Experimental Test Site for Small Wind Turbines of Narbonne

Test Report n°010 version 2 of Jul. 17 2007

FD2.5-300 Wind Turbine – Battery Charging

Manufacturer	Shangdu Stock-Breeding Machine Plant (China)
Reference	FD2.5-300
Rotor shaft	horizontal
Number of blades	3
Rotor diameter	2.5m
Mechanical regulation type	Furling
Nominal output	300W at 8m/s
Battery Charger	Shangdu Stock-Breeding Machine Plant
Tower type	6m guyed tubular
Importer	DER EDF
Test duration	May 2006 to March 2007

FD2.5-300 installed at the Narbonne experimental test site (front)

Summary

1 Manufacturer Data

型 号 Models	风轮直径 Diameter of Wind Wheel (m)	额定风速 Rated Speed (m/s)	额定电压 Rated Voltage (v)	额定功率 Rated Power (W)	发电机形式 Forms	塔架高 Height of Tower (m)
FD2-100	2	6	28	100	永磁式 Magneto	5
FD2.1-200	2.1	8	28	200	永磁式 Magneto	5
FD2.5-300	2.5	8	28 或 42 28 or42	300	永磁式 Magneto	6
FD2.5-500	2.5	8	28 或 42 28 or 42	500	永磁式 Magneto	6

2 Objectives

The Experimental Test Site for Small Wind Turbines of Narbonne is intended to observe the behaviour and the performances of small wind turbines with a rotor diameter smaller or equal to 7 meters (or generated power smaller than approximately 10kVA) proposed to the test within the framework of a voluntary program by a manufacturer or an official distributor.

The following points are studied:

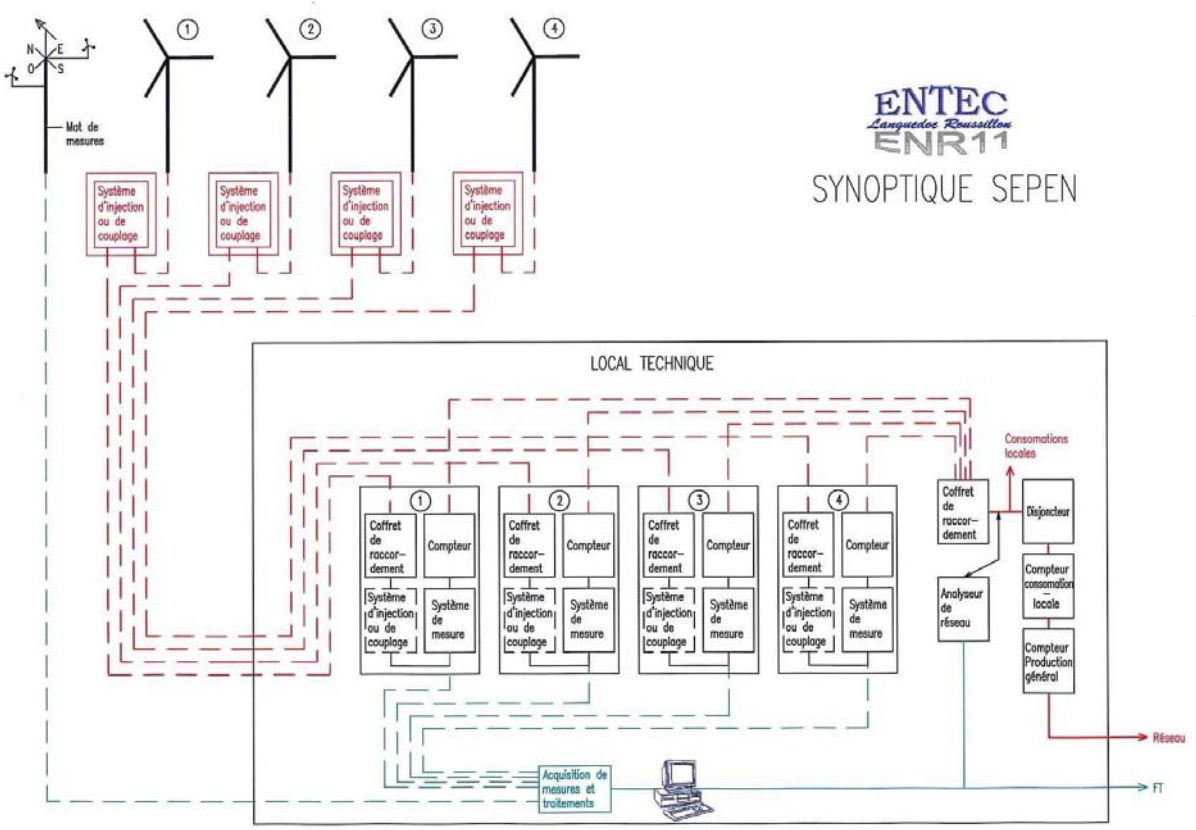
- evaluation of operation, safety, quality, reliability and integrity of the wind turbine and associated systems, according to the protocol of measurements defined in this document and approaching as far as possible to the rules and procedures of the IEC WT01 and IEC61400-2 standards
- measurements of the power curve and production of electrical energy of the machine according to the wind resource, and according to the protocol of measurements defined in this document and approaching as far as possible to the IEC61400-12 standard
- measurements of noise levels at audio frequencies (acoustic noise) near the wind turbines
- evaluation of the quality of the electrical current produced, according to a protocol of measurements of grid disturbances defined by EDF R&D Department
- measurements of environmental conditions at the test site (speed, direction and turbulence of the wind, temperature, pressure and relative humidity)
- appreciation of the visual impact (investigation carried out with visitors of the experimental test site)

The recording and the process of the measurements were carried out on the test site during the period of operation of the equipment installed.

3 Installations

The test site is equipped:

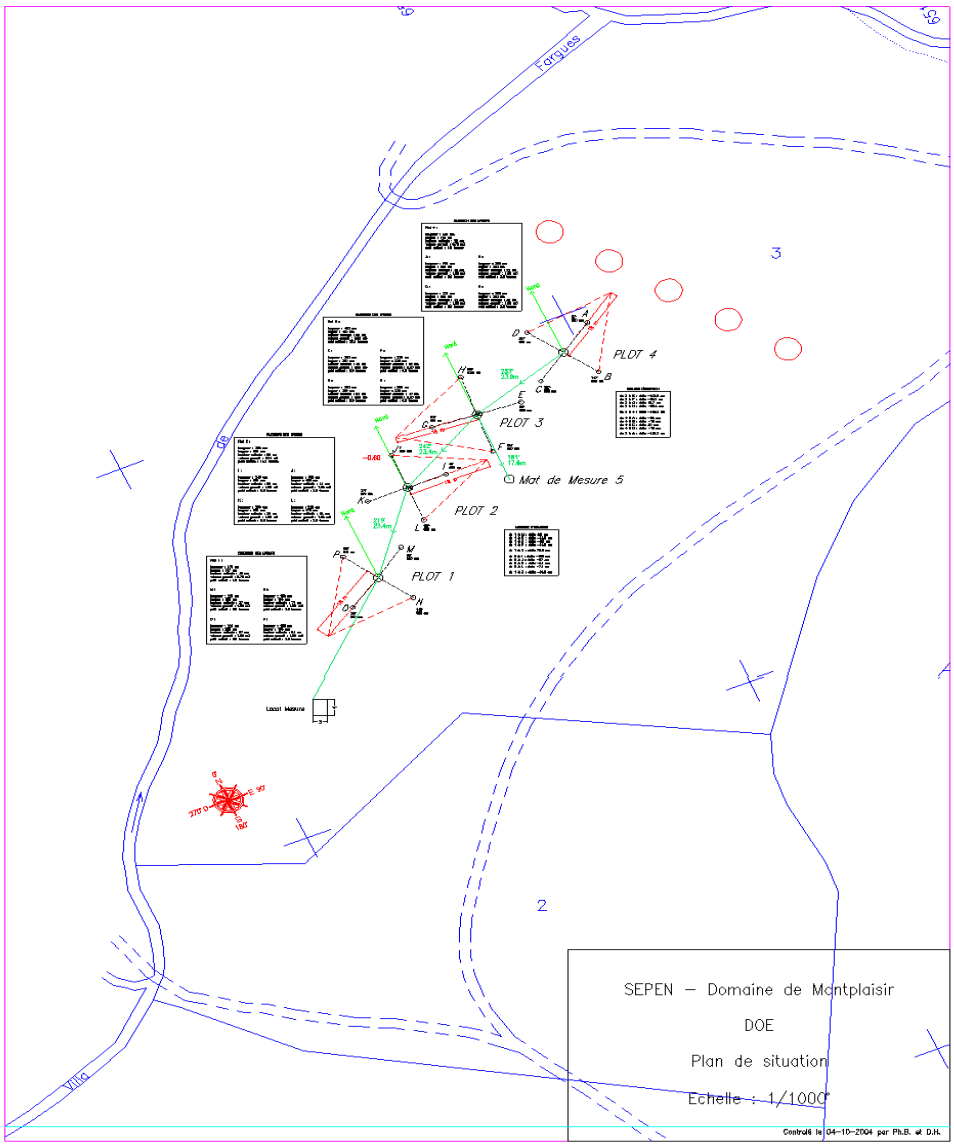
- with a technical building where are gathered:
    - equipment to accesses the grid for each wind turbine, with room reserved for the installation of the manufacturer grid connection equipment for each machine
    - safety equipments and energy meters:
        - safety equipment to disconnect the sources of energy in the event of disturbance on the grid
        - meters for generated and consumed energy
        - measurement of the grid disturbances (LEM QWave parameterized according to NF-EN-50160 standard)
    - equipments for power measurement in grid connection systems:
        - power measurement transducers (single-phase or three-phase current balanced or not, Lumel N10A)
        - acquisition of current information by current transformers
        - output of power information by analog signal 4-20mA
        - visualization of the grid parameters (tension, current, frequency, active and reactive power …)
    - equipement for power measurement of battery charging systems:
        - 3 phase active power transducer (Load Controls Inc. UPC) variable voltage and variable frequency
        - frequency transducer (Lumel P12O)
        - DC voltage transducer (Lumel P12U)
        - Hall effect DC current transducer (NKT DT)
    - equipments for measurement of environmental parameters:
        - ambient temperature transducer (Prosensor 700PT100)
        - atmospheric pressure transducer (NRG BP20)
        - relative humidity transducer (NRG RH5)
        - insulating transducers (Phoenix Contact MCR-C-UI-UI-DCI)
    - equipments for data recording
        - dedicated desktop PC computer
        - USB data logger (IOTech Personal DAQ/56 and PDQ2 extension)
        - remote access by ADSL modem on telephone line



