

European Week for Safety and Health at Work

2005

Prevention of risks from occupational noise in practice



European Agency
for Safety and Health
at Work

Prevention of risks from occupational noise in practice



**Europe Direct is a service to help you find answers
to your questions about the European Union**

**Freephone number (*):
00 800 6 7 8 9 10 11**

() Certain mobile telephone operators do not allow access to 00 800 numbers or these calls may be billed*

A great deal of additional information on the European Union is available on the Internet.
It can be accessed through the Europa server (<http://europa.eu.int>)

Cataloguing data can be found at the end of this publication.

Luxembourg: Office for Official Publications of the European Communities, 2005

ISBN: 92-9191-153-4

© European Communities, 2005

Reproduction is authorised provided the source is acknowledged.

Printed in Spain



Contents

Introduction	5
1. Noise reduction for automated standard lamp production line No 234	10
2. Participatory co-operation in preventing noise exposure in a planning and construction project for a new beverage plant	16
3. Comprehensive noise reduction programme and exposure management in broadcasting	19
4. Converting a system for manufacturing concrete blocks to a new concrete compression procedure with "harmonic vibration"	24
5. Introduction of noise management to enable the recording, implementation and evaluation of all opportunities for noise reduction	27
6. Hearing protection from military rifle shooting noise	32
7. Sound design in a typical rock club, an interventions project	35
8. Away with noise! Reducing noise hazards in the workplace	39
9. Reducing noise when manufacturing concrete vats by immersion of vibrating trestles in water	43
10. Mechanism for preventing noise risk in an energy service company	46
11. Making hypoacusis visible in the Basque Country	49
12. Noise reduction and acoustic improvement of the control room in the combined heat and power station – TE-TOL, Ljubljana	52
13. Courses for noise monitors	57
14. Noise in Agriculture – Tools to evaluate exposure and find beneficial solutions	62
15. The Noise Reduction Factor (GRF)	64
16. The Voivodship Program of Health Promotion: "Corporate Program for Hearing Protection" for the years 2000-2005	69
17. Occupational Noise Reduction in certain Power Plant Workplaces	75
18. Programme of prevention of exposure to noise	77
19. A Sound Ear: Training and awareness raising of noise exposure to musicians	79
Annex: Overview of examples	83
Index	87



Introduction



INTRODUCTION

Background

"Noise-induced hearing loss is insidious, permanent, and irreparable. In a developed country, exposure to excessive noise is at least partially the cause in more than one-third of those in the population who have hearing loss. Noise-induced hearing loss is the most prevalent irreversible industrial disease, and noise is the biggest compensable occupational hazard."⁽¹⁾

Despite being a well-known hazard, noise is still a risk to workers at the start of the 21st century. It is difficult to estimate how many people may be harmed by noise, but with 20% of workers in Europe being exposed to loud noise⁽²⁾ (about 40 million workers) the human and economic cost of this hazard is very great.

"Noise can cause hearing impairment, interfere with communication, disturb sleep, cause cardiovascular and psycho-physiological effects, reduce performance, and provoke annoyance response and changes in social behaviour"⁽³⁾. In short, noise is a problem.

The legal framework

European Directives exist to protect workers from harm caused by exposure to noise. The "Framework Directive"⁽⁴⁾, together with other workplace orientated Directives such as the 2003 Noise Directive⁽⁵⁾, the "PPE Directive"⁽⁶⁾, and the "Pregnant Workers' Directive", provides a structure for dealing with all risks (not just the risk of noise-induced hearing loss) to all workers from noise. The Framework Directive sets out the general principles of prevention and then the more specific directives, of which the 2003 Noise Directive is the most significant for noise, give greater detail.

The requirements in the "Machinery Directive"⁽⁷⁾ and "Outdoor Machinery Directive"⁽⁸⁾, for manufacturers to provide noise information about the machinery, and for some machinery to limit emissions, should also help the employer to have an effective procurement policy, so reducing workers' exposure to noise.

(1). Speech by Dr R.H. Henderson, Assistant Director-General, World Health Organisation, at "Prevention of Noise-Induced Hearing Loss", Informal consultation held at the World Health Organization, Geneva, 28-30 October 1997

(2). Third European Survey on Working Conditions 2000 (EWSC), European Foundation for the Improvement of Living and working Conditions (2000)

(3). Factsheet 258 Occupational and Community Noise, World Health Organisation, revised 2001

(4). Council Directive 89/391/EEC of 12 June 1989 on the introduction of measure to encourage improvements in the safety and health of workers at work

(5). 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), that is replacing Council Directive 86/188 of 12 May 1986

(6). 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

(7). Directive 98/37/EC of the European Parliament and of the Council of 22 June 1998 on the approximation of the laws of the Member States relating to machinery

(8). Directive 2000/14/EC of the European Parliament and of the Council 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. There is an amendment proposed. See:

http://europa.eu.int/smartapi/cgi/sga_doc?smartapi!celexapi!prod!CELEXnumdoc&lg=en&model=guicheti&numdoc=52005PC0370



These Directives also make clear that prevention through design is vitally important in dealing with occupational noise. *"Machinery must be so designed and constructed 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"*.

Sharing good practice

An important role of the European Agency for Health and Safety at Work is to make information available to support and promote the prevention of risks from noise, helping employers and others with legal duties comply with national legislation based on the directives. The Agency achieves this by publishing its own material and by making available existing good practice from across Europe. The Good Practice Awards competition is a method to promote and encourage practical solutions in workplaces and to share this good practice.

This publication contains real examples of how enterprises and organisations from across the European Union have taken a variety of actions to reduce the exposure of workers to noise. The cases should inspire owners, managers and workers about what could be achieved in their workplaces. They are not intended to be definitive or to provide detailed technical guidance. Not all elements of all cases were successful and these short summaries present the best features to demonstrate what can work in practice and how to achieve it. Some enterprises developed their own solutions using in-house expertise. Others found it useful and cost effective to use consultants with expert knowledge and practical experience in preventing exposure to noise. The majority included the involvement of employees and their representatives to identify problems and develop solutions; this is crucial to success, as workers have firsthand experience of the work situation.

Every workplace is different! Therefore work practices and solutions to problems must be matched to the particular situation by carrying out an assessment of the risks at the workplace concerned. However, concepts can be transferred across sectors, organisation size and type, and Member States.

The practical examples

The practical examples presented here were all entries in the 6th annual good practice competition run by the European Agency for Safety and Health at Work. The aim of this competition is to support the dissemination of good practice information and to promote the application of "practical solutions" in workplaces in the twenty-five Member States.

Thirty two entries from 19 Member States were received, covering a wide variety of employment sectors and process, from protecting workers in broadcasting to technical solutions in the manufacture of concrete blocks, via raising awareness in agriculture to assessing the exposure of street cleaners.

