Noise hazards associated with the call centre industry

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Summary

A study has been carried out by the French National Research and Safety Institute (INRS) in order to estimate the daily noise exposure of the call centre operators who are using headsets. Acoustic measurements were carried out through twenty four call centres operating an instrumentation matched to headsets. Most of the telephone installations observed during these measurements are likely to generate noise levels exceeding 85 dB(A). A questionnaire has shown that 36% of the operators do not know or are not aware of the potential hearing damage risk when the headsets are used at high levels. In addition the levels of ambient noise into the observed call centres are generally higher than 52 dB(A). This level leads the operators to adjust the headset gain to high levels in order to be able to understand properly the persons they are speaking to. The study results show that 27% of the operators having answered the questionnaire are daily exposed with more than 85 dB(A) and that 3% of them are daily exposed with more than 90 dB(A). Uncertainties associated with these results are estimated to be around 5 dB. They are linked to the headset position on the measuring system, the interpersonal variability of the transfer function used to estimate the external equivalent noise level and the sampling method used to choose the operators. To reduce noise risk in the call centre industry, operators should receive information about noise effects and regular training on the headset and telephone equipment they are using. The walls and ceiling of the workplace must be treated with appropriate acoustic materials to reduce reverberation. The workplace should be sufficiently large to ensure 10 m^2 space per operator. Also to reduce noise risk in the call centre industry, INRS and the French National Scientific Research Centre (CNRS) are now carrying out a study on the use of active acoustic noise control technique to reduce background noise level directly in the headset.

1. INTRODUCTION

In spite of the fast growth of the telecommunication sector these last years, relatively few studies were devoted to the working conditions in this sector and in particular to the assessment of the noise exposure of call centre operators. The phone calls are regarded as normal conversations and even when the telephone systems are amplified the calls are regarded as natural tasks and are not associated to a hearing damage risk. Moreover, this lack is probably related to the metrological difficulties to determine the real noise exposure of the operators. However many people working in this branch of industry are exposed to noise levels delivered by the headphones. Many complaints have been recorded relative to voices and hearing disorders.

Figure 1 : typical call centre

The acoustic studies carried out in the years 1965 to 1975 on the telephone operators tended to show the presence of an hearing damage risk for this type of employees who used primarily a telephone headset. On the other hand more recent studies undertaken in the years 1995 on operators carrying continuously a headphone showed that the hearing damage risk was present. A study carried out in England in 1999 [1] in various call centres revealed that the average daily personal noise exposure of these call centre operators was close to 78 dB(A) and that approximately 15% of the operators were exposed to levels exceeding 85 dB(A). Similar studies were led in Germany, in the Netherlands and in Italy in 2000 and 2001 [2] and lead to the same exposure levels. The increase of the noise exposure in this industry is due to the evolution of the telephone material like the replacement of telephone headsets by more ergonomic headphones but sometimes delivering amplified noise levels more important than those delivered by telephone headsets.
Taking into account the many requests concerning the evaluation of the noise exposure of the telephone operators wearing "hands free" headsets, a study was led by the INRS on 24 call centre distributed in all France. This paper presents methodology as well as the results of this study.

2. METHODOLOGY

The aim of the study was to evaluate the daily noise exposure of the operators working in the call centre. The study consisted in developing a measurement method of the noise levels delivered by the headphones to the ears of the operators and implementing this measurement technique in various companies.
In addition, for each visited company, a questionnaire intended to estimate "feeling" of the operators with respect to their noise exposure was distributed to all the employees in charge of customers.
For each call centre visited, the following information was collected:

- maximum acoustic pressure level delivered by the headsets,
- average background noise level,
- average operators work pattern to estimate the average duration of their noise exposure,
- answers to the questionnaire on the preferred volume control setting and "feeling" of the operators with respect to the noise.

