

## THE IMPACT OF OCCUPATIONAL NOISE ON THE WORKERS. ROMANIAN AND EU LEGISLATION

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### ABSTRACT

*Noise is most obviously a problem in industries such as manufacturing, mining and construction but it can also be an issue in a wide range of other working environments like energy, transports, call centers, schools, orchestra pits, bars and restaurants, entertainment. At the same time, the noise pollution is an element with a very important influence on the human life: in residential areas, schools, public institutions, hospitals, entertainment areas). About the impact of the noise at work, one in five of Europe's workers has to raise their voices to be heard for at least half of the time that they are at work and 7% suffer from work-related hearing difficulties. The most well-known effect of noise at work is loss of hearing, a problem observed among handworkers from beginning of 18-th century. Noise-induced hearing loss is the most common reported occupational disease in the European Union. However, it can also ex-acerbate stress and increase the risk of accidents. Exposure to noise at work can harm workers' health. This article describes the effects of workplace noise and outlines the key issues surrounding noise at work, including the risks, legal responsibilities and solutions.*

### 1. Introduction. Noise characteristics

The (pure) sound is the physiological perception of the subject (human or not) ear of the "acoustic pressure" produced by the mechanical vibration of an acoustic source. The noise is an unwanted mixture of many of this kind of pure sounds.

Every sound or every noise has a lot of objective and subjective features and these depend on them physical and physiological characteristics. The main characteristic of a noise are [1], [2]:

- physical characteristics
- frequency or sound pitch  $f$  [Hz]
- frequency (spectral) distribution
- acoustic pressure  $p$  [ $N/m^2$ ] and the level of acoustic pressure  $L_p$  [dB]
- acoustic intensity  $I$  [ $W/m^2$ ] and the level of acoustic intensity  $L_I$  [dB]
- acoustic power  $P$  [W] and the level of

acoustic power  $L_W$  [dB]

- physiological characteristics
- the level of loudness

$$\Lambda = 20 \lg \left( \frac{p}{p_0} \right)_{f=1kHz} \quad [fon] , \quad (1)$$

where  $p_0$  is the reference pressure

$$p_0 = 2 \times 10^{-5} N/m^2$$

- the loudness

$$T = 2^{\frac{\Lambda - 40}{10}} \quad [son] \quad (2)$$

-the pitch (tone) is the perception of the sound frequency; the measure unit is [mel]

-the timbre (sound quality) shows how the noise is composed from pure sounds; it is the perception of the spectral distribution

For occupational acoustics, the most important sound characteristics are the level of intensity and the frequency (plus spectral distribution of frequencies).

**Level of intensity.** The **acoustic intensity** measured in  $[W/m^2]$  is the most important feature for occupational acoustics but, due to the wide range of values for it, it uses the related value **level of intensity**

$$L_I = 10 \lg \frac{I}{I_0} [dB], \quad (3)$$

where  $I$  is the acoustic intensity of the noise and  $I_0 = 10^{-12} W/m^2$  is reference intensity

The decibel (dB) scale is logarithmic, so a three dB increase in the sound level already represents a doubling of the noise intensity. For example, a normal conversation may be about 65 dB and someone shouting typically can be around 80 dB. The difference is only 15 dB but the shouting is 30 times as intensive. To take into account the fact that the human ear has different sensitivities to different frequencies, the strength of noise is usually measured in A-weighted decibels [dB(A)].

## 2. The noise – hazard and risks at the workplace

The facts which can affect how hazardous noise is at workplace include the following:

**1. The exposure.** It is not just the intensity that determines whether noise is hazardous. The **duration of exposure** is also very important. To take this into account, time-weighted average sound levels are used. For workplace noise, this is usually based on an 8 hour working day.

**2. Impulsiveness.** The noise with “peaks” is perceived as a “bigger” noise (for example, the noise produced by electric arcs).