- with 4 positions for installations for the wind turbines:
    - 1 concrete base which can accept a wind turbine with a 7m rotor diameter maximum (approximately 10kVA), the wind turbine can be installed on guyed or free standing tower with a maximum height of 18m
    - 1 concrete base which can accept a wind turbine with a 5m rotor diameter maximum (approximately 5kVA), the wind turbine can be installed on guyed or free standing tower with a maximum height of 18m
    - 2 concrete bases which can accept a wind turbine with a 5m rotor diameter maximum (approximately 5kVA), the wind turbine can be installed on guyed tower only with a maximum height of 18m
    - each concrete base is intended to receive a mechanical adaptation plate for each tower from each manufacturer

- of a 20m guyed measurement tower, equipped with:
    - 3 anemometers placed at 16, 18 and 20m (NRG # 40H including 1 calibrated)
    - wind vanes placed at 16 and 20m (NRG # 200P)
    - 5 signal transducers with 4-20mA output (Lumel P120 and P12U)

- equipment for noise measurement (on site only during the noise measurement campaigns)



Unless otherwise specified for a particular test, the tests will follow the following procedures:

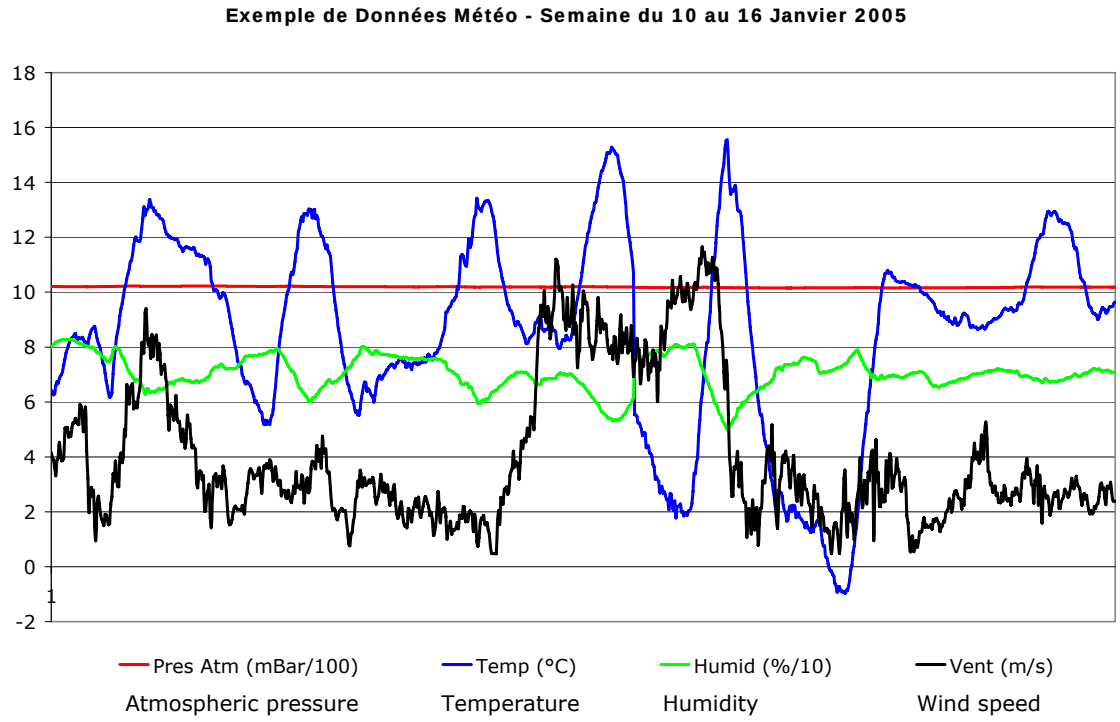
- recording of all the data every 2 seconds
- statistical processing on 1mn (average, standard deviation, min and max values)
- data recording in a computer file
- periodic visual inspection of the test site (any anomaly will be recorded and reported)
- in the event of change of equipment (measurement equipment or equipment under test) the test will be re-started
- data recorded under particular operating conditions (heavy rain, snow, ice…) will be validated in a special data base, the criteria of selection of the data will be specified in the measurement report
- throughout the measurement campaign, the data will be checked periodically to ensure the quality and the repetitiveness of the results
- a logbook will be maintained up to date on all the important events which have occurred during the measurement period
- all the data recorded during the periods of unavailability of the equipment under test will be ignored

4 Test site environmental data

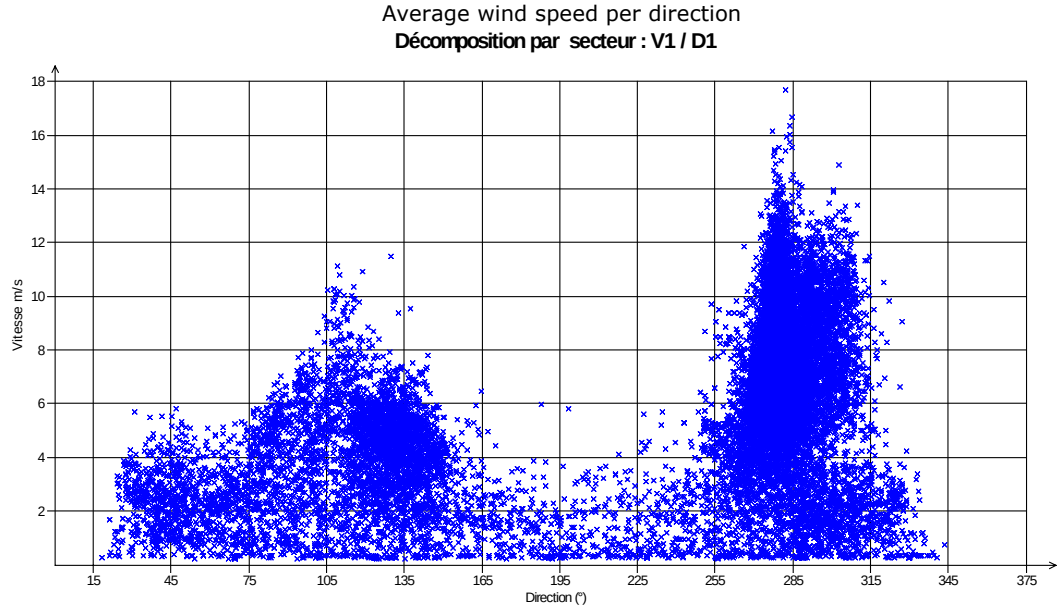
December 2004 to November 2005	Temperature (°C)	Relative Humidity (%)	Atmosph. Pressure (mBar)
Maximum	38.8	83	1029
Average	14.9	67	1011
Minimum	-6.3	33	988

December 2004 to Mars 2005	Wind Speed at 19m (m/s)		Wind Speed at 15m (m/s)
Maximum Gust	30.5	-	30.2
Max Average (1mn)	24.3	-	22.9
Average on the total duration	7.1	-	6.0
May 2005 to November 2005	Wind Speed at 20m (m/s)	Wind Speed at 18m (m/s)	Wind Speed at 16m (m/s)
Maximum Gust	26.4	25.9	25.4
Max Average (1mn)	17.7	17.4	16.8
Average on the total duration	-	5.7	5.6

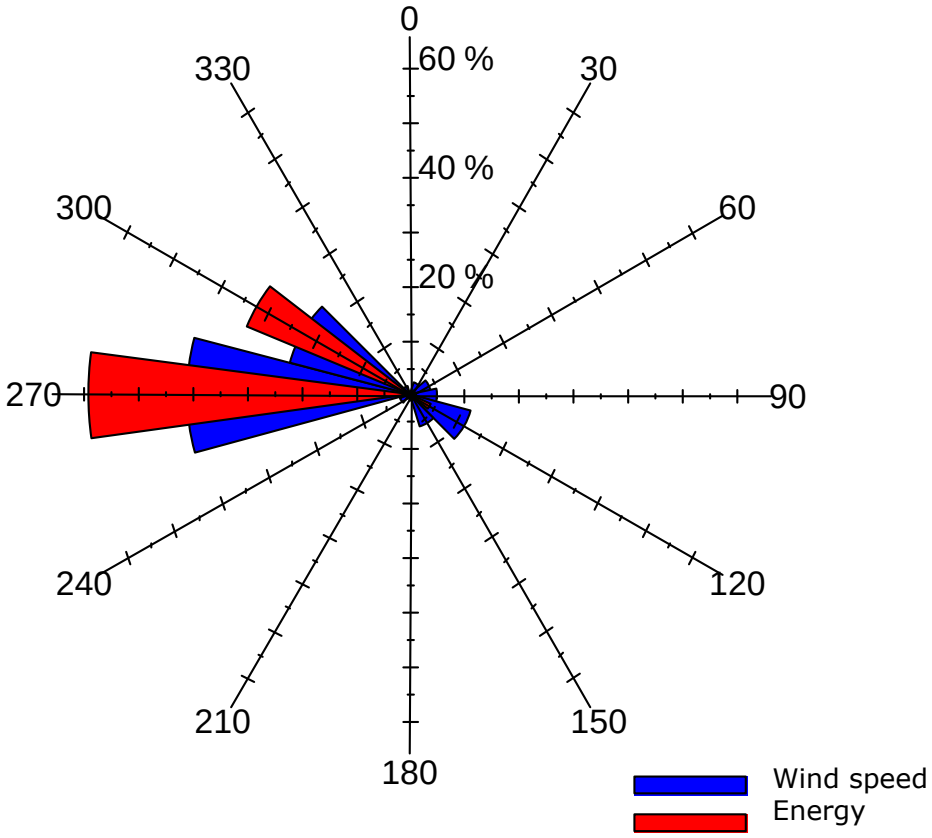
Example of environmental data – week from 10 to 16 January 2005