What the judges were looking for

In selecting the examples, the judging panel were looking for solutions that:

- Tackled hazards and risks at source through good management, particularly the effective use of risk assessment and implementation of its findings;
- Demonstrated good consultation between management and the workforce, and the effective participation of the workers;
- Showed a successful implementation in the workplace, achieving real improvements, sustainable over time;



Prevention of risks from occupational noise in practice

- Complied with all relevant legislative requirements, and demonstrated good practice going beyond minimum requirements, and;
- Could be transferred to other workplaces.

Risk assessment and prevention principles

Before good practice information is applied, an assessment of the risks present in the workplace should be carried out and reference made to relevant national legislation. A risk assessment is a careful examination of what could cause harm to people, so that you can decide whether you have taken enough precautions or need to do more to prevent harm. The aim is to make sure that no one gets hurt or becomes ill. If a risk assessment is not carried out before implementing good practice information, there is a danger not only that risks may not be controlled but also that there may be a waste of resources.

The general principles of prevention

- Avoiding risks;
- Evaluating the risks which cannot be avoided;
- Combating the risks at source;
- Adapting the work to the individual, especially as regards the design of workplaces, the choice of work equipment, and the choice of working and production methods;
- Adapting to technical progress;
- Replacing the dangerous by the non-dangerous or the less dangerous;
- Developing a coherent overall prevention policy which covers technology, work organisation, working conditions, social relationships and the influence of factors related to the working environment;
- Giving collective protective measures priority over personal preventive measures; and
- Giving appropriate instructions to the workers.

Further information

The Agency's web site⁽⁹⁾ contains much more information in all 20 European languages on the prevention of risks from occupational noise⁽¹⁰⁾. All Agency publications are can be downloaded free of charge from the site.

Acknowledgements

The Agency would like to thank its network of Focal Points in Member States (competent authorities, or bodies nominated by them, responsible for occupational health and safety) for assessing and nominating good practice examples for the Agency award scheme. The competition would not have been possible without their assistance. The Agency also thanks the experts from the European Commission and social partners who made up the judging panel for their input. Last but not least, many thanks to the organisations who are featured in this publication for their initiative!

November 2005

(9). <http://osha.eu.int>

(10). Good practice on noise can be found at: http://osha.eu.int/good_practice/risks/noise/



Practical Solutions



1

NOISE REDUCTION FOR AUTOMATED STANDARD LAMP PRODUCTION LINE NO 234

GE Hungary Rt. Light Source Factory in Nagykanizsa

8800 Nagykanizsa
Kinizsi Pál utca 97
HUNGARY
<http://www.ge.com/hu/hu>

Issue

Achieving noise reduction to prevent hearing loss along a complete production line in a light source factory.

Problem

The Nagykanizsa factory is the largest light source factory in Europe. It provides 5% of the world's light source production, producing more than 500 million units of hundreds of different types of light sources, and 800 million units of cover glass on a total built-up surface area of 79 400m², and on a total land area of 36 hectares. The factory now employs more than 4 000 people, compared to 341 when the plant was first established.

Steps in lamp production

Disc manufacture

The disc, made from filament tubes and mount pipes, is one of the basic components of the electric light bulb. The manufacturing process consists of feeding in and flanging the filament tube and then cutting up the flanged tube.

The flanged, soft glass is quickly cooled and hardened in the next position by blowing cold air on to it inside and out. The flanged tube is then moved forward in accordance with the required disc length, and the disc is split. The cracked disc is placed in the kiln, while the glass tube is returned to the start of the process in order to produce the next disc.

Stem mounting

The stem mount is produced initially from the disc, the lead-glass filament tube and two installation wires (electrodes).

After the materials have been fed in, the end of the disc begins to warm up. When the disc becomes soft, it starts to stretch inwards and is flattened slightly by two metal jaws.



After initial flattening, the end of the disc continues to be heated until such time as the softened glass is sealed off from air ducts. Then the final metal-glass joint is moulded by means of a second larger-scale lamination process.

After the second lamination, the soft glass is blown out with preheated air blown into the suction pipe, which ensures that after sealing, the lamp can be pumped via the suction pipe. At the same time, preheated air is blown into the disc to round off the inner laminated side and to prevent the formation of sharp angles. The finished stem mount then has to be cooled in the regulating oven so that residual heat potential is not broken.

Coil winding

The objective of this operation is to fix in place the coil that emits light to the conductors. This may be done mechanically or by spot welding. Vacuumed air infiltrations pick the coil up in its fixed position and feed it into the bent hook. The rod is warmed up at gradually increasing heats until it reaches melting point, when, with melted ends, the rod is squeezed into a 'nest', including the supports. After being cut to size, these supports are placed into the twisting position. After installation, the support has to be twisted, and the electrodes brought into a suitable position. After this, the coil is immersed into a phosphorous alcohol solution and the electrodes are coated with a zircon aluminium alcohol varnish.

Soldering

The mounted stem and cover glass are fed into the machine, and the cover glass begins to warm up above the disc flange. As the glass begins to soften, it is pulled down until it reaches the disc edge and the two components are joined. Thereafter the soft glass is blown onto the neck-shaping metal during the neck-shaping operation. This neck-shaped part is then cooled.

The stem mount, arriving along the storage chain, is placed into the holder of the soldering machine by the stem mount loader. The cornice moves intermittently, while the solder head rotates around its own axis in soldering positions with the stem mount and cover glass. Flames in the area around the height of the disc heat a wide band of the glass with gradual intensity. The neck of the cover glass grows soft as a result of warming. Due to the effect of softening and 'pressure' of the flames, the neck gets closer to the disc as it extends and grows thinner, followed by piercing.

The glass is cut by a special burner and sharp darting flame, with the assistance of air blown in from below, which crosses the spike tube under the soldered disc, followed by neck shaping. The neck-shaped lamp, proceeding along several positions, gradually cools and solidifies on the effect of the regulating flames.

In the extraction position, a vacuum extractor raises the lamp from the cone of the sealed holder and places it in the suction head vacuum seal for the pump. The flange of the mounted stem is welded to the cover glass, and so only the suction pipe ensures contact with the sealed air space of the lamp.

Pumping and piercing

The loader places the suction-pipe lamp from the soldering machine into the pump cornice vacuum seal. After radical reduction in air pressure, the cover glass is loaded with filling



gas prescribed for the lamp. The filling gas is usually over-inflated, and surplus gas is released. Gradual heating, capillary tension and cutting the suction pipe with a sharp jet flame then seal the suction pipe. After the internal airspace of the lamp has been formed, this has to be sealed off from any external air - this is the piercing process.

Head lubrication

A ring of putty is placed onto the head of the head lubrication machine. The head lubrication machine moves intermittently in alternating rotating or straight-line steps. The head is placed loosely into the head feed tank, which feeds each header individually by vibration movement. The pre-produced mass of putty, held in the same container as the piston feeder, is then pushed into the lamp head via a cone-shaped valve.

Heading

The head, smeared in a mass of putty, is applied to the pumped and functioning lamp. The head putty is burned on the heading machine to join the glass to the metal head. The bound lamp, fitted with a head, is placed on the heading device to:

- carry out head burning (forming solidity with the appropriate binding between the head and the sealed cover glass);
- fasten electrodes to the head connecting pins by soldering and welding;
- pre-burn the coil; and
- make selection of the lamp as BURN-NOT BURN.

