ANNEXE E

COURBES D'ÉMISSION ACOUSTIQUE DES ÉOLIENNES CONSIDÉRÉES

Sound Power Level

of the

ENERCON E-82 E2

Operational Mode I

(Data Sheet)

Imprint

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Glossary

WEC	means an ENERCON wind energy converter.
WECs	means more than one ENERCON wind energy converter.

Sound Power Level for the E-82 E2 with 2300 kW rated power

in relation to wind speed at 10 m height					
hub height / V_s in 10 m height	78 m	85 m	98 m	108 m	138 m
5 m/s	96,3 dB(A)	96.6 dB(A)	97.2 dB(A)	97.5 dB(A)	98.2 dB(A)
6 m/s	100.7 dB(A)	101.0 dB(A)	101.6 dB(A)	101.9 dB(A)	102.6 dB(A)
7 m/s	103.3 dB(A)	103.5 dB(A)	103.6 dB(A)	103.6 dB(A)	103.8 dB(A)
8 m/s	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)
9 m/s	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)
10 m/s	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)
95% rated power	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)	104.0 dB(A)

Measured value at 95% rated power				*103,4 dB(A)* *KCE 209244-03.03*	

in relation to wind speed in hub height									
wind speed at hub height [m/s]	7	8	9	10	11	12	13	14	15
Sound Power Level [dB(A)]	96.6	99.9	102.6	103.5	104.0	104.0	104.0	104.0	104.0

1. The relation between the sound power level and the standardized wind speed in 10 m height as shown above is valid on the premise of a logarithmic wind profile with a roughness length of 0.05 m. The relation between the sound power level and the wind speed at hub height applies for all hub heights. During the sound measurements the wind speeds are derived from the power output and the power curve of the WEC.

2. A tonal audibility of $\Delta L_{a,k} \leq 2$ dB can be expected over the whole operational range (valid in the near vicinity of the turbine according to IEC 61 400 -11 ed. 2).

3. The sound power level values given in the table are valid for the **Operational Mode I** (defined via the rotational speed range of 6 – 18 rpm). The respective power curve is the calculated power curve E-82 E2 dated November 2009 (Rev. 3.x).

4. The values displayed in the tables above are based on official and internal measurements of the sound power level. If available the official measured values are given in this document as a

reference (in italic print). The extracts of the official measurements can be made available upon request. The values given in the measurement extracts do not replace the values given in this document. All measurements have been carried out according to the recommended German and international standards and guidelines as defined in the measurement reports, respectively.

5. Due to the typical measurement uncertainties, if the sound power level is measured according to one of the accepted methods the measured values can differ from the values shown in this document in the range of +/- 1 dB.

   Accepted measurement methods are:

   a) IEC 61400-11 ed. 2 („Wind turbine generator systems – Part 11: Acoustic noise measurement techniques; Second edition, 2002-12"), and

   b) the FGW-Guidelines („Technische Richtlinie für Windenergieanlagen – Teil 1: Bestimmung der Schallemissionswerte", published by the association "Fördergesellschaft für Windenergie e.V.", 18th revision).

   If the difference between total noise and background noise during a measurement is less than 6 dB a higher uncertainty must be considered.

6. For noise-sensitive sites it is possible to operate the E-82 E2 with reduced rotational speed and reduced rated power during night time. The sound power levels resulting from such operational mode can be provided in a separate document upon request.

7. The sound power level of a wind turbine depends on several factors such as but not limited to regular maintenance and day-to-day operation in compliance with the manufacturer's operating instructions. Therefore, this data sheet can not, and is not intended to, constitute an express or implied warranty towards the customer that the E-82 E2 WEC will meet the exact sound power level values as shown in this document at any project specific site.

GE Energy

Commercial Documentation Wind Turbine Generator Systems 2.75-103 - 50 Hz and 60 Hz

Product Acoustic Specifications

Normal Operation according to IEC 61400-11

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Table of Contents

1 Introduction

This document defines the noise emission characteristics of the wind turbine series 2.75-103, 50 Hz and 60 Hz versions, equipped with 103 m rotor diameter (GE 50.2 type blade) operating in normal operation (NO).

General Electric continuously verifies specifications with measurements, including those performed by independent institutes.

The calculated apparent sound power level $L_{WA,k}$ as function of v_{10m} (reference wind speed 10 m above ground level) is provided for **normal operation** (**NO**) over cut-in to cut-out wind speed range.

The corresponding wind speeds at hub height v_{HH} are provided assuming different standard hub heights and a logarithmic wind profile.

If a wind turbine noise performance test is to be carried out, it needs to be done in accordance with both IEC 61400-11 and GE's "Machine noise performance test" reference guidelines.