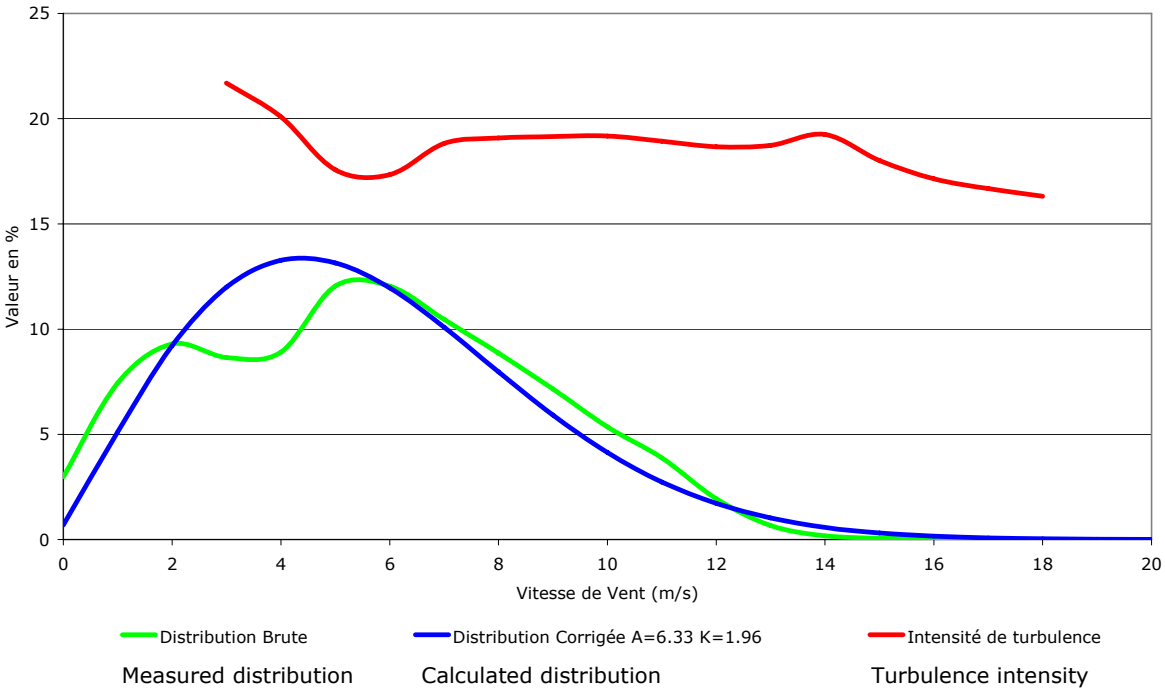
Average wind speed per direction



Wind speed and energy distribution



Wind speed distribution and turbulence intensity at 20m



5 Operation and safety tests

- tests objectives
    - to check that the wind turbine shows a operational behaviour in conformity with its design
    - to check that provisions related to people safety are correctly put in practice
    - to test that the control and protection systems are functioning with satisfaction
    - to check the good dynamic behaviour of the wind turbine with at least 1.8 times the wind speed corresponding to its nominal power output (data from manufacturer)

- operation and safety tests
    - observation of yawing at various wind speeds
        - yawing is satisfactory, straight and is well amortized (without jolts nor vibrations) whatever the wind speed
    - start-up and stop test sequences following the protocols recommended by the manufacturer
        - no possibility of manual intervention on the manufacturer charger to stop the wind turbine
    - checking of the generated power compared to the manufacturer data
        - the measured generated power with the complete system is lower than the data given by the manufacturer (approximately 220W at 8m/s for 300W announced)
    - checking of the rotor speed limitation
        - during strong winds, the rotor speed limitation per furling action is functioning correctly

- at low to medium wind speed, the rotor is facing the wind and is at right angle from the tail

- at high wind speed, the maximum power is limited automatically by side furling of the rotor (limitation of the rotor surface facing the wind)

- picture showing the different behaviour between a rotor furling and a blade pitching machine

- simulations of grid loss network (micro cut and normal cut)
  - test not applicable

- test of preventions against not authorized parameters system changes
  - test validated, no possibility of manual intervention on parameters

- checks of equipment and safety procedures (mechanical, electrical) for installation and maintenance
  - mechanical parts of the tower, nothing to report

- checking of the grounding system and lightning protection
  - it is essential to electrically connect to the ground all the mechanical parts of the tower

6 Reliability tests

- test objectives
    - to check structural integrity and temporal deterioration of the system, the components or the materials (cracks, deformations, wears…)
    - to check the quality of environmental protections (corrosion, paintings and joints …)
    - to check the dynamic behaviour of the wind turbine and its grid connection system over the test period

- reliability test
    - production for at least 1500 hours at unspecified wind speed
        - test validated
    - production lasting at least 250 hours at higher or equal wind speed of 1.2 times the wind speed corresponding to the nominal power output (data manufacturer data)
        - test validated
    - production lasting at least 25 hours at higher or equal wind speed of 1.8 times the wind speed corresponding to the nominal power output (data manufacturer data)
        - test validated
    - measured energy higher than 80% of expected energy (according to data manufacturer)
        - test not validated

7 Power curve measurement

- the data were recorded uninterrupted, with a sampling rate of two seconds:
    - wind speed at 16, 18 and 20m
    - wind direction at 16 and 20m
    - temperature on the ground
    - atmospheric pressure on the ground
    - relative humidity on the ground
    - active power at grid connection point (technical building)

- the data are sorted out by:
    - validated values compared to the sensor range
    - plausible values compared to the considered site
    - incomplete series on the 1mn measurement averaging period (30 data)
    - values outside the validated wind direction sector

To calculate validated wind direction sector for the measurement of each machine, it is necessary to take into account the neighbouring obstacles, which can be: another wind turbine, trees, measurements mast … The IEC61400-12 standard gives a calculation defining the disturbed sectors by neighbouring wind turbines according to their diameter and hub height.

Disturbed sector: $\alpha = 2\text{Arctan}(2Dn/Ln + 0.25)$

Where	Dn	is the diameter of the neighbouring machine
	Ln	is the distance between the 2 machines

This formula has been applied for each wind turbine tower position, the following table summarizes the characteristics of the obstacles taken into account, and the limits of the disturbed sectors calculated.

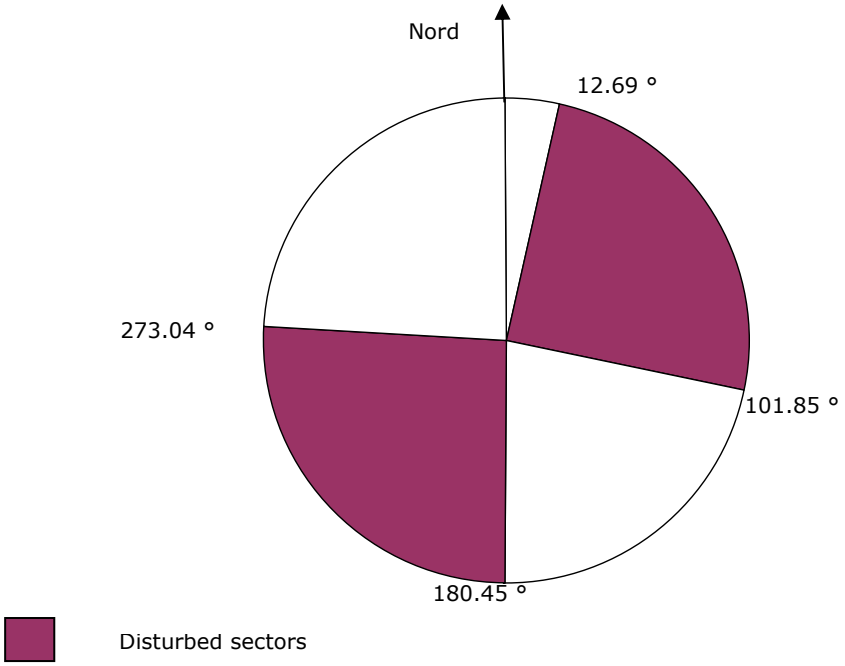
The height and the width of the obstacles other than the close machines (trees) not having been measured, the calculation was not applied for these obstacles. However, the final selected disturbed sectors are rather strongly penalizing, since they include in fact all the disturbed sectors of each machine, as represented on the following diagram.

One can notice that, compared to the Northern direction, the 2 large disturbed sectors correspond to the alignment of the 4 towers. The machines were installed so that they are facing undisturbed prevailing winds (wind of the North-West and wind of south-east).

The data processing software eliminates all the data with wind direction inside one of the 2 disturbed sectors.

