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|   | <b>GENERAL CHARACTERISTICS MANUAL</b>                            | Code: <b>GD276478-en</b> <span style="float: right;">Rev: <b>2</b></span>    |
|  |  | Date: <b>05/12/2016</b> <span style="float: right;">Pg. <b>1 of 9</b></span> |
| Documentation Type:<br><b>PDTD - Product</b>   | <b>G126 2.625MW CIIIA 50/60Hz Power and Noise Curves for NRS</b> | Approval process: <b>Electronic: PDM Flow</b>                                |
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## RECORD OF CHANGES

| Rev. | Date       | Author     | Description   |
|------|------------|------------|---|
| 0    | 02/03/2016 | JOANAVARRO | Initial version   |
| 1    | 30/06/2016 | JOANAVARRO | Updated power values. Noise according to IEC61400-11 Ed.3 |
| 2    | 05/12/2016 | JOANAVARRO | H=137m tower added  |



## GENERAL CHARACTERISTICS MANUAL

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### 1 AIM

This document presents the power curves and noise emission levels associated with the low noise operating modes of the G126 2.625MW CIIIA wind turbine.

### 2 SCOPE


The values in the present document are applicable to all the existing configurations for the G126 2.625MW CIIIA, for low noise operation modes. Tonality is not considered. The noise levels given in the document do not apply to high temperature versions.

### 3 DEFINITIONS AND ACRONYMS

- **WT:** Wind turbine.
- **Power (P):** Expressed in kW, this is the electric power obtained at the generator terminals without considering the losses in the transformer or high voltage cables of the wind turbine, or the occasional power consumption which may exist in the same to supply a component. Averaged every 10 minutes.
- **Wind speed ( $W_s$ ):** Expressed in m/s, it is the horizontal wind component value at the height of the hub averaged every 10 minutes.
- **Power curve (CdP):** Represents the change in the P in accordance with the  $W_s$  for the different WT operating modes.
- **FP:** Full Power, the power curve without NRS mode activated.
- **Annual Output / Annual Energy Production (AEP):** Expressed in [MWh], it is the total electrical energy produced in a WT during a one-year period, in accordance with a given CdP and a given wind distribution.
- **Wind distribution:** Weibull distribution is used for different K-distribution parameters and for annual average wind speed values ( $W_{ave}$ ).
- **Power coefficient:**  $C_p$
- **Thrust coefficient:**  $C_T$
- **Noise level:** The expected sound power level values, expressed in dB(A), represent the sound power that the WT emits at the height of the hub for a given wind speed.

The noise levels shown in this document are average expected values, called  $L_w$  in IEC-61400-14. To obtain the  $L_{wd}$  value, as defined in IEC-61400-14, an increase of 2 dB(A) shall be considered over said  $L_w$  values.

- **$L_{WA}$ :** A weighted sound power level, in accordance with the IEC standard.

|   |                                       |                          |                          |
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## 4 DESCRIPTION

When not specified otherwise, data in following sections is calculated using the parameters from **Table 1**. All power curve and annual energy production values in this document are subject to the validity ranges presented in **Table 2**.

|                              |                            |
|------------------------------|----------------------------|
| <b>Rated power</b>           | 2.625 MW                   |
| <b>Frequency</b>             | 50 Hz/60Hz                 |
| <b>Rotor Diameter</b>        | 126m                       |
| <b>Angle of blade tip</b>    | Pitch control regulation   |
| <b>Turbulence intensity</b>  | 10 % (for all wind speeds) |
| <b>Air density reference</b> | 1.225 kg/m <sup>3</sup>    |

**Table 1** Calculation parameter values for the G126 2.625MW CIIIA wind turbine power curve.

|  |   |
|--|---|
| <b>Wind Shear (10min average)</b>            | $\leq 0.3$  |
| <b>Turbulence intensity TI [%] for bin i</b> | $5\% \frac{(0.75v_i + 5.6)}{v_i} < TI_i < 12\% \frac{(0.75v_i + 5.6)}{v_i}$ |
| <b>Terrain</b>                               | Not complex according to IEC 61400-12-1                                     |
| <b>Upflow <math>\beta</math> [°]</b>         | $-2^\circ \leq \beta \leq +2^\circ$   |
| <b>Grid frequency [Hz]</b>                   | $\pm 0.5$ Hz  |