In the course of the operation, the ends of a protruding electrode have to be cut to size to make them capable of being welded or soldered. Soldering may be completed with flames or irons.

Coil pre-burning

In coil pre-burning, the finished lamp is gradually burned over several positions. After this process, there is quality control and the packaging of finished goods.

The factory in Nagykanizsa commenced its long-term noise reduction project in 2003. The noise level was over 85 dB(A) in 90% of workplaces at the plant. Previous attempts had been made at reducing the noise level by fitting noise protection and reduction covers, but in lamp manufacturing, regular human intervention for the purpose of replenishing materials, maintenance and setting adjustments is required. This reduces the effectiveness of these covers.

Given that the technology is the same for all types of lamp, with small deviations, it seemed advisable, instead of covers, to develop machines and equipment that are easily adaptable to the relevant technological process, though operating at a substantially lower noise level than machines used until now.

Solution

A general noise assessment was carried out on all the plant's traditional automated lamp production lines, particularly with regard to positions where permanent or temporary work is carried out. Noise measurements were conducted on 49 automated lamp production lines, at 14 measurement points per production line, providing records from around 700 measurement points. It was evident in the



course of preliminary measurements that the two main sources of noise affecting employees were operation of the head vibration feeder on the production line and operation of controlled air valves running with pneumatic tools on the entire production line.

Production line number 234, operating with the highest noise level from data acquired via the noise measurements was selected as a pilot scheme to test the prevention measures. The noise level of each mechanical unit on this line exceeded 87 dB(A). Twenty-four persons were involved in the improvements to the pilot production line chosen while the technical solutions developed on the pilot scheme affect 1 521 workers.

Management initiated the requirement to improve the noise reduction process after notifying technicians and skilled employees working on the production lines, and after making comments at various employment protection committee and works council meetings.

A development team was set up at the plant to implement the project and improvements, and each factory unit involved in light source production delegated some employees to this team. When creating the team, one key factor was that at least half the members should be manual workers. This also served the purpose of efficiency, since the most useful improvements and ideas largely came from mechanics in direct contact with the production lines. The chairman of the factory's employment protection committee and the NFDSZ trade union representative regularly attended improvement meetings as invited guests.

After the initial brainstorming session, the team decided on a number of improvements for each mechanical unit. The ideas necessary for implementation were collected in two different ways. The noise reduction team surveyed some positive examples employed at the Nagykanizsa factory and other GE Hungary⁽¹¹⁾ Rt. plants, filtering out any that might be suitable for wide-scale introduction at the plant. Where this proved impossible, the improvement team reduced the noise level instead with completely new technical solutions.

Actions taken along the production line

Disc maker

The pneumatic valves and a cooling block operated at 5-bar air pressure were identified as being the primary noise sources on this unit. The noise emitted by mechanical parts when only the machine was operating came to 81.2 dB, the figure jumping to 88.5 dB with the operation of the valves and disc-maker cooling block.

Examination of the disc-maker cooling block revealed that the high noise level occurred when the air current was broken on the sharp corner where the air is released. The revised cooling block was designed avoiding a blowpipe form and using a radial shape on the outlet points in the interior of the cooling block and in place of each sharp corner.

Stem moulder

As with the disc-maker, pneumatic valves and air used for cooling and cleaning were identified as the causes of high noise levels. By unscrewing the holder for the purpose of removing any glass fragments left in the holder and keeping it open in the next position, the need for air for cleaning was removed.

(11). <http://www.ge.com/hu/en/>



Solderer

A cooling ventilator is located on the soldering unit to assist in cooling the soldered lamp. This ventilator had no soundproofing and was given a coating to prevent simple extension. A new cooling ventilator was commissioned with 63 dB specified as the maximum operating noise level.

Head feeder

There was another appliance operating on the vibration principle on this mechanical unit - a smooth vibration design head replacement feeder unit, with the task of using the sensor on the side of the vibration feeder to notice when there are not many aluminium heads in the feeder, at which time it turns on automatically, and after a few seconds feeds the aluminium head into the appliance. The mechanical unit does not operate continually, switching on every 3-5 minutes, but when in operation, the noise level, like that of the feeder, is between 98 and 101 dB(A). The solution in this case was a conveyor belt replacement header appliance, replacing the smooth vibration employed so far with an intermittent-operation guided conveyor belt.

This was one of the project's most significant improvements. The previously employed head feeder, used for feeding the standard lamp's aluminium head, worked on the principle of vibration. A magnetic nucleus and coil was located on the inner side of the equipment, with a gap of around 8 mm between the two parts. As a result of variable magnetism, this made the equipment vibrate, and conveyed the aluminium head in this way. Obviously, the equipment functioned with a very high noise level (98-101 dB(A)), consisting partly of noise from the unit itself, and partly of the knocking together of aluminium heads to be fed in. Different head feeding solutions were considered, with noise measurements being taken under operational conditions.

A 'disc head feeder' was taken as a possible solution. There was a disc inside the appliance, which rotated at a specified speed, and thus the aluminium heads drifted to the edge of the disc on the basis of centrifugal force, into the gap between the disc and cylinder, where they proceeded towards the feed outlet as a result of continual rotation of the disc.

In its original form, the disc head feeder was not capable of being adapted to the technology, but after alterations, which consisted of reducing the size of the appliance, allowing for feeding various types of aluminium heads, and reducing the speed of the equipment (a feeder speed of 3 000-3 500 units/hour instead of 14 000 units/hour), it was perfectly adjustable.

Header

Noise reduction on the header unit was achieved by releasing the cooling air used. Cooling air at 5-bar pressure is applied at three positions on this unit, first blowing it onto points in all three positions to cool down the upper solder of the lamp. The new cooling ventilator allowed for a capacity of 650 m³/h, so that solder cooling is performed on one branch from air transported to the solder machine by the ventilator, and using this air pursuant to the soldering position. Given that the air emerging from the end of the pipe was somewhere around atmospheric pressure, the noise level also fell due to lower current speed.

General noise reduction measures

There are a large number of pneumatic tools operated by slave cylinders over the entire



lamp production line. In the course of measurements, it became clear that these are the main cause of the high noise level during operation of the production line. The improvement began by measuring valves located on the production line. Given that there was one valve for each tool, these made the air escape by means of an air pocket when performing a tool operation. There were 72 valves on a unit. The solution was to create a block of valves, setting up 'valve enclaves'. Valves were then located in one block in a soundproof box rather than scattered around alongside tools. Rather than 72 valves, 12 'valve enclaves' were located in soundproof boxes on one production line.