Site	Obstacle	Diameter Dn	Distance Ln	Angle	Lower limit	Higher limit
1	Site 2	2.9 m	23.4 m	52.6°	12.7°	65.3°
1	trees	not calculated	not calculated	not calculated	not calculated	not calculated
2	Site 1	6.4 m	23.4 m	77.1°	180.5°	257.6°
2	Site 3	1.4 m	23.4 m	40.3°	41.8°	82.2°
3	Site 2	2.9 m	23.4 m	52.6°	215.7°	268.3°
3	Site 4	3.6 m	23.9 m	57.7 °	44.1°	101.9°
4	Site 3	1.4 m	23.9 m	40.1°	233°	273°
4	trees	not calculated	not calculated	not calculated	not calculated	not calculated

Summary table of the characteristics of the obstacles for the calculation of the disturbed sectors.



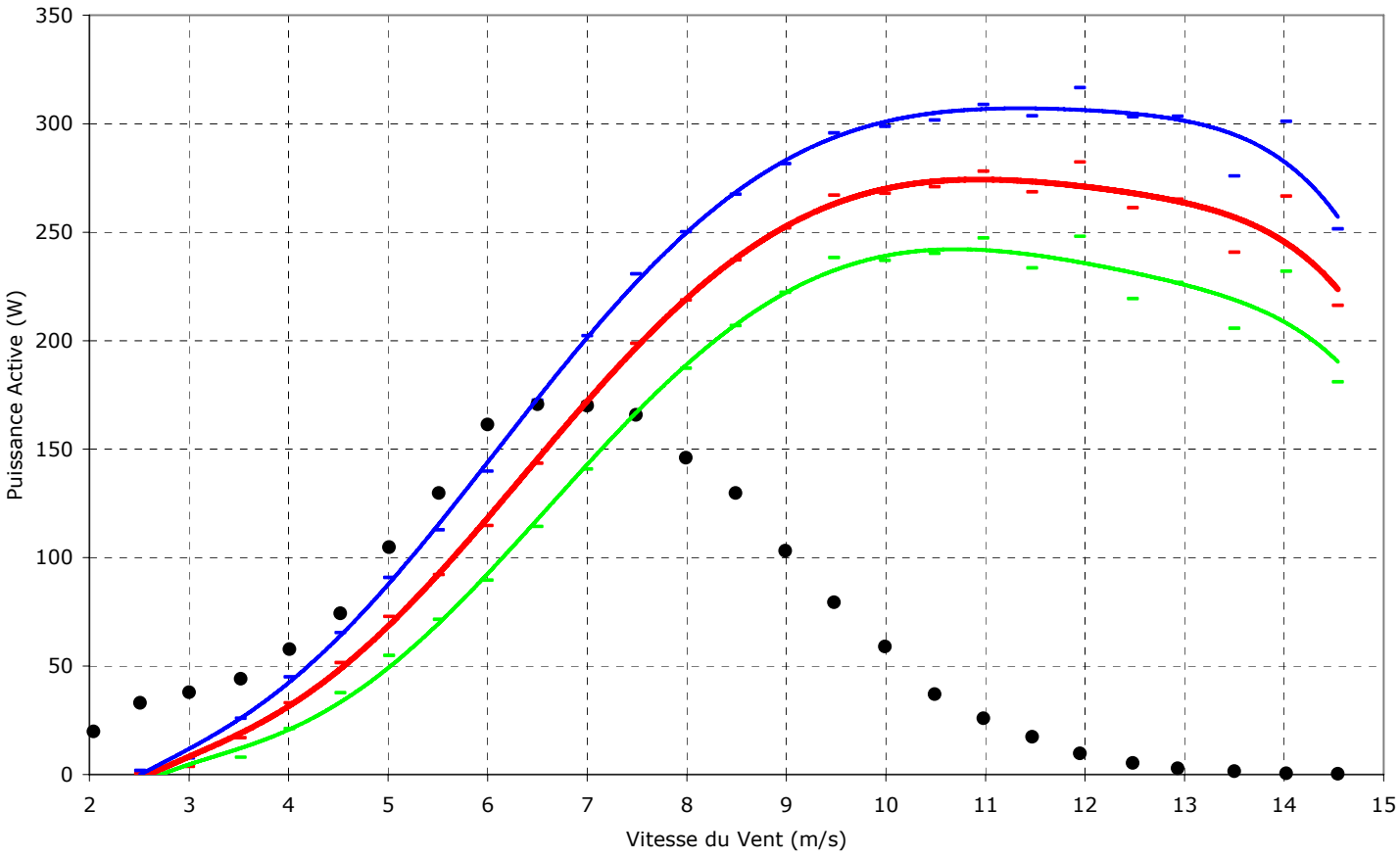
- the data are processed to extract the following information by 1mn steps:
    - average value
    - standard deviation
    - maximum value
    - minimum value

- the data are corrected according to the wind gradient

- the series are normalized for the average air density measured on the test site

- the power curve:
    - the normalized power curve is established according to the bin method (see standard IEC61400-12 §5.2)
    - the 0.5m/s bins are contiguous and aligned on the multiple of 0.5m/s
    - for each bin one records:
        - the number and values of the normalized wind speeds (representing the 1mn normalized averages)
        - the number and values of normalized active power (representing the 1mn normalized averages)
    - for each bin one calculates:
        - the total average the wind speed on the interval (total number of values divided by their number)
        - the total average of the power on the interval (total number of the values divided by their number)

- measured power curve
    - in blue power curve plus ½ standard deviation
    - in red power curve
    - in green power curve minus ½ standard deviation
    - in black number of measurement points divided by 10



- the measured generated power curve measured with the complete battery charging system is slightly lower than the data given by the manufacturer (around 220W at 8m/s for 300W announced)

- the measured power curve limitations appears at around 280W

8 Acoustic noise measurements

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Acoustic Noise Measurements

Summary

- **Objectives**
- **Principle**
- **Measurements**
- **Analysis**
- **Conclusion**

Date: 9 March 2007

- **Objectives**

Our intervention aims at specifying the acoustic impact of wind turbine on the environment. The selected site is the small wind turbine test site of Montplaisir in Narbonne.

- **Principle**

The site of Montplaisir comprises 4 positions which receive 4 small wind turbines simultaneously. The figure in the following pages specifies the relative position of the towers of the wind turbines.

The analysis of this noise impact is done with reference to the French law text of April 18, 1995, decree 95-408 "Limitation of the neighbourhood noises". It fixes values of emergence not to be exceeded: 5 dB (A) during day time (7am to 10pm) and 3 dB (A) during night time (10pm to 7am). Emergence being the difference in noise levels recorded when the machine is operating (ambient noise) and when the machine is not operating (residual noise).

For each tower, or for each wind turbine installed on the towers, we considered 4 measurement points (points numbered 1, 3, 5, 7) respectively located at distances of 5m, 10m, 20m and 35m of the tower. For each one of these points we recorded the ambient noise and the residual noise, and by calculating the difference between the 2, we determined emergence.

The records, of either ambient noise or residual noise for one point of analysis, consisted in carrying out five records of 10sec during one period of 5mn.
These measurements of 10sec are carried out through an analysis in frequency whose base is the third of octave.

The study is carried out tower after tower. With only one wind turbine functioning at the site at any one time, we measured its four characteristic points, the ambient noise, then we stopped the wind turbine to measure for these four points the level of residual noise. This procedure has been repeated for the three other wind turbines.

With these noise measurements are associated wind speed measurements recorded with an anemometer placed on a metrological mast located at the centre of the site.

In order to be able to appreciate the variability of the sound level of the wind turbines, we proceeded to 3 series of measurement at 3 different times (different days). By measurement campaign we define a characterization of all measurement points of the site for ambient noise and residual noise, at a given day.

- **Measurements**

Equipment used: Real time noise analyzer CESVA, standard RC-401.

Measurement campaign:

Wind Turbine	**Mast**	**Series of measurements**		
		13/02/2007 8H00	13/02/2007 11H00	13/02/2007 16H00
FD2.5-300	3	X	X	X

- **Analysis**

The three campaigns correspond to three wind configurations: for the 2 first campaigns the wind came systematically from North West (offshore), for the last campaign the wind came from south-east (onshore). At the time of the first campaign, we can regard the wind speed as medium (between 10 and 15m/s). During the second and third campaign, it was low (between 5 and 10m/s).

The strength of the wind has an immediate impact on the perceived residual noise, depending on the neighbouring highway circulation, but especially depending on the surrounding vegetation (presence of pine trees and vegetation of the scrubland type).

We see that the residual noise varies from 55dBA to 40dBA, in general the residual noise is more important on the peak (position 1 and 3) that on the slope of the test site (positions 5 and 7), fact more valid when the wind is offshore (the hill of the site has a filtering effect for noise coming from the A61 highway).

During onshore winds, the A9 highway and the national road are the 2 main sources of noise, and the topography of the site does not filter this noise, the site is in direct line of sight from these roads. The greater distance of the site from these roads highlight the damping effect of the atmosphere which has more effect on high frequencies (2000 and 4000Hz), the measured curves are well defined with a upper limit at 1000Hz, then the noise level is decreasing rapidly for higher frequencies.

FD2.5-300 wind turbine

Point 1

We notice a strong noise increase (more than 10dBA) specially for frequencies above 1250Hz, this noise increase is higher than the legal level for wind speed around 6m/s.

For lower wind speeds (between 3 and 5 m/s) and for a residual noise level of 50dBA, the noise increase is within the legal limit, but noticeable.

Comparing the all the results it appears that the noise level of this wind turbine is varying a lot with the wind speed.

Point 3

Same as for point 1, strong noise increase for wind speed around 6m/s.