**3. Time distribution** – show when the noise occurs and how often.

Noise don't need to be excessively loud to cause problems in the workplace. Noise can interact with other workplace hazards to increase risks to workers by, for example:

**4. increasing the risk of accidents by masking warning signals**

**5. interacting with exposure to some chemicals** to further increase the risk of hearing loss

**6. being a causal factor** in work-related stress.

Exposure to noise may pose a variety of **health and safety risks** to workers:

**1. Hearing loss.** Excessive noise damages the hair cells in the cochlea, part of the inner ear, leading to loss of hearing. According to World Health Organisation, “*In many countries, noise-induced hearing loss is the most prevalent irreversible industrial disease.*” [5]. It is estimated that the number of people in Europe with hearing difficulties is more than the

population of France or Spain [6].

**2. Physiological effects.** There is evidence that exposure to noise has an effect on the cardiovascular system resulting in the release of catecholamines and an increase in blood pressure. Levels of catecholamines in blood (including epinephrine/adrenaline) are associated with **stress**.

**3. Work-related stress.** Work-related stress rarely has a single cause, and usually arises from an interaction of several risk factors. Noise in the work environment can be a stressor, even at quite low levels.

**4. Increased risk of accidents.** High noise levels make it difficult for staff to hear and communicate, increasing the probability of accidents. Work-related stress (in which noise may be a factor) can compound this problem.

Anyone who is exposed to noise is potentially at risk. The higher the noise level, and the longer you are exposed to it, the more risk you have of suffering harm from noise. In **table 1** it can see the percentage of employees experience significant noise levels for more than half of their working time.

**Table 1.** Percentage of employees exposing on significant noise for more of half of working time

Activity	Exposure [%]
Manufacturing	40
Mining	40
Construction	35
Transport and communication	20
Agriculture	20

It is not only manufacturing and other traditional industries where noise is a problem. Noise is being recognized as a problem in service sectors such as education and healthcare, bars and restaurants. A study of noise in kindergartens found average noise levels to be over 85 dB. During a performance of Swan Lake, a conductor was recorded as being exposed to 88 dB. Staff in nightclubs can be exposed to up to 100 dB.

Truck drivers can be exposed to 89 dB. The noise on pig or caw farms has been measured up to 115 dB.

**Standards** play a key role in the prevention of occupational noise exposure. The 2003/10/EC “**noise directive**” [7] refers to ISO 1999:1990 for the assessment of workers' exposure, and many standards prepared by the technical committees of the European Committee for Standardisation (CEN) have provisions on noise to support the essential

safety and health requirements on noise in the "machinery directive" [8].

### 3. Reducing and controlling the noise at workplaces - responsibilities

Employers have a legal duty to protect the health and safety of staff from all noise-related risks at work. They should:

- ▶ conduct a risk assessment - this may involve carrying out noise measurements, but should consider all the potential risks from noise (e.g. accidents as well as hearing loss);

- ▶ based on the risk assessment, put in place a programme of measures to:

- where possible, eliminate sources of noise;

- control noise at source;

- reduce worker exposure by work organisation and workplace layout measures, including the marking of, and restriction of access to, workplace areas where workers are likely to be exposed to noise levels exceeding 85 dB(A);

- provide personal protective equipment to employees as a last resort;

- ▶ inform, consult, and train workers about the risks faced, low noise working measures, and how to use noise protection;

- ▶ monitor the risks and review preventive measures - this may include health surveillance.

**Employee involvement.** Consulting the workforce is a legal requirement and helps to ensure that the workers are committed to safety and health procedures and improvements. Using their knowledge helps to ensure that hazards are correctly spotted and workable solutions implemented. Worker representatives have an important role in this process. Employees must be consulted on health and safety measures before the introduction of new technology or products.

Directives requiring workplace measures are not the only means by which workers' health is protected. **Manufacturers of machinery** and other equipment also have the responsibility to reduce noise levels. The requirements in the "machinery directive" [8] and "outdoor machinery directive" [9], whereby manufacturers are required to provide noise information about the machinery, and in some cases limit emissions, should also help reduce the risk to workers. According to "machinery directive" 98/37/EC, machinery should be "designed and constructed (so) that risks resulting from the emission of airborne noise are reduced to the lowest level taking account of technical progress and the availability of means of reducing noise, in particular at source".