2.1 NOISE LEVELS PRODUCED BY THE HEADSETS MEASUREMENTS

The main source of noise exposure for call centre operators is due to the noise levels generated by the headsets. To ensure the protection of workers against the risks created by noise exposure, the current French legislation is based on two level gauges of risk:

- the average value of noise levels to which a worker is exposed during his working day: it is the daily noise exposure level, noted $L_{EX,d}$ and expressed in decibel weighted A[1], noted dB(A);
- the maximum instantaneous noise level value received during the working day: it is the peak acoustic pressure level, noted L_{PC} and expressed in dB.

The French legislation relating to workers protection against the noise comprises provisions which are applicable gradually, in the event of exceeding one of the following four lawful action levels:

- daily noise exposure level: $L_{EX,d}$ = 85 and 90 dB(A),
- peak acoustic pressure level: L_{PC} = 135 and 140 dB.

These lawful action levels, currently into force in France, apply to an incident acoustic pressure level existing outside the ear noted $L_{Aeq,T}$ expressed in dB(A). To determine the noise level values existing outside the ear when the noise levels are generated by a headset, it is necessary to use a specific measurement material as well as a particular measuring protocol.
The noise levels generated by the headsets were measured using an artificial ear Bruel and Kjaer 4152 presented on figure 2. A total correction was used to transform the acoustic measurements taken on the artificial ear into equivalent levels of incident acoustic pressure in diffuse field existing outside the ear noted $L_{AeqDF,T}$ expressed in dB(A). The total correction was built using a procedure equivalent to that described in the ISO standard 11904-1.
The total correction used depends on the frequency and holds account:

- effect of frequency weighting A,
- relation between the acoustic pressure measured in the ear canal and the incident acoustic pressure existing outside the ear in diffuse field,
- relation between the acoustic pressure measured on the artificial ear used and the acoustic pressure measured in the ear canal.

Figure 2: artificial ear used for measurements

[1] Weighting A: natural sensitivity curve of the human ear according to the frequency

Two other normalized measuring techniques can be used to determine the noise level generated by the headsets. The first one was used by the Health and Safety Laboratory (HSL) in the study [1] and also by Peretti and all in the study [2]. With this technique the measurements are carried out using a manikin equipped with ear simulators including microphones. This method is described in the ISO 11904_2 [3] international standard (manikin technique). Figure 3 shows the Bruel and Kjaer 4128 manikin.
The other measuring technique is described in the ISO 11904_1 [4] international standard (MIRE technique). With this technique the measurements are carried out using miniature microphones inserted in the ears of human subjects.
These two other methods also use frequency-dependent corrections to transform the acoustic measurements taken on the microphone into equivalent levels of incident acoustic pressure in diffuse field existing outside the ear ($L_{AeqDF,T}$).
The second method, using microphone in the real ears of human subjects, is difficult to apply outside of laboratory because the frequency-dependant correction needs to be measured for each subject in a well known acoustic environment which is difficult to create in industrial environment. The manikin technique has not been used in our study because of the weight and size of the manikin compared with the artificial ear.

Figure 3 : Bruel and Kjaer 4128 manikin

In spite of the differences, all the measuring techniques described here are based on the ISO 11904 standard and are equivalent. They give same uncertainties estimated to be globally around 5 dB.
First of all, these uncertainties are linked to the headset position on the measuring system and to the interpersonal variability of the correction function used to estimate the external equivalent noise level. Another kind of uncertainty is related to the sampling technique used to choose the operators and to the measurement procedure used.

In our study, the operators were chosen randomly at each call centre and the measurements were carried out with a headset identical to that used by the operator, connected to the supervisor's telephone and set to the maximum volume value. The mean maximum value measured was then used with the results of the questionnaire on the preferred volume control setting to determine the exposure of each operator having answered the questionnaire. In such a way, results are obtained for a large number of operators with few measurements but they are related to their declaration on the preferred volume control setting. As we have seen it during the measurements, a large proportion of operators uses the maximum value of the volume control. So the impact of non realistic declarations on the study's results is of the second order.
In studies [1] or [2], the operators were chosen randomly and the measurements were carried out with a headset identical to that used by the operator, connected on the operator's telephone console into a second socket or to a splitter box designed to produce to identical output signals. These measurements give directly the noise level received by the operator but the results are only related to the operators that have been chosen. The results of these two studies are thus strongly dependent on the operators sampling.

