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# Noise at Workplaces in the Call Center

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In the last years the number of new forms of workplaces, such as call centers, increases. It is defined as a workstation where the basic tasks of a worker are carried out with the use of a phone and a computer. According to statistics, about 1.3–4% of workers are employed in call centers in the European countries. The noise is one of the harmful and annoying hazards of call center workstations. The paper presents the noise sources in call center rooms, assessment criteria of noise and results of noise measurements in call center workstations. The results of measurements show that the noise at call center workstations (during the use of handset receiver phone by operators) can be harmful (causing the risk of hearing loss) and annoying, as it makes it difficult to carry out the basic work activities and causes additionally auditory disadvantageous changes in health.

**Keywords:** noise, exposure, call center.

## 1. Introduction

In accordance with the British Health and Safety Executive, a call center is defined as a work environment where all basic employee's tasks are completed simultaneously by phone and on PC. The very first call centers appeared in Europe in Sweden, in the mid-70's of the last century. The last decade brought a rapid development of call centers proven by a 10 percent growth in employment in this sector between 2002 and 2007. According to statistics, approximately 1.3–4 percent of all employees work in call centers (Gavhed, Toomingas, 2007). Majority of call centers workstations (helpdesks included) take on shape of a so-called *open space* environments. Characteristic feature of such a place is an organization of work for a large number of workers being in one and the same space instead of separate rooms.

Based on the research conducted by the Central Institute for Labour Protection – National Labour Institute at such workstations, the following annoying and/or harmful work environment factors can occur: chemical, biological or dust pollutants, noise, mechanical vibrations, electromagnetic field, static electricity, improper lighting and microclimate (Jankowska *et al.*, 2007; Kaczmarska *et al.*, 2004). Exposure to such factors can lead the workers to suffer from symptoms of the illness known in the literature as the Sick Building Syndrome. Sources of noise occurring in offices can be divided into four categories (Kaczmarska *et al.*, 2004):

- human activity (for example: noise created by walking people, phone calls including speaker systems),
- office equipment (for example: computers, printers, copy machines, faxes, ringing phones, net devices, mobile headsets),
- building indoor installations (for example: ventilation, heating system and air condition system – HVAC, hydraulic and lift systems),
- outdoor noise (most often a result of traffic).

There are many factors that have an impact on indoor noise level such as outside area noise, neighbour workers from the side as well as from the upper and lower levels activity and finally, the call center's technical equipment noise. The loudest systems with regard to the last one are ventilation and air condition. In accordance to research, the level of the background noise is not high (54–60 dB) and should not be considered to be a threat towards health; however, due to focusing employee's involuntary attention on information delivered by noise, it should be seen as an annoying factor.

## 2. State of knowledge

Basic parameter describing employees' exposure to noise during intellectual work is equivalent to continuous $A$-weighted sound pressure level ($L_{Aeq}$). And so, the Swedish research carried out on a group of 156 call center employees, representing 16 companies, show the average of $A$-weighted sound pressure level in open space offices to be 61 dB, which means that in 72 percent of these offices, the noise boundary A of 55 dB has been exceeded (Gavhed, Toomingas, 2007).

Similar results were acquired 5 years ago by Patel and Broughton who, on the basis of the research carried out in 15 call centers, described the averaged $A$-weighted sound pressure level of acoustic background to be 62 dB (Patel, Broughton, 2002). Planueu results from similar research conducted in 24 call centers also indicated that noise boundary A of 55 dB exceeded in 66 percent of cases (Planueu, 2005).

The first call centers noise measurements were carried out on the basis of dosimeter methods or methods implying the third-octave analysis. Along with development tools and their use at workstations, such as sensitive microphones,

the first indications showing that they may also become additional source of noise in call centers, has appeared.

