RECOMMENDED PRACTICES FOR WIND TURBINE TESTING AND EVALUATION

12. CONSUMER LABEL FOR SMALL WIND TURBINES

1. EDITION 2011

Submitted to the Executive Committee of the International Energy Agency Implementing Agreement for Co-operation in the Research, Development, and Deployment of Wind Energy Systems

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FOREWORD

Development of internationally agreed procedures for testing and evaluation in the field of small wind energy are needed to aid the development of the industry, to strengthen confidence in the technology and to prevent chaos in the market.

In the past, the International Energy Agency Implementing Agreement for Co-operation in the Research, Development, and Deployment of Wind Energy Systems (IEA Wind) has many times provided contributions to the development and deployment of wind turbines by publishing Recommended Practices, before an International Electro-Technical Commission (IEC) standard exists for a certain technical area. With this new Recommended Practice, developed in liaison between IEA Wind Task 27 Development and Deployment of Small Wind Turbine Labels for Consumers and IEC TC88 MT2, a method for consumer labelling of small wind turbines has been developed. In the future, the plan is that a similar method for consumer labelling will be part of IEC 61400-2 Ed. 3.

IEA Wind Task 27 also aims to do further work regarding small wind research topics (small wind turbines in urban environments, other wind conditions, wind pump system testing, validation of simplified equations for vertical axis wind turbines [VAWT], etc.) and the formation of a Small Wind Association of Testers (SWAT), in order to improve the labelling system, testing of small wind turbines and related standards.

This Recommended Practice was agreed in consensus by the IEA Wind Task 27 working group at the meeting in Madrid, Spain, on the 4 March 2011. It was adopted by the IEA Wind Executive Committee by electronic ballot on 22 June 2011.

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INTRODUCTION

As the market for small wind turbines increases it was recognised that consumers have a need to easily compare the different products available in the market. IEA Wind Task 27 was tasked to develop a consumer label and its objective during this work has been to address the following issues:

- Provide information that is relevant to the consumer when making purchase decisions (estimated energy output, indicator of durability, acoustic parameters);
- Summarise the detailed test results to comparable metrics;
- Encourage high quality testing by having the label based on international standards and systems; and
- Provide the consumer labels and test summary reports on the internet.

One of the main results of IEA Wind Task 27 is this Recommended Practice, describing a method for producing the IEA Wind Consumer Label for Small Wind Turbines. It is an international label, which presents test results based on IEC standards in a condensed and comparable form, regardless of where the testing has been conducted.

During the consensus development of this consumer labelling methodology, we have strived to be consistent with the American Wind Energy Association's (AWEA) and the British Wind Energy Association's (BWEA) methods for comparable energy performance ratings.

Apart from the consumer label described in this Recommended Practice, the wind turbine may also have a type certificate, which means that testing, structural safety and compliance with standards in the IEC 61400 series has been reviewed by an accredited 3rd party certification organization. This is normal practice for large wind turbines. At the time of this writing, an increasing number of small wind turbines are going through international and/or national certification. Certification is an excellent complement to the IEA Wind Consumer Label for Small Wind Turbines, and testing can normally be done at the same time for both certification and labelling. Certification involves a more thorough review of calculations etc. The improvement with this Recommended Practice is an international system for consumer labelling, which has not been available before. Since national rules often apply to building permits and grid connection, it has not been possible to cover those aspects with an international consumer label. Within this Recommended Practice there is a section on interpretation of the label.

The target audience for this Recommended Practice is mainly wind turbine manufacturers, test organisations and authorities involved in the small wind turbine sector.

RECOMMENDED PRACTICE FOR CONSUMER LABELLING OF SMALL WIND TURBINES

1. GENERAL

This Recommended Practice describes a consumer label, hereafter called a label. If a label looking similar to the label in this document is provided, the entire instructions given in this document shall be followed.

It is recommended that a label be provided for each small wind turbine model. The label is based on tests conducted per the relevant IEC standards on one or more individual wind turbines (same model but different serial numbers), and can then be used for wind turbines of the same fundamental design.