2.2 MEASUREMENTS IN COMPANIES

Measurements in companies consisted in recording, during approximately 20 minutes for each operator, the third octave mean spectrum of the acoustic pressure produced on the artificial ear by a headset identical to that used by the operator, connected to the supervisor's telephone and set to the maximum volume value. Measurements were carried out for various operators on each call centre visited in order to determine a statistical average of the highest levels of the telephone installation of the call centre. The duration of measurement corresponds to five calls per operator and allows to integrate the level and spectrum fluctuations which can be related on the voice forces and tonality of the various callers like at the various lines and telephones used by the callers. The signals recorded on the artificial ear took into account the caller voice and the operator voice because the microphone signal of the headset is sent to the operator ears by the ear-phones.
The evaluation of the daily noise exposure of the operators was then carried out using the average highest noise levels of each company and the questionnaire results on the usual volume control setting and by exploiting the daily average time spent in communication which was provided to us by the call centre supervisors.
In parallel to the recordings on the artificial ear, measurements of background noise level were realized in various points located throughout the call centre.

3. RESULTS

24 telephone call centres distributed across a wide range of industry sectors of customer service were visited.

3.1 HEADSET MAXIMUM NOISE LEVEL

The distribution of the maximum diffuse field equivalent noise levels delivered by the headphones is presented figure 4.

It appears that only 27% of the visited call centre have a telephone installation producing maximum noise levels lower than 85 dB(A). In addition, it appears that 27% of the visited call centre have a telephone installation being able to deliver noise levels higher than 90 dB(A). The diversity of the noise levels measured on the various call centre (from 76 to 100 dB(A)) results from the association of various materials (telephone, headphone and lines multiplex). Indeed the same headphone connected on two different telephone consoles can deliver very different noise levels according to the telephone console used. In addition on certain call centre, an additional amplifier was inserted between the telephone console and the headset. This kind of amplified installations produce the highest noise levels (from 92 to 100 dB(A)). However, the examination of the questionnaire of these call centre revealed that, even with this kind of amplified installation, 10% of the operators used the maximum volume control setting.

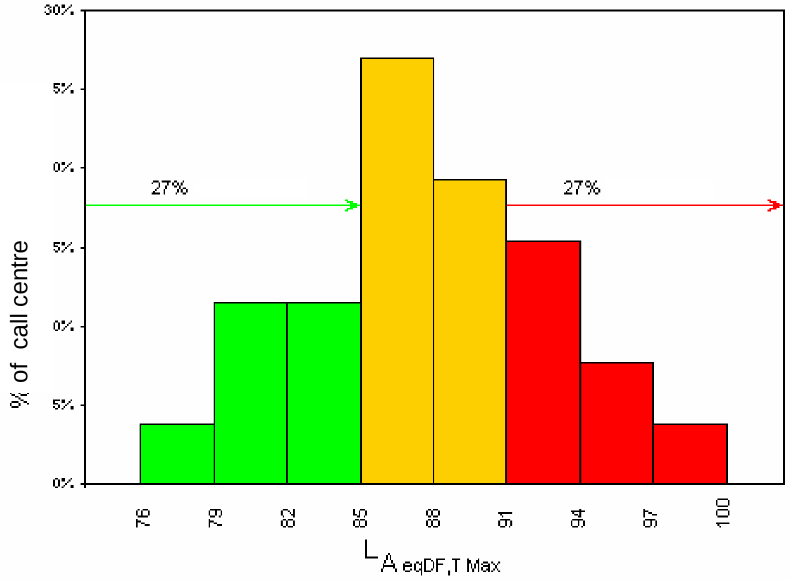

Figure 4: maximum noise level distribution

3.2 PERSONAL DAILY NOISE EXPOSURE LEVEL

The joint exploitation of the questionnaire on the usual volume control settings and of the average daily times spent in communication allows, starting from the maximum noise levels measured, allows to determine the daily noise exposure distribution of the population having answered the questionnaire. The results are presented on figure 5.