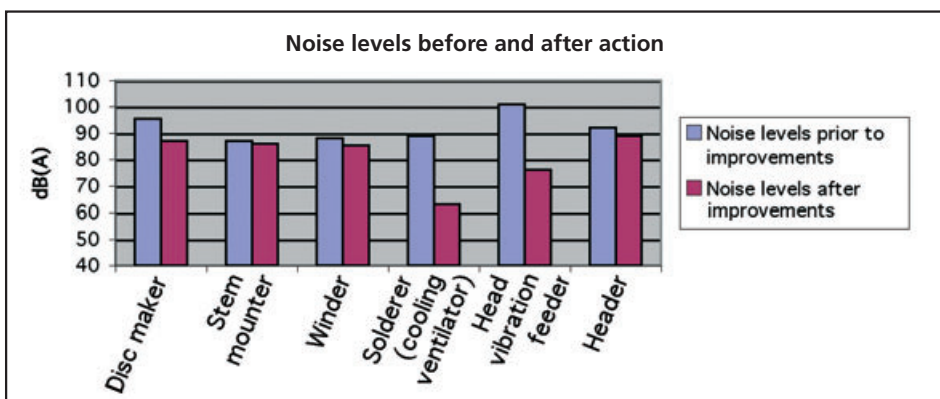
Results

The measurement results show that the noise level has fallen on all mechanical units where technical changes were made, while in two areas, head feeders and cooling ventilators, reductions of around 30 dB(A) were achieved. The total cost of the project for one production line was HUF 3 455 000 (about 13 800 €).

The project took approximately half a year, and clearly the objectives set out, i.e. to find technical solutions that can easily be adapted to lamp production technology, but can work at low operational noise levels, were achieved.

During the project, four particularly significant innovations (disc head feeder, conveyor belt head replacement feeder, cooling ventilator, valve enclaves) were introduced, and several less important improvements, which nonetheless helped, reduce the operational noise level.

Great emphasis was placed on technicians and mechanics working on the production line being involved in the entire improvement process, as they are in direct contact with the machines and thus were able to provide a great deal of information. Information acquired during the project is being applied to the factory's other lamp production lines. At present replacement of head feeders in the plant has virtually been completed, and the introduction of other innovations is ongoing.



Comments

The national jury was impressed with the participation of employees in the entire risk assessment process.



2 PARTICIPATORY CO-OPERATION IN PREVENTING NOISE EXPOSURE IN A PLANNING AND CONSTRUCTION PROJECT FOR A NEW BEVERAGE PLANT

Oy Hartwall Ab / Hartwall Ltd.

PL 44
15101 Lahti
FINLAND
<http://www.hartwall.fi>

Issue

Designing out noise while meeting food hygiene requirements in the creation of a new production plant



Problem

Two old production plants in Finland belonging to Hartwall Ltd. were combined to form a single large production plant. Some old lines were transferred from the old works while new lines and equipment were added. The intent was that with increasing automation, production and speed, noise problems would be brought under control.

The increased sophistication of tasks brought more pressure to bear on achieving a quieter production plant. In order to achieve exacting (food) hygiene levels and humidity at certain points on the production line, significant challenges were faced in achieving successful noise abatement. It was felt that the use of participatory planning added a distinct, favourably experienced viewpoint.

Noise was a major problem in the old production plants with noise levels in production areas usually exceeding 85 dB. Employees suffered from hearing damage, even if noise abatement measures were also used in old factories and workers wore personal hearing protection. Noise, besides causing hearing damage, made conditions unpleasant.

This example tackles risks at source through participatory tripartite co-operation within all partners (management, employees, occupational safety and health manager and representative, occupational health service, architect) included in the planning and building project of the new beverage plant. The whole realization process in this kind of huge project has been open-minded and appreciative about all partners' work.

Solution

There were three key stages in the process to reduce the noise exposure of workers on the new line:

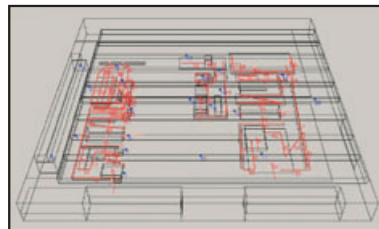
- Joint activity, participatory planning
- Actions during the planning and construction phase
- Procedures while operating the new factor

Joint activity, participatory planning

Due to the wide scope of the project, the enterprise used the participatory planning method to solve health and safety problems with an open mind. A noise abatement working group was formed in which representatives of employees and employers, the occupational health service, planners and a noise abatement expert from the Occupational Health Institute acted together, with the group evaluating the solutions and materials to ensure their effectiveness.

Steps taken during the planning and construction phase

Acoustic computer modelling (Odeon⁽¹²⁾) was used to evaluate the impact of noise abatement measures so that the acoustic solutions could be optimised in respect of costs. Using the old production plant data as a starting point, noise levels in work areas were calculated so that the impact of the planned solutions on noise levels could be evaluated in advance. Most of the noise abatement



Computer modelling of new production to reduce noise

(12). <http://www.odeon.dk>



Prevention of risks from occupational noise in practice

measures were aimed at effectively muffling the area in question and optimising the quantity, quality and locations of muffling materials. Low noise levels became one of the key purchasing criteria in the procurement of new machines and equipment.

Procedures while operating the new factory

Particular attention is being paid to protect the hearing of workers in the new plant. This is being achieved by providing information and training, particularly during induction for new workers. Training checklists and check-ups are now used for all new workers.

In addition to the induction and training, there is also a procedure through which workers can, if they wish, get personally fitted earplugs. This option has increased the number of workers who are using personal hearing protection.

Results

By virtue of advance planning implemented through joint activity, the production plant is properly lit and hygienic, making production areas more pleasant. The materials used and the suspended baffle solutions proved functional and easy to maintain. Noise exposure for employees usually remains below 85 dB. Compared to equivalent lines in the old production areas, exposure levels have been reduced 2–5 dB depending on the line. In other words, the risk of hearing damage has been reduced 20–70 %.

Direct costs of acoustic measures (supports, materials and planning) at the construction stage came to about 1.5 Million €. Benefits can be weighed in terms of improved congeniality at work and thus fewer sick days, for example, and improved production. The impact of intrusive noise was estimated to cause a 0-8 % reduction in working hours by the Project for a Productive Office. Even a 1 % improvement entails significant savings yearly. The prevention of 1-2 cases of occupational health compensation yearly at about 2 500 €/case is also reflected in reduced insurance premiums.

Comments

In this example, the national jury felt that the risks were tackled at source through participatory tripartite cooperation in the planning process. Innovative methods were used in the design of the new plant to reduce noise exposure.



3

COMPREHENSIVE NOISE REDUCTION PROGRAMME AND EXPOSURE MANAGEMENT IN BROADCASTING

Finnish Broadcasting Company (YLE)

PL 96
00024 Yleisradio
FINLAND
<http://www.yle.fi>

Uusimaa Regional Institute of Occupational Health

Arinatie 3 A
00370 Helsinki
FINLAND
<http://www.ttl.fi/Internet/English/FIOH+in+action/Regional+Institutes+of+Occupational+Health/Uusimaa+Regional+Institute+of+Occupational+Health>

Issue

Reducing noise exposure in broadcasting through a holistic management programme.

