

Noise Management at Work

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Abstract

Every single day millions of European workers are exposed to noise at work. One in five of European's workers have to raise his voice to be heard for at least half of the time that there are at work and 7% suffer from work-related hearing impairment. In Europe noise-induced hearing loss is the most common reported occupational disease.

This paper⁶ deals with issues related with noise management at work, especially regarding the compliance with the new noise European Directive, (2003/10/EC).

Introduction

The compliance with the Safety and Health at Work legislation is the minimum requirement that an organization must achieve to ensure the protection of the safety, hygiene and health of their workers. One of the issues is the protection from the risks related to occupational noise exposure. After taking in consideration the effects on the health and safety of workers, in particular damage to hearing, the European Parliament and the Council of the European Union released on 2003, February 6th, a new directive concerning the protection of workers from the risks arising from noise (Directive 2003/10/EC). This Directive introduces new limits to workers' noise exposure and has to be transposed to EU States national legislations before 15 February 2006.

This directive on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise) is the seventeenth individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC ("Framework Directive").

Besides the easily recognized direct effects of loud noise exposure on human health, like hearing loss, the exposure to noise affects people in many other non-auditory ways such as hypertension and stress (Haslegrave, 1995; NIOSH, 1998; Sanders and McCormick, 1993; WHC, 2004). For instance, excessive noise can:

- cause ringing in the ears which can be very distracting and cause severe difficulties in concentration or sleep;
- affect sense of balance and cause dizziness;
- be a stressor which can lead to tiredness, irritability and headaches, and result in an increased metabolic rate that lowers individual resistance to noise;
- affect the eyes, causing loss of clarity, color perception and night vision.

Due to this variety of effects on humans, besides the effect on workers' performance, one very important aspect to consider is the role of noise as a safety hazard, since it increases the risk of accidents by interfering with oral communication, by masking sounds of warnings or approaching danger, by causing stress and fatigue or by its effect on balance and concentration (Sanders and McCormick, 1993; WHC, 2004).

⁶ The content of this paper was gathered as result of the work developed by the authors in the context of the TC-GPSP - Topic Centre on Good Practice, Systems and Programmes of the European Agency for Health and Safety at Work, as a contribution to the edition of the issues 56 to 59 of the agency's FACTS factsheets dedicated to the thematic of Noise at Work.

The design of workstations and places of work and the selection of work equipment, procedures and methods that give priority to reducing the risks at source based on collective protection measures is the most effective way to reduce the level of exposure to noise. Whenever this is not possible employers should make adjustments improving the safety and health of workers at work by applying an effective noise reduction program, which can include engineering and organizational/administrative noise control, and individual hearing protection measures. Another important factor to the reduction of the exposure to hearing loss risk is an adequate information and training plan to make workers aware of the problem and to instruct them on the correct use of work equipment.

Considering the importance of the Noise as a Safety and Health at Work risk factor this paper will address some of the basic issues related with noise management at work, especially regarding the compliance with the new noise European Directive. In fact, 7% of European's workers suffer from work-related hearing impairment (Eurostat, 2004), and noise-induced hearing loss is the most common reported occupational disease in Europe (EASHW, 2002).

Noise exposure limit and action values

On the Directive's preamble it is recognized that current scientific knowledge on the effects that exposure to noise may have on health and safety is not sufficient to enable setting precise exposure levels covering all risks to health and safety, especially the effects of noise other than those of an auditory nature.

Nevertheless, the Directive fixes the exposure limit values and the exposure action values for the protection of workers from risks to their health and safety, in particular the risk to hearing. Such limits are defined based on three physical parameters, which are used as noise risk predictors. These parameters are the peak sound pressure and the daily and weekly noise exposure levels, which are defined as follows:

- peak sound pressure (p_{peak}): maximum value of the "C"-frequency weighted instantaneous noise pressure;
- daily noise exposure level ($L_{\text{EX}, 8\text{h}}$) (dB(A) re. 20 μPa): time-weighted average of the noise exposure levels for a nominal eight-hour working day. It covers all noises present at work, including impulsive noise;
- weekly noise exposure level ($L_{\text{EX}, 8\text{h}}$): time-weighted average of the daily noise exposure levels for a nominal week of five eight-hour working days.

