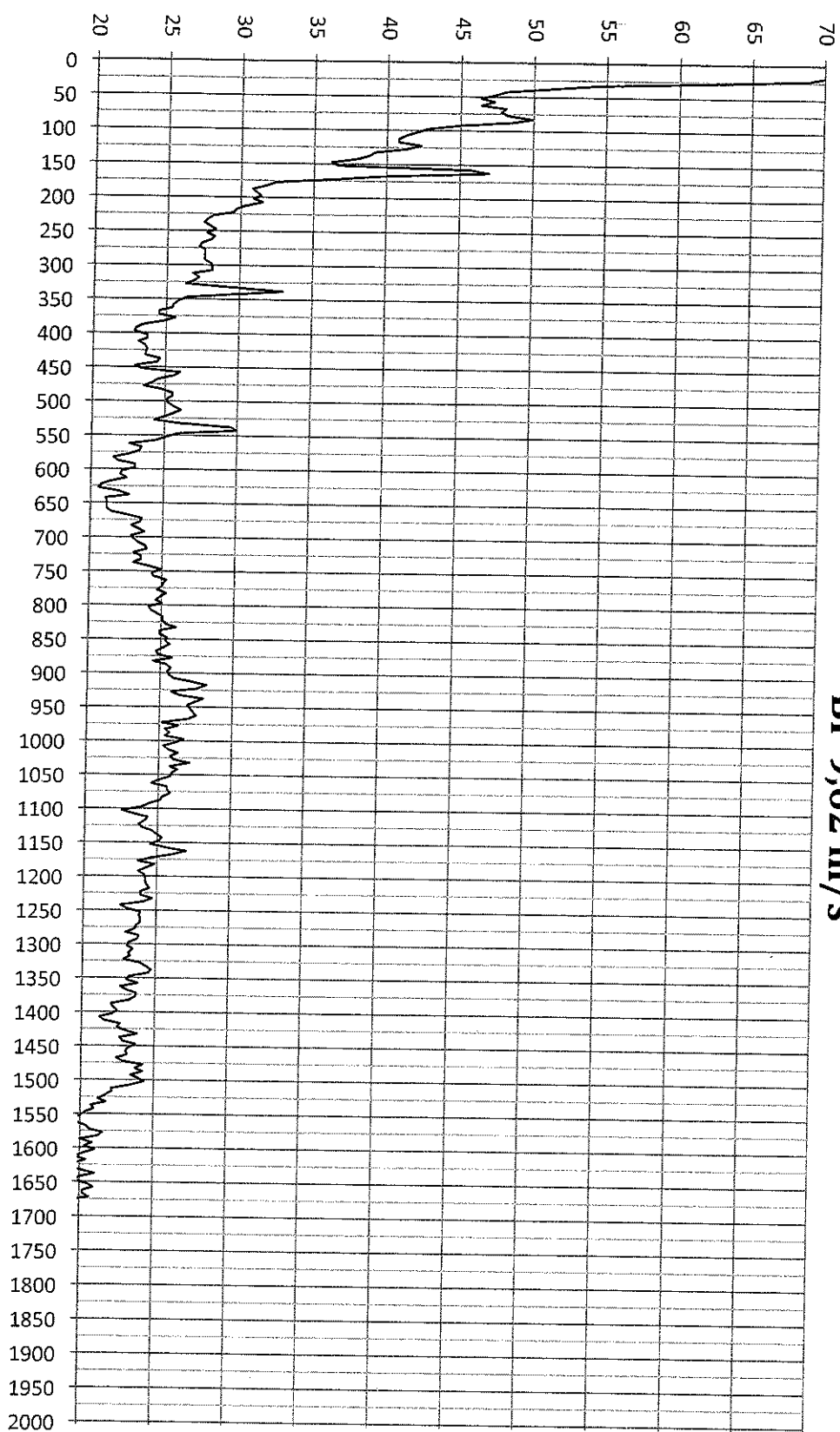
FFT Spectrum #16 BGN
7,32 m/s



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Background noise FFT analysis (SP17).