For campaign 2, the increase of noise level is within the legal limit (below 3dBA) but with higher increase in the high frequencies (2000 and 4000 Hz), making it noticeable.

For onshore winds at around 3m/s, the wind turbine noise is less noticeable.

Point 5

The noise increase is above legal limit for the first 2 campaigns, due to the wind turbine and the measuring point away and hidden from the highway by the small hill.

Point 7

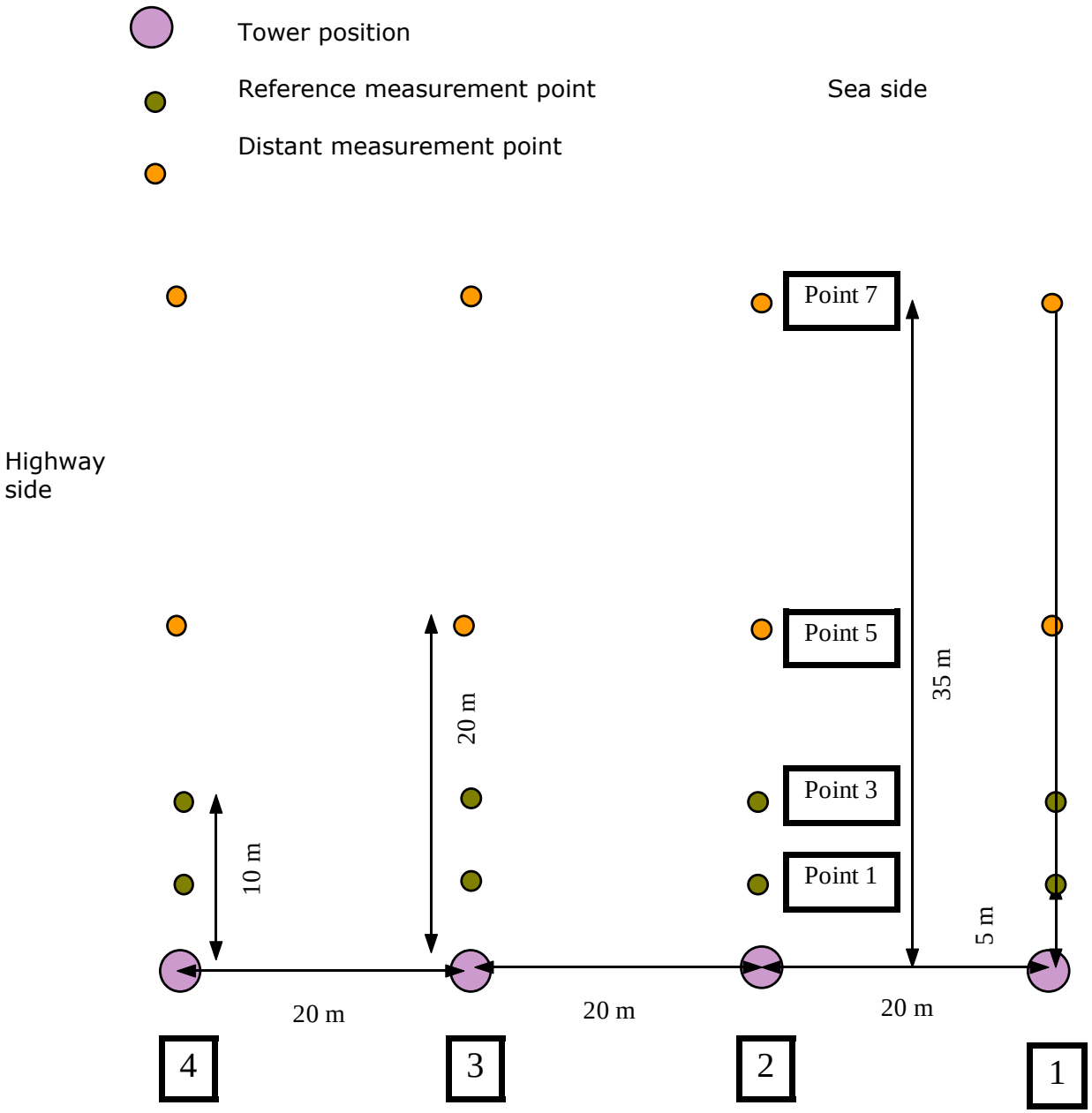
With low ambient noise level, the noise increase above the legal limit is noticeable due to the high frequencies of the spectrum.

With ambient noise level at around 48dBA, during campaign 3, for this distance higher than 30m, the noise level increase is within the legal limit.

- **Conclusion**

This second measurement series allowed validating the measurement procedure used on the test site, which highlighted certain site characteristics (interesting for measurement possibilities): offshore or onshore winds, great variation of the residual noise depending on the direct or indirect relation between the measurements points and the highways.

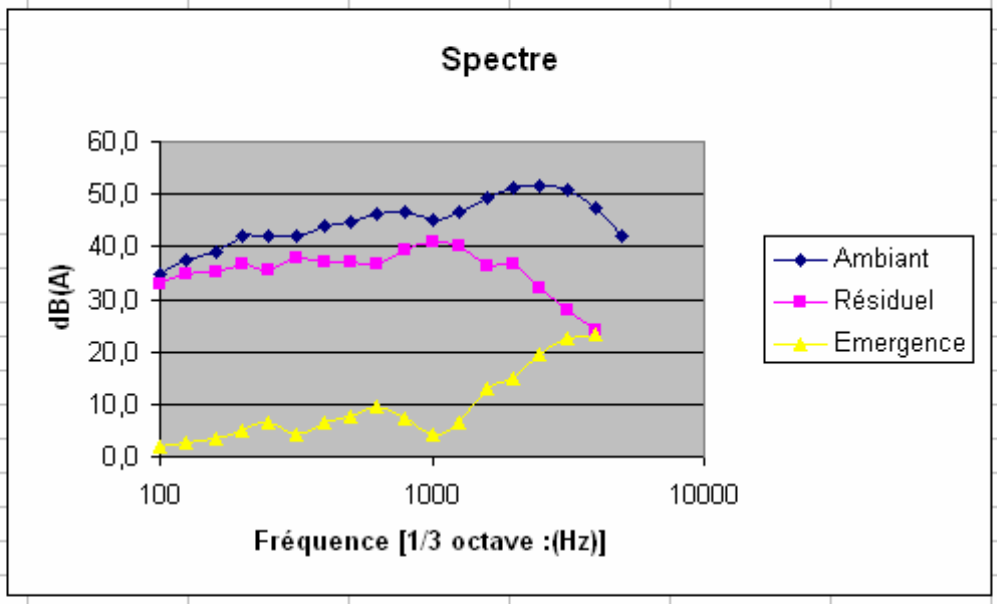
This type of investigation makes it possible to practically apprehend the sound emission of wind turbines within the framework of their environmental impact.



Measurement Point Positions

Point N°1

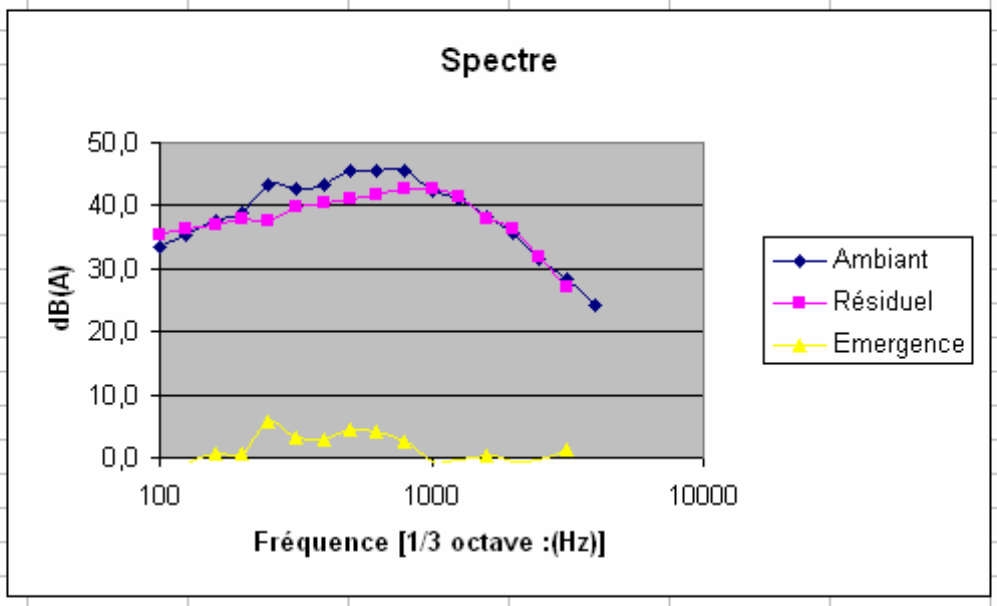
Date :	13/02/2007	Campagne	1



1/3 Octave	Ambiant	Résiduel	Emergence
100	34,8	32,8	2,0
125	37,6	34,9	2,7
160	38,8	35,2	3,6
200	41,9	36,8	5,1
250	42,1	35,6	6,5
315	42,1	37,8	4,3
400	43,9	37,2	6,7
500	44,7	36,9	7,8
630	46,2	36,7	9,5
800	46,7	39,4	7,3
1000	45,1	40,9	4,2
1250	46,7	40,2	6,5
1600	49,4	36,3	13,1
2000	51,4	36,5	14,9
2500	51,6	32,1	19,5
3150	50,7	28,0	22,7
4000	47,4	24,2	23,2
5000	42,0	0,0	0,0
Global	59,2	49,0	10,2

