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CONTRIBUTIONS TO ESTIMATE THE HEARING DAMAGE DUE TO PROFESSIONAL NOISE

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Abstract: *The paper presents a documentary study on the hearing damage over the industry workers. Noise damage is due to the assessment of the effects of hearing threshold of audibility associated with age for a quantile equal for the men and the women on different periods of noise exposure. This paper is part of a study regarding the assessment of noise pollution in industrial activity. Quantile is selected sort of population, with the same age.*
Key words: *professional noise, hearing damage, industrial activity.*

1. INTRODUCTION

Estimation method of hearing damage is indicated in the SR ISO 1999:1996 *Acoustics. Determination of noise exposure and hearing damage estimation* [1]. This revised standard and adapted according to the European standardization is based on statistical data and is used to predict or determine the hearing damage or handicap individuals for this applies to stationary character, noise intermittently, fluctuating, or irregular pulse, frequency audiometrice of less than about 10kHz [1].

As a result it was arrived at by statistical findings:

1. The left ear is more affected than the right, when it comes to the outer ear –perforation of tympanic membrane; middle ear – leaked and otosclerosis and even in cases of idiopathic sudden deafness due to noise trauma is installed that affects the inner ear.

2. People with blonde hair are more affected than brunette people.

3. People with blue eyes are more affected than those with brown eyes [2].

4. Men are more affected than women.

5. The maximum risk if suddenly hearing damage is installed of persons with 50 – 59 years, exposed to noise, on a background of cardiovascular disease [3].

2. ESTIMATION METHOD

Estimation method of calculation allows two variants on two different databases: a normal otologic population (A database) and any other typical industrial environment selected population (B database).

The consequences of hearing damage sufficient to affect the efficiency of the day-to-day business of a person, usually expressed as a function of understanding conversations at low levels of noise, causes an auditory disability. For a fraction of the population exposed (quantile) it selects a limit of audibility threshold above which it is considered that there is a risk of disability [1].

Adverse effects of exposure to noise give risks of auditory disabilities due just noise, but and insufficiency hearing due to the age.

2.1. Indicators of hearing damage

Hearing Threshold Levels associated with Age (HTLA) noted H [dB], is reported only at age, without the influence of noise and in

the absence of other causes of auditory damage [1].

The level of permanent movement, actual or potential threshold hearing induced by noise (NIPTS), N [dB], is considered to be just a consequence of the influence of noise exposure.

Hearing threshold levels associated with age and noise (HTLAN), H' [dB], permanent hearing threshold of a population. To calculate this indicator must be used [1] in the following relationship:

$$H' = H + N - \frac{HN}{120} \tag{1}$$

The average values of the potential level of permanent displacement of the threshold of hearing due to exposure to noise between 10 and 40 years of age, are obtained from [1] with the relation:

$$N_{0,50} = \left[u + v \lg\left(\theta / \theta_0 \right) \right] \cdot \left(L_{EX,8h} - L_0 \right)^2 \tag{2}$$

Where:

- ✓ L_0 is the sound pressure level limit what depends on the frequency, and is given in table 1;
- ✓ Θ is the time exposure [year};
- ✓ θ_0 is the reference time exposure for 1 year;
- ✓ u and v depend on frequency and are give in table 1;
- ✓ For exposures of less than 10 years, permanent displacement of the threshold of audibility will be extrapolated from the value $N_{0,50}$ for 10 years, using [1] in the relationship:

$$N_{0,50;\theta<10} = \frac{\lg(\theta+1)}{\lg(11)} N_{0,50;\theta=10} \tag{3}$$

Table 1.

u, v şi L_0 values used for NIPTS determination [1]

Frequency [Hz]	u	v	L_0 [dB]
500	-0.033	0.110	93
1000	-0.020	0.070	89
2000	-0.045	0.066	80
3000	0.012	0.037	77
4000	0.025	0.025	75
6000	0.019	0.024	77

For different quantile of the population, Q, which has normal otologic level of audibility threshold greater than the value of the threshold level HQ, audibility, H, specified according to age (Y) and sex is calculated from the following relations (4) given in [1]:

$$\begin{cases} H_Q = H_{0,50} + kS_u, & 0.05 \le Q < 0.50 \\ H_{0,50} = a(Y-18)^2 + H_{0,50;18}, & Q = 0.50 \\ H_Q = H_{0,50} - kS_l, & 0.50 < Q \le 0.95 \end{cases} \tag{4}$$

In these relations, the noptations are:

- $H_{0,50;18}$ represents the mean value of the threshold of otologic audibility, of same sex, under the age of 18 years;
- multiplication factor k corresponding to the size of the quantile;

Table 2.