Paragraph §2 provides **nominal calculated acoustic performance** for:

- 2.75-103 (50 & 60 Hz) calculated apparent sound power level $L_{WA,k}$ as function of v_{10m} and at **95% rated electrical power** per IEC 61400-11.
- 2.75-103 (50 & 60 Hz) tonality level $\Delta L_{a,k}$ per IEC 61400-11

Paragraph §3 provides 2.75-103 acoustic performances additional data:

- The wind speeds at reference height v_{10m} extrapolated to v_{HH} (wind speed at hub height)
- Uncertainty information
- IEC 61400-11 and IEC/TS 61400-14 additional information

2 2.75-103 Product Normal Operation Acoustic Performance

2.1 2.75-103 Normal Operation Calculated Apparent Sound Power Level

The Table 1 provides nominal acoustic specifications for 2.75-103 equipped with 103 m rotor diameter (GE 50.2 type blade) and 100 m hub height as function of wind speed v_{10m} (reference wind speed 10 m above ground level), operating at normal operation (NO) per IEC 61400-11 standard and GE's "Machine noise performance test" reference guidelines:

Wind speed at v_{10m} [m/s]	$L_{WA,k}$* Apparent sound power level [dB]
≤ 5	≤ 97.1
6	≤ 102.2
6.5	≤ 104.4
7	≤ 105.0
8	≤ 105.0
≥ 9	≤ 105.0

Table 1: Normal operations, 2.75-103 wind turbine, 50.2 m blades (103 m rotor), 100 m hub height, apparent sound power level at wind speed v_{10m}.

At wind speeds lower than 5 m/s the sound power levels decreases, and may get so low that the wind turbine noise becomes indistinguishable from the background noise. For a conservative calculation the data at 5 m/s may be used.

At wind speeds above 9 m/s turbine has reached rated power and the increasing pitch angle decreases the noise level. For a conservative calculation the data at 9 m/s may be used.

The nominal acoustic performances for **2.75-103**, 50 Hz and 60 Hz versions, equipped with 103 m rotor diameter (GE 50.2 type blade) operating in **normal operation** (NO), specified at **95 % rated electrical power**:

- The calculated apparent sound power level is $L_{WA,k}$ ≤ 105.0dBA.

* $L_{WA,k}$ indicates apparent sound power level per IEC-61400-11 standard measured in dB, A-weighted 10 base logarithmic value of apparent sound power relative to reference sound power of 10^{-12} W.

2.2 2.75-103 Normal Operation Calculated Tonality

The nominal acoustic performance for **2.75-103**, 50 Hz and 60 Hz versions, equipped with 103 m rotor diameter (GE 50.2 type blade) operating in **normal operation** (NO), specified at reference ground measuring distance $\mathbf{R_o}$ measurement position #1 per both IEC 61400-11 and GE's "Machine noise performance test" reference guidelines:

- Tonal audibility $\mathbf{\Delta L_{o,k} < 4\ dB}$.

3 2.75-103 Product Additional Information

3.1 2.75-103 Wind Speeds at Reference Height extrapolated to Hub Height

The wind speeds v_{10m} at reference height (10 m above ground) can be extrapolated from v_{10m} to v_{HH} (wind speed at hub height), per IEC 61400-01, assuming surface roughness of $z_{0,ref}$ = 0.05 m typical average condition and using:

$$V_{10m\ height} = V_{hub} \frac{\ln\left(\frac{10m}{z_{0ref}}\right)}{\ln\left(\frac{hub\ height}{z_{0ref}}\right)}$$

Meaning wind speeds from Table 1 can be extrapolated to 100 m hub height using $\mathbf{v_{HH} = v_{10m}}$ * 1.43 and to 85 m hub height using $\mathbf{v_{HH} = v_{10m}}$ * 1.40 per **Table 2.**

Wind speed at 10 m reference height v_{10m} [m/s]	Wind speed at 85 m hub height $V_{HH=85}$ [m/s]	Wind speed at 100 m hub height $v_{HH=100}$ [m/s]
≤ 5	≤ 7.0	≤ 7.2
6	8.4	8.6
6.5	9.1	9.3
7	9.8	10.0
8	11.2	11.5
≥ 9	≥ 12.6	≥ 12.9

Table 2: Relation between wind speed at reference height v_{10m} and wind speeds at different hub heights v_{HH} for $z_{0,ref}$ = 0.05 m

3.2 2.75-103 Testing Uncertainty and Product Variation per IEC/TS 61400-14

Per IEC/TS 61400-14, $\mathbf{L_{WAd}}$ is the maximum apparent sound power level resulting from ***n*** measurements performed according to IEC 61400-11 standard for 95 % confidence level: $L_{WAd} = \overline{L_{WA}} + K$, where $\overline{L_{WA}}$ is the mean apparent sound power level from ***n*** IEC 61400-11 testing reports and $\mathbf{K = 1{,}645 \cdot \sigma_T}$.