This histogram makes it possible to note that 73% of the operators having answered the questionnaire are located below the first lawful action level (85 dB(A) for the moment). On the other hand 27% of the operators are exposed to noise levels exceeding this first lawful action level and 3% of the operators are exposed to more than 90 dB(A). These results are in agreement with those of the similar studies carried out recently and quoted [1], [2] in the introduction.

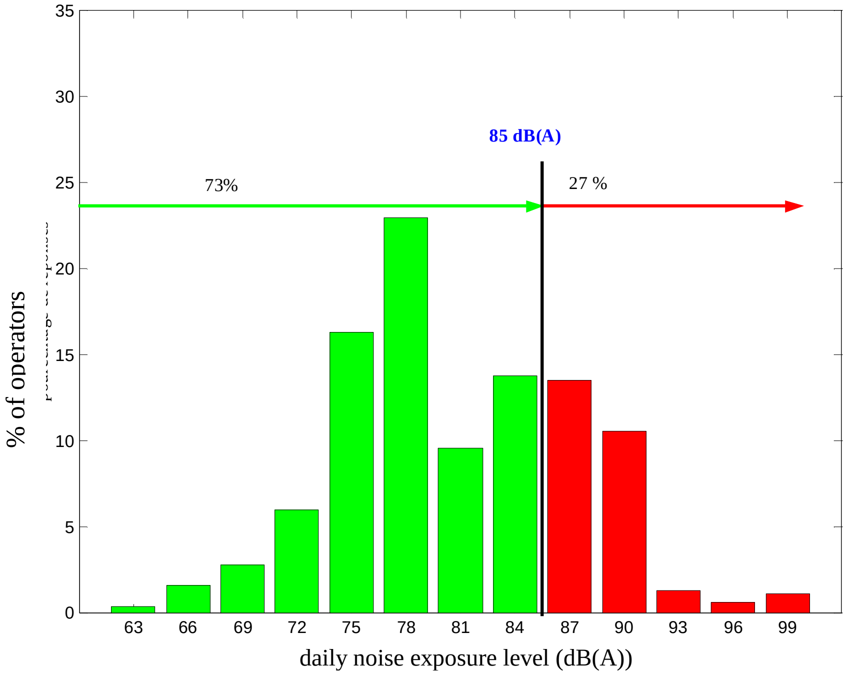

Figure 5: histogram of the daily noise exposure $Lex_{,d}$ of the operators having answered the questionnaire

3.3 BACKGROUND NOISE LEVEL

Figure 6 presents the background noise level distribution on the call centres. This figure shows background noise levels diversity on the call centres (45 dB(A) to 68 dB(A)). The call centres having a background noise level exceeding the ISO recommended value for work on computer (55 dB(A)) account for 66% of the visited call centres. These high values of the background noise on the call centre are at the origin of the high usual volume control setting used to be able to hear the callers in a high background noise.