According to literature, depending on the type of headset, *A*-weighted sound pressure levels fluctuate between 50 and 87 dB (average *A*-weighted sound pressure level – 80 dB) in PERETTI's research (PERETTI *et al.*, 2003), from 65 to 88 dB (average *A*-weighted sound pressure level – 77 dB) according to PATEL and BROUGHTON (2002), from 64 to 88 dB according to DAJANI and KUNOV (1996), and from 80 to 104 dB (average *A*-weighted sound pressure level – 87 dB) according to CHIUSANO *et al.* (1995). Therefore in some cases defined as acoustic shock, the cases possibility of hearing loss connected with exposure to headset noise was stated. The phenomenon occurs if an employee is under short-term exposure to high-intensity noise, which can even reach 118 dB under equipment. Its main source are "static's" – short sounds resulting from phone call clutter or disruptions caused by malicious callers puffing at the headset. It was LAWTON who first formulated a thesis on possible hearing losses caused by acoustic shock at workplaces in the call center. However, no research confirmed it afterwards, although employees still complained on ear hums, tiredness and annoyance caused by a short-term exposure to sudden, loud noise (LAWTON, 2003).

Therefore, new methods of noise measurement in work environment that take technological advancement into account, in regard of employees which use the headsets, various radio communication systems and/or equipment, were developed (EN ISO 11904-2:2005; EN ISO 11904-1:2008). Currently, the methods recommended to measure noise heard by a call center employee are in the line with EN ISO 11904 (part 1 and 2) as well as MIRE technique or acoustic phantom.

The article presents test results of exposure to noise seen as annoying and harmful factor in open space call center work environment.

## 3. Methods and criteria of noise evaluation at call centers

Measurements and noise evaluation at call center's workstations were conducted in pursuance of decree requirements (Ordinance of the Minister of Environment; Ordinance of the Minister of Labour and Social Policy) and standards such as PN-ISO 9612:2004, PN-N 01307:1994 and PN-N-87/B-02151/02 (EN-ISO 9612:2004; PN-N-87/B-02151/02; PN-N 01307:1994).

Evaluation of employees' exposure to noise at workstations was conducted regarding to:

- hearing protection – harmfulness criterion (exceeding the Maximum Admissible Intensities – MAI) – in pursuance of the Minister of Labour and Social Policy's ordinance (Ordinance of the Minister of Labour and Social Policy).
- possibility of basic work functions realization – criterion of annoyance (exceeding MAI in pursuance of PN-N 01307:1994).

Noise harmfulness and annoyance criteria are presented in Tables 1 and 2.

**Table 1**. Harmfulness criterion of noise – MAI (Maximum Admissible Intensities) values of noise, established for general workers on account of hearing protection.

| No. | Noise volume | MAI value [dB] |
|---|---|---|
| 1. | $A$-weighted noise exposure level normalized to 8-hours working day (daily noise exposure level) $L_{EX,8\mathrm{h}}$ or $A$-weighted noise exposure level, normalized to a nominal working week (weekly noise exposure level) $L_{EX,w}$ | 85 |
| 2. | $A$-weighted maximum sound pressure level, $L_{A\max}$ | 115 |
| 3. | $C$-weighted peak sound pressure level, $L_{C\mathrm{peak}}$ | 135 |

**Table 2**. Noise annoyance criterion – admissible noise values settled for the employees due to the possibility of basic work functions realization.

| No. | Noise characteristics | Workstation | Admissible MIA [dB] |
|---|---|---|---|
| 1. | Equivalent continuous $A$-weighted sound pressure level over the duration $T_e$, $L_{Aeq,Te}$ | In dispatch chambers, observatories, telephone remote control rooms used in management procedures, precision workshops and other similar places | 65 |
| 2. | $A$-weighted maximum sound pressure level, $L_{A\max}$ | sa. | 115 |
| 3. | $C$-weighted peak sound pressure level, $L_{C\mathrm{peak}}$ | sa. | 135 |

The method of assessing the exposure to noise at call center workstations – due to hearing or health protection – is meant to compare the values acquired during measurements with the criteria values (setting multiplicities of admissible value surpassion).