The label can be shown on shipping containers, packaging, the turbine itself, operation and maintenance manuals and marketing literature related to that wind turbine model. The Task 27 section of the www.ieawind.org web site (or its successors) will show all of the labels granted in accordance with this Recommended Practice and can thus be used to ensure the validity of the label itself.

1.1 Scope and field of application

This Recommended Practice is applicable to those wind turbines covered by the latest edition of IEC 61400-2, presently 2nd edition, "Design requirements for small wind turbines". According to the 2nd edition of that standard, published in 2006, the standard applies to wind turbines with a rotor swept area smaller than 200 m^2, generating at a voltage below 1 000 V a.c. or 1 500 V d.c.

Wind turbines with an output power form that is not electrical, such as mechanical wind pumps, are outside the scope of this edition of the Recommended Practice.

1.2 Definitions

For definitions, refer to the applicable IEC standards 61400-2, 61400-11, 61400-12-1 and 61400-14.

In the absence of definitions in the relevant IEC standard, the following definitions shall be used:

declared sound power level
The declared apparent sound power level in dB(A) at a wind speed of 8 m/s as measured per IEC 61400-11 and as calculated per IEC 61400-14.

maximum output current (for wind turbine systems)
Maximum current (a.c. or d.c.) that can be taken from the connection facilities of the wind turbine system and which shall be specified as a 600 s average value, i_{600}, a 60 s average value, i_{60} and as a 0,2 s average value, $i_{0,2}$.

maximum output power (for wind turbine systems)
Maximum power (a.c. or d.c.) that can be taken from the connection facilities of the wind turbine system and which shall be specified as a 600 s average value, P_{600}, a 60 s average value, P_{60} and as a 0,2 s average value, $P_{0,2}$.

maximum output voltage (for wind turbine systems)
Maximum voltage (a.c. or d.c.) that will be produced at the connection facilities of the wind turbine system and which shall be specified as a 600 s average value, U_{600}, a 60 s average value, U_{60} and as a 0,2 s average value, $U_{0,2}$.

reference annual energy
The calculated total energy that would be produced during a one-year period at an average wind speed of 5.0 m/s at hub height, assuming a Rayleigh wind speed distribution, 100% availability, and the power curve derived from IEC 61400-12-1, where it is referred to as "Annual Energy Production" (AEP). The AEP from IEC 61400-12-1 is either the "AEP-measured" or the "AEP-extrapolated"; and is either "sea-level normalised" or "site-specific". Within this document reference annual energy is AEP-measured and sea-level normalised.

2. ADMINISTRATION

An organisation that publishes a label is below called the labelling organisation. The intention is that results displayed on a label will be comparable to results on other labels, regardless of who publishes the label. Therefore it is necessary that the labelling organisation must at all times act in an objective manner.

2.1 Test summary report

The labelling organisation publishes a test summary report. The test summary report shall have the following minimum contents, which may be achieved by publishing the full measurement reports:

1. Name of labelling organisation, publication date of test summary report and unique test summary report number with current revision number
2. A photograph of the turbine tested
3. The wind turbine specification provided by the manufacturer (see Appendix A)
4. The name and contact information of the manufacturer
5. The tested turbine configuration, as verified by the test organisation including as a minimum:
    a. model name and serial number;
    b. support structure;
    c. hub height;
    d. general description of main components;
    e. rotor diameter (m) (if applicable);
    f. swept area (m^2);
    g. number of blades;
    h. upwind or downwind rotor (if applicable);
    i. VAWT or HAWT or other;
    j. direction of rotation;
    k. cut-in wind speed (m/s);
    l. cut-out wind speed if observed (m/s);

m. observed max 3 sec gust during duration test (m/s);

n. power form; and

o. observed ambient temperature range during duration test (°C).

6. Power curve and annual energy production (see Appendix B for recommended format)
7. Measured and declared sound power level, plus immission noise map (see Appendix B)
8. Duration test results (see Appendix B) and turbine test class
9. References to measurement reports with, as a minimum, the originating organisation, date issued, and unique report number
10. A short description of how the requirements of ISO/IEC 17025 and relevant standards used to define the test requirements (e.g. IEC 61400-12-1) have been fulfilled, stating as a minimum whether any accredited test organisations were involved.