**Table 2** Validity ranges of power curves for the G126 2.625MW CIIIA wind turbine power curve.

## 5 LOW NOISE OPERATION MODES

### 5.1 LOW NOISE POWER CURVES

There are two different types of noise reduction modes:

- The noise reduction modes that limit the noise at higher wind speed are indicated as N1, N2 up to N3. The noise reduction levels that correspond to the mode indication in this document are represented in **table 3** below:

| <b>Mode</b>                | FP    | N1    | N2    | N3    |
|----------------------------|-------|-------|-------|-------|
| <b>Noise level [dB(A)]</b> | 106.8 | 105.2 | 104.2 | 103.2 |

**Table 3** Noise reduction levels at high wind speed for the G126 2.625MW CIIIA

- The noise reduction modes that limit the noise at lower velocities are indicated as NRS A, B and C. It is possible to activate any of the noise reduction modes at high wind speed from table 3 with a noise reduction mode at lower velocity, for example: N2 + NRS B, at the same time.



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**Table 4** shows the feasibility for low noise operation:

| <b>G126 2.625MW<br/>CIIIA</b> | <b>N1</b> | <b>N2</b> | <b>N3</b> | <b>NRS A</b> | <b>NRS B</b> | <b>NRS C</b> |
|-------------------------------|-----------|-----------|-----------|--------------|--------------|--------------|
| <b>H = 84m</b>                | Yes       | Yes       | Yes       | Yes          | Yes          | Yes          |
| <b>H = 102m</b>               | Yes       | Yes       | Yes       | Yes          | Yes          | Yes          |
| <b>H = 129m</b>               | No        | No        | No        | Yes          | Yes          | Yes          |
| <b>H = 137m</b>               | Yes       | No        | No        | Yes          | Yes          | Yes          |

**Table 4** WT G126 2.625MWCIIIA low noise levels

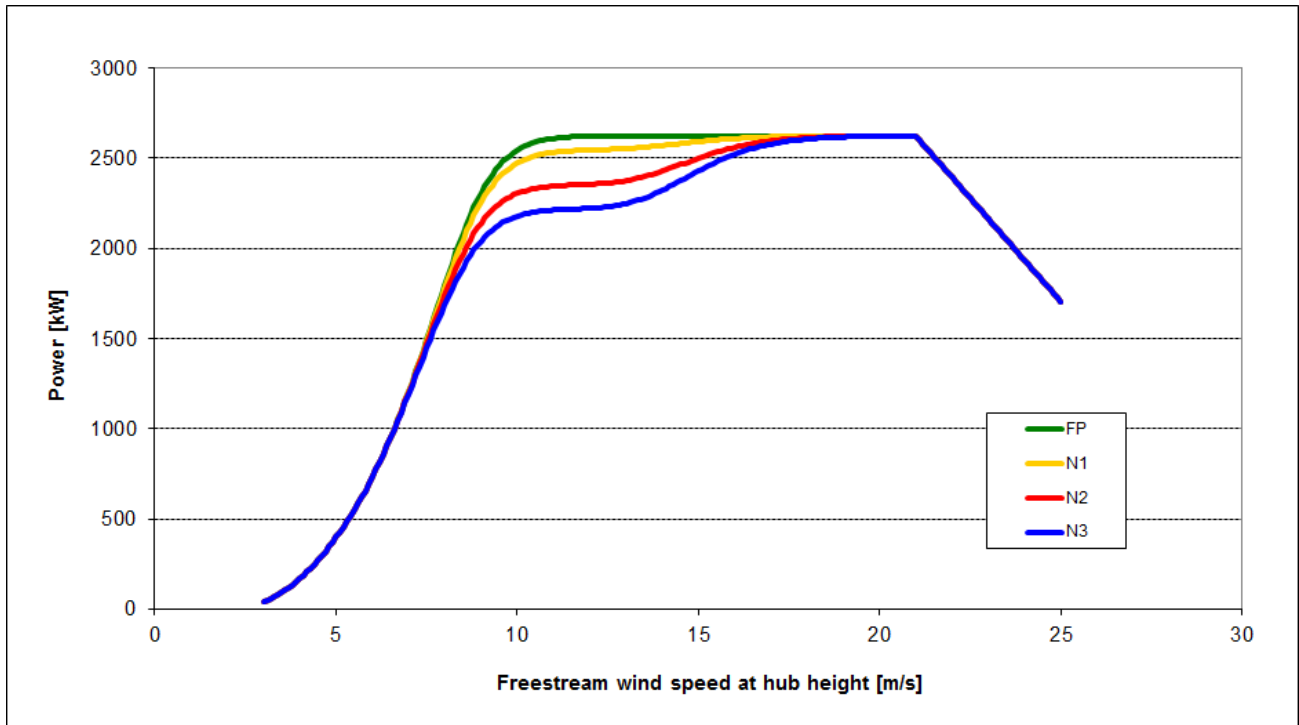
**Table 5** presents the electrical power output [kW] in function of the horizontal wind speed at hub height  $W_s$  [m/s] for different noise reduction mode settings.