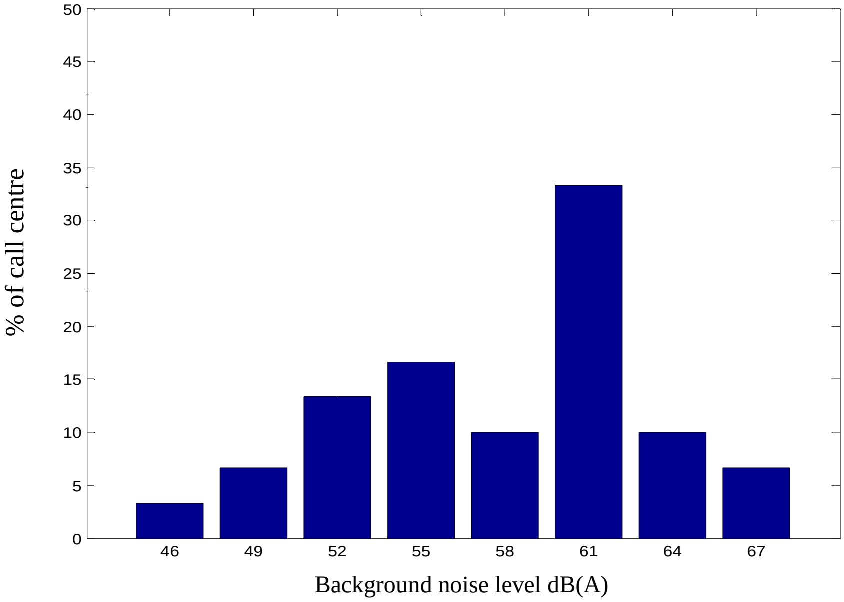

Figure 6: background noise level distribution

Indeed, for a large proportion of the call centres in this study, the operators set or let the volume control to the maximum value. However many operators of these call centres commented that, even with the maximum volume value, they had difficulties to hear callers when background noise levels were high.
Many operators also commented that they had not received training on the volume control unit of the telephone console and therefore never used this control.

3.4 KNOWLEDGE OF THE POTENTIAL HEARING DAMAGE RISK

Our questionnaire to the operators had a question on their knowledge of the hearing damage risk and one on their feeling with respect to the noise. The results show that 66% of the operators consider that they are working in a noisy environment and that 36 % of the operators do not know or are not aware of the potential hearing damage risk.

4. DISCUSSION

The daily noise exposure level of the call centre operators has been measured on 24 call centres and exceed for 27% of the operators the first lawful action level fixed for the moment at 85 dB(A) in France. There is thus an hearing damage risk likely in the long term to generate professional deafness's in this profession of the tertiary sector which represents currently more than 250 000 employees in France. Therefore, this risk has to be carefully taken into account. These high noise exposure levels are explained on the one hand by the background noise levels inside the call centres which exceed for 66% of them the ISO recommended value for work on computer and on the other hand by the noise levels generated by the telephone installations which can exceed 85 dB(A) for 73% of them. Adding with these two facts, a large part of the operators has not received training on the telephone console volume control and is not sensitised to the potential hearing damage risk.
In order to reduce noise risk in the call centre industry, first all operators should receive regular training with the equipment they use and should be sensitised to potential risk of hearing damage. Then, the background noise levels need to be reduced as low as possible in order to allow operators to use their headset below the maximum volume without difficulties to hear callers.
To reduce background noise levels, it's necessary to fit the workplace with appropriate acoustic materials to reduce reverberation. In case of partition used to separate individual workstations, they must be as high as possible because of diffraction effect on edge which reduces acoustic isolation between adjacent workstations. Another way or a complementary one to reduce background noise level consists in having at least 10 m^2 space per operator. In our study, when this criterion was respected the background noise level was below 50 dB(A) and the daily exposure level of the operators was below 77 dB(A).
These recommendations to reduce the background noise levels are often difficult to implement because of their cost (enlargement of the workplace and whole acoustic treatment of the work place). To widen the range of the solutions available to reduce background noise, a research project has been initiated with the collaboration of the French National Scientific Research Centre (CNRS). The project aims at applying the active acoustic noise control techniques on call centre. The objective is to reduce the workplace background noise heard by the operators when they are in communication with a caller by producing a cancellation signal in their headset. This technique would allow operators to use their headset below the maximum volume without difficulties to hear callers. The project's results are expected for the beginning of 2007.

5. CONCLUSION

Noise measurements at 24 call centres in France showed that the daily exposure of call centre operators could exceed 85 dB(A). Therefore, this obvious risk has to be carefully taken into account. In France, the first cases of hearing damage have been noticed. The practical solutions to reduce the noise exposure are limited and difficult to implement. However, INRS is presently working with French university in order to explore the possibility of using active noise cancellation to decrease the noise exposure of the operators. Of course, the training and sensitisation of the operators should be undertaken. Adding to noise effects, the activity on call centre is affected by the work organisation and the working conditions. Many complaints are related to the noise and to the psychological aspect that lead to a high proportion of turn-over in this industry. Adapted organisational choices and ergonomic and acoustic installations can improve the working conditions of the operators and limit this emerging occupational safety and health risk that has been noticed by the European experts.

6. BIBLIOGRAPHY

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