The testing standard deviation values σ_T, σ_R and σ_P for measured apparent sound power level are described by IEC/TS 61400-14, where σ_T is the total standard deviation, σ_P is the standard deviation for product variation and σ_R is the standard deviation for test reproducibility.

Assuming σ_R **< 0.8 dB** and σ_P **< 0.8 dB** typical values, leads to calculated **K < 2 dB** for 95 % confidence level.

3.3 IEC 61400-11 and IEC/TS 61400-14 Terminology

- $L_{WA,K}$ is wind turbine apparent sound power level (referenced to 10^{-12}W) measured with A-weighting as function of reference wind speed v_{10m}. Derived from multiple measurement reports per IEC 61400-11, it is considered as a mean value
- σ_P is the product variation i.e. the 2.75-103 unit-to-unit product variation; typically < 0.8dB
- σ_R is the overall measurement testing reproducibility as defined per IEC 61400-11; typically < 1dB with adequate measurement conditions and sufficient amount of data samples
- σ_T is the total standard deviation combining both σ_P and σ_R
- $K = 1{,}645 \cdot \sigma_T$ is defined per IEC/TS 61400-14 for 95 % confidence level
- R_o is the ground measuring distance from the wind turbine tower axis per IEC 61400-11
- $\Delta_{La,k}$ is the audibility according to IEC 61400-11, described as potentially audible narrow band sound

References:

- IEC 61400-1, Wind turbines – part 1: Design requirements, ed. 3, 2005-08
- IEC 61400-11, wind turbine generator systems part 11: Acoustic noise measurement techniques, ed. 2.1, 2006-11
- IEC/TS 61400-14, Wind turbines – part 14: Declaration of apparent sound power level and tonality values, ed. 1, 2005-03
- MNPT – Machine Noise Performance Test, Technical documentation, GE 2007

GE Energy

Commercial Documentation Wind Turbine Generator Systems 2.75-103 - 50 Hz and 60 Hz

Product Acoustic Specifications

Noise Reduced Operations according to IEC 61400-11

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Table of Contents

1 Introduction

This document describes the noise emission characteristics of the wind turbine series 2.75-103 50 Hz and 60 Hz versions, equipped with 103 m rotor diameter (GE 50.2 type blade) operating in **Noise Reduced Operations** (**NRO**).

General Electric continuously verifies specifications with measurements, including those performed by independent institutes.

The calculated apparent sound power level $L_{WA,k}$ as function of v_{10m} (reference wind speed 10 m above ground level) is provided for **Noise Reduced Operations** (**NRO**) over cut-in to cut-out wind speed range.

If a wind turbine noise performance test is to be carried out, it needs to be done in accordance with both IEC 61400-11 and GE's "Machine noise performance test" reference guidelines.

Paragraph §2 provides nominal calculated acoustic performance for:

- 2.75-103 (50 and 60 Hz) calculated apparent sound power level $L_{WA,k}$ as function of **NRO mode** and v_{10m} and at **95% rated electrical power** per IEC 61400-11.
- 2.75-103 (50 and 60 Hz) tonality level $\Delta L_{a,k}$ per IEC 61400-11

Paragraph §3 provides 2.75-103 product additional information:

- The wind speeds at reference height v_{10m} extrapolated to v_{HH} (wind speed at hub height)
- Uncertainty information
- IEC 61400-11 and IEC/TS 61400-14 additional information

2 2.75-103 Product Noise Reduced Operation Acoustic Performance

2.1 2.75-103 Noise Reduced Operation Calculated Apparent Sound Power Level

Table 1 provides nominal acoustic specifications for 2.75-103, 50 Hz and 60 Hz versions, equipped with 103 m rotor diameter (GE 50.2 type blade) and 100 m hub height as function of wind speed $\mathbf{v_{10m}}$ (reference wind speed 10 m above ground level), operating at **Noise Reduced Operations** (**NRO**) with reference to **Normal Operations** (**NO**) per IEC 61400-11 standard and GE's "Machine noise performance test" reference guidelines:

Wind speed at v_{10m} [m/s]	Normal Operation $L_{WA,k}$[1] Apparent sound power level [dB]	NRO 104	NRO 103	NRO 102	NRO 101	NRO 100
≤ 5	≤ 97.1	≤ 97.1	≤ 97.1	≤ 97.1	≤ 97.1	≤ 97.1
5.5	≤ 99.8	≤ 99.8	≤ 99.8	≤ 99.8	≤ 99.8	≤ 99.6
6	≤ 102.2	≤ 102.2	≤ 102.1	≤ 101.9	≤ 101.0	≤ 100.0
6.5	≤ 104.4	≤ 103.8	≤ 103.0	≤ 102.0	≤ 101.0	≤ 100.0
7	≤ 105.0	≤ 103.8	≤ 103.0	≤ 102.0	≤ 101.0	≤ 100.0
8	≤ 105.0	≤ 104.0	≤ 103.0	≤ 102.0	≤ 101.0	≤ 100.0
≥ 9	≤ 105.0	≤ 104.0	≤ 103.0	≤ 102.0	≤ 101.0	≤ 100.0