2.2 Publication of labels

When the labelling organisation deems that the requirements for labelling stated in this document are fulfilled they will publish the test summary report and a copy of the label on the web URL described in section 4 below. The labelling organisation shall obtain written consent from the manufacturer to do this.

2.3 Wind turbine variants

Wind turbines can appear in different variations. Therefore, the label and all documentation in relation to that needs to clearly indicate which variant refers to.

3. TESTS FOR LABELLING

The label summarises the results of the following three tests, which are to be documented in measurement reports that meet the requirements of ISO/IEC 17025:

- Duration test per IEC 61400-2;
- Power performance test per IEC 61400-12-1; and
- Acoustic noise test per IEC 61400-11.

The editions of the IEC standards listed in the reference section below, or later valid editions, shall be used. However, the use of latest editions is highly recommended. The latest edition of the standards can be found at www.iec.ch or any national standardisation body.

It is recommended that all tests for a particular label are carried out on the same site, by the same test organisation and using one wind turbine (i.e. one serial number). Deviations from this principle are allowed only if this is clearly stated in the test summary report (with a detailed description of the circumstances, such as different serial numbers used) and, if more than one wind turbine is used, it is assured that they are essentially the same. It is, for example, not allowed to test power performance with one set of blades configured for maximum power production, and test for noise with another set of blades designed for minimum noise.

3.1 Duration test

On the label the “Turbine Test Class” shall show the small wind turbine (SWT) class for which the duration test has been completed in accordance with IEC 61400-2.

3.2 Power curve and reference annual energy

A power curve shall be measured in accordance with the small wind turbine annex of IEC 61400-12-1. The corresponding reference annual energy shall be displayed as “Reference Annual Energy” on the label.

3.3 Acoustic noise test

An acoustic noise test shall be conducted in accordance with IEC 61400-11. For the label only the apparent sound power level at 8 m/s at hub height will be used. The IEC 61400-14 is then used to convert the measured sound power level from one or more tests into a declared sound power level (in IEC 61400-14 called declared apparent sound power level) which accounts for variability of the noise within a wind turbine population and the uncertainty in the measurements. The label takes no account of noise character.

Some models of small wind turbines will require test sites with very low background noise levels to conduct the testing.

4. LABEL LAYOUT

The label shall include information in the format shown in the sample of Figure 1.

The example information in the gray parts of the label is to be replaced with the relevant information from the measurements of the wind turbine in question.

No thousands separator is used. Numerical values on the label are displayed with decimals (,) rounded to one decimal point for declared sound power level, and to the nearest integer for other values (e.g. 8567,53 kWh/yr would be displayed as 8568 kWh/yr; and 88,54 dB(A) would be displayed as 88,5 dB(A)).

The “Published date” on the label is the publication date of the corresponding test summary report in the format YYYY-MM-DD.

A label is considered valid only if the consumer is able to find a copy of the label, together with the corresponding test summary report, on the web site URL stated on the label.

The Task 27 section of www.ieawind.org shall be used for labels published under this edition of the Recommended Practice.

The label may be translated to other languages and a sample of a bilingual label is shown in Appendix C.

Test Results	
Manufacturer	**Manufacturer**
Model	**Model**
Reference Annual Energy at 5 m/s average wind speed, actual production will vary depending on site conditions	**### kWh/yr**
Declared Sound Power Level at 8 m/s	**## dB(A)**
Turbine Test Class (I-IV or S for Special)	**II**
Tested by	**Test Organisation**
Published Date (Year-Month-Day)	**2011-03-04**
For more information, see the Task 27 section of www.ieawind.org	

Figure 1. Sample label in English.

5. INTERPRETATION OF LABEL

Different countries/states/municipalities have different rules, for example on acceptable noise levels and legal product requirements. It is therefore recommended, that the consumer will investigate local rules, such as

- building/planning requirements;
- relevant requirements on the installer;
- electrical requirements, grid codes and utility requirements;
- noise requirements, including how acoustic character shall be handled;
- etc.