Problem

In the programme production of the Finnish Broadcasting Company (YLE) several occupational groups involved in television and radio broadcasting must work in very noisy conditions, in which the safe limits for hearing protection may be exceeded, for example when broadcasting concerts, sports events and large public events. Additional stress to hearing is caused by the various intercom devices that are necessary for the programme team. Some of these devices are actual hearing protectors, others are pure intercom devices that do not provide adequate protection. In some situations, communication is directed to only one ear, whereas the other ear is left unprotected and exposed to external noise.

The aim of this project was to create a comprehensive noise reduction programme for broadcasting, in other words, to perform a detailed risk assessment, to determine the possibilities of reducing noise, to prepare a code of conduct for agreements, productions and acquisitions, to train and instruct the staff and to develop protection and intercom devices, as well as to monitor more closely the health of staff.



Between 1990 and 2005 there were eight diagnosed cases and 21 suspected cases of noise-induced occupational diseases in broadcasting. Before this, the company had not studied the risk of hearing damage in detail, nor had the additional stress from intercom devices been taken into account. Hearing and communication play a major role in broadcasting occupations, so even minor changes to hearing may significantly reduce the ability to work. The employees have perceived noise as being extremely stressful, particularly in long productions. During long, noisy events, the employees have reported temporary hearing loss, tinnitus, dizziness and headaches.

Risk assessment

Among the employees studied, cameramen were exposed to the highest noise levels. This concerns particularly those working with portable cameras, with daily noise exposure levels exceeding 85 dB. High exposure levels were also measured among stage managers, mixers and light engineers who worked in concerts, as well as among musicians (the Finnish Radio Symphony Orchestra).

Of the events, the highest external exposure levels were measured in rock and pop concerts, particularly among those working on stage. During concerts, noise exposure comes from electrically amplified music, in sports events from advertisement music and the audience. On average, sports events had lower noise levels, yet some high exposure levels were measured in those working among the spectators. The highest average sound levels during these events almost equalled those measured in rock concerts (approximately 100 dB). Differences between various sports were insignificant. In studio productions and large public events, the average noise exposure level was below 80 dB, even if there were some high short-term noise peaks.

The measurements (microphone in real ear, MIRE) performed inside the protector or earphone outside the ear canal showed that the noise exposure level to the ear remained below 85 dB, on average. However, the level was exceeded in nine cases; in two of them the employee used hearing protectors, whereas ordinary earphones were used in the remaining cases. The contribution of communication sound in the noisiest situations inside the protector was 6 dB, which corresponds to the speaking voice level compared to the ambient noise level found in previous studies. The average attenuation from protectors was 11 dB with communication sound, but the 2 dB attenuating effect from earphones was negligible.

Several factors influence the adjustment of the volume of communication sound: the suitability of the protector for the person or its effectiveness in the actual situation, the frequency of background noise, the quality of communication sound, including the transmission of background noise from the production control room into the communication channel, as well as its effect on the intelligibility of speech. The employees can adjust the volume of communication sound, which is not technically restricted today. The effect of such factors on the employees' exposure to noise cannot be separated from the results achieved in these measurements. Based on the measurements, external noise, such as the human voice, correlates with the higher volume of communication sound. At events perceived as being noisy, such as concerts, the employees mostly had protectors instead of earphones.

In sports events, earphones were used, even if the noise level would have required using protectors. It was found that some protectors were old and rather worn, so the effective attenuation from them may be below the original attenuation values given by the manufacturer. Having an intercom protector or earphone in just one ear does not provide adequate protection in noisy conditions. In programme production, the noise source can be influenced by adjusting the electric amplification of sound. However, as YLE does not normally organise an event, only broadcast it, the possibility for YLE to influence the source noise level are mostly based on programme production agreements.



Solution

Four actions were taken to address the issue raised:

- Administrative, production, and work organisation-related noise reduction methods
- Planning and training
- Technical noise reduction methods
- Hearing protectors

Administration, production and work organisation-related noise reduction methods

The project on noise exposure in broadcasting included preparing a code of conduct for production agreements in which the issue of noise during events is dealt with according to the Occupational Safety and Health Act and the Housing Health Instructions from the Sosiaali - ja terveystieteiden ministeriö (Ministry of Social Affairs and Health, Finland⁽¹³⁾). The organiser of the event undertakes to follow the noise limit values of the Housing Health Instructions and to inform all the performers of these values. The instructions include a risk assessment method as well as procedures for cases where these limit values are exceeded. The company has acquired noise level meters, which can be used to perform the necessary risk assessments in programme production. Technical managers have been trained to perform the noise measurements required by the risk assessment. There are instructions on the maintenance and calibration of the devices as well as on the appropriate documentation and storing of the measurement results. In addition, up-to-date measuring equipment has been acquired for the purpose of monitoring the employees' exposure to noise.

Planning and training

The noise reduction programme for programme production was prepared according to YLE's Occupational Safety and Health Action Plan for 2002. A steering group supervised this work, with representatives from the line organisation, the users, the occupational health care staff, the YLE safety unit and the Finnish Institute of Occupational Health⁽¹⁴⁾, as well as safety representatives. Workers were informed of the noise project and noise risks, and key persons were trained to perform noise measurement and to evaluate noise risks.

The ways of reducing the employees' exposure to noise, such as the use of remote-controlled cameras and positioning the staff outside the immediate proximity of amplifier systems, are taken into account in programme production planning. Action is being taken to include the issue of noise risks in the training of those responsible for programme planning.

Technical noise reduction methods

Programme productions are of such a short duration that significant noise-reducing structural or acoustic changes to production facilities with reasonable costs are impossible. Other technical solutions may reduce the exposure of the broadcast personnel. Methods already in use include using ear monitors in music productions to reduce the noise level on the stage and positioning the amplifiers, such as raising them, so that the cameramen near the stage remain outside their "primary cone". As to noise reduction, the development and harmonisation of the intercom devices in use plays a significant role in reducing overall exposure. A project has been launched to this end. The aim is to improve the quality of the voice signal, so that the sound level of the communication channel could be reduced.

(13). <http://www.stm.fi>

(14). <http://www.ttl.fi>



Hearing protectors

The employees were given clear and concise instructions on how to select the protectors. They describe the procedure for selecting personal intercom protectors for an individual employee as well as the types of protectors to be used in the various productions. The selection criteria are based on the noise levels of various productions established by the measurements. Users can choose from several protector combinations. Protector combinations that meet the necessary protection, communication and usability requirements were developed in conjunction with protector manufacturers. So far, the company has acquired personal protectors for all the cameramen, a total of some 180 protectors.

Results

The use rate of protectors has risen, as the employees have been able to select the most suitable protectors from a number of options, and the protectors have become genuinely personal, instead of a camera-related accessory. In the noisiest situations, double protection (earplug + ear muff) has increased the total time of use of protectors (with plugs being used during breaks and on the way there), improving the highest protection level achieved (an increase of 5–10 dB compared to having only one type of protector) and the audibility of communication sound. A drop in the highest noise levels in concerts, the result of including noise levels in production agreements, could be detected as early as the summer of 2004. The material from the noise project has been used in presentations at the Audiopäivät seminar, the ICA Conference, and the meeting of European Broadcasting Union (EBU)⁽¹⁵⁾ physicians and human resource managers, for example.