Table 1: Noise Reduced Operations (NRO) 2.75-103 wind turbine, 50.2 m blades (103 m rotor), 100 m hub height, apparent sound power level at wind speed v_{10m}

The **nominal acoustic performance** for 2.75-103 wind turbine, 50 Hz and 60 Hz versions, equipped with 103 m rotor diameter (GE 50.2 type blade) being specified at **95% rated electrical power** (related to the reduced rated power values of the corresponding NRO modes) per IEC61400-11 shall be:

- The Normal Operations (NO) apparent sound power level $L_{WA,k}$ ≤ 105.0dBA
- The Noise Reduced Operations NRO 104 apparent sound power level $L_{WA,k}$ ≤ 104.0 dB
- The Noise Reduced Operations NRO 103 apparent sound power level $L_{WA,k}$ ≤ 103.0 dB
- The Noise Reduced Operations NRO 102 apparent sound power level $L_{WA,k}$ ≤ 102.0 dB
- The Noise Reduced Operations NRO 101 apparent sound power level $L_{WA,k}$ ≤ 101.0 dB
- The Noise Reduced Operations NRO 100 apparent sound power level $L_{WA,k}$ ≤ 100.0 dB

[1] $L_{WA,k}$ indicates apparent sound power level per IEC 61400-11 standard measured in dB, A-weighted 10 base logarithmic value of apparent sound power value relative to reference sound power of 10^{-12} W.

2.2 2.75-103 Noise Reduced Operation Calculated Tonality

The nominal acoustic performance for **2.75-103**, 50 Hz and 60 Hz versions, equipped with 103 m rotor diameter (GE 50.2 type blade) operating in **Noise Reduced Operation** (NRO), specified at reference ground measuring distance $\mathbf{R_o}$ measurement position #1 per both IEC 61400-11 and GE's "Machine noise performance test" reference guidelines:

- Tonal audibility $\mathbf{\Delta L_{a,k} < 4\ dB}$.

3 2.75-103 Product Additional Information

3.1 Wind Speeds at Reference Height extrapolated to Hub Height

The wind speeds v_{10m} at reference height (10 m above ground) can be extrapolated to v_{HH} (wind speed at hub height), per IEC 61400-01, assuming surface roughness of $z_{0,ref}$ = 0.05 m typical average condition and using:

$$V_{10m\ height} = V_{hub} \frac{\ln\left(\frac{10m}{z_{0ref}}\right)}{\ln\left(\frac{hub\ height}{z_{0ref}}\right)}$$

Meaning wind speeds from Table 1 can be extrapolated to 100 m hub height using $\mathbf{V_{HH} = V_{10m}}$ * 1.43 and 85 m hub height using $\mathbf{V_{HH} = V_{10m}}$ * 1.40 per Table 2.

Wind speed at v_{10m} [m/s]	Wind speed at 100 m hub height v_{HH}=100 [m/s]	Wind speed at 85 m hub height v_{HH}=85 [m/s]
≤ 5	7.2	7.0
5.5	7.9	7.7
6	8.6	8.4
6.5	9.3	9.1
7	10.0	9.8
8	11.5	11.2
≥ 9	12.9	12.6

Table 2: Relation between wind speed at reference height v_{10m} and wind speeds at different hub heights v_{HH} for $z_{0,ref}$ = 0.05 m

3.2 Testing Uncertainty and Product Variation per IEC/TS 61400-14

Per IEC/TS 61400-14, $\mathbf{L_{WAd}}$ is the maximum apparent sound power level resulting from ***n*** measurements performed according to IEC 61400-11 standard for 95 % confidence level: $L_{WAd} = \overline{L_{WA}} + K$, where $\overline{L_{WA}}$ is the mean apparent sound power level from ***n*** IEC 61400-11 testing reports and $\mathbf{K = 1{,}645 \cdot \sigma_T}$.

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Assuming σ_R **< 0.8 dB** and σ_P **< 0.8 dB** typical values, leads to calculated **K < 2 dB** for 95% confidence level.