Local authorities are encouraged to disseminate their requirements for small wind turbines, together with information about the label. For example, within the European Economic Area, the wind turbine needs to be CE marked and each product shall be delivered with a “declaration of conformity”.

For example, an interpretation of noise requirements may look like this table:

Example

The declared sound power level on the label does not include penalty for noise character. Penalties for noise character are not applicable in this country. The table below shows the approximate minimum distance to the nearest neighbour in a normal residential area, according to this country’s laws. Areas considered noise sensitive may have stricter rules, but industrial areas may have less strict rules.

Sound power figure on label	Approximate minimum distance to neighbour*
75 dB(A)	20 m
80 dB(A)	40 m
85 dB(A)	70 m
90 dB(A)	120 m
95 dB(A)	210 m
100 dB(A)	340 m

* if noise limit 40 dB(A) sound pressure level at neighbour's property applies

6. REFERENCES

IEC 61400-2: 2006, Wind turbines – Part 2: Design requirements for small wind turbines

IEC 61400-11: 2006, Wind turbine generator systems – Part 11: Acoustic noise measurement techniques

IEC 61400-12-1: 2005, Wind turbines – Part 12-1: Power performance measurements of electricity producing wind turbines

IEC TS 61400-14: 2005, Wind turbines – Part 14: Declaration of apparent sound power level and tonality values

ISO/IEC 17025: 2005/Cor 1:2006, General requirements for the competence of testing and calibration laboratories

APPENDIX A. WIND TURBINE TESTING APPLICATION FORM

This appendix contains an example of a Wind Turbine Testing Application Form, including a wind turbine specification.

Client details
Company:
Contact name:
Address:
Telephone:
E-mail:

Wind turbine specification
Manufacturer:
Model:
General description of main components:
Rotor diameter (m) (if applicable):
Swept area (m^2):
Number of blades:
Upwind or downwind rotor (if applicable):
VAWT or HAWT or other:
Tower top weight (kg):
Protection and shutdown system:
Yaw mechanism:
Direction of rotation:
Cut-out wind speed (m/s):
Design extreme wind speed (3 sec gust with 50 year recurrence period, m/s):
SWT class (as designed) (if it is an S class a precise explanation of the design parameters is required):
Power form:
Maximum output power (per definitions, giving the P_{60} as a minimum);
Maximum output voltage (per definitions, giving the $U_{0.2}$ as a minimum);
Maximum output current(s) (per definitions, giving the i_{60} as a minimum);
Operating temperature range (°C):
Available support structures:
Design life (years):

Foundation
Max vertical load:
Max horizontal load:
Max overturning moment:
Specify if load safety factors are included in the above loads (and, if so, which factors):

Planning
Max total height:
Estimated delivery date:

Assembly
Erection method (crane/gin pole/…):

Laydown area:

Electrical
Generator type:
Number of poles in generator:
Electrical system certification status:
Application (grid/battery charging/heating/…):
Normal output voltage and range:
Normal output frequency and range:
Control software version number:

Grid connection (if applicable)
Single phase or 3-phase:
Inverter type and software version (if applicable):
Inverter settings (separate sheet to be supplied, if applicable):
Maximum current per phase:
Max acceptable distance to grid connection:

Manual (to be supplied separately):

Date form completed:
Form completed by:

APPENDIX B. REPORTING DETAILS

This appendix contains examples of figures to include in the test summary report that is linked to the label (section 2.1).