| <b><math>W_s</math> [m/s]</b> | <b>P [kW]</b> |           |           |
|-------------------------------|---------------|-----------|-----------|
|                               | <b>N1</b>     | <b>N2</b> | <b>N3</b> |
| <b>3</b>                      | 41            | 41        | 41        |
| <b>4</b>                      | 170           | 170       | 170       |
| <b>5</b>                      | 397           | 397       | 397       |
| <b>6</b>                      | 734           | 734       | 734       |
| <b>7</b>                      | 1204          | 1200      | 1192      |
| <b>8</b>                      | 1782          | 1741      | 1691      |
| <b>9</b>                      | 2259          | 2142      | 2041      |
| <b>10</b>                     | 2474          | 2305      | 2179      |
| <b>11</b>                     | 2532          | 2345      | 2212      |
| <b>12</b>                     | 2545          | 2356      | 2221      |
| <b>13</b>                     | 2553          | 2376      | 2248      |
| <b>14</b>                     | 2571          | 2429      | 2324      |
| <b>15</b>                     | 2592          | 2501      | 2430      |
| <b>16</b>                     | 2609          | 2561      | 2522      |
| <b>17</b>                     | 2618          | 2597      | 2579      |
| <b>18</b>                     | 2622          | 2613      | 2606      |
| <b>19</b>                     | 2624          | 2620      | 2617      |
| <b>20</b>                     | 2625          | 2623      | 2622      |
| <b>21</b>                     | 2625          | 2625      | 2625      |
| <b>22</b>                     | 2394          | 2394      | 2394      |
| <b>23</b>                     | 2163          | 2163      | 2163      |
| <b>24</b>                     | 1931          | 1931      | 1931      |
| <b>25</b>                     | 1700          | 1700      | 1700      |

**Table 5** Electric power [kW] of the G126 2.625MW CIIIA wind turbine, calculated according to  $W_s$  [m/s] and noise level [dB(A)] (ref.: 20160630G126NRS2p625MW)



Title: G126 2.625MW CIIIA 50/60Hz Power and Noise Curves for NRS



**Figure 1** Power curve of the G126 2.625MW CIIIA wind turbine for different versions of low noise operating mode (ref.: 20160630G126NRS2p625MW)