The exposure limit values and the exposure action values refer to the daily noise exposure levels and peak sound pressure and are fixed by the Directive as follows:

- exposure limit values: $L_{\text{EX}, 8\text{h}} = 87$ dB(A) and $p_{\text{peak}} = 200$ Pa respectively;
- upper exposure action values: $L_{\text{EX}, 8\text{h}} = 85$ dB(A) and $p_{\text{peak}} = 140$ Pa respectively;
- lower exposure action values: $L_{\text{EX}, 8\text{h}} = 80$ dB(A) and $p_{\text{peak}} = 112$ Pa respectively.

It must be noted that, when applying the exposure limit values, the determination of the worker's effective exposure shall take account of the attenuation provided by the individual hearing protectors worn by the worker. On other hand, the exposure action values shall not include the effect of any such protectors.

The Directive foresees that, in duly justified circumstances, for activities where daily noise exposure varies markedly from one working day to the next, for the purposes of applying the exposure limit values and the exposure action values, to assess the levels of noise to which workers are exposed, instead of the daily noise exposure level, it may be used the weekly noise exposure level, on condition that:

- the weekly noise exposure level as shown by adequate monitoring does not exceed the exposure limit value of 87 dB(A); and
- appropriate measures are taken in order to reduce the risk associated with these activities to a minimum.

The Directive also states that under no circumstances shall the exposure of the worker exceed the exposure limit values. If, despite the measures taken, exposures above the exposure limit values are detected, the employer shall:

- take immediate action to reduce the exposure to below the exposure limit values;
- identify the reasons why overexposure has occurred; and
- amend the protection and prevention measures in order to avoid any recurrence.

Noise Control

Regarding provisions aimed at avoiding or reducing exposure, the above-mentioned Directive settles that, taking account of technical progress and of the availability of measures to control the risk at source, the risks arising from exposure to noise shall be eliminated at their source or reduced to a minimum.

Noise can be effectively reduced by incorporating design preventive measures into workstations and work places and by selecting work equipment, procedures and methods that reduce the risks on the source, thus contributing to the protection of the workers and giving priority to collective protection over individual protection.

For situations where the upper exposure action values are exceeded, the same Directive defines that employers shall establish and implement a programme of technical and/or organisational measures intended to reduce the exposure to noise and the workplaces marked with appropriate signs, the area delimited and the access restricted where this is technically feasible and the risk of exposure so justifies.

Engineering/Design Noise Control

Noise control should be taken into account from the beginning of the planning process for new buildings, new equipment, infrastructures, materials used, working areas organization, as well as maintenance programs, in order to ensure the physical reduction of the noise energy, either at its source or in its path (Casali and Robinson, 1999; NOHSC, 1991; OSH, 2000 and 2002; Sanders and McCormick, 1993; Tandon, 2000; WHO, 1980). Noise control engineering should not be replaced by hearing protection and/or administrative controls. The best solutions are the ones that reduce the noise itself, preferably at the emission source, not depending on workers behaviour.

Examples of control strategies include (Casali and Robinson, 1999; NOHSC, 1991):

- isolation of the noise source – via relocation, enclosure, or vibration damping using metal or air springs (< 30 Hz) or elastomer (> 30 Hz) supports, use of separate bases for large and heavy machines which are not vibration isolated (e.g., put on a separate piece of ground without contact with the remainder of the building);
- reduction at the source or in the path – using mufflers or silencers on exhausts, reducing cutting, fan, or impact speeds, dynamically balancing rotating components, reducing fluid flow speeds and turbulence, absorbing foam or fibreglass on reflective surfaces to reduce reverberation, sealing around doors and windows, shields to reflect and redirect noise (especially high frequencies), lining or wrapping of pipes and ducts and use flexible pipes, or preventing impact and collision during manual and mechanical materials handling (e.g., using soft rubber or plastic to receive hard impacts);
- replacement or alteration of machines – including belt drives as opposed to noisier gears, electrical rather than pneumatic tools, belt conveyors instead of roller conveyors, and shifting frequency outputs such as by using centrifugal fans (low frequencies) rather than propeller or axial fans (high frequencies), keeping in mind that low frequencies propagate further than high frequencies, but high frequencies are more hazardous to hearing;

- application of quieter materials – such as rubber liners in parts bins, conveyors, and vibrators, resilient hammer faces and bumpers on materials handling equipment, nylon slides or rubber tires rather than metal rollers, and fibre rather than metal gears;
- active noise reduction – the superposition of 180 degrees out-of-phase electronically generated noise with the original noise causes the physical cancellation of the noise in a target zone of the workplace. This technique is most effective at frequencies below 1000 Hz because passive noise control materials (such as absorptive liners and barriers) are typically heavy, bulky, and expensive;
- maintenance - lack of maintenance (e.g. inadequate lubrication and loose or worn mufflers) can create or worsen noise hazards, thus it's required an appropriate maintenance programmes for work equipment and exhausts, the workplace and workplace systems.