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- σ_P is the product variation i.e. the 2.75-103 unit-to-unit product variation; typically < 0.8 dB
- σ_R is the overall measurement testing reproducibility as defined per IEC 61400-11; typically < 0.8 dB with adequate measurement conditions and sufficient amount of data samples
- σ_T is the total standard deviation combining both σ_P and σ_R
- $K = 1{,}645 \cdot \sigma_T$ is defined by IEC/TS 61400-14 for 95% confidence level
- R_o is the ground measuring distance from the wind turbine tower axis per IEC 61400-11
- $\Delta L_{a,k}$ is the tonal audibility according to IEC 61400-11, described as potentially audible narrow band sound

References:

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- IEC 61400-11, wind turbine generator systems part 11: Acoustic noise measurement techniques, ed. 2.1, 2006-11
- IEC/TS 61400-14, Wind turbines – part 14: Declaration of apparent sound power level and tonality values, ed. 1, 2005-03
- MNPT – Machine Noise Performance Test, Technical documentation, GE 2007
- 2.75-103_xxHz_PCD_allComp_NRO_IEC

Fact Sheet

GE Energy

GE 2.5MW Option "Sound Power Management"

Introduction

En tant que fournisseur mondial de produits et services liés à l'énergie, General Electric investit largement dans le secteur des énergies renouvelables, en particulier pour la plateforme éolienne GE 2.5MW afin de s'adapter aux besoins Clients tels que la configuration machine, l'amélioration des rendements et les applications spécifiques à chaque site.

Ainsi la nouvelle option **SPM** "Sound Power Management" de l'aérogénérateur GE 2.5MW se focalise sur le besoin des marchés très spécifiques où la réglementation acoustique locale est particulièrement critique, et où le besoin de contrôler la puissance acoustique d'un aérogénérateur sur une grande plage de régime de vent est impératif.

L'option **SPM** "Sound Power Management" offre les propriétés suivantes :

- Sélection du mode **SPM** d'émission acoustique réduite à basses vitesses de vent
- Sélection du mode **SPM** d'émission acoustique réduite à hautes vitesses de vent
- Combinaison des deux modes **SPM** avec transition

De plus, l'option **SPM** offre les propriétés suivantes au niveau du parc éolien :

- Commutation mode "jour" et "nuit" (intervalle de temps)
- Commutation en fonction de la direction du vent (secteurs de vent)
- Organisation par groupe de machines

Configurations

L'option **SPM** "Sound Power Management" de l'éolienne GE 2.5MW est disponible sur les variantes suivantes :

- 2.5-100 (rotor de 100m de diamètre) pour les classes de vent IEC II et IEC III
- 2.5-103 (rotor de 103m de diamètre) pour la classe de vent IEC III
- Configurations standards de hauteur de moyeu

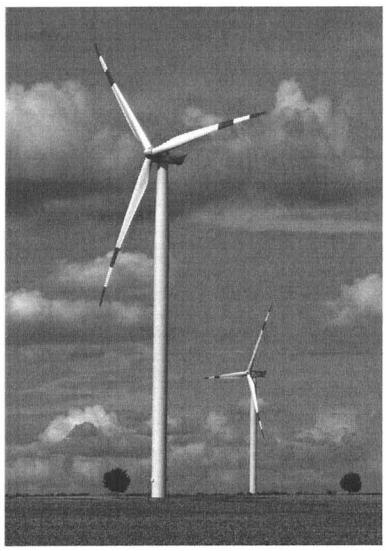

Figure 1. Aérogénérateurs GE 2.5MW en opération sur un site éolien Client

Caractéristiques techniques

Les caractéristiques de l'option **SPM** "Sound Power Management" pour l'aérogénérateur GE 2.5MW pour les modes **SPM** basses vitesses, hautes vitesses et combinés sont les suivantes.

GE 2.5MW modes L-SPM "basse vitesse"

L'option **SPM** permet de sélectionner un mode de réduction d'émission acoustique parmi les modes nommés **L-SPM** "low wind speed" illustrés par la **Figure 2**.

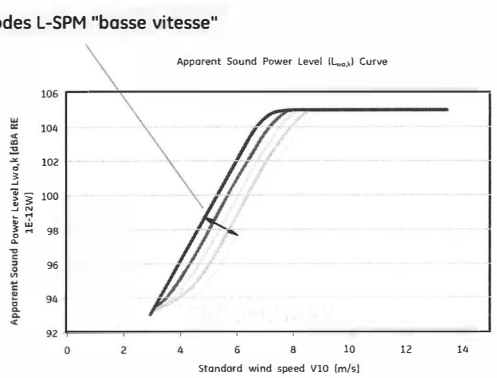

Figure 2. GE 2.5MW plage de sélection des modes d'émission acoustique réduite **L-SPM** à basses vitesses de vent

L-SPM propose quatre décréments de réduction de bruit (par pas de 1dB) relatifs à la courbe d'émission acoustique de référence GE 2.5MW. Soit une gamme de -1dB à -4dB pour la plage de vitesse V_{10} 3-7 m/s (vitesse à 10m du sol).