Assessment of noise indoors, where call center workstations are placed, was conducted also taking into account the noise produced by technical equipment of the building and the noise penetrating the walls. In order to determine the noise coming from the technical equipment of the building, equivalent continuous $A$-weighted sound pressure level measurements were carried out at one point (in the middle of the room), with furnishings and equipment placed accordingly to their purposes. Admissible indoor noise values are determined in PN-N-87/B-02151/02. Admissible equivalent continuous $A$-weighted sound pressure level penetrating the wall from all sources combined $L_{Aeq,t}$ is set to 45 dB.

To determine the noise level in relation to outdoor sources, the equivalent continuous $A$-weighted sound pressure level was measured in spots characteristic to certain part of the building (that is, on the surface of the elevation of 1–2 m from its surface).

Admissible outdoor sound pressure levels are defined by the Minister of Environment with regard to admissible sound pressure levels in the work environment (Ordinance of the Minister of Environment, 2007). In the ordinance areas within the limits of cities populated by 100 thousand people or more (with dense building, administration, trade and services development) they are not to be disturbed by noise with equivalent continuous $A$-weighted sound pressure level value exceeding 65 dB.

## 4. Measurement environment

Measurements of values parameters determining noise at call center workstations were conducted among the employees hired to work for mobile network customers. The workstations were situated in the open space area, lined up in boxes (approximately 8 workstations in one box), individually suppressed and with small gaps in between. Approximately 60 employees were present in the area during the measurements. An employee at the workstation was performing the following activities: answering phone calls, anticipating phone calls and performing administrative work such as writing e-mails to the customers. Average time spent for phone calls was approx. 5 hours daily, administrative work took approx. 2 hours and break for each employee took less than 1 hour. On average, approx. 80 percent of work time was spent by sitting employees. Average phone call took 4 minutes. In regard of more sophisticated and demanding phone calls, that time lengthened to approx. 10 minutes. All employees used the same type of headsets.

Measurements of noise under headsets at call center workstations were carried out by determining: equivalent continuous $A$-weighted sound pressure level

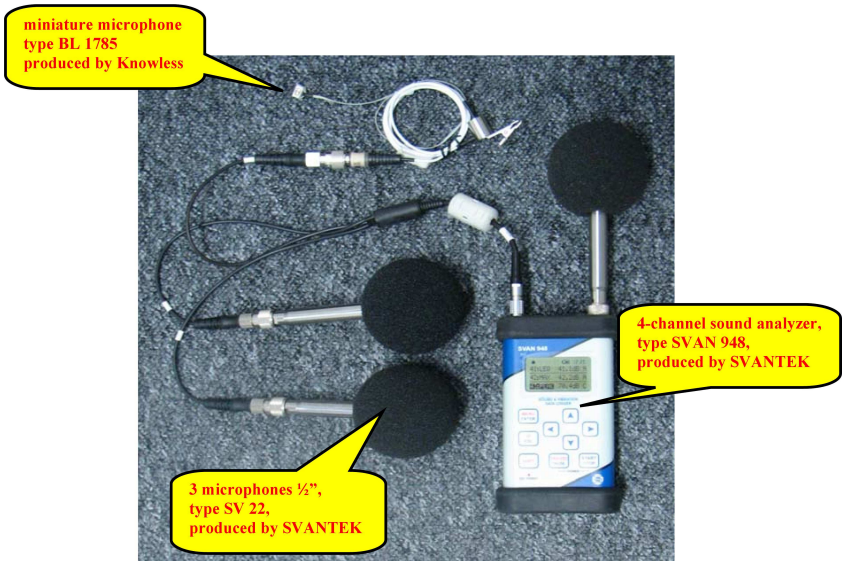


Fig. 1. Measurement equipment.

($L_{Aeq,Te}$), $A$-weighted maximum sound pressure level ($L_{A\,\max}$) and $C$-weighted peak sound pressure level ($L_{C\text{peak}}$), during phone calls as well as during the anticipation time. Measurement equipment is shown in Fig. 1. Measurements were conducted by use of a miniature microphone placed at the input of an external hearing canal. The way placed of microphone according to PN-EN ISO 11904-1 is shown in Fig. 2.