Multiplication factor k values [1]

Quantile		K
0.05	0.95	1.645
0.10	0.90	1.282
0.15	0.85	1.036
0.20	0.80	0.842
0.25	0.75	0.675
0.30	0.70	0.524
0.35	0.65	0.385
0.40	0.60	0.253
0.45	0.55	0.126
0.50		0

- ✓ the coefficient a depends on the audimetric frequency, and of sex of selected population (table 3);

Table 3.

Multiplication factor a values [1]

Frequency [Hz]	Men	Women
125	0.0030	0.0030
250	0.0030	0.0030
500	0.0035	0.0035
1000	0.0040	0.0040
1500	0.0045	0.0050
2000	0.0055	0.0060
3000	0.0070	0.0075
4000	0.0115	0.0090
6000	0.0150	0.0120
8000	0.0220	0.0150

- ✓ parameters S_u and S_l are let by the relations:

$$S_u = b_u + 0.445\,H_{0,50} \quad (5)$$

$$S_l = b_l + 0.356 H_{0,50} \quad (6)$$

Values of b_u and b_l are presented in the table 4.

Table4.

Values of b_u and b_l [1]

Frequency [Hz]	b_u		b_l	
	Men	Women	Men	Women
125	7.23	6.67	5.78	5.34
250	6.67	6.12	5.34	4.89
500	6.12	6.12	4.89	4.89
1000	6.12	6.12	4.89	4.89
1500	6.67	6.67	5.34	5.34
2000	7.23	6.67	5.78	5.34
3000	7.78	7.23	6.23	5.78
4000	8.34	7.78	6.67	6.23
6000	9.45	8.90	7.56	7.12
8000	10.56	10.56	8.45	8.45

3. MODE OF WORK

In this paper follow these steps esteblished through European standardisation, which is adopted in Romania.

3.1. The level of the audibility threshold

Based on the values given in SR ISO 1999:1996 [1] shows the relationship between hearing threshold level values associated with age differences in audiometrice frequencies of 500 to 6000 Hz, with sex, with population database type for a 0.5 quantile population. This dependence is illustrated graphically in figures 1 and 2.

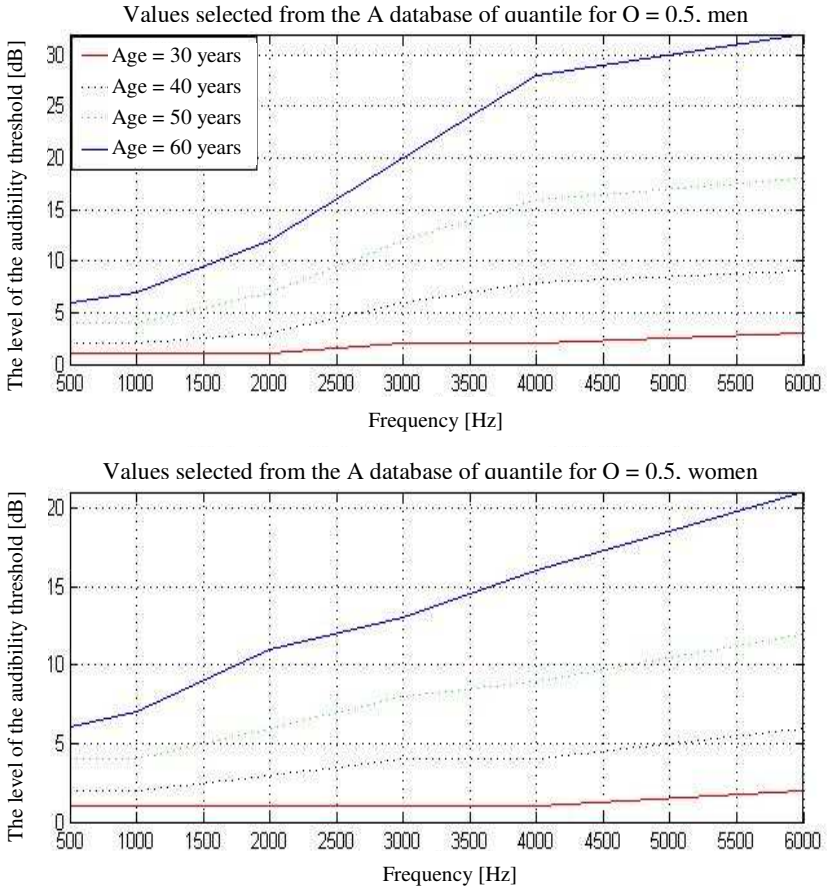

Fig. 1. Hearing levels associated with age for A database [1], [4]

In the figure 1 there is a difference between the selected values from the A databases for the men regarding the same quantile Q=0.5 for the the women. With the age = 60 years old the men have the level equal with 60dB, in time the women have only 20dB.

