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Risk assessment related to noise and infrasonic noise in a wind farm

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Abstract

The development of wind energy in Poland is accompanied by an increase in the number of people employed in the workplaces of wind energy sector. According to recent estimates, 8,400 persons were employed in wind energy sector, with 600 of them directly employed on wind farms. On the basis of an analysis of the activities carried out by the wind farm staff and interviews with the employees, a typical weekly profile of work including 15 activities was developed. Thereafter, noise and infrasonic noise measurements at workplaces in the wind farm were carried out during service and maintenance activities carried out by the staff. The scope of the measurements at workplaces included the determination of the following parameters: the A-weighted sound pressure levels, the A-weighted maximum sound pressure levels, the C-weighted peak sound pressure levels and the G-weighted sound pressure levels. The results of the measurements made it possible to perform risk assessments related to noise and infrasonic noise. It was concluded that noise and infrasonic noise at the workplaces in the wind farm do not exceed the values of Maximum Admissible Intensities for noise in the working environment and the infrasonic noise nuisance criteria, respectively. The results of risk assessment showed that risk related to exposure to noise and infrasonic noise in the wind farm is small (admissible).

Keywords: noise, workplace, wind turbine
Risk assessment related to noise and infrasonic noise in a wind farm

1 Introduction

Renewable sources of energy are minor but growing sources of electrical energy and thermal energy in Poland. The share of energy from renewable sources in final consumption of energy was 11.45% in 2014 [1]. By way of comparison, in the European Union the share of renewable energy in gross final energy consumption was 14.1 % in 2013 [2].

In Poland the necessity of development of renewable power generation, including wind power, results among others from the provisions of the 2009/28/EC Directive of 23 April 2009 on the promotion of the use of energy from renewable sources [3], which came into effect in June 2009. General goals of the Directive assume reaching 20% of final gross energy consumption in 2020 within the European Union coming from renewable sources. Poland has to achieve a 15% share of energy from renewable sources in 2020.

The development of wind energy in Poland is accompanied by an increase in the number of people employed in the workplaces of wind energy sector. According to recent estimates 8,400 persons were employed in wind energy sector in 2014, with 600 of them directly employed on wind farms (compared to 300 people employed for this purpose in 2010) [4].

The impact of wind farms during their operation can be brought down to their impact on [5]:

- avifauna and chiropteran fauna,
- acoustic climate of the environment (noise and infrasonic noise emissions),
- electromagnetic climate of the environment (generation of magnetic fields and interferences of electromagnetic communication),
- optical phenomena (effect of shadow flicker),
- landscape (negative visual impact),
- failures and accidents,
- value of property (negative impact).

There are a number of publications relating to the environmental and health impact of wind turbine noise. However in the case of occupational exposure to noise and infrasonic noise emitted by wind turbines (workplaces of turbine operation personnel, including persons performing maintenance and repairs), there are no documented data in literature in this regard. For this reason, the aim of the project was to carry out a pilot study on the occupational risk assessment related to noise and infrasonic noise at workplaces in a wind farm.

2 Tested wind farm

At the end of April 2016 in Poland a total of 646 wind turbines manufactured by 8 various companies were installed at 38 wind farms with a capacity of more than 5 MW each [6]. The most
popular wind turbine manufacturers is Vestas, whose 239 wind turbines are operated at 12 wind farms. The Vestas V80 – 2.0 MW type is in the majority. Therefore, the tested objects were Vestas V80-2.0 MW type wind turbines.

The characteristic technical parameters of the tested Vestas V80 – 2.0 MW wind turbines are following:

- rated power: 2 MW,
- rotor diameter: 80 m,
- tower height: 100 m.

The measurements of noise and infrasonic noise were carried out in a wind farm located in West Pomeranian Voivodeship (north-west part of Poland). The farm includes 25 Vestas V80 – 2.0 MW wind turbines. The wind turbines are located about 450 m from each other.

3 Test methods

3.1 Noise and infrasonic noise measurement methods

Noise measurements were carried out in accordance with the European Standard EN ISO 9612 [7]. Whereas, infrasonic noise measurements were carried out in accordance with the Polish Standard PN-Z-01338 [8] and the European Standard EN ISO 9612.

3.2 Admissible values

According to the Polish Regulation of the Minister of Labour and Social Policy [9] admissible values of quantities of noise (maximum allowable intensities (MAI) for noise) are following: the daily noise exposure level $L_{A_{Ex,8h}} = 85$ dBA (or the weekly noise exposure level $L_{A_{Ex,w}} = 85$ dBA), the A-weighted maximum sound pressure level $L_{A_{max}} = 115$ dBA, the C-weighted peak sound pressure level $L_{C_{peak}} = 135$ dBC.

In the case of infrasonic noise there is an annoyance criterion specified in the above mentioned Polish Standard PN-Z-01338. According to this Standard the values of the infrasonic noise annoyance criterion are following:

- the equivalent G-weighted sound pressure level, normalised to a nominal 8-hour working day or the 40-hour average weekly working time for all employees $L_{G_{eq,8h}}/L_{G_{eq,w}} = 102$ dBG,
- the equivalent G-weighted sound pressure level, during occupation of a workplace designated for conceptual work $L_{G_{eq}} = 86$ dBG.