Fig. 2. The way placed of microphone according to PN-EN ISO 11904-1.

## 5. Noise measurement results under employees headsets at call center workstations

Measurements of values of the parameters determining noise under employee's headsets at call center workstations were conducted during phone calls as well as during awaiting them.

During phone calls performed by call center workstations employees, the following values of noise parameters were measured: equivalent continuous $A$-weighted sound pressure level ranging from 68 to 91 dB, $A$-weighted maximum sound pressure level ranging from 88 to 102 dB and $C$-weighted peak sound pressure level ranging from 97 to 125 dB.

On the other hand, while anticipating a phone call, the following values of parameters of noise were measured: equivalent continuous $A$-weighted sound pressure level ranging from 55 to 65 dB, $A$-weighted maximum sound pressure level ranging from 55 to 91 dB and $C$-weighted peak sound pressure level ranging from 77 to 119 dB.

Detailed results of noise parameters measurements conducted during phone calls and while awaiting for them, are presented in Table 3. Whereas, Figs. 3

and 4 show the percentage distribution of workstations depending on equivalent, continuous $A$-weighted sound pressure level values, under headsets during phone calls, during phone calls and while anticipating them at 18 workstations.

**Table 3**. Results of measurement of sound pressure levels at workstations, measured under headset in the time $T_{e,i}$.

| No. of the workstation | during phone calls | | | | during awaiting | | | |
|---|---|---|---|---|---|---|---|---|
| | $T_{e,i}$ [s] | $L_{Aeq,Te,i}$ [dB] | $L_{A\max,Te,i}$ [dB] | $L_{C\text{peak},Te,i}$ [dB] | $T_{e,i}$ [s] | $L_{Aeq,Te,i}$ [dB] | $L_{A\max,Te,i}$ [dB] | $L_{C\text{peak},Te,i}$ [dB] |
| 1 | 1348 | 78.8 | 90.9 | 124.9 | 805 | 54.8 | 59 | 81.7 |
| | 1237 | 80.8 | 90.9 | 124.9 | 14 | 56.8 | 58.8 | 77.1 |
| 2 | 172 | 81.5 | 89.6 | 107.9 | | | | |
| 3 | 90 | 80 | 88 | 104.9 | | | | |
| 4 | 382 | 83.5 | 96.2 | 109.5 | | | | |
| 5 | 111 | 80.2 | 98.3 | 105.9 | 54 | 63.3 | 71 | 87.4 |
| | 112 | 85.8 | 97.9 | 117.7 | 12 | 57.7 | 61.7 | 84.2 |
| 6 | 681 | 87.6 | 98.7 | 114.1 | | | | |
| 7 | 432 | 83.2 | 96.8 | 124.9 | 63 | 60.4 | 68.1 | 89.3 |
| | 711 | 79.3 | 94.2 | 108.8 | 24 | 66.1 | 66 | 84.6 |
| 8 | 25 | 84.5 | 91.9 | 107.2 | 29 | 62.4 | 67.4 | 86.4 |
| | 67 | 85.9 | 96.3 | 114.5 | 62 | 61.1 | 67.7 | 85.4 |
| | 304 | 85.6 | 97.6 | 124.9 | 56 | 64.4 | 73.6 | 91.3 |
| | | | | | 63 | 75 | 91.5 | 118.9 |
| 9 | 291 | 89.8 | 100.6 | 118.6 | 129 | 67.2 | 93.9 | 102.6 |
| | 1622 | 84.1 | 102 | 116.2 | | | | |
| 10 | 80 | 77 | 81.5 | 100.8 | 35 | 63.4 | 68.9 | 89.2 |
| 11 | 89 | 67.9 | 80 | 97.4 | 62 | 61.8 | 69.8 | 94 |
| 12 | 75 | 77.8 | 83.2 | 102.7 | | | | |
| 13 | 221 | 82.5 | 92.7 | 111.7 | 20 | 58.8 | 60.5 | 78.6 |
| 14 | 32 | 76.4 | 82.2 | 100.9 | 56 | 60.3 | 65.7 | 83.6 |
| | 47 | 82.8 | 89.6 | 107.6 | 31 | 59.6 | 63.9 | 88.7 |
| 15 | | | | | 109 | 64.7 | 73.5 | 93.8 |
| 16 | 276 | 85.1 | 100.4 | 112.4 | | | | |
| 17 | | | | | 256 | 58.3 | 67.9 | 92.9 |
| 18 | 342 | 89.9 | 101.7 | 116.9 | | | | |