The cost of the intervention was:

- Project Costs - 48 000 €
- B&K measurement devices - 35 230 €
- LD dose meters - 13 400 €
- 180 noise protector combinations - 54 000 €

The following benefits have been experienced:

- Improved quality of work
- Increased job satisfaction
- More efficient use of working time amongst production crew

An estimated improvement of 0.5% for the 85 production crewmembers amounts to 17 000 € every year. Also future benefits are to be expected, as the number of cases of occupational diseases will fall (estimated at 2 500 €/case).



(15). <http://www.ebu.ch/>

Because the aim of this example was also to have more continuous effects on noise reduction, the example complies with the relevant and future legislative requirements and thus goes more beyond minimum legal requirements.

Comments

In this example the noise exposure of radio and TV broadcast production personnel was widely evaluated – not only the sound exposure caused by the ambient noise in production sites but also the effect of communication sound within the production team members on total noise exposure.

This example is raising awareness of a common interest in noise exposure of both musicians and audience. Thus, the noise exposure and reduction activities have been evaluated in the view of shared workplace with different employers' workers. The hearing protector policy tested in this YLE example has reduced noise exposure clearly and the production personnel feedback has been positive. Also this example shows a real evidence of good consultation between management and trade unions/workers and occupational safety and health experts.



4

CONVERTING A SYSTEM FOR MANUFACTURING CONCRETE BLOCKS TO A NEW CONCRETE COMPRESSION PROCEDURE WITH "HARMONIC VIBRATION"

F.C. Nüdling Betonelemente GmbH & Co. KG

Betonwerk Themar Schleifmühlenweg 22
D - 98660 Themar
GERMANY
<http://www.nuedling.de>

Betonwerk unter Beteiligung des IFF Institut für Fertigteiltechnik und Fertigbau Weimar e.V.

Cranachstraße 46
D - 99423 Weimar
GERMANY
<http://www.iff-weimar.de>

Issue

Development of a low-noise method for concrete compression, based on harmonic vibration, that results in the broad impact vibration frequency spectrum usually produced by the vibrating process being converted into a single, easier to dampen, vibration frequency band.

Problem

Hearing impairment and noise are still among the most common occupational diseases leading to early retirement from the building materials industry. The noise emitted by machinery generally arises from the machine vibrations and oscillations in the air.

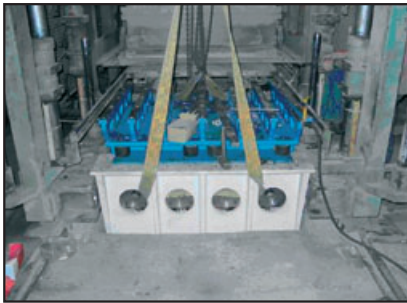
The manufacture of concrete blocks involves a vibrating process to compress the concrete. The shock vibration-based compression method is state-of-the-art for concrete block makers. In this method, the machine parts are deliberately made to collide with each other, leading to a particularly intense compression of the batch of concrete with short compression times. However, the impacts cause all the machine parts to vibrate strongly across a very broad frequency range. The machinery vibrated in this way emits high noise levels at the production site, including in the most uncomfortable frequency ranges, which over time leads to hearing impairment in machine operators and staff



working nearby. Indeed, during the vibration process, noise levels up to 120 dB(A) had been recorded, which is equivalent to the noise emitted by a starting jet engine. Although these systems were only operated in closed, noise-insulation cabins, noise levels of around 94 dB(A) still arose at the workplace, which are amongst the noisiest in the stone and earth industry.

Solution

Following a risk assessment, F.C. Nüdling Betonelemente decided to implement a technical solution so reducing the noise at source. In co-operation with the Weimar Institute for Precast Unit Technology and Prefabrication (Institut für Fertigteiletechnik und Fertigbau (IFF)) and the company's management, technical department, production staff and workers' council, a new quiet but economically viable compression method was developed. This new concrete compression process is based on harmonic vibration as opposed to the shock vibration commonly used so far.



The newly developed compression procedure during installation in the concrete block manufacturing plant

The key to noise reduction through harmonic vibration lies in the avoidance of unnecessary oscillations in the sensitive frequency range. The overall purpose of harmonic vibration is to create only sinusoidal oscillations with a frequency of ca. 40 to 60 Hz. To this end, the mould is mounted firmly on the bench and the end-stops are removed. The noise emissions are thus considerably lower and in a frequency range that is better suited to the human ear.

In addition, parameters of the vibrating system, such as revolution speed and amplitude, are specifically adapted to the very concrete products being manufactured, which enables the avoidance of the noisy, unwanted impact shocks occurring when the conventional compression method is used. Revolution speed and amplitude

Previously, mechanical engineers had not succeeded in putting into practice such a method, although it seems so simple. Indeed, in order to achieve compression results equivalent to or better than shock vibration, more force is needed in the compression process, which, in a confined space, is not an easy task.

Results

The method has thus made it possible to successfully dampen the noise emitted by one of the noisiest types of machinery in the building materials industry, substantially reducing workers' exposure to high noise levels in these production areas. Following the intervention, the noise measurements made directly at the machine have shown an average emission value of 103 dB(A) within the housing, as compared to 122 dB(A) produced with the conventional shock-vibration-based systems. A reduction in noise emission of about 20 dB(A) has been reached. Moreover, noise levels at the workplace have been considerably reduced as well. While workers were exposed to 94 dB(A) before the intervention, 84 dB(A) have been recorded in the workplace after the intervention, a reduction of 10 dB(A).

The cost/benefit analysis of the new manufacturing process as compared to the conventional compression procedure has shown improvements to the quality of the product surface and increased production flexibility from using the new compression method.



The co-operation of partners from research institutes and from the industry has resulted in a ready-for-use technology for the manufacture of concrete products, with significant noise reduction and improved product features, which is transferable to large segments of the concrete industry.

Comments

This is an example of an innovative method for concrete compression that has been successfully implemented. Noise reduction at the workplace has been achieved by tackling noise at its source. However, it should be noticed that the 84 dB(A) noise level reached at the workplace is still above the lower exposure action values of 80 dB(A) set by the 2003 Noise Directive. The example is transferable to other companies in the sector, (many of them small and medium enterprises, and even to other applications).



5

INTRODUCTION OF NOISE MANAGEMENT TO ENABLE THE RECORDING, IMPLEMENTATION AND EVALUATION OF ALL OPPORTUNITIES FOR NOISE REDUCTION

Luzenac Naintsch Mineralwerke GmbH

Statteggerstraße 60
A-8045 Graz
AUSTRIA
<http://www.leitbetriebe.at/graz/naintsch/naintsch.htm>

Issue

A structured management programme to reduce noise in mineral extraction.