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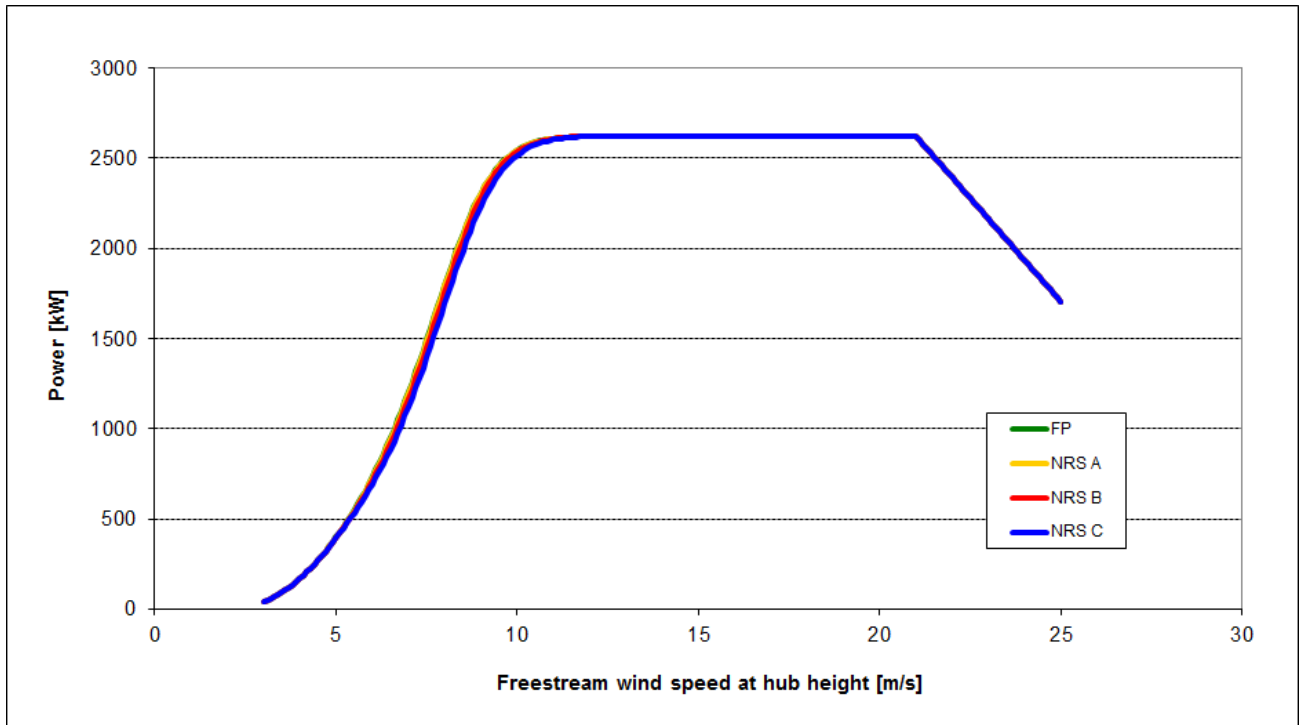
**Table 6** presents the power output [kW] of the G126 2.625MW CIIIA for different noise reduction modes at low wind speed NRS A, B and C. The power output is represented against wind speed at hub height  $W_s$  [m/s].

| $W_s$ [m/s] | P [kW] |       |       |
|-------------|--------|-------|-------|
|             | NRS A  | NRS B | NRS C |
| <b>3</b>    | 32     | 32    | 32    |
| <b>4</b>    | 173    | 173   | 173   |
| <b>5</b>    | 397    | 396   | 395   |
| <b>6</b>    | 730    | 720   | 705   |
| <b>7</b>    | 1199   | 1184  | 1156  |
| <b>8</b>    | 1790   | 1775  | 1743  |
| <b>9</b>    | 2301   | 2294  | 2274  |
| <b>10</b>   | 2542   | 2540  | 2533  |
| <b>11</b>   | 2609   | 2609  | 2607  |
| <b>12</b>   | 2622   | 2622  | 2622  |
| <b>13</b>   | 2625   | 2625  | 2625  |
| <b>14</b>   | 2625   | 2625  | 2625  |
| <b>15</b>   | 2625   | 2625  | 2625  |
| <b>16</b>   | 2625   | 2625  | 2625  |
| <b>17</b>   | 2625   | 2625  | 2625  |
| <b>18</b>   | 2625   | 2625  | 2625  |
| <b>19</b>   | 2625   | 2625  | 2625  |
| <b>20</b>   | 2625   | 2625  | 2625  |
| <b>21</b>   | 2625   | 2625  | 2625  |
| <b>22</b>   | 2394   | 2394  | 2394  |
| <b>23</b>   | 2163   | 2163  | 2163  |
| <b>24</b>   | 1931   | 1931  | 1931  |
| <b>25</b>   | 1700   | 1700  | 1700  |

**Table 6:** Power output [kW] of the G126 2.625MW CIIIA wind turbine, calculated according to  $W_s$  [m/s] for different noise reduction modes at low wind speeds NRS A, B and C. (ref.: 20160630G126NRS2p625MW)