FFT Spectrum # 17 BGN
BF 9,62 m/s

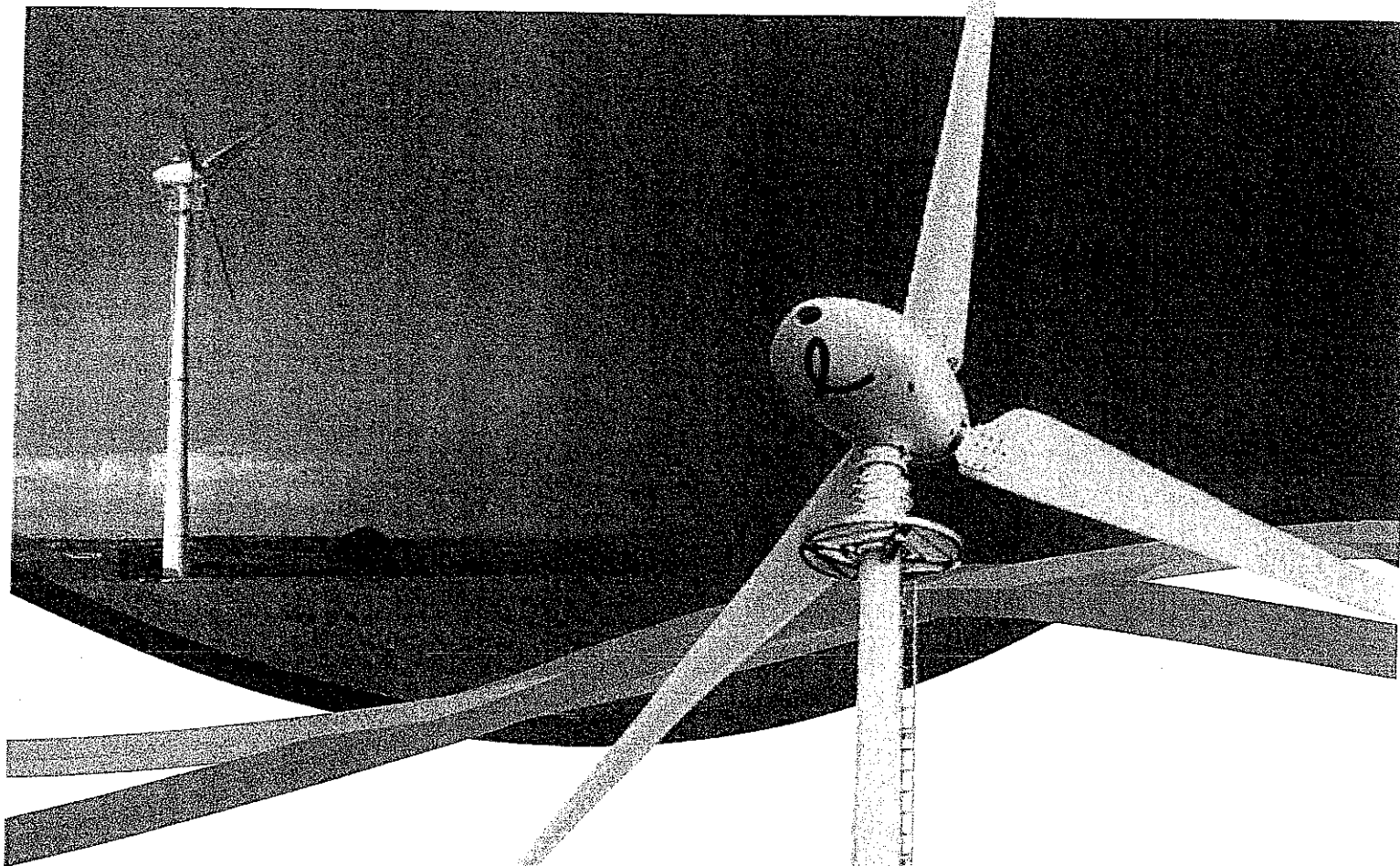


Endurance

wind power

we power the future

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E-3120 50kW Wind Turbine

The Endurance E-3120 wind turbine is designed to produce renewable energy efficiently, reliably, safely, and quietly. This turbine is ideal for larger farms, schools, hospitals, and commercial/industrial sites, and will produce 100,000 - 250,000 kWh per year in appropriate winds.