3.3 Occupational risk assessment

The Polish Standard PN-N-18002 [10] recommends using a three-point risk-level estimator. In accordance with the principles given in the Polish Standard PN-N-18002, occupational risk:

- related to noise can be estimated based on the values of noise exposure and the values of the MAI for noise (see Table 1),
- related to infrasonic noise can be estimated on the values of infrasonic noise exposure and the values of the annoyance criterion (see Table 2).
Table 1: Occupational risk assessment related to noise

<table>
<thead>
<tr>
<th>Noise exposure quantity</th>
<th>Risk estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{AEx,8h}$ or $L_{AEx,w}$ \leq 82 dBA</td>
<td>small - acceptable</td>
</tr>
<tr>
<td>$L_{Amax} \leq 109$ dBA</td>
<td></td>
</tr>
<tr>
<td>$L_{Cpeak} \leq 129$ dBC</td>
<td></td>
</tr>
<tr>
<td>$82$ dBA &lt; $L_{AEx,8h}$ or $L_{AEx,w}$ \leq 85 dBA</td>
<td>medium - acceptable</td>
</tr>
<tr>
<td>$109$ dBA &lt; $L_{Amax} \leq 115$ dBA</td>
<td></td>
</tr>
<tr>
<td>$129$ dBC &lt; $L_{Cpeak} \leq 135$ dBC</td>
<td></td>
</tr>
<tr>
<td>$L_{AEx,8h}$ or $L_{AEx,w} &gt; 85$ dBA</td>
<td>high - unacceptable</td>
</tr>
<tr>
<td>$L_{Amax} &gt; 115$ dBA</td>
<td></td>
</tr>
<tr>
<td>$L_{Cpeak} &gt; 135$ dBC</td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Occupational risk assessment related to infrasonic noise

<table>
<thead>
<tr>
<th>Infrasonic noise exposure quantity</th>
<th>Risk estimation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>Medium</td>
</tr>
<tr>
<td>$L_{Geq,8h}$ or $L_{Geq,w}$ \leq 99 dBG</td>
<td>&gt; 99 dBG and \leq 102 dBG</td>
</tr>
<tr>
<td>$L_{Geq} \leq 83$ dBG</td>
<td>&gt; 83 dBG and \leq 86 dBG</td>
</tr>
</tbody>
</table>

4 Test results

Measurements of noise and infrasonic noise were carried out during the performance of service support and maintenance activities by employees on 6 wind turbines and at the transformer station. Based on the characteristics of works associated with the service support and operation of the wind turbines, the most representative (most common) activities (15 activities) were selected, for which the measurements of noise and infrasonic noise were carried out.

As regards this category of employees, the noise affecting their bodies is non-uniform in nature on particulars days of the week. It was therefore necessary to determine the noise exposure level normalised to the average weekly working time, $L_{AEx,w}$.

The values of noise exposure and infrasonic noise exposure of employees operating the tested wind farm are given in Table 3.

Table 3: Noise and infrasonic noise exposure

<table>
<thead>
<tr>
<th>Day</th>
<th>$L_{AEx,8h}$ dBA</th>
<th>$L_{AEx,w}$ dBA</th>
<th>$L_{Amax,8h}$ dBA</th>
<th>$L_{Amax,w}$ dBA</th>
<th>$L_{Cpeak,8h}$ dBC</th>
<th>$L_{Cpeak,w}$ dBC</th>
<th>$L_{Geq,8h}$ dBG</th>
<th>$L_{Geq,w}$ dBG</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>76.5</td>
<td>93.0</td>
<td>93.9</td>
<td></td>
<td>113.4</td>
<td>126.2</td>
<td>93.5</td>
<td>92.5</td>
</tr>
<tr>
<td>2</td>
<td>76.2</td>
<td></td>
<td>90.9</td>
<td>109</td>
<td>113.4</td>
<td>126.2</td>
<td>93.4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>75.7</td>
<td>93.9</td>
<td></td>
<td>109</td>
<td>113.4</td>
<td>75.2</td>
<td>93.4</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>83.0</td>
<td>97.0</td>
<td></td>
<td>109</td>
<td>113.4</td>
<td>75.2</td>
<td>93.4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>39.9</td>
<td>41.4</td>
<td></td>
<td>109</td>
<td>113.4</td>
<td>75.2</td>
<td>93.4</td>
<td></td>
</tr>
</tbody>
</table>

The results of occupational risk assessment related to the noise are given in Table 4. In the presence of the infrasonic noise, the result of risk assessment is given in Table 5.
5 Conclusions

It was concluded, based on the study, that noise of the Vestas V80-2.0 MW wind turbines at workplaces in wind farms poses no threat to employees' health, because the noise exposure levels normalized to working week did not exceed the exposure limit value, which is 85 dBA.

The infrasonic noise likewise doesn’t constitute the annoyance factor, as the G-weighted sound pressure level was below the criterial value which is 102 dBG.

The assessment of occupational risk showed that the risks related to noise and infrasonic noise exposure were small (acceptable) at workplaces belonging to personnel operating the wind farm where Vestas V80-2.0 MW wind turbines were installed.

Acknowledgments

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References