GE 2.5MW modes H-SPM "haute vitesse"

L'option **SPM** permet de sélectionner un mode de réduction d'émission acoustique parmi les modes **H-SPM** "high wind speed" illustrés par la **Figure 3.**

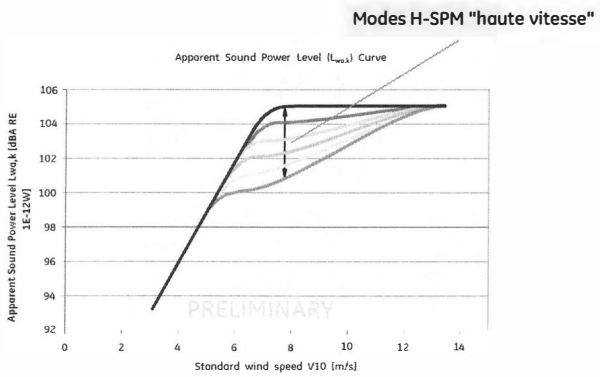

Figure 3. GE 2.5MW plage de sélection des modes d'émission acoustique réduite **H-SPM** à hautes vitesses de vent

H-SPM propose cinq décréments de réduction de bruit (par pas de 1dB) relatifs à la courbe d'émission acoustique de référence GE 2.5MW. Soit une gamme de -1dB à -5dB, pour la plage de vitesse supérieure à V_{10} = 7 m/s (vitesse à 10m du sol).

GE 2.5MW modes SPM combinés

Les modes **L-SPM** et **H-SPM** choisis se combinent de manière continue avec une transition intermédiaire progressive pour donner la courbe d'émission acoustique désirée.

Exemple d'application

Pour un site donné, le Client choisit deux configurations parmi les modes disponibles:

- Configuration 1 : **L-SPM =-2dB** et **H-SPM =-1dB**
- Configuration 2 : **L-SPM =-3dB** et **H-SPM =-5dB**

Les courbes d'émission acoustique résultantes des groupes de machines sont illustrées par les **Figures 4** et **5**.

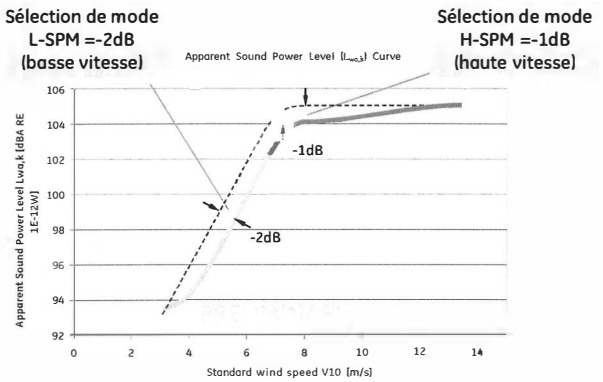

Figure 4. Configuration 1: GE 2.5MW courbe d'émission acoustique obtenue avec **L-SPM=-2dB** et **H-SPM =-1dB**

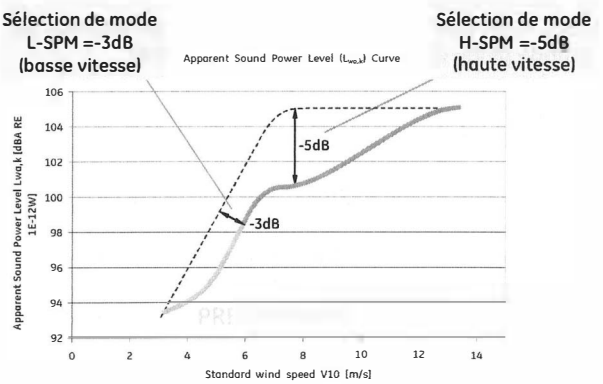

Figure 5. Configuration 2: GE 2.5MW courbe d'émission acoustique obtenue avec **L-SPM=-3dB** et **H-SPM =-5dB**

En résumé : La combinaison des modes **SPM** permet une grande souplesse de configuration des courbes d'émission acoustique GE 2.5MW à toute vitesse de vent.

Parc éolien à configuration acoustique programmable

L'option **SPM** offre également les possibilités suivantes:

- Commutation par mode "jour" et "nuit" (intervalle de temps)
- Commutation en fonction de la direction du vent (secteurs de vent)
- Organisation par groupe de machines (**Figures 6**)

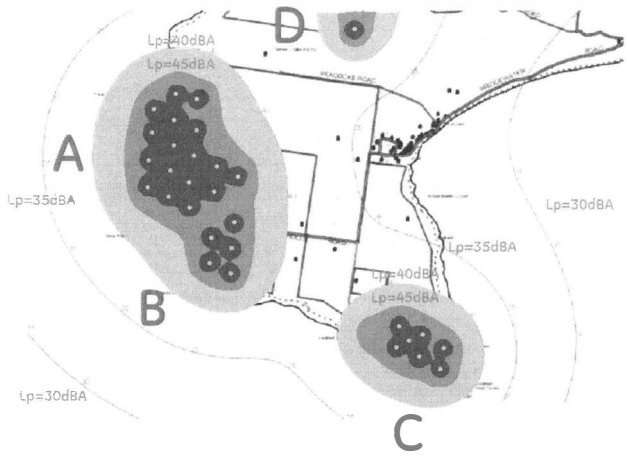

Figure 6. Cartographie d'émission acoustique d'un parc éolien avec configuration par groupes de machines A, B, C, D

Avec l'option **SPM**, il est donc possible de concevoir une gestion des paramètres de contrôle acoustique du parc éolien afin de réaliser l'objectif de cartographie d'émission acoustique (impact acoustique) tout en optimisant la production énergétique annuelle.