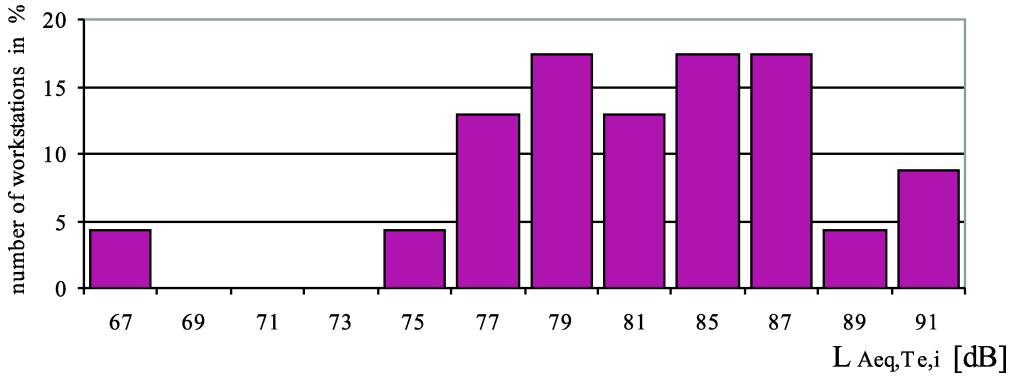


Fig. 3. Percentage distribution of workstations, depending on equivalent continuous $A$-weighted sound pressure level values, under headsets during the phone calls.

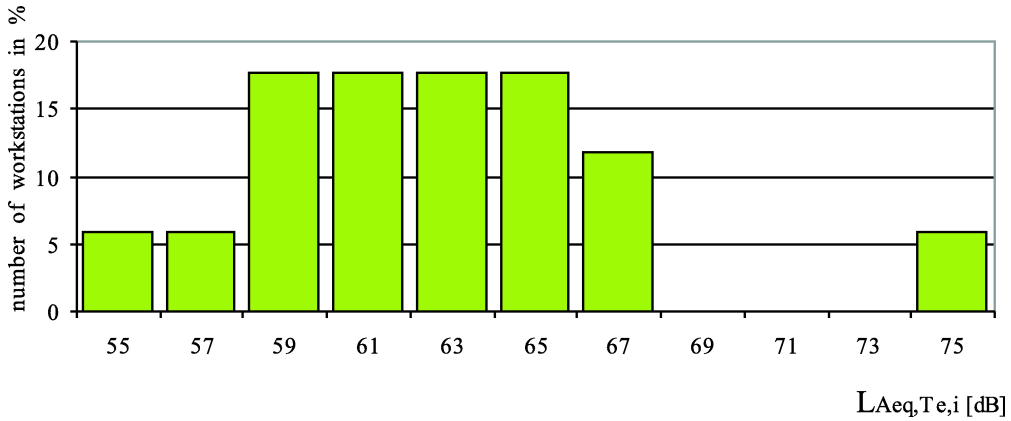


Fig. 4. Percentage distribution of workstations, depending on equivalent continuous $A$-weighted sound pressure level values, under headsets while anticipating the phone calls.