Vent m/s	6,6	6,8

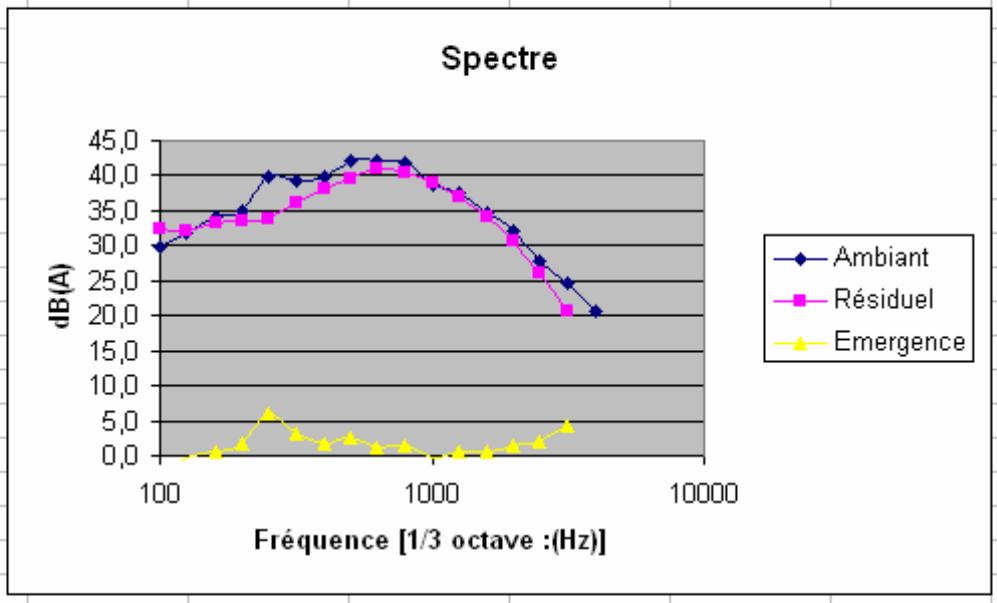
Date :	13/02/2007	Campagne	2



1/3 Octave	Ambiant	Résiduel	Emergence
100	33,3	35,4	-2,1
125	35,5	36,4	-0,9
160	37,6	37,1	0,5
200	38,7	38,0	0,7
250	43,3	37,6	5,8
315	42,8	39,8	3,1
400	43,4	40,6	2,8
500	45,6	41,1	4,6
630	45,7	41,7	4,0
800	45,5	42,8	2,7
1000	42,2	42,8	-0,5
1250	41,1	41,4	-0,3
1600	38,3	38,1	0,3
2000	35,8	36,5	-0,6
2500	31,5	31,9	-0,4
3150	28,3	27,1	1,2
4000	24,2	0,0	0,0
5000	0,0	0,0	0,0
Global	53,7	51,6	2,1

Vent m/s	4,3	3,6

Date :	13/02/2007		Campagne	3

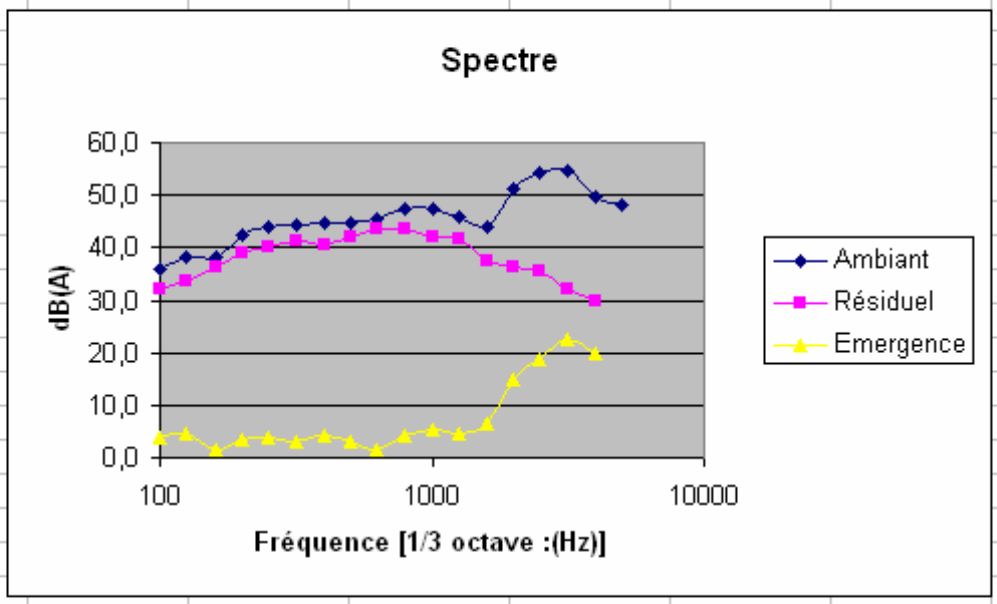


1/3 Octave	Ambiant	Résiduel	Emergence
100	29,7	32,3	-2,6
125	31,9	32,2	-0,3
160	34,0	33,3	0,7
200	35,1	33,5	1,6
250	39,7	33,8	5,9
315	39,2	36,0	3,2
400	39,8	38,2	1,6
500	42,0	39,5	2,5
630	42,1	41,0	1,1
800	41,9	40,5	1,4
1000	38,6	38,9	-0,3
1250	37,5	36,9	0,6
1600	34,7	34,1	0,6
2000	32,2	30,7	1,5
2500	27,9	26,0	1,9
3150	24,7	20,5	4,2
4000	20,6	0,0	0,0
5000	0,0	0,0	0,0
Global	50,1	48,5	1,6

Vent m/s	-3,3	-2,9

Point N°3

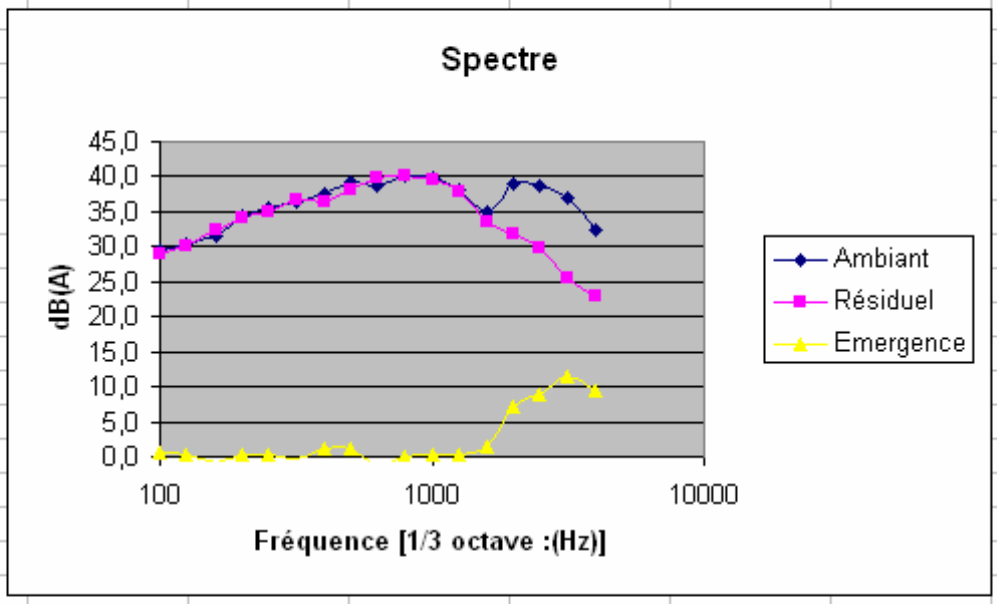
Date :	13/02/2007		Campagne	1



1/3 Octave	Ambiant	Résiduel	Emergence
100	36,1	32,1	3,9
125	38,2	33,6	4,6
160	38,1	36,4	1,6
200	42,3	38,9	3,4
250	43,8	40,0	3,8
315	44,3	41,3	3,0
400	44,6	40,4	4,2
500	44,8	41,9	2,9
630	45,3	43,6	1,7
800	47,5	43,5	4,0
1000	47,3	42,1	5,2
1250	46,1	41,5	4,6
1600	43,9	37,3	6,5
2000	51,3	36,2	15,1
2500	54,2	35,6	18,6
3150	54,6	32,2	22,4
4000	49,7	29,6	20,0
5000	48,2	0,0	0,0
Global	60,8	52,0	8,8

Vent m/s	6	6,3

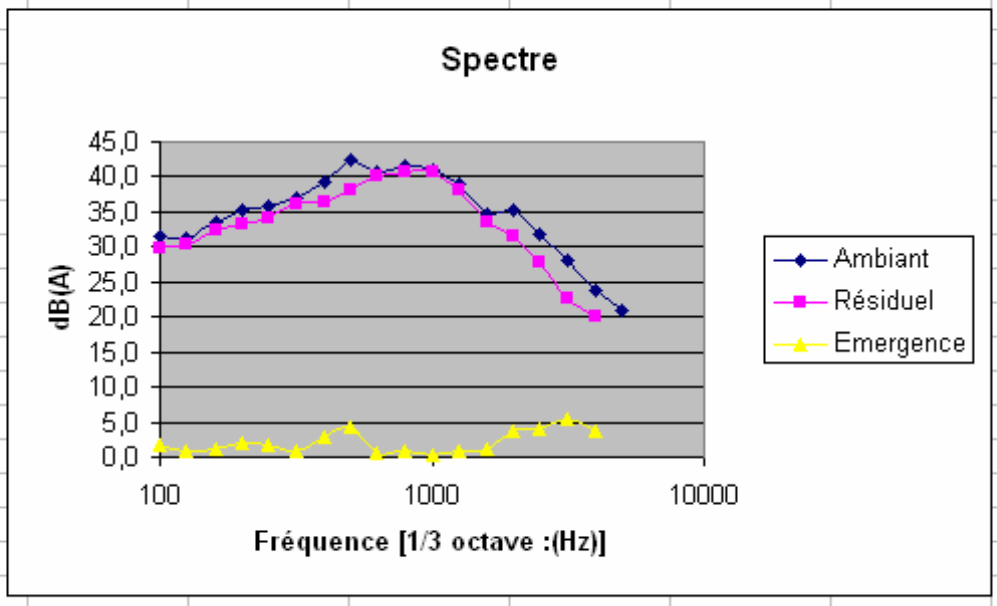
Date :	13/02/2007		Campagne	2



1/3 Octave	Ambiant	Résiduel	Emergence
100	29,5	29,0	0,5
125	30,3	30,1	0,3
160	31,5	32,5	-1,0
200	34,5	34,2	0,3
250	35,5	35,1	0,4
315	36,3	36,7	-0,4
400	37,6	36,5	1,1
500	39,3	38,0	1,2
630	38,6	39,8	-1,2
800	40,1	40,1	0,0
1000	39,8	39,5	0,3
1250	38,2	37,8	0,3
1600	35,0	33,4	1,5
2000	39,0	31,9	7,1
2500	38,7	29,7	8,9
3150	37,1	25,5	11,6
4000	32,4	23,0	9,5
5000	0,0	0,0	0,0
Global	51,0	48,2	2,8