green energy that works



www.endurancewindpower.co.uk

E-3120 Benefits

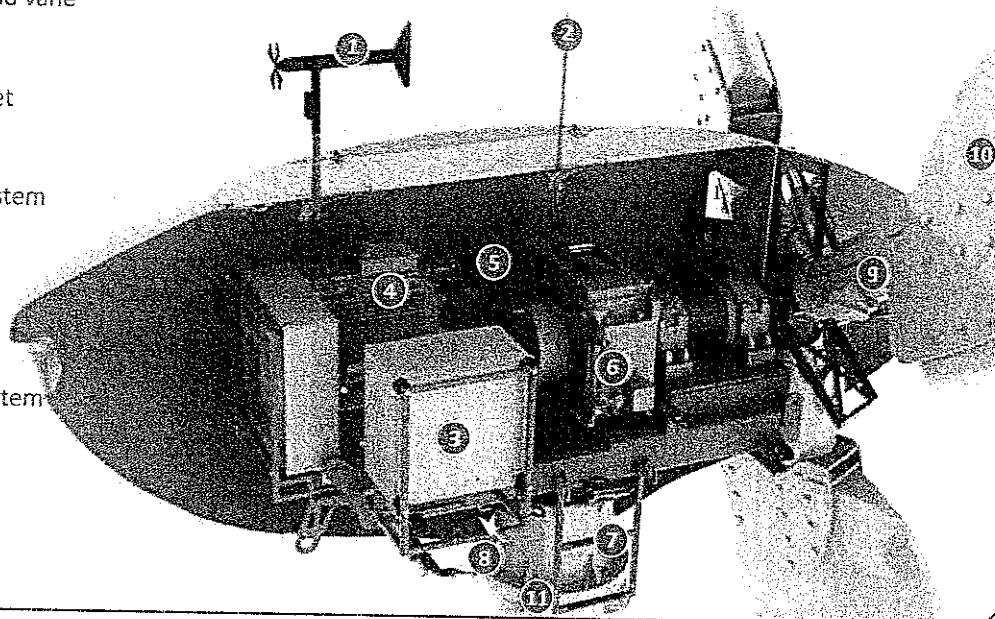
- Contributes to the national renewable energy and carbon emission reduction targets
- Promotes community sustainability values
- Eligible for renewable energy credits
- Provide an additional revenue stream with the government's Feed-In-Tariff program
- Provides energy independence



E-3120 50kW Wind Turbine

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- ① Anemometer and wind vane
- ② Lightning rod
- ③ Nacelle control cabinet
- ④ Induction generator
- ⑤ Fail-safe disk brake system
- ⑥ Gearbox
- ⑦ Access ladder
- ⑧ Yaw damper
- ⑨ Pitch control safety system
- ⑩ Fiberglass blade
- ⑪ Tower



① Anemometer and wind vane

Measures wind speed and direction to control starting, stopping, and orientation of the turbine to maximize power production.

② Lightning rod

Guides lightning to the ground, protecting the turbine.

③ Nacelle control cabinet

Houses the tower-top electronics in a weather-protected environment for maximum reliability. The main turbine control panel is located at the base of the tower for easy access.

④ Induction generator

Delivers grid-compatible power and eliminates the need for an inverter or other power electronics. This improves efficiency and reliability, and reduces up-front costs.

⑤ Fail-safe disk brake system

Safely stops the wind turbine using twin brake calipers in situations such as extreme wind or grid failure.

⑥ Gearbox

Drives the generator at full speed while the rotor turns slowly. The gearbox uses rugged, conventional design for long life and high reliability.

⑦ Access ladder

Allows easy and safe access to the nacelle for maintenance. Safety is a top design priority.

⑧ Yaw damper

While the turbine is aerodynamically oriented by the wind, the yaw damper smooths the movement to ease tower and rotor loads.

⑨ Pitch control safety system

Provides backup protection against rotor over speed. If the rotor turns too fast for any reason, the blades are pitched by a spring mechanism to control the speed.

⑩ Fiberglass blade

Designed to quietly and efficiently produce energy, particularly in light winds.

⑪ Tower

Attractive monopole towers are available in 24 and 36.5m (80 and 120 ft) to comply with height restrictions or reach the best winds at your site.

Cornerstones of Endurance Design

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Production Efficiency

Most distributed wind customers did not select their site for wind resources, but look to generate power from the wind available to them. Endurance wind turbines are designed specifically for less-than-perfect wind conditions.

218,000 kWh
@7M/\$ E-3120 50kW
ANNUAL ENERGY PRODUCTION

Swept Area

The blades capture the energy of the wind. The larger the rotor diameter, the more wind energy the turbine captures. The Endurance E-3120 has a 19m (63 ft) rotor diameter- one of the largest rotor diameters per rated kW in its class- to capture the most wind energy.

Motoring

Motoring starts the blades spinning so the turbine operates in lighter wind conditions than if it relied solely on the wind to start.

Generator Type

The induction generator produces electricity that can be transferred to the power grid without inverters. This provides lower equipment and maintenance costs and increases overall power production.

Reliability

All Endurance turbines have been extensively tested to ensure customers receive dependable energy production. They are built with proven commercial components for durability and easy support in the future.

Five Year Warranty

Endurance offers one of the best warranties in the wind industry, covering all defective components and labor for five years.

Safe Operation

When the turbine control system detects any fault, such as high wind or a grid power loss, the dual caliper disc brake system activates, safely stopping the turbine until the condition is cleared.

Passive Stall Rotor Design

The fixed-speed rotor aerodynamically stalls the blades as the first layer of protection for the turbine during high winds.

Control and Remote Interface Software

Each Endurance wind turbine is operated safely by an onboard computer system with advance control logic. This system also records data including energy production, average power, wind speed and event history. Turbine controls and data are also remotely available from a web browser.