Taking into account the B databases, for the same quantile of population, the situation becomes different.

Realizing the figure 2 the proportionality is different between men and women for the same level of audibility.

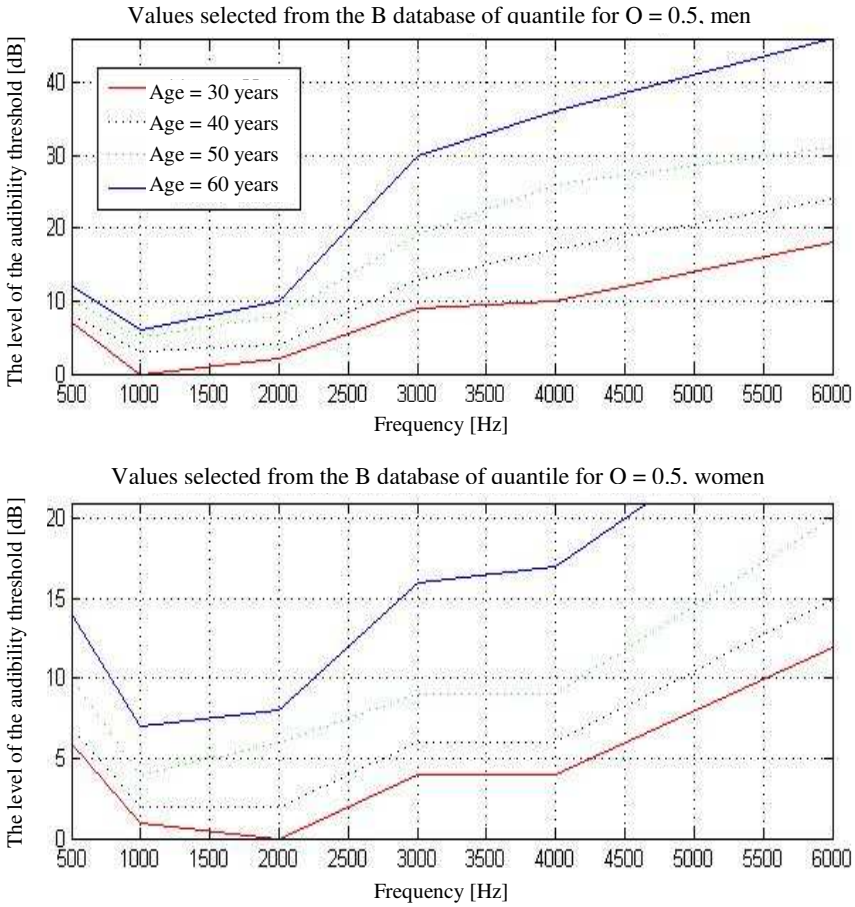

Fig. 2. Hearing levels associated with age for B database [1], [4]

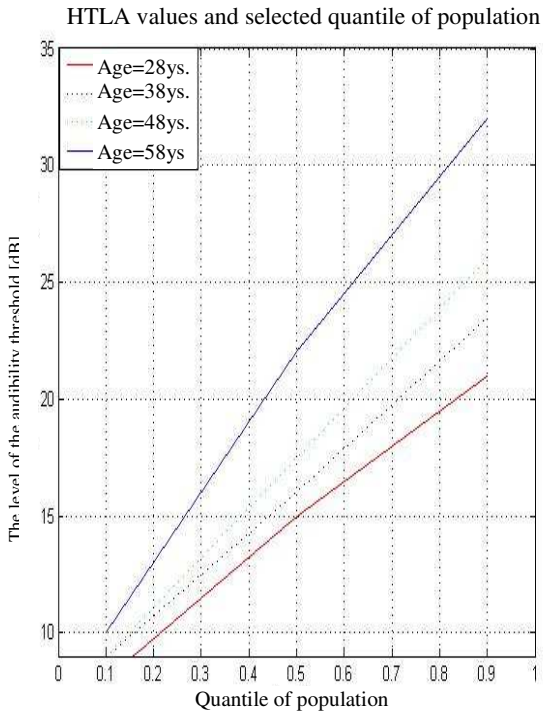

Fig. 3. Dependence of HTLA values and selected quantile of population

3.2. The HTLA values for the quantiles of population

As specified in the ISO SR 1999:1996 [1], which is illustrated in Figure 3 the dependence of values for the quantiles of population and the combination of frequencies of 10dB, 15dB, 20dB, 25dB, 30dB, and 35dB levels of audibility. The age of selected quantile grows with 10 years, and HTLA modifies very strong its values growing with the age of people.