In the design and implementation of noise control equipment it is also important to take in consideration ergonomics factors, regarding operators comfort and performance, accesses and production and maintenance needs. When operators face difficulties in carrying out their jobs, they tend to modify or remove such equipment, rendering it ineffective.

Organizational/Administrative Noise Control

Organizational/Administrative controls allow managing the duration of noise exposure. Reducing the noise risks by means of this type of control measures involves taking into account (some of them are proposed by the noise Directive):

- adoption of an equipment procurement policy where noise is an evaluation factor;
- working methods that require less exposure to noise;
- organisation of work to reduce noise:
 - limitation of the duration and intensity of the exposure;
 - the number of employees working in the noisy area should be limited to the absolute minimum;
 - task rotation;
 - noisy activities should be scheduled for the period of the day where less employees are exposed;
 - appropriate work schedules with adequate rest periods.

Reduction of Noise Exposure by Personal Protective Means

There are many cases where noise control is ineffective, infeasible or prohibitively expensive, e.g., airport taxi areas (Casali and Robinson, 1999). The Directive state that if the risks arising from exposure to noise cannot be prevented by other means, individual hearing protectors shall be used by the workers as follows:

- where noise exposure exceeds the lower exposure action values, the employer shall make individual hearing protectors available to workers;
- where noise exposure matches or exceeds the upper exposure action values, individual hearing protectors shall be used;
- individual hearing protectors shall be so selected as to eliminate the risk to hearing or to reduce the risk to a minimum.

The employer shall make every effort to ensure the wearing of hearing protectors and shall be responsible for checking the effectiveness of the measures taken.

Some types of hearing protection devices are (Casali and Robinson, 1999):

- earplugs – vinyl, silicone, spun fibreglass, cotton/wax combinations, and closed-cell foam products that are inserted or semi-inserted in the ear canal to form a noise blocking seal. Comparatively the attenuation is better below 500 Hz and above 2000 Hz;
- earmuffs – ear cups, usually of rigid plastic material with an absorptive liner, that completely enclose the outer ear and seal around it with foam- or fluid-filled cushions. Comparatively the attenuation is better at intermediate frequencies;
- active noise cancellation – new technologies that offer active noise-level-dependent attenuation, as well as passive protection.

Information and Training

According to the Directive the employer shall ensure that if workers are exposed to noise at or above the lower exposure action values, they receive information and training relating to risks resulting from exposure to noise. Such information and training concerns:

- nature of the risks;
- measures taken in order to eliminate or reduce to a minimum the risks from noise, including the circumstances in which the measures apply;
- exposure limit values and exposure action;
- results of the assessment and measurement of the noise carried out together with an explanation of their significance and potential risks;
- correct use of hearing protectors;
- why and how to detect and report signs of hearing damage;
- circumstances in which workers are entitled to health surveillance and the purpose of health surveillance;
- safe working practices to minimise exposure to noise.

Risk Assessment

According to the Directive the employer shall assess and, if necessary, measure the levels of noise to which workers are exposed. Such assessment and measurement shall be planned and carried out by competent services at suitable intervals. The data obtained shall be preserved to permit consultation at a later stage. The risk assessment shall be updated regularly, in particular when there were significant changes, which could render it out of date, or when the results of health surveillance show it to be necessary.

The basic assessment of exposure to noise can be done in a simple way. For instance, if the answer to any of the following questions is yes, the workplace may have a noise problem (CCOHS, 1999).

- Do people have to raise their voices?
- Do people who work in noisy environments have ringing in their ears at the end of a shift?
- Do they find when they return home from work that they have to increase the volume on their car radio higher than they did when they went to work?
- Does a person who has worked in a noisy workplace for years have problems understanding conversations at parties or restaurants, or in crowds where there are many voices and "competing" noises?