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**Figure 2** Power curve of the G126 2.625MW CIIIA wind turbine for different versions of low noise operating modes at low wind speeds NRS A, B and C (ref.: 20160630G126NRS2p625MW)



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## 5.2 ANNUAL ENERGY PRODUCTION FOR THE LOW NOISE OPERATION MODES

**Table 7** presents the annual energy output [MWh] for the G126 2.625MW CIIIA wind turbine calculated with different Weibull distribution parameters  $W_{ave}$  [m/s] and K, for different noise reduction modes.

|                                   |                             | <b>AEP [MWh]</b> |          |            |          |            |
|-----------------------------------|-----------------------------|------------------|----------|------------|----------|------------|
| <b><math>W_{ave}</math> [m/s]</b> |                             | <b>5.5</b>       | <b>6</b> | <b>6.5</b> | <b>7</b> | <b>7.5</b> |
| <b>N1</b>                         | <b><math>K = 1.5</math></b> | 7089             | 8064     | 8962       | 9775     | 10500      |
|                                   | <b><math>K = 2.0</math></b> | 7027             | 8268     | 9436       | 10518    | 11508      |
|                                   | <b><math>K = 2.5</math></b> | 6783             | 8222     | 9599       | 10883    | 12056      |
| <b>N2</b>                         | <b><math>K = 1.5</math></b> | 6823             | 7751     | 8608       | 9387     | 10084      |
|                                   | <b><math>K = 2.0</math></b> | 6794             | 7961     | 9059       | 10078    | 11013      |
|                                   | <b><math>K = 2.5</math></b> | 6608             | 7959     | 9243       | 10435    | 11526      |
| <b>N3</b>                         | <b><math>K = 1.5</math></b> | 6607             | 7500     | 8326       | 9079     | 9756       |
|                                   | <b><math>K = 2.0</math></b> | 6597             | 7706     | 8751       | 9723     | 10619      |
|                                   | <b><math>K = 2.5</math></b> | 6450             | 7732     | 8944       | 10068    | 11098      |

**Table 7** Annual energy production for the G126 2.625MW CIIIA wind turbine for different Weibull parameters  $W_{ave}$  [m/s], Weibull K parameter and different noise reduction modes. (ref.: 20160630G126NRS2p625MW)

**Table 8** presents the annual energy output [MWh] for the G126 2.625MW CIIIA wind turbine calculated with different Weibull distribution parameters  $W_{ave}$  [m/s] and K, for different noise reduction modes at low wind speeds NRS A, B and C.

|                                   |                             | <b>AEP [MWh]</b> |          |            |          |            |
|-----------------------------------|-----------------------------|------------------|----------|------------|----------|------------|
| <b><math>W_{ave}</math> [m/s]</b> |                             | <b>5.5</b>       | <b>6</b> | <b>6.5</b> | <b>7</b> | <b>7.5</b> |
| <b>NRS A</b>                      | <b><math>K = 1.5</math></b> | 7193             | 8186     | 9099       | 9925     | 10660      |
|                                   | <b><math>K = 2.0</math></b> | 7117             | 8385     | 9580       | 10686    | 11696      |
|                                   | <b><math>K = 2.5</math></b> | 6847             | 8318     | 9730       | 11049    | 12255      |
| <b>NRS B</b>                      | <b><math>K = 1.5</math></b> | 7161             | 8153     | 9065       | 9891     | 10627      |
|                                   | <b><math>K = 2.0</math></b> | 7075             | 8341     | 9536       | 10643    | 11654      |
|                                   | <b><math>K = 2.5</math></b> | 6798             | 8265     | 9677       | 10996    | 12204      |
| <b>NRS C</b>                      | <b><math>K = 1.5</math></b> | 7100             | 8089     | 9000       | 9826     | 10562      |
|                                   | <b><math>K = 2.0</math></b> | 6998             | 8259     | 9451       | 10558    | 11570      |
|                                   | <b><math>K = 2.5</math></b> | 6709             | 8167     | 9574       | 10892    | 12103      |

**Table 8** Annual energy production for the G126 2.625MW CIIIA wind turbine for different Weibull parameters  $W_{ave}$  [m/s], Weibull K parameter and different noise reduction modes at low wind speeds NRS A, B and C. (ref.: 20160630G126NRS2p625MW)





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### 5.3 NOISE CURVES

This section presents an estimate of aero-acoustic noise emitted by the rotor of the G126 2.625MW CIIIA wind turbine in the various NRS modes mentioned in this document, simulated for different wind speeds at the height of the hub ( $W_s$ ).