3.3. The NIPTS values depending of frequencies of industrial noise polution

Based on data from the standard [1], was made a comparative study for the permanent

displacement of audibility threshold induced by noise (NIPTS).

Values were calculated for 6 NIPTS frequency (500, 1000, 2000, 3000, 4000, 6000 Hz) and quantile 0.5 exposed to noise for 10, 20, 30, 40 years and corresponding levels of exposure of $L_{EX,8h}$ at noise polution having 85, 90, 95, 100 dB during the industrial acyivity.

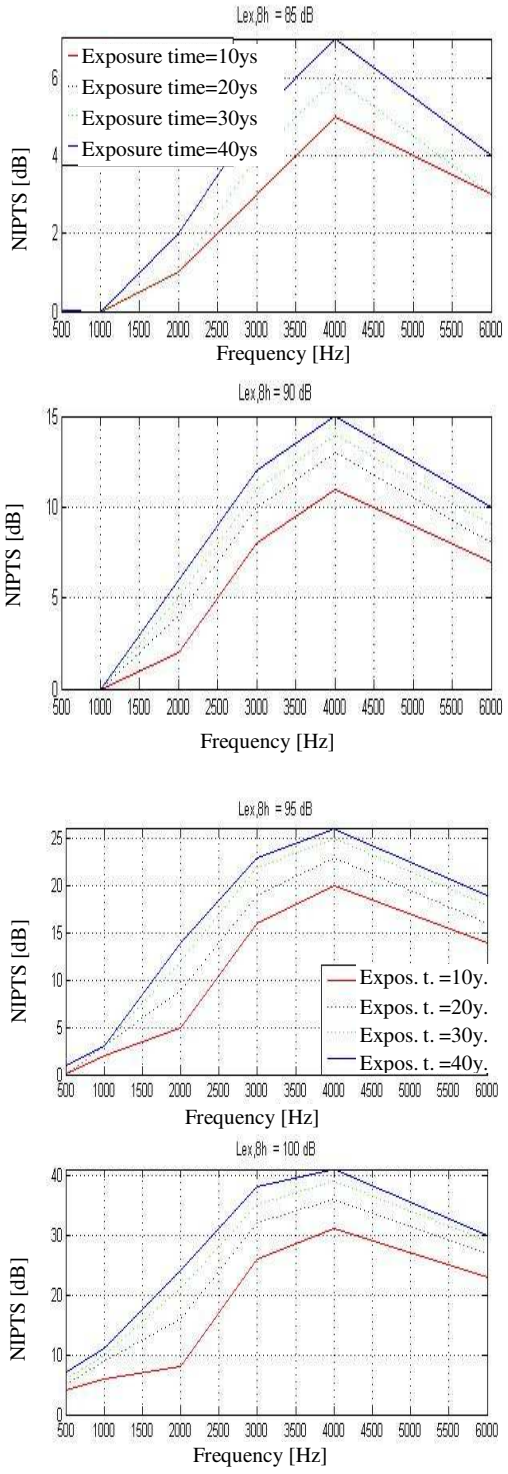

Fig. 4. Dependence of NIPTS values and frequencies of industrial noise polution

The conditions indicated, NIPTS value varies depending on the frequency, as shown in the graphs in Figure 4.

4. CONCLUSIONS REGARDING HEARING DAMAGE CAUSED BY PROFESSIONAL NOISE

NIPTS - the permanent displacement of the hearing threshold induced by industrial noise can by concluded as:

- ✓ has double values for the variations of 5dB on the levels of exposure to the same exposure period;
- ✓ begin to grow only at a frequency of 2kHz for the audiometric values of the noise exposure level of 85dB and 90dB;
- ✓ the permanent displacement of the threshold of audibility induced noise reaches maximum values at 4kHz audiometric frequency;
- ✓ over 4kHz appears a slight decrease of NIPTS so its level reaches a frequency of 6kHz sensitive level equal to 3kHz, presumably due to a threshold of endurance of the human body.

5. BIBLIOGRAPHY

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Contribuţii la estimarea deteriorării auzului datorată zgomotului profesional

Rezumat: L*ucrarea prezintă un studiu documentar asupra deteriorării auzului lucrătorilor din industrie. Deteriorarea este datorată zgomotului profesional. Se prezintă efectele deteriorării auzului prin evaluarea pragului de audibilitate asociat cu vârsta pentru o cuantilă egală la bărbaţi şi la femei, pe diferite perioade de expunere la zgomot profesional. Această lucrare este o parte a unui studiu în ceea ce priveşte evaluarea poluării sonore în activitatea industrială.*

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