Vent m/s	3,7	3

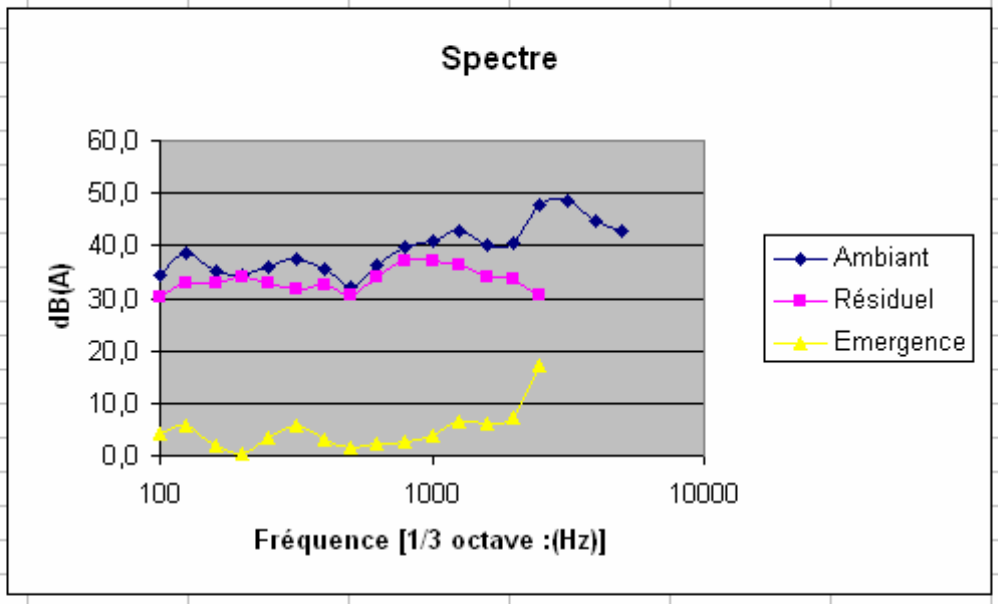
Date :	13/02/2007		Campagne	3



1/3 Octave	Ambiant	Résiduel	Emergence
100	31,6	29,7	1,9
125	31,2	30,4	0,8
160	33,6	32,4	1,2
200	35,3	33,3	2,0
250	36,0	34,1	1,9
315	37,1	36,1	1,0
400	39,3	36,5	2,8
500	42,5	38,1	4,4
630	40,6	40,0	0,6
800	41,5	40,6	0,9
1000	41,0	40,7	0,3
1250	39,0	38,1	0,9
1600	34,8	33,5	1,3
2000	35,4	31,5	3,9
2500	31,9	27,8	4,1
3150	28,2	22,7	5,5
4000	23,9	20,2	3,7
5000	21,0	0,0	0,0
Global	49,9	48,3	1,6
Vent m/s	-3,4	-3,4	

Point N°5

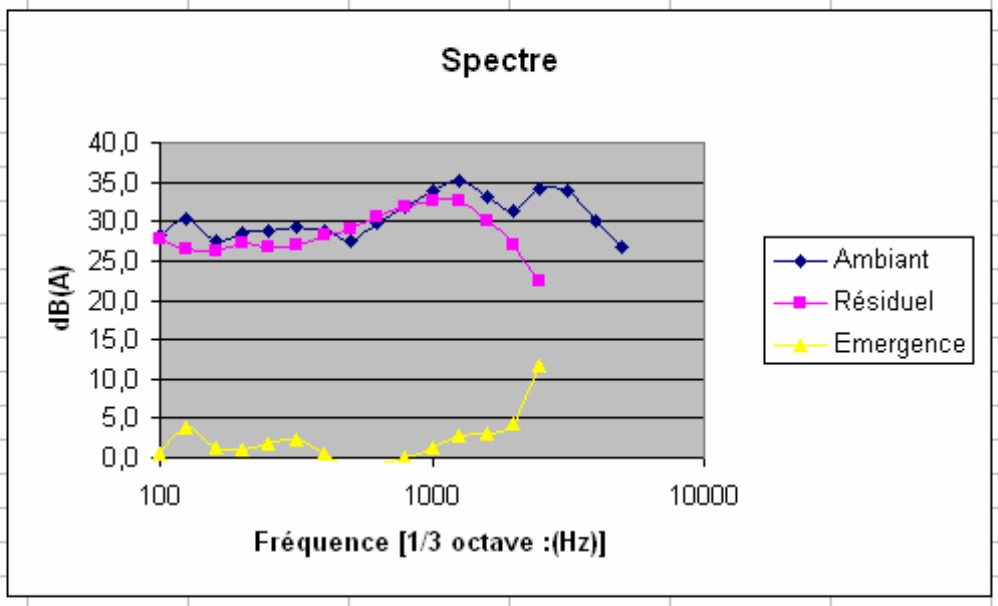
Date :	13/02/2007		Campagne	1



1/3 Octave	Ambiant	Résiduel	Emergence
100	34,4	30,0	4,3
125	38,5	32,7	5,8
160	35,0	33,0	2,0
200	34,3	33,8	0,4
250	36,1	32,8	3,3
315	37,4	31,7	5,6
400	35,7	32,5	3,2
500	32,1	30,7	1,4
630	36,3	34,1	2,2
800	39,9	37,2	2,7
1000	41,1	37,2	3,8
1250	42,7	36,1	6,6
1600	40,1	34,1	6,0
2000	40,7	33,5	7,1
2500	47,8	30,4	17,4
3150	48,6	0,0	0,0
4000	44,8	0,0	0,0
5000	42,8	0,0	0,0
Global	54,5	45,7	8,8

Vent m/s	5,9	5,6

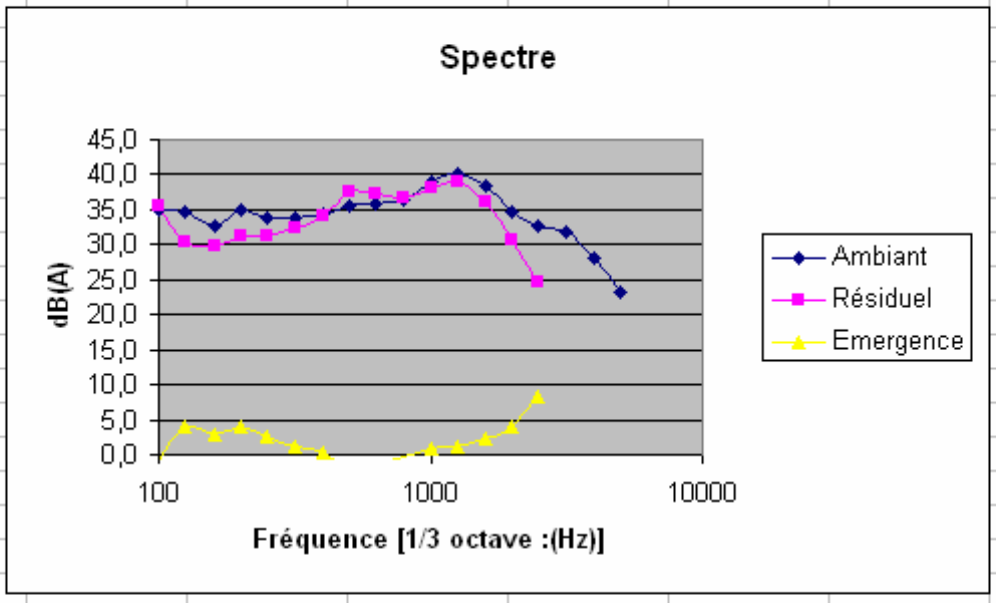
Date :	13/02/2007	Campagne	2



1/3 Octave	Ambiant	Résiduel	Emergence
100	28,4	27,7	0,6
125	30,3	26,5	3,8
160	27,6	26,3	1,3
200	28,4	27,4	1,1
250	28,7	26,8	1,8
315	29,3	27,0	2,3
400	28,8	28,2	0,5
500	27,5	29,1	-1,5
630	29,9	30,7	-0,8
800	31,9	31,9	0,0
1000	33,8	32,6	1,2
1250	35,2	32,5	2,7
1600	33,0	30,1	2,9
2000	31,4	27,0	4,4
2500	34,1	22,4	11,6
3150	33,9	0,0	0,0
4000	30,1	0,0	0,0
5000	26,8	0,0	0,0
Global	45,0	41,2	3,8