Problem

In the mining and grinding industry exposure to noise from the many noise-intensive operations, including maintenance, may induce the associated health effects and also increase the risk of occupational accidents, if the perception of acoustic signals or hazards is impaired by excessive ambient noise. The assessment of noise-related risks and their effects is especially difficult in the case of combined effects of noise or of hardly measurable disturbances.

Solution

In order to identify, assess and reduce all possible noise-related risks, Luzenac Naintsch Mineralwerke developed an extensive noise management programme on all its sites comprising:

- a detailed risk assessment aimed at identifying the main noise sources and related work processes;
- the implementation of active noise reduction measures, for example, modifying the production equipment and work processes and passive measures, for example, encapsulating the noise source;
- the development of clear guidelines for the use of personal protective equipment, including personal hearing protection);
- the provision of training to workers by the Austrian Social Insurance Agency for Occupational Risks (Allgemeine Unfallversicherungsanstalt⁽¹⁶⁾ (AUVA));
- the measurement of noise levels at the workplace as well as on workers themselves; and
- the evaluation of the measures adopted.

(16). <http://www.auva.at>



Risk assessment

A number of steps were taken as part of the risk assessment process:

- Identifying and mapping sources of noise
- Identifying high risk groups
- Evaluation of the measures taken: change management
- Informing workers

Identifying and mapping sources of noise

All noise sources were identified by means of a sound level meter specifically purchased and calibrated for this purpose. Based on the noise measurements, a map of noisy areas in the company was drawn up. In addition, worker's exposure to noise was measured over entire shifts with a portable body-worn noise meter.

Identifying high risk groups

Workers were divided up into so-called "Similar Exposure Groups" (SEGs) for workplaces with similar exposures. These groups were established on the basis of a risk assessment carried out in co-operation with the workers. The aim was to carry out long-term statistical evaluations of workers' exposure. At least six measurements per SEG per year are necessary. So that measurements are statistically comparable they have to be carried out under comparable working conditions. Special attention was paid to SEGs that are exposed to particularly high noise. The results were recorded in the 'Occupational Hygiene Database', which is used for producing statistics and making analysis. This enables the easy monitoring of trends over the years.

Evaluation of the measures taken: change management

A 'Change Management' module available in the database enabled the systematic recording and implementation of the processes of change. Once a measure has been implemented, noise measurements are carried out in order to check that the noise levels have actually been lowered. The system also enables an evaluation to take place before a measure is implemented, for example, replacing an old machine with a new one, of whether higher noise levels would be generated. For this purpose, manufacturers are required to provide data on the noise levels produced by the new machine.

Informing workers

Various information sheets for workers and SEGs were produced, distributed and discussed on the basis of the noise measurements entered in the database.

Measures to prevent or limit risks

Having carried out the assessment, action was taken to prevent or limit risks, by:

- A noise prevention policy
- Elimination of noise sources
- Reduction of noise at the source
- Collective preventive measures

Noise prevention policy

The internal policy developed by the company stipulates that all following measures must be taken in the event of exposure to noise:

- elimination of noise sources or replacement by a quieter system;



- implementation of technical measures on-site to reduce the noise exposure;
- documented procedure for inspections, assessments and maintenance of the technical measures and equipment;
- documented programme for personal hearing protection; and
- selection of personal hearing protection with regards to the nature and intensity of noise, to the wearing comfort and the compatibility with the tasks.

Elimination of noise sources

Wherever possible, noise sources have been eliminated or replaced. For instance:

- ventilators for compressor cooling system have been replaced;
- diesel forklift trucks are now used instead of electric forklift trucks;
- a piston compressor has been replaced;
- plastic hammers are used instead of copper hammers, when possible.

Reduction of noise at the source

When it was not possible to eliminate the source itself, technical solutions were implemented to tackle the noise at its source:

- air outlet sound attenuator for silo trucks;
- housings for the ventilators;
- strip curtain for ball mills;
- timber cladding for the re-circulation of jet mills;
- construction of separate rooms for rotary piston blowers (roots blower); and
- silencers on blower pipes.

Collective measures of prevention

A range of collective control measures were taken, including:

- application of the Rio Tinto health standards;
- development of purchasing guidelines;
- management of sub-contracting;
- information, training and awareness-raising activities;
- tools for minimization of risk.

Collective control measures to prevent exposure to noise

Application of the Rio Tinto health standards

Rio Tinto has developed the Rio Tinto Health Standard (RTHS) applicable to all its sites throughout the world. In particular, the RTHS 'Hearing Protection' advocates the evaluation of noise hazards, the drafting of a control programme and its evaluation with audiometric monitoring.

Purchasing guidelines

Personal Protective Equipment (PPE) must now be used as last resort, when eliminating the source of noise, controlling the noise at its source or reducing the exposure by work organisation or workplace layout are not possible. When used, it has to be in conformity with the regulations and RTHS. Health, safety and environment (HSE) management, in co-operation with the purchasing department and workers themselves, has prepared a list of



PPE that may be purchased. Workers were given the opportunity to select the most comfortable hearing protection for the list.

All investments must be signed and approved by the HSE manager, who verifies that the HSE guidelines are met. For instance, these guidelines specify that only machines with state-of-art noise damping technology may be purchased.

Management of sub-contracting

Before a contract with a sub-contractor is signed, an analysis of possible health risks related to the tasks to be sub-contracted must now be made. The same safety and health guidelines and noise guidelines also apply to sub-contracted workers, who also receive appropriate training.

Information, training and awareness-raising activities

Monthly HSE training modules are now provided and follow the monthly targets defined in the yearly HSE calendar published by the HSE department. The 'health topics' and PPE training modules address more especially the noise issue and the correct use of PPE. Health and safety representatives usually deliver the training.

Tools for minimization of risk

Campaign: 'Think before you act' - As far as noise pollution is concerned, workers are trained to consider BEFORE any activity starts what levels of noise pollution could arise and how they should tackle them.

Checklist: 'SAFE' - Before starting non-routine activities, workers have to fill in the 'safety first' checklist in their teams in order to analyse possible risks, for example, increased levels of noise pollution, and to take countermeasures.

Motto: 'zero-tolerance' - The 'zero-tolerance' motto has been adopted to serve the company's objective of zero occupational accident and zero occupational illnesses. According to this motto, workers failing to wear personal hearing protection when required will have to face consequences such as warnings.