On the basis of acquired results it was confirmed that the equivalent continuous $A$-weighted sound pressure level under headset, approaches during the phone calls 80 dB at 60 percent of the workstations. On the other hand, measurements conducted during the anticipation time resulted in equivalent continuous $A$-weighted sound pressure level, reaching 65 dB at 45 percent of workstations.

## 6. Evaluation of noise results at call center employees workstations

Assessing of the exposure to noise at call center employees' workstations was performed in relation to a harmful and annoyance noise. Daily noise exposure level for these workstations (referred to $T_e = 480$ minutes), on the basis of noise parameters value measurements during particular activities (phone call anticipation, phone call in progress, administrative work and so on) and their time were calculated. Time $T_{e,i}$ for each action was determined on the basic interview with

the manager. Assessment and measurement results are described in Table 4 as well as in Figs. 5 and 6.

**Table 4**. Results of measurement of noise parameters at workstations.

| No. of the workstation | $L_{Aeq,Te}$ [dB] | $L_{EX,8h}$ [dB] | $L_{A\,max}$ [dB] | $L_{Cpeak}$ [dB] |
|---|---|---|---|---|
| 1 | 79.7 | 79.2 | 90.9 | 124.9 |
| 2 | 79.3 | 78.8 | 89.6 | 107.9 |
| 3 | 79.3 | 78.8 | 88 | 104.9 |
| 4 | 82.0 | 81.6 | 96.2 | 109.5 |
| 5 | 79.1 | 78.6 | 98.3 | 105.9 |
| 6 | 84.9 | 84.2 | 98.7 | 114.1 |
| 7 | 81.7 | 81.2 | 96.8 | 124.9 |
| 8 | 83.9 | 83.4 | 96.3 | 118.9 |
| 9 | 87.7 | **87.2** | 102 | 118.6 |
| 10 | 75.1 | 74.6 | 81.5 | 100.8 |
| 11 | 67.6 | 67.1 | 80.0 | 97.4 |
| 12 | 75.8 | 75.3 | 83.2 | 102.7 |
| 13 | 80.4 | 79.9 | 92.7 | 111.7 |
| 14 | 80.7 | 80.2 | 89.6 | 107.6 |
| 15 | 66.0 | 65.5 | 76.9 | 95.9 |
| 16 | 83.0 | 82.5 | 100.4 | 112.4 |
| 17 | 62.5 | 62.1 | 76.9 | 95.9 |
| 18 | 87.7 | **87.3** | 101.7 | 116.9 |

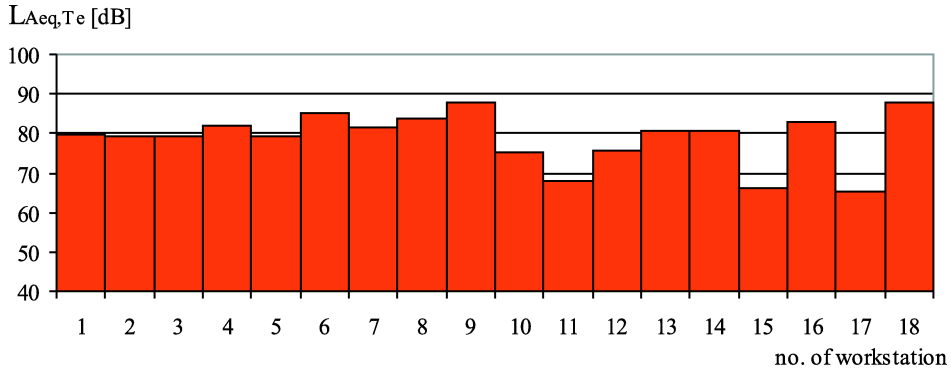


Fig. 5. Measurement results of equivalent $A$-weighted sound pressure level A in the time $T_e$ at workstations.