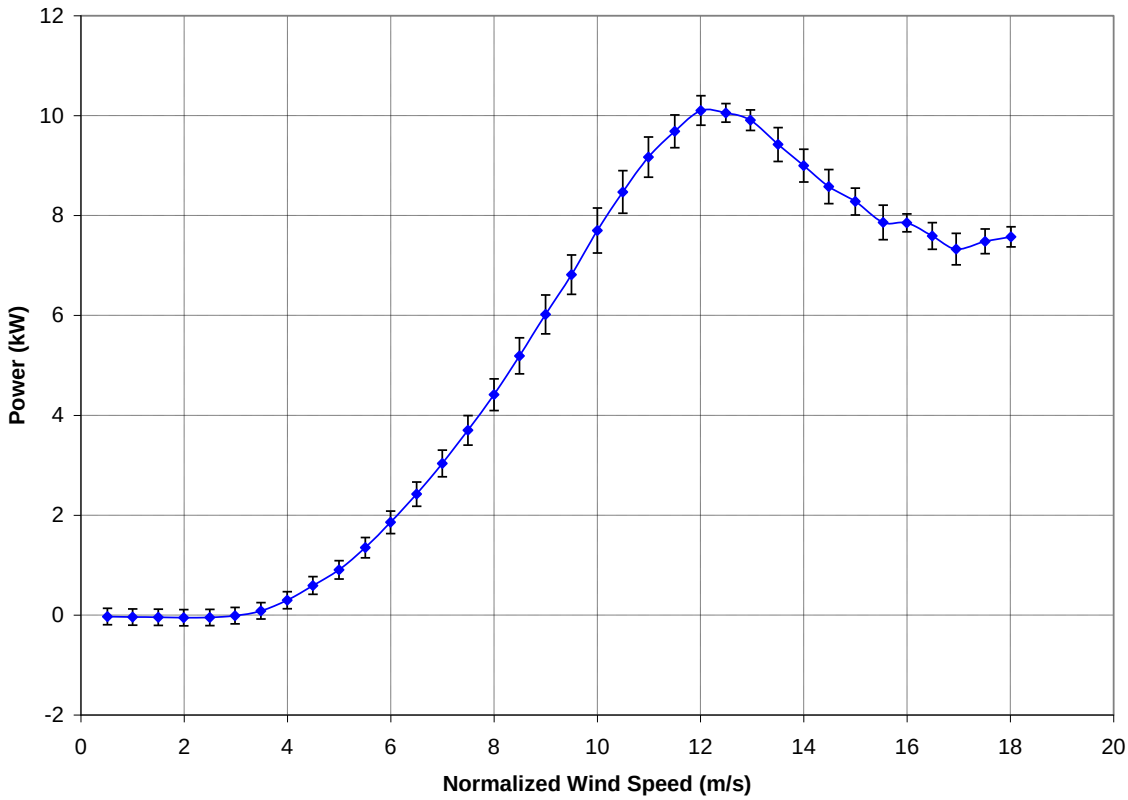
Power/energy performance

The following figures should be included in the summary report:

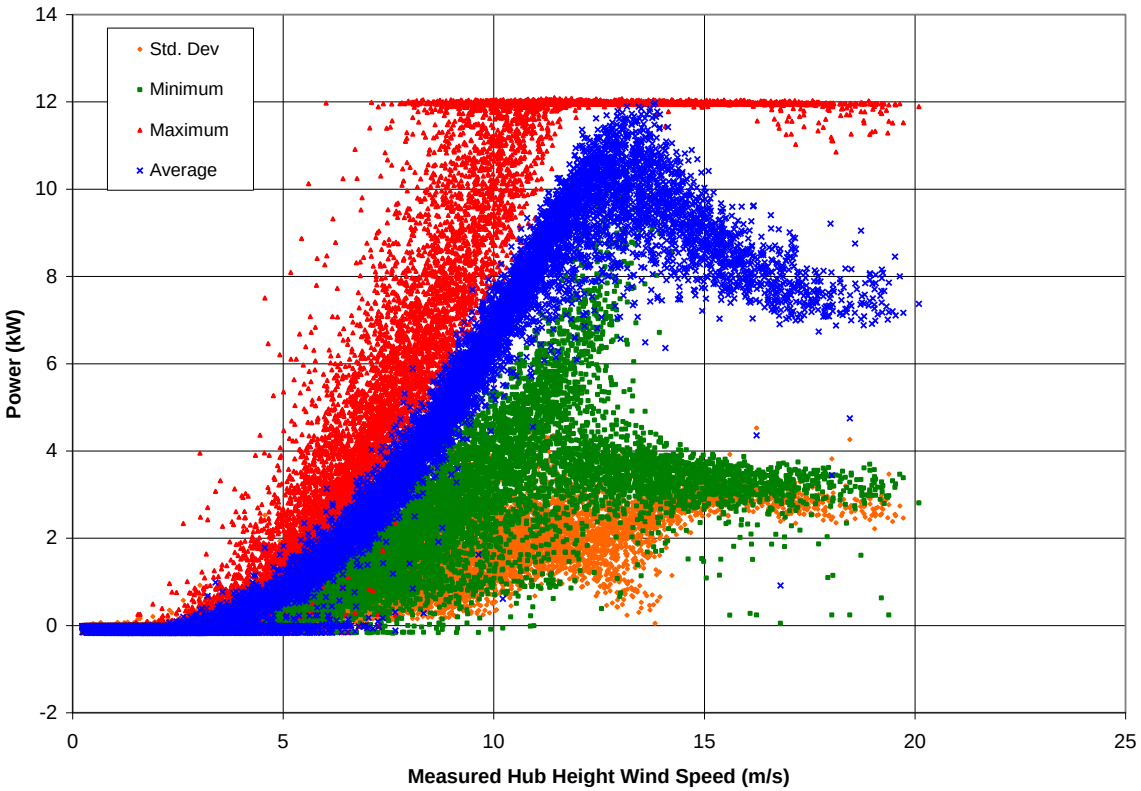
1. A plot showing the binned sea level normalized power curve. The power curve should also show any power consumption below cut in wind speed. The plot should show the uncertainty bands indicating the standard uncertainty on power in both directions.

   Note that some wind turbines will adjust their settings (e.g. blade pitch) to accommodate for air density effects. For those turbines no additional air density normalization should be done

.



2. A scatter plot of the measured power and wind speed used for the binned power curve. Average, maximum and minimum and standard deviation for each data point should be shown.



3. A table with the calculated Annual Energy Production for sea level air density.

Estimated annual energy production, database A (all valid data)					
	Reference air density:	1.225	kg/m^3		
	Cut-out wind speed:	25.00	m/s		
Hub height annual average wind speed (Rayleigh)	AEP-measured	Standard Uncertainty in AEP-measured		AEP-extrapolated	Complete if AEP measured is at least 95% of AEP extrapolated
m/s	kWh	kWh	%	kWh	
4	7,884	1,717	22%	7,884	Complete
5	15,327	1,948	13%	15,329	Complete
6	23,516	2,144	9%	23,572	Complete
7	30,967	2,271	7%	31,330	Complete
8	36,718	2,325	6%	37,924	Complete
9	40,459	2,314	6%	43,158	Incomplete
10	42,350	2,254	5%	47,049	Incomplete
11	42,770	2,160	5%	49,696	Incomplete
AEP measured assumes zero power between highest bin and cutout AEP extrapolated assumes power in last bin between last bin and cutout					