Vent m/s	2,8	2,3

Date :	13/02/2007	Campagne	3

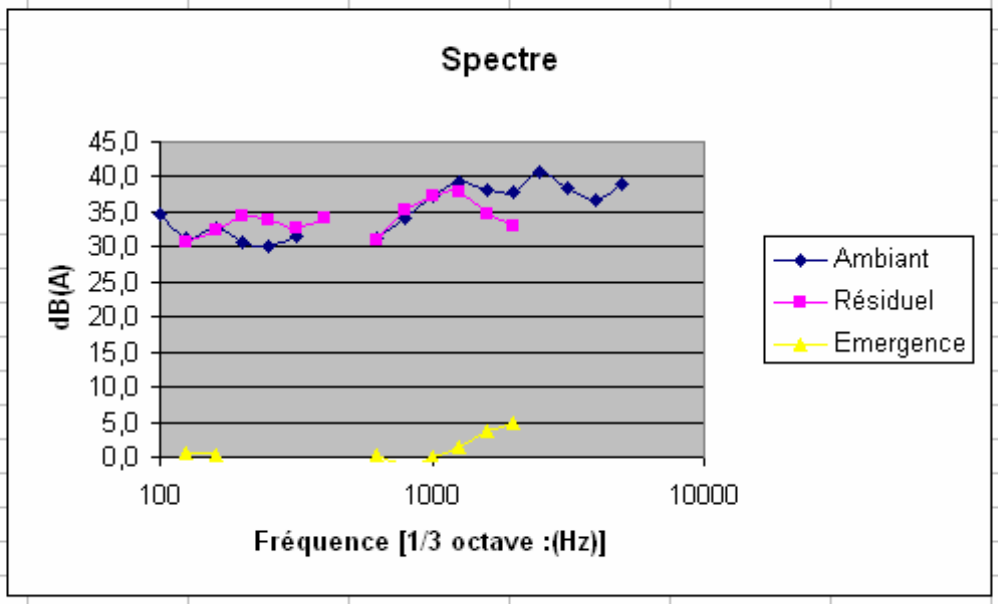


1/3 Octave	Ambiant	Résiduel	Emergence
100	34,9	35,6	-0,8
125	34,6	30,5	4,1
160	32,7	29,8	2,9
200	35,1	31,1	4,0
250	33,8	31,1	2,7
315	33,7	32,5	1,2
400	34,3	34,1	0,2
500	35,5	37,6	-2,2
630	36,0	37,4	-1,5
800	36,4	36,7	-0,3
1000	39,1	38,2	0,8
1250	40,2	39,1	1,1
1600	38,4	36,2	2,2
2000	34,7	30,6	4,1
2500	32,8	24,6	8,2
3150	31,7	0,0	0,0
4000	28,0	0,0	0,0
5000	23,3	0,0	0,0
Global	48,0	46,9	1,1

Vent m/s	-3,1	-2,2

Point N°7

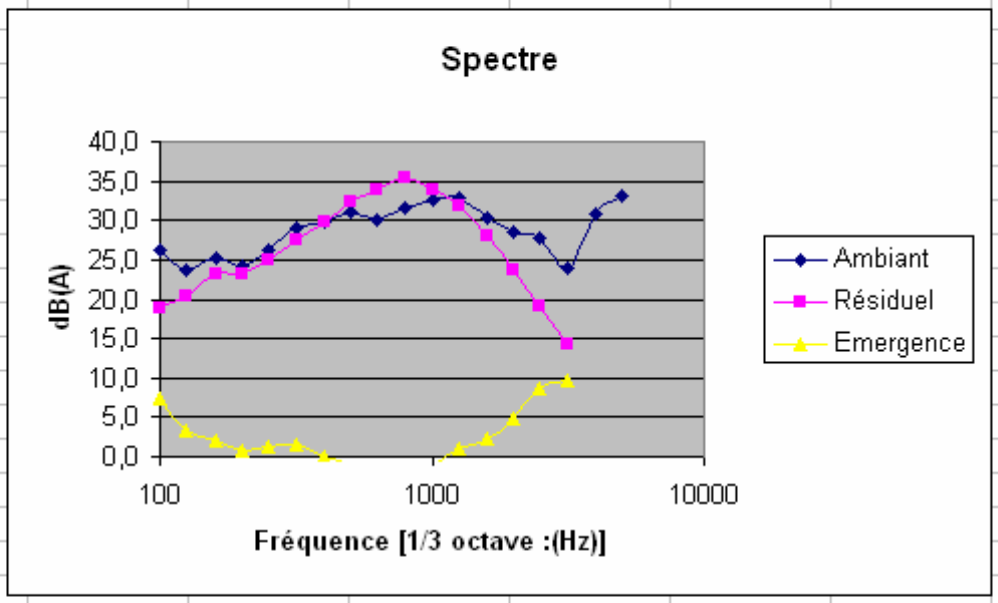
Date :	13/02/2007		Campagne	1



1/3 Octave	Ambiant	Résiduel	Emergence
100	34,6	0,0	0,0
125	31,3	30,7	0,6
160	32,7	32,4	0,4
200	30,7	34,4	-3,7
250	30,2	34,0	-3,8
315	31,5	32,8	-1,3
400	0,0	34,1	0,0
500	0,0	0,0	0,0
630	31,1	30,9	0,3
800	34,1	35,2	-1,1
1000	37,2	37,2	0,0
1250	39,4	38,0	1,5
1600	38,3	34,6	3,7
2000	37,8	33,0	4,8
2500	40,8	0,0	0,0
3150	38,4	0,0	0,0
4000	36,6	0,0	0,0
5000	39,0	0,0	0,0
Global	48,0	45,2	2,8

Vent m/s	4,9	5,7

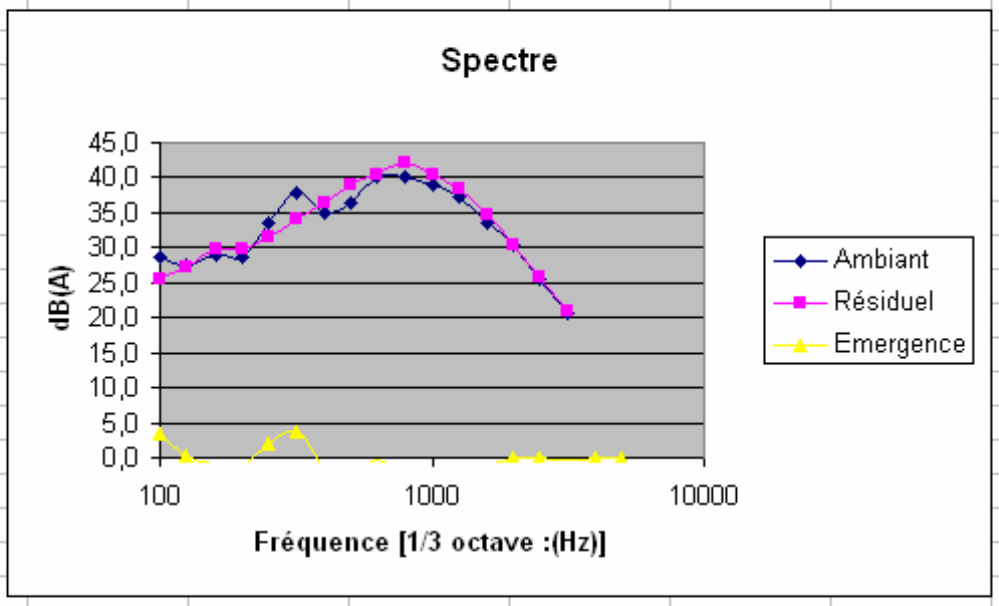
Date :	13/02/2007	Campagne	2



1/3 Octave	Ambiant	Résiduel	Emergence
100	26,1	18,8	7,3
125	23,8	20,5	3,3
160	25,3	23,2	2,1
200	24,2	23,3	0,9
250	26,4	25,0	1,4
315	29,1	27,5	1,6
400	29,8	29,8	0,0
500	31,1	32,4	-1,3
630	30,1	33,9	-3,8
800	31,6	35,4	-3,9
1000	32,5	33,9	-1,4
1250	32,8	31,8	1,0
1600	30,3	28,0	2,3
2000	28,5	23,7	4,8
2500	27,7	19,1	8,6
3150	24,0	14,3	9,7
4000	30,8	0,0	0,0
5000	33,2	0,0	0,0
Global	42,2	41,8	0,4

Vent m/s	3,8	4,7

Date :	13/02/2007		Campagne	3



1/3 Octave	Ambiant	Résiduel	Emergence
100	28,8	25,4	3,4
125	27,4	27,1	0,3
160	29,0	29,8	-0,8
200	28,7	29,9	-1,2
250	33,6	31,6	2,0
315	37,8	34,1	3,7
400	35,1	36,4	-1,3
500	36,4	39,0	-2,6
630	40,2	40,5	-0,3
800	40,1	42,0	-1,9
1000	39,0	40,5	-1,5
1250	37,3	38,4	-1,1
1600	33,5	34,6	-1,1
2000	30,4	30,3	0,1
2500	25,6	25,7	-0,1
3150	20,7	20,9	-0,2
4000	0,0	0,0	0,0
5000	0,0	0,0	0,0
Global	47,5	48,4	-0,9
Vent m/s	-3	-4,3	

9 Measurements of power quality

- General data

The impedance of the electrical supply network at the point of injection is to be determined.

Measurements carried out correspond to the standard EN 50160 (Characteristics of the power provided by the public distribution network). The object of this standard is to provide and describe the values characterizing the supply voltage provided such as:

- the frequency,
- the voltage amplitude,
- the form of the wave,
- the symmetry of the three-phase voltages.

- Measurement not applicable