### 4. Occupational noise – Romanian and EU legislation

In 2003, **Directive 2003/10/EC** of the European Parliament and of the Council "on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise)" was adopted (replacing the directive 86/188/EEC). This directive is to be transposed into the national legislation of all Member States before 15 February 2006. Romania already has transposed this Directive by the **Romanian Government decision no. 493 from 12 April 2006** [11]. Article 5(1) of the directive requires that, taking into account technical progress and the measures available to control the risk at source, "the risks arising from exposure to noise shall be eliminated at their source or reduced to a minimum". **The directive also sets a new daily exposure limit value of 87 dB(A).**

The relevant EU directives about safety and health at work which contains provisions on noise are:

- Council Directive **89/391/EEC** of 12 June 1989 "on the introduction of measures to encourage improvements in the safety and health of workers at work"

- Council Directive **89/656/EEC** of 30 November 1989 "on the minimum health and safety requirements for the use by workers of personal protective equipment at the workplace"

- Council Directive **89/686/EEC** of 21 December 1989 "on the approximation of the laws of the Member States relating to personal protective equipment"

- Council Directive **92/85/EEC** of 19 October 1992 "on the introduction of measures to encourage improvements in the safety and health at work of pregnant workers and workers who have recently given birth or are breastfeeding"

- Council Directive **94/33/EC** of 22 June 1994 "on the protection of young people at work"

- European Parliament and Council Directive **98/37/EC** of 22 June 1998 "on the approximation of the laws of the Member States relating to machinery"

- European Parliament and Council Directive **2000/14/EC** of the of 8 May 2000 "on the approximation of the laws of the Member States relating to the noise emission in the environment by equipment for use outdoors"

- European Parliament and Council Directive **2003/10/EC** of 6 February 2003 "on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise)"

**5. Conclusions**

Instead conclusions, there are some figures from a French study about noise at workplace and about noise-related diseases [12], which outlines the importance of a coherent policy and necessary legislation on

**Table 2.** Percentage of employees exposing on noise

Activity	Exposure [%]	
	Hazardous noise	Other noise
Production	22.0	43.1
Installation, maintenance, tuning and repairs	11.6	53.7
Handling, storage, transport	4.6	24.4
Cleaning, security, domestic cleaning	2.0	16.0
Teaching, health, information, other	1.0	18.6
General management	0.9	7.4
Research, analysis, computing	0.4	15.3
Reception, data entry, switchboard, secretarial	0.3	12.7
Management, accounts, administration	0.3	10.1
Commerce, sales, sales technician	0.3	12.0
<b>Average</b>	<b>6.8</b>	<b>24.6</b>

occupational noise.

The figures (table 2) and brief conclusion about noise at work of the French survey from 2003 outline the exposure of employees to the main workplace risks in France. The survey is administered by company doctors (all employees are required to attend these doctors at least once every two years), which enables the use of quite a technical questionnaire. Between June 2002 and end 2003, 1.792 physicians (20% of company doctors) filled in the questionnaire for 49.984 workers chosen at random. Final conclusions are that approximately one-third of employees reported being exposed to noise pollution. **Almost 7% of employees are subjected to over 20 hours per week of noise exceeding the 85 dB(A) threshold, or of impact and impulse noise. These types are classed as “hazardous noise”.** Furthermore, 25% of employees are subjected to “other noise”: **exceeding 85 dB(A), but for less than 20 hours per week, as well as all other bothersome noise of a lower sound level.** It has to say that, according to the provisions of the new EU directive 2003/10/EC, the figures have to be revised.

Hazardous noise is likely to impair hearing. Other noise has less severe consequences, even though it can also have adverse effects on health, quality of life in the

workplace and even on hearing in the longer term.