Equipment for noise measurements includes sound level meters and noise dosimeters. The Directive allows methods used to include sampling, which shall be representative of the personal exposure of a worker.

The Directive defines that, when carrying out risk assessments, employers shall give particular attention to the following:

- level, type and duration of exposure, including any exposure to impulsive noise;
- exposure limit values and the exposure action values;
- any effects concerning the health and safety of workers belonging to particularly sensitive risk groups;
- as far as technically achievable, any effects on workers' health and safety resulting from interactions between noise and work-related ototoxic substances, and between noise and vibrations;
- any indirect effects on workers' health and safety resulting from interactions between noise and warning signals or other sounds that need to be observed in order to reduce the risk of accidents;
- information on noise emission provided by manufacturers of work equipment in accordance with the relevant Community directives;
- existence of alternative work equipment designed to reduce the noise emission;
- extension of exposure to noise beyond normal working hours under the employer's responsibility;
- appropriate information obtained following health surveillance, including published information, as far as possible;
- availability of hearing protectors with adequate attenuation characteristics.

Conclusions

Noise is a very important issue for Safety and Health at Work. Noise-induced hearing loss is the most common reported occupational disease in Europe. Noise has also a variety of other indirect effects, like affecting workers' performance, and playing an important role as a safety hazard since it increases the risk of accidents.

The new European Directive on the minimum health and safety requirements regarding the exposure of workers to the risks arising from the physical agents (noise) fixes new limits to the noise worker exposure. The daily noise personnel exposure limit will be reduced compared with the actual legal values. The new value will be 87 dB(A), which corresponds to a reduction of 3 dB(A). This Directive must be transposed to all European Member States legislations before 15 February 2006.

In this paper we discussed some of the control measures that can be used in order to eliminate or reduce noise-related risks. Such measures include Engineering/Design controls, Organizational/Administrative controls, and Personal Protective Means. Employers play a determinant role on the implementation of such control measures. However, a key factor for the reduction of hear-loss and noise related accidents is workers awareness about the risks and the ways of elimination of reducing its effects, and this can only be achieved by means of information and training.

References

- Casali, J. and Robinson, G. (1999), Noise in Industry: Auditory Effects, Measurement, Regulations, and Management, in The Occupational Ergonomics Handbook, 1st Edition, W. Karwowski and W. Marras, CRC Press
- CCOHS, (1999), Noise - Basic Information, Published by Canadian Centre for Occupational Health and Safety, at http://www.ccohs.ca/oshanswers/phys_agents/noise_basic.html
- 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
- 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

- Directive 2003/10/EC of the European Parliament and of the Council of 6 February 2003 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise)
- Eurostat, (2004), *Work and health in the EU: a statistical portrait, Data 1994–2002*, ISBN 92-894-7006-2
- European Agency for Safety and Health at Work, (2002), *Data to describe the link between OSH and employability*, ISBN 92-95007–66-2
- Haslegrave, C. (1995), *Auditory environment and noise assessment*, in *Evaluation of Human Work*, 2nd Edition, J. Wilson and E. Corlett, Taylor & Francis
- NIOSH, (1998), *Occupational Noise Exposure*, DHHS (NIOSH) Publication No. 98-126
- NOHSC, (1991), *NOISE CONTROL*, published by National Occupational Health and Safety Commission, Australia, at <http://www.nohsc.gov.au/OHSInformation/OHSSolutions/noise/contents.htm>
- OSH, (2000), *Noise Control*, Health Bulletin no. 5, May, Occupational Safety and Health Service, New Zealand
- OSH, (2002), *Approved code of practice for the Management of Noise in the Workplace*, Revised Edition, Occupational Safety and Health Service, New Zealand
- Sanders, M. and McCormick, E., (1993), *Noise*, in *Human Factors in Engineering and Design*, 7th Edition, McGraw-Hill International Editions
- Tandon, N., (2000), *Noise-reducing designs of machines and structures*, in *Sadhana*, Vol. 25, Part 3, June, pp. 331-339.
- WHC, (2004), *Noise in Facts007*, Edited by Worker Health Center, at <http://www.workershealth.com.au/facts007.html>
- WHO, (1980), *Noise*, World Health Organization, Geneva, ISBN 92-415-4072-