Besoins présents et futurs

Par ailleurs, l'option **SPM** "Sound Power Management" GE 2.5MW offre la possibilité de mettre à jour l'ensemble des paramètres de contrôle **SPM** afin de remodeler la cartographie d'émission acoustique du parc éolien. Par exemple :

- Modification des exigences acoustiques
- Modification de l'environnement externe au parc éolien (nouvelles constructions, etc.)
- Evolutions après-vente offertes pour les aérogénérateurs GE 2.5MW
- Ajout d'aérogénérateurs supplémentaires

L'option **SPM** vise à répondre aux besoins spécifiques du parc éolien Client depuis la phase initiale de construction puis tout au long de la vie du parc en s'adaptant aux changements futurs (évolutions technologiques de l'aérogénérateur GE 2.5MW ou extension du parc éolien).

Figure 7. Aérogénérateurs GE 2.5MW en opération sur un site éolien Client

Conclusion

Avec l'option **SPM**, l'aérogénérateur GE 2.5MW est ainsi doté d'une "empreinte acoustique" ajustable aux besoins site du Client, tout en bénéficiant de l'importante capacité de capture énergétique d'un rotor de grand diamètre.

Il est possible de réaliser un contrôle fin de l'ensemble du parc éolien équipé de GE 2.5MW avec l'option **SPM** pour répondre aux exigences acoustiques environnementales avec l'objectif de production électrique maximale pour le gisement de vent du site.

Pour plus d'information, veuillez contacter votre responsable commercial local ou visiter le site internet www.ge-energy.com/wind.

REpower Systems

Power Curve &

Sound Power Level

REpower 3.4M104

[3.4M/104/50Hz]

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Table of Contents

Applicable Documents

The following documents are mentioned within this document without being subject matter of this product description.

Title	Document no.

* Depending on the project specific selection of REpower products the respective documents will appear in each case as separate amendments of the contract in their actual version.

List of Abbreviations and Units

Abbreviation/Unit	Description
cP	Power coefficient
cT	Thrust coefficient
FGW	Fördergesellschaft Windenergie e.V.
IEC	International Electrotechnical Commission
WEC	Wind Energy Converter (equal to Wind Turbine Generator System [WTGS])

1 Introduction

This document shows the guaranteed power curve and sound power level of the *REpower 3.4M104* and the corresponding guarantee and measurement conditions.

2 Conditions for guarantee and measurement of power curve and sound power level

2.1 General information

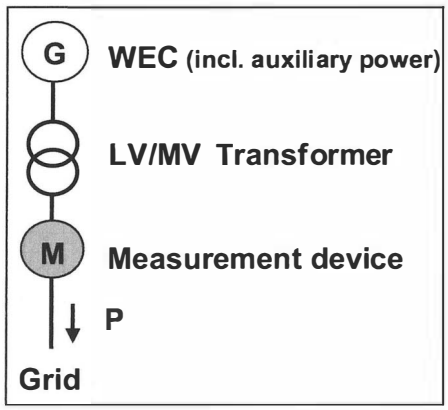
Rotor diameter:	104	m
Air density:	1.225	kg/m³
Cut in wind speed:	3.5	m/s
Cut out wind speed:	25.0	m/s
Wind speed at hub height:	10 minute mean values	
Blades:	clean, no ice/snow formation	

2.2 Conditions for power curve guarantee and measurement

Verification according to IEC 61400-12-1: 2005[1,2]		
Turbulence intensity:	6 to 12	%
Terrain:	not complex according to IEC 61400-12-1: 2005[1]	
Vertical wind shear coefficient (measured between hub height and hub height minus rotor diameter divided by 2):	≤ 0.3	
Air density at location (10 minutes mean value):	≥ 1.13	kg/m³
Temperature range:	acc. to related Standard Conditions of use	
Anemometer type:	Thies First Class/ Thies First Class Advanced	
Voltage level for measurement:	660 V / 950V V (50Hz)	

[1] For obstacle assessment according to 61400-12-1: 2005 Annex A.2 the following condition applies:
To determine significant obstacles the procedure "Power Performance Measurement Procedure – Version 5, December 2009" chapter 3.9 has to be followed.
In addition no obstacles with a height greater than 1/3 of the distance between the ground and the lower blade tip shall exist in the measurement sector within 0-4 rotor diameters of the WEC or met mast.