**Table 3.** Maximal time exposure on noise depending on the level of noise

Level of the noise $L_{IeqA}$ [dB]	Maximal time exposure [hours]
115	0,25
110	0,5
105	1
100	2
97	3
95	4
92	6
90	8

About the definition of “hazardous noise”, it have to say that the U.S. laws in force is less severe than the EU legislation. Thus, the figures from table 3 show maximal exposure limits  $L_{IeqA}$  depending on the time exposure on the noise.

The figure 1 shows the dependence between the values of maximal limits of the level of noise exposure and exposure time according to U.S. workplace legislation.

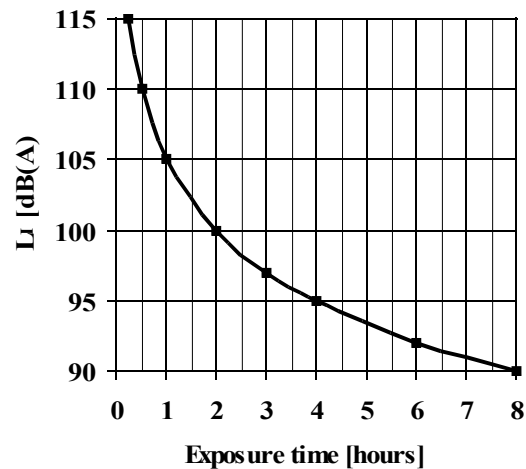


Fig. 1 U.S. workplace legislation - maximal equivalent exposure limits  $L_{IeqA}$  [dB(A)] depending on the time exposure on the noise

**Most vulnerable groups.** Hazardous noise affects 18% of employees in manufacturing and 12% of employees in agriculture and the construction sector. The main sectors concerned are wood-paper, metallurgy and metal processing, mechanical equipment, automotives, mineral goods, textiles, agriculture and food industry. The survey has identified the following risk groups:

1. hazardous noise is more prevalent in establishments with 200 to 500 employees

2. men (10%) tend to be subjected to hazardous noise more frequently than women (2%)

3. workers in production, installation, maintenance, tuning and repairs are particularly at risk

4. temporary workers are subjected to three times the average exposure (20.2%)

5. industrial workers are particularly affected (30% from qualified, 26% from non-qualified).

**Combined risks.** Employees subjected to hazardous noise tend to be considerably more involved in the manual handling of loads than other employees are. They also tend to work more frequently with vibrating machinery and tools, as well as operating mobile machinery more frequently in the workplace. In addition, these workers have a higher exposure to extreme temperatures. Almost all of them suffer from postural and articular cartilage problems. Three-quarters of employees exposed to hazardous noise are also exposed to one or several chemical products, including: lubricating oil, silica, crystalline, solvents, welding fumes, exhaust emissions or wood dust.

**Types of work organisation.** Employees subjected to hazardous noise are more likely to work in teams and at night than other employees are. They have a more highly controlled pace of work, as it tends to depend more on automatic procedures, stringent production standards or short lead times. They also tend to rely more on colleagues and line management. They generally have to be more versatile when a colleague needs to be urgently replaced.

**Hearing protection.** While effective hearing protection can prevent hearing impairment, 32% of those exposed to hazardous noise do not have access to any type of hearing protection. In the manufacturing sector, 77% of exposed employees have recourse to hearing protection. The same is true for 71% of exposed employees in construction and 67% in agriculture. However, in the services sector, where there is less exposure to hazardous noise, over half of exposed employees are not protected.

**Other noise.** A quarter of employees are exposed to other types of noise, whether it is noise above the 85 dB(A) threshold, but for a duration of less than 20 hours per week, or simply bothersome noise. The sectors most exposed to this risk are often the same as for hazardous noise. However, certain sectors of the service industry are also greatly affected by other types of noise, such as automotive sale and repairs (47.8%), operational services (including temporary agencies), and the transport sector. While hazardous noise primarily affects employees with a production-based role, other noise mainly affects those with a position in installation, maintenance, tuning or repairs. These employees are often exposed to noise over 85 dB(A), but for a shorter period.

In conclusion, it may be said that noise exposure remains a major constraint for certain employee categories, for which the risk of work-related deafness is far from being overcome.

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