**Table 9** includes the noise curves of the G126 2.625MW CIIIA wind turbine for different noise reduction modes in function of  $W_s$  [m/s].

| $W_s$<br>[m/s] | <b>N1</b><br>[dB(A)] | <b>N2</b><br>[dB(A)] | <b>N3</b><br>[dB(A)] | <b>NRS A</b><br>[dB(A)] | <b>NRS B</b><br>[dB(A)] | <b>NRS C</b><br>[dB(A)] |
|----------------|----------------------|----------------------|----------------------|-------------------------|-------------------------|-------------------------|
| <b>3</b>       | 96.0                 | 96.0                 | 96.0                 | 96.0                    | 96.0                    | 96.0                    |
| <b>3.5</b>     | 96.0                 | 96.0                 | 96.0                 | 96.0                    | 96.0                    | 96.0                    |
| <b>4</b>       | 96.0                 | 96.0                 | 96.0                 | 96.0                    | 96.0                    | 96.0                    |
| <b>4.5</b>     | 96.0                 | 96.0                 | 96.0                 | 96.0                    | 96.0                    | 96.0                    |
| <b>5</b>       | 96.0                 | 96.0                 | 96.0                 | 96.0                    | 96.0                    | 96.0                    |
| <b>5.5</b>     | 97.4                 | 97.4                 | 97.4                 | 96.4                    | 96.0                    | 96.0                    |
| <b>6</b>       | 99.5                 | 99.5                 | 99.5                 | 98.5                    | 97.4                    | 96.4                    |
| <b>6.5</b>     | 101.4                | 101.4                | 101.4                | 100.3                   | 99.3                    | 98.3                    |
| <b>7</b>       | 103.1                | 103.1                | 103.1                | 102.1                   | 101.0                   | 100.1                   |
| <b>7.5</b>     | 104.7                | 104.2                | 103.2                | 103.6                   | 102.6                   | 101.7                   |
| <b>8</b>       | 105.2                | 104.2                | 103.2                | 105.1                   | 104.1                   | 103.2                   |
| <b>8.5</b>     | 105.2                | 104.2                | 103.2                | 106.8                   | 105.4                   | 104.5                   |
| <b>9</b>       | 105.2                | 104.2                | 103.2                | 106.8                   | 106.8                   | 105.8                   |
| <b>9.5</b>     | 105.2                | 104.2                | 103.2                | 106.8                   | 106.8                   | 106.8                   |
| <b>10</b>      | 105.2                | 104.2                | 103.2                | 106.8                   | 106.8                   | 106.8                   |
| <b>10.5</b>    | 105.2                | 104.2                | 103.2                | 106.8                   | 106.8                   | 106.8                   |
| <b>11</b>      | 105.2                | 104.2                | 103.2                | 106.8                   | 106.8                   | 106.8                   |
| <b>11.5</b>    | 105.2                | 104.2                | 103.2                | 106.8                   | 106.8                   | 106.8                   |
| <b>12</b>      | 105.2                | 104.2                | 103.2                | 106.8                   | 106.8                   | 106.8                   |
| <b>12.5</b>    | 105.2                | 104.2                | 103.2                | 106.8                   | 106.8                   | 106.8                   |
| <b>13</b>      | 105.2                | 104.2                | 103.2                | 106.8                   | 106.8                   | 106.8                   |
| <b>13.5</b>    | 105.2                | 104.2                | 103.2                | 106.8                   | 106.8                   | 106.8                   |
| <b>14</b>      | 105.2                | 104.2                | 103.2                | 106.8                   | 106.8                   | 106.8                   |
| <b>14.5</b>    | 105.2                | 104.2                | 103.2                | 106.8                   | 106.8                   | 106.8                   |

**Table 9** Noise curves of the G126 2.625MW CIIIA wind turbine (ref.: 20160630G126NRS2p625MW)