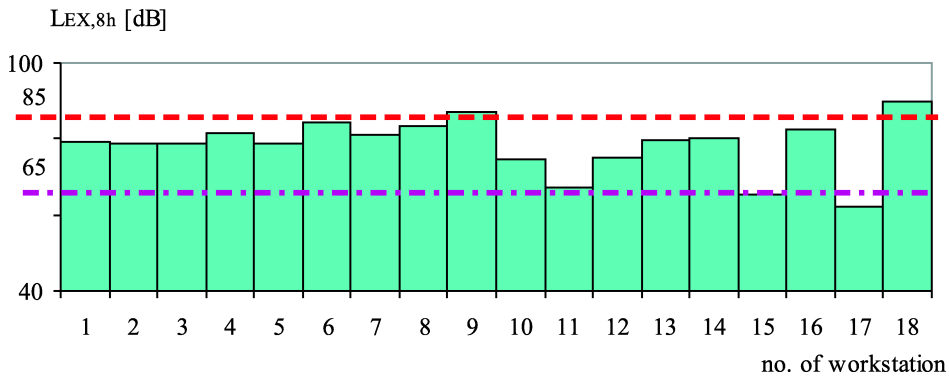


Fig. 6. Results of noise exposure level at workstations normalized to a 8-hours working day.

Equivalent continuous $A$-weighted sound pressure level over the duration $T_e$ ($L_{Aeq,Te}$) ranged from 62 to 87 dB and exceeded the admissible value of 65 dB (excluding one of the workstations), which is defined to ensure the employees ability to perform basic work functions. It should also be noted that the difference between equivalent continuous $A$-weighted sound pressure levels over the duration $T_e$ during phone calls vs. the anticipation time was approx. 15 dB.

The $A$-weighted noise exposure level normalized to 8-hours working day at workstations ($L_{EX,8h}$) ranged from 62 to 87 dB. At two workstations it exceeded 85 dB which is the admissible value established to protect employee's hearing. Measured values of the $A$-weighted maximum sound pressure level ($L_{A\max}$) ranged from 77 to 102 dB and the $C$-weighted peak sound pressure level ($L_{C\text{peak}}$) – between 96 and 125 dB, thus not exceeding the admissible intensities at all workstations.

## 7. Indoor and outdoor noise measurement results

The value of equivalent continuous $A$-weighted sound pressure level measured inside the call center from the technical equipment of the building, did not exceed the admissible level of the indoor equivalent continuous $A$-weighted sound pressure level, being 45 dB. In regard of outdoor noise, the value of measured equivalent continuous $A$-weighted sound pressure level on the surface of the building's elevation remained under the admissible level of the equivalent continuous $A$-weighted sound pressure level within the city limits, being 65 dB.

## 8. Conclusions

On the basis of the results of noise measurement at 18 workstations of the call center, the equivalent continuous $A$-weighted sound pressure level under headset during phone calls, exceeded 80 dB at 60 percent of the analyzed workstations.

Whereas, during phone call anticipation, the equivalent continuous $A$-weighted sound pressure level under headset exceeded 65 dB at 45 percent of the workstations. Acquired values of $A$-weighted maximum sound pressure level ranged from 77 to 102 dB, however the $C$-weighted peak sound pressure level ranged from 96 to approx. 125 dB and did not exceed the admissible level.

On the basis of measurement results it can be confirmed that daily noise exposure level exceeded the admissible level (85 dB) at 10 percent of workstations set that way, in regard of the employees hearing protection. Whereas, equivalent continuous $A$-weighted sound pressure level exceeded (excluding one workstation) the admissible level (65 dB), established in relation to the noise annoyance. Measured values of equivalent continuous $A$-weighted sound pressure level of noise, finding its source in the call center's technical equipment and on the surface of the building elevation, did not exceed the admissible level.

It has to be noted that noise at the call center workstations, where employees use headsets, should be considered as an annoying factor, making basic work functions difficult and causing extra-audible unfavorable changes to health. In some cases it might even become a harmful factor causing hearing loss. Further noise measurements should be supplemented by a survey on the subjective evaluation of noise annoyance at work as well as by taking into consideration various types of headsets.

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