Duration test

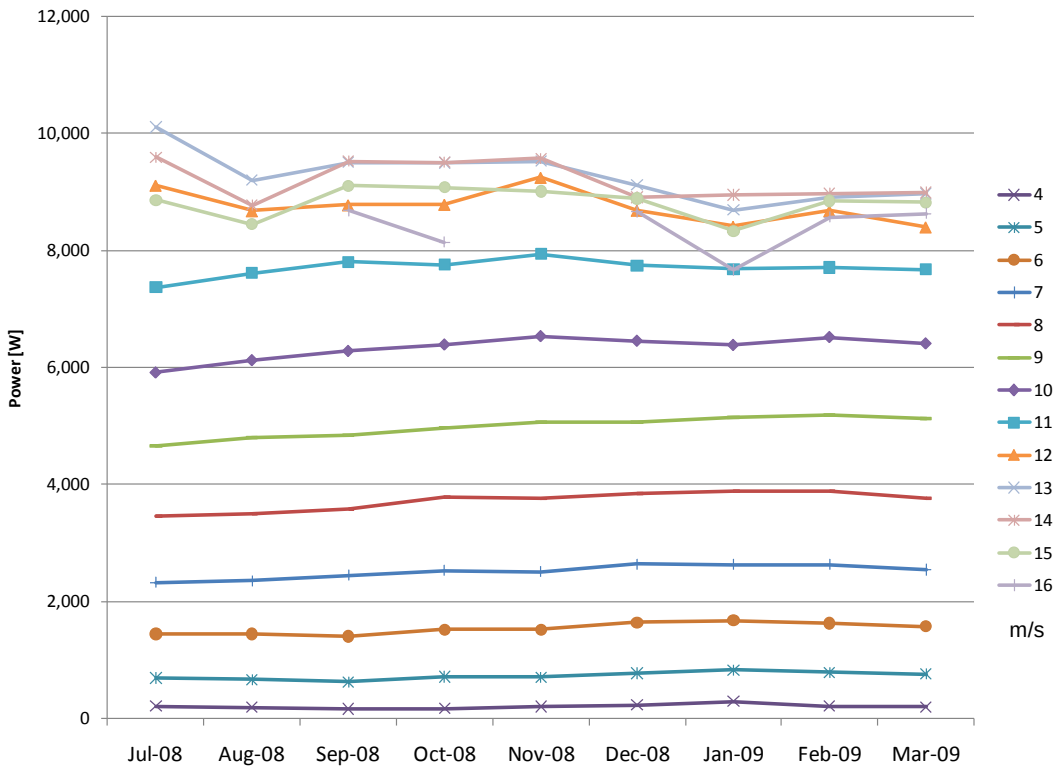
For the duration test the following two figures are required:

1. A table summarising the duration test results.

	Hours of power production above:										
		*[1.2*Vave]*	*[1.8*Vave]*	*max gust*	I_{15}	*# Data*	T_T	T_U	T_E	T_N	*O*
Month	*0 m/s*	*9 m/s*	*13.5 m/s*	*(m/s)*	*(%)*	*points*	*(hours)*	*(hours)*	*(hours)*	*(hours)*	*(%)*
Overall	2704,9	710,6	215,0	41,9	19,0	255	7094	172,5	152,0	624,6	90,8
Jun 2008	238,2	36,2	3,8	28,6	18,5	5	518	11,3	7,8	3,3	99,3
Jul	256,0	8,5	0,3	23,9	-	-	744	78,2	2,2	38,8	94,1
Aug	115,8	4,5	0,0	19,2	-	-	744	6,3	20,0	323,0	55,0
Sep	120,5	11,7	1,8	22,4	-	-	720	36,2	30,3	174,7	73,3
Oct	236,0	45,0	12,2	32,8	17,3	10	744	0,7	1,3	0,0	100,0
Nov	348,0	98,7	22,5	37,0	20,9	40	720	22,1	0,0	0,0	100,0
Dec	339,7	160,5	54,8	41,4	17,4	68	744	7,9	27,2	32,8	95,4
Jan 2009	385,0	155,5	56,0	38,8	19,9	76	744	4,9	32,0	36,5	94,8
Feb	333,2	107,3	36,8	41,9	20,0	23	672	3,2	27,0	0,0	100,0
Mar	332,5	82,7	26,8	36,7	18,0	33	744	1,7	4,2	15,5	97,9

The example table above for a SWT class III provides the key overall results but also the breakdown for each month. The report further will describe the reason for any time classified as T_U, T_E and T_N. The column labelled I_{15} (turbulence intensity) is based on a ten-minute statistics. The max gust is the highest instantaneous (3-seconds) wind speed measured during the test.