[2] Valid for active power set points



Arrangement of a measuring unit for the power curve measurement of a *REpower 3.4M104*

2.3 Conditions for sound power level guarantee and measurement

Verification according to IEC 61400-11: 2002 + A1: 2006[3]

Roughness length (average peak): 0.05 m

[3] Method 1, as outlined in section 7.3 of the IEC standard 61400-11

3 Guaranteed electrical power curve and sound power level[4]

The sound power level guaranteed by REpower includes a measurement uncertainty of approx. 1 dB(A). REpower warrants that there is no tonal audibility > 0 dB[5].

The guaranteed electrical power curve of the *REpower 3.4M104* is applicable at the medium-voltage side of the transformer and includes the transformer losses

Wind speed v [m/s] [6]	**Power** P [kW]	**Sound Power Level** L_{WA}[dB(A)] [7]	**Thrust coefficient** cT [-]	**Power coefficient** cP [-]
3.5	28	-	1.10	0.125
4	87	-	0.91	0.261
5	246	-	0.79	0.378
6	471	-	0.76	0.419
7	783	100.2	0.76	0.439
8	1209	102.9	0.76	0.454
9	1733	104.6	0.76	0.457
10	2293	105.4	0.71	0.441
11	2839	105.6	0.66	0.410
12	3269	105.3	0.57	0.364
13	3340	105.0	0.40	0.292
14	3370	104.8	0.31	0.236
15	3370	104.8	0.25	0.192
16	3370	104.8	0.20	0.158
17	3370	104.8	0.17	0.132
18	3370	104.8	0.14	0.111
19	3370	104.8	0.12	0.094
20	3370	104.8	0.11	0.081
21	3370	104.8	0.09	0.070
22	3370	104.8	0.08	0.061
23	3370	104.8	0.07	0.053
24	3370	104.8	0.06	0.047
25	3370	104.8	0.06	0.041

[4] Valid for unrestricted operation only. During sound reduced operation modes different power and sound levels are effective.

[5] Valid for $V_{10} \geq 6$m/s

[6] Wind speed at hub height

[7] Sound power level at hub height

3.1 Sound Power Level according to IEC for different Hub Heights

HH*	V_{10}[8] [m/s]	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
78-80m	L_{WA}[9] [dB(A)]	100.1	103.7	105.3	105.6	105.1	104.8	104.8	104.8
96.5-100m	L_{WA}[9] [dB(A)]	100.7	104.2	105.4	105.5	105.0	104.8	104.8	104.8
125-128 m	L_{WA}[9] [dB(A)]	101.3	104.5	105.6	105.3	104.9	104.8	104.8	104.8

* Hub height depending on foundation design

All sound power levels above are based on wind speeds of v_{10} at 10 m height. The data of the noise level are based on the requirements of the IEC 61400-11 : 2002 + A1 : 2006
The calculation of the wind speed in 10m height is based on a roughness length of 0.05m.

3.2 Sound Power Level according to FGW Guideline at 95% of rated power

The sound power level measured according to the "Technische Richtlinie für Windenergieanlagen Teil 1: Rev. 18 der FGW" at 95% of the rated power is independent of the hub height:

$$\mathbf{L_{WA,\,95\%} = 105.6\ dB(A)}$$

[8] Wind speed in a height of 10 meters

[9] Sound power level at hub height

4 Calculated electrical power curve (for information only)

The calculated electrical power curve of the *REpower 3.4M104* is a theoretical one which is applicable at the low-voltage side of the transformer and does not include the transformer losses. It has been derived from the guaranteed electrical power curve in chapter 2 using typical operation conditions of the electrical system. The calculated electrical power curve is for informative purposes only and is not content of the guaranteed electrical power curve.

The values of the calculated electrical power curve are a non-binding additional information. No rights or duties for *REpower Systems SE* result from the values given in this chapter. Legal claims against *REpower Systems SE* for any costs incurred and/or damages suffered (including direct, indirect, consequential damage or damages, as well as loss of income or profits) caused by the use or non-use of the information offered here or the use of erroneous or incomplete information are excluded.

Wind speed **v [m/s]** [10]	**Power** **P [kW]**	**Thrust coefficient** **cT [-]**	**Power coefficient** **cP [-]**
3.5	37	1.10	0.167
4	94	0.91	0.282
5	253	0.79	0.390
6	479	0.76	0.426
7	791	0.76	0.443
8	1219	0.76	0.458
9	1745	0.76	0.460
10	2309	0.71	0.444
11	2860	0.66	0.413
12	3295	0.57	0.366
13	3370	0.40	0.295
14	3400	0.31	0.238
15	3400	0.25	0.194
16	3400	0.20	0.160
17	3400	0.17	0.133
18	3400	0.14	0.112
19	3400	0.12	0.095
20	3400	0.11	0.082
21	3400	0.09	0.071
22	3400	0.08	0.061
23	3400	0.07	0.054
24	3400	0.06	0.047
25	3400	0.06	0.042

[10] Wind speed at hub height