Quiet Operation

Quiet operation is essential for a wind turbine in a community environment. Endurance turbines use slowly turning blades and high-quality manufactured components to make them the quietest turbines in their class.

Clean Aesthetics

A wind turbine makes a powerful statement about your commitment to the environment and clean energy. Endurance wind turbines have clean lines and make an attractive addition to any landscape.

Endurance[®]

wind power

we power the future

Turbine

Configuration	3 blades, horizontal axis, downwind
Rated power @ 9.5 m/s	50kW
Applications	Direct grid-tie
Rotor speed	43 rpm
Cut-in wind speed	3.5 m/s (7.8 mph)
Cut-out wind speed	25 m/s (56 mph)
Survival wind speed	52 m/s (116 mph)
Overall weight	3 990 kg (8 800 lbs)

Rotor

Rotor diameter	19.2 m (63.0 ft)
Swept area	290 m ² (3120 ft ²)
Blade length	9.00 m (29.5 ft)
Blade material	Fiberglass/Polyester
Power regulation	Stall control (constant speed)

Generator

Type	Induction generator
Configurations	3 ϕ , 400 VAC @ 50 Hz

Brake & Safety Systems

Main brake system	Rapid fail-safe dual mechanical brakes
Secondary safety	Pitch control system (for over-speed regulation) using passive, spring-loaded mechanism

Automatic shut down triggered by :	- High wind speed - Grid failure - Over-speed - All other fault conditions
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Controls

Control System	Programmable logic controller (PLC)
User interface	Wireless or wired network software interface for remote monitoring and control

Warranty

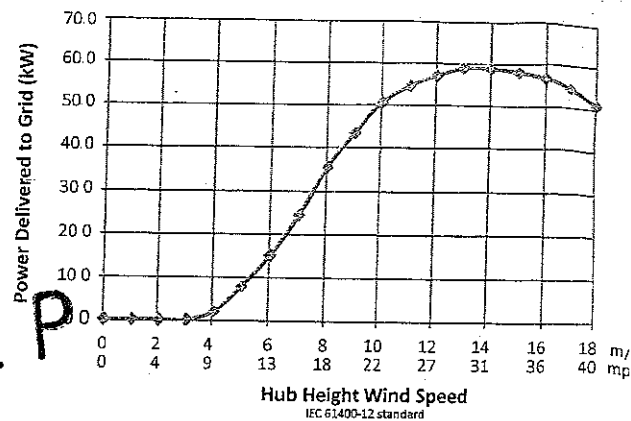
Turbine & controls	5 years parts and labour
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Towers

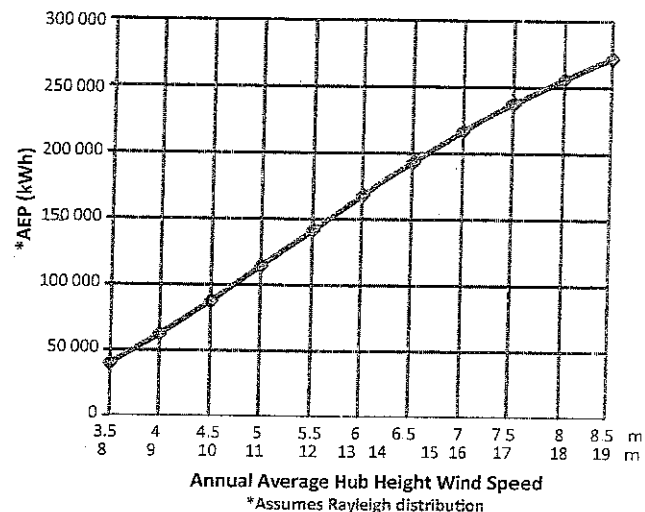
Types	Free-standing monopole: 24m (80ft) 36.5 m (120 ft)
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Maintenance access	Safe climbing system Working space inside the nacelle Tower-top work platform
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Power Curve



Annual Energy Production (AEP)



Annual Average Hub Height Wind Speed (m/s)	Annual Energy Production (kWh)
3.5	40 100
4.0	62 500
4.5	88 000
5.0	114 900
5.5	142 200
6.0	168 900
6.5	194 300
7.0	217 700
7.5	238 800
8.0	257 200
8.5	273 000

Wind Speed Conversion Table

m/s	4	5	6	7	8	9	10	11	12	14
km/h	14	18	22	25	29	32	36	40	43	50
mph	9	11	13	16	18	20	22	25	27	31

www.endurancewindpower.co.uk
info@endurancewindpower.com



Endurance Wind Power uses 100% renewable energy at its head office and manufacturing plant