2. A plot showing any potential power degradation.



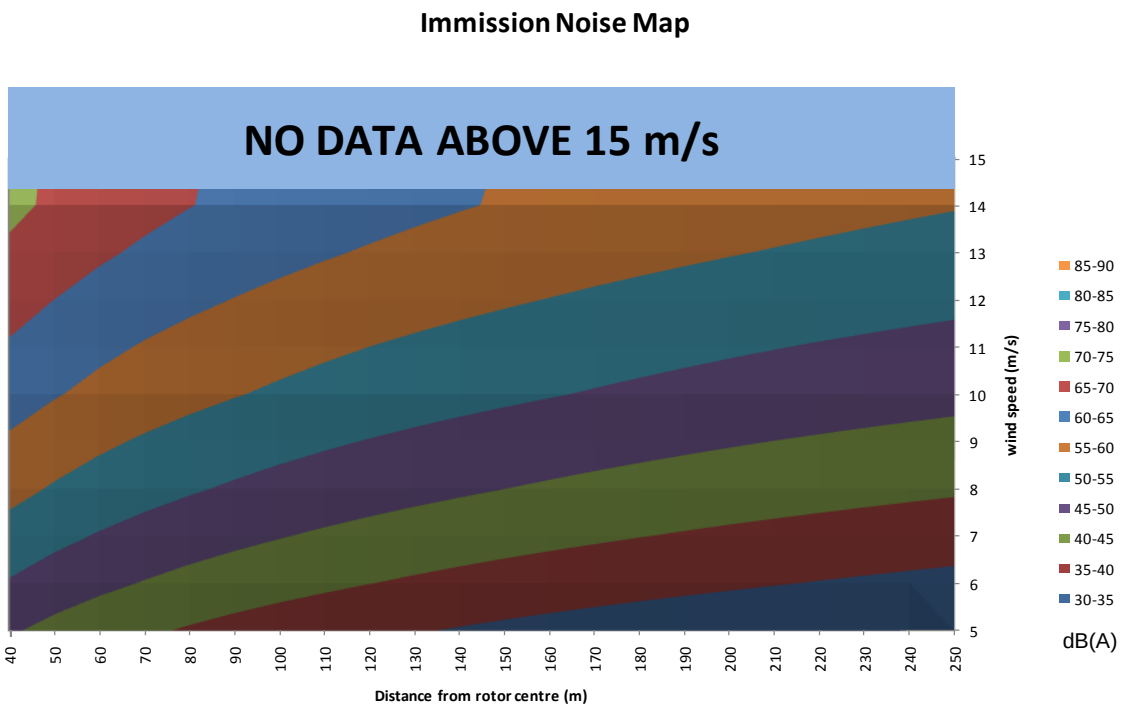
The power degradation plot shows the trend in the binned power level (based on ten-minute averages) for several wind speeds from month to month. Only data from within the measurement sector is used to assure good inflow conditions. The data should also be

sea level normalised to reduce the effect of air density on the plot. The objective for the plot is to look for trends that might suggest hidden degradation of the turbine system. Some changes are still expected due to seasonal effects such as temperatures, air density etc.

Acoustic noise test

For the acoustic noise test an immission map is required.

The plot shows sound pressure levels which are calculated from a declared apparent sound power level for a range of wind speeds and distances to the centre of the wind turbine rotor.



APPENDIX C. SAMPLE BILINGUAL LABEL (ENGLISH/FRENCH)

Test Results / Résultats des Essais

Manufacturer / Fabricant	**Manufacturer**
Model / Modèle	**Model**
Reference Annual Energy / Énergie Annuelle de Référence at 5 m/s average wind speed, actual production will vary depending on site conditions / vitesse moyenne du vent à 5 m/s, la production réelle peut varier selon les conditions du site	**### kWh/yr**
Declared Sound Power Level / Niveau de Puissance de Bruit Déclaré at 8 m/s / à 8 m/s	**## dB(A)**
Turbine Test Class / Classe d´Éolienne Testée (I-IV or S for Special) / (I-IV ou S pour Spécial)	**II**
Tested by / Testé par	**Test Organisation / Organisme d´Essai**
Published Date / Date de Publication (Year-Month-Day) / (Année-Mois-Jour)	**2011-03-04**

For more information, see the Task 27 section of / Pour plus d'informations, voir la section de la Tâche 27
www.ieawind.org