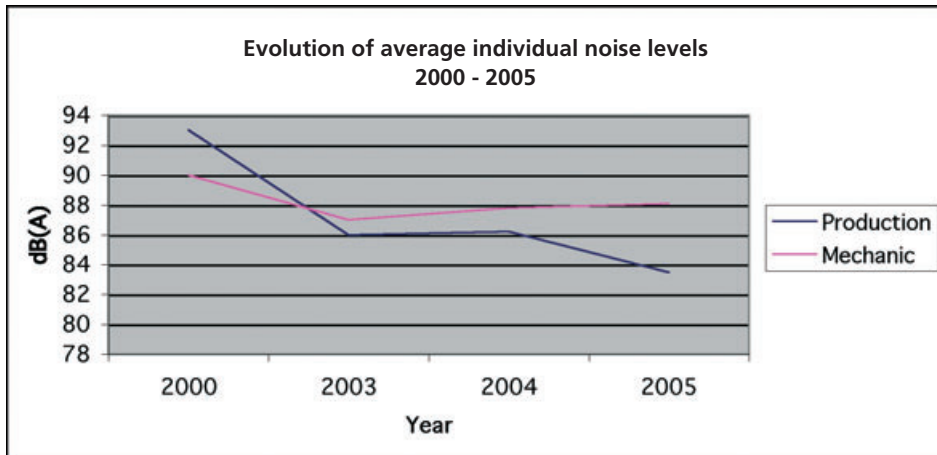
Monitoring risks and control measures

In addition to the measurements carried out every five years by AUVA, Luzenac Naintsch also has introduced an annual noise measurement programme based on the aforementioned 'Similar Exposure Groups' (SEG). Noise measurement data have been recorded since 1994 – and introduced into the database since 2004.



Results

The records kept over many years under the noise management program indicate a significant reduction of the noise level, above all in production.



The computer-based evaluations, worker training and the audits have also contributed to a greater workers' awareness of noise and its effects, one consequence being a better acceptance towards wearing personal hearing protection when required. In addition, no noise-induced occupational diseases have been reported for many years. Consequently, costs of work-related diseases have been reduced for the company but also for AUVA, for the social security and for the whole national economy.

Comments

This case is a comprehensive noise management method with a systematic approach and where the documentation of a comprehensive measurement system supports decision-making, monitoring and evaluation overtime. An informative booklet on the programme has been produced and the example could be transferred to other industries and sectors.



6

HEARING PROTECTION FROM MILITARY RIFLE SHOOTING NOISE

Noise-Control-Hellas

14 Grig. Kydonion str 171.23
Nea Smyrni – Athens
GREECE
<http://www.noise-control.gr>

Issue

Reducing noise exposure and other risks during the testing of weapons.

Problem

In a military installation employing many civilian technical staff, a weapon-repair programme receives faulty rifles that come in from nation wide military bases, reconstruct them and test their performance and shooting durability. In order to test the rifles' performance several thousand bullets are fired per month in a 100 metre long shooting tunnel.

As a basic safety precaution and in order to check the rifle's efficiency, each rifle is mounted on a rigid testing rig, and then fired. No hand held shooting is performed.

The rifle's target accuracy is checked by a remote video camera and all necessary adjustments are performed and then fired again. Each operator is firing per day about 50 rifles and about 15 bullets per rifle, So a total of 18 000 bullets are shot per month, producing a rather unbearable noise environment.

Due to the firing of thousands of bullets during an 8-hour shift in an enclosed concrete space, workers were being exposed to significant risks to their hearing even with heavy-duty hearing protectors on. Not only was the total sound energy significant, but also the impulse noise (shock wave) of each shot was causing problems – not surprisingly considering that the airborne noise was measured over 140dB(A) per firing. The work process in this task is highly demanding and requires complete concentration. Several reports were made from workers complaining of symptoms including dizziness and fatigue. Furthermore, there is always the risk of an explosion due to a malfunction of the reconstructed rifle, excess gunpowder is always in the air (even with 2 high capacity fans on) and empty rejected shells are scattered on the floor. All of the above consist a major health and safety problem, (short term as well as long term) considering the every day use of the shooting tunnel and the requested high productivity and performance of each rifle.



Solution

The in-house health and safety office of the base performed a series of evaluations of the problem, and in collaboration with the shooting tunnel operators (military and civilian personnel) and with the technical support of the “Noise-Control-Hellas” consultancy and manufacturing firm drew up the requirements of the needed solution.

These requirements were presented to the management and technical drawings were drawn of the solution. The drawings were presented to the operators in order to retrofit the solution with more specific requests and optimisations. After the optimisation offered by all involved personnel, construction began.

The solution was to manufacture an ergonomic and adjustable heavy-duty noise insulating noise enclosure with attached silencer. The construction can be considered as “heavy duty” and the in-line silencer is both of passive and energetic design. The enclosure was manufactured in three parts and erected on the existing test rig, the three parts being:

- the main enclosure with 3 opening panels and 2 bullet proof inspection glasses;
- the in-line silencer (of rectangular cross section); and
- the guidance system of the rejected empty shells.



Enclosure with both upper main panel and with front panel open. (in order to adjust the holding)

In order to fire the rifle, with the noise enclosure closed, a retractable “hook” was installed at the trigger and an external latch at the outer side of the noise enclosure, so it will be always closed during the shootings.

The construction was done by metallic plates welded on heavy-duty skeleton with internal filling of rock wool and protection of perforated galvanized metal sheet. The silencer is both of passive and energetic design with no restriction to the bullet path in order to avoid accidents due to possible misalignment of the rifle.

The guidance system of the rejected shells is simultaneously a collector of the empty shells so they are disposed in a specific container and not scattered around the floor. The enclosure is mounted on the revolving and adjustable pre-existing test rig of the rifle.

Results

With the above design, the risks at work are minimized; the working environment is greatly improved by reducing the noise level from 140 dB(A) to under 87dB(A) (the limit according to Greek legislation).

The solution is not imposing risks to the operator, nor reducing productivity, since it is reducing the airborne gunpowder (by controlled passive rejection system) and reduces the risk of injury by explosion of the rifle. The above intervention is solely developed and manufactured in order to improve the workplace conditions. Upon installation and several days of trial, all operators were asked and replied as “satisfied” or “highly satisfied” so real improvement is achieved. Due to its heavy construction and its panelled form a very long efficient life is expected.

As mentioned above all parties (management, health and safety office, workers, external acoustic consultant and manufacturer) were involved in pinpointing the problem, developing its best ergonomic design, and participating to optimise the final acoustic and safe solution. The information



Prevention of risks from occupational noise in practice

or the solution can be implemented to any other shooting range (with similar demanding problems) and is being expected to perform equally well.

The benefits accrued by the action implemented include:

- improved health and safety of personnel;
- a better working environment for all personnel, both civilian and military – the working personnel scored themselves “satisfied” or “highly satisfied” with the result;
- an improved image for the military installation by demonstrating that it is a caring institution;
- reduced noise pollution to nearby residential areas.

Comments

The jury warmly welcomed this example, coming as it does from a sector where occupational safety and health initiatives are not always visible. The national jury felt that this demonstrated good consultation between all involved in the phases of risk assessment, solution design, implementation and evaluation of the results.



7

SOUND DESIGN IN A TYPICAL ROCK CLUB, AN INTERVENTIONS PROJECT

Arbetslivsinstitutet (National Institute for Working Life)

Box 8850SE-402 72 Göteborg
SWEDEN
<http://www.arbetslivsinstitutet.se>

Issue

Implementing technical and organisational measures aimed at reducing noise levels and staff exposure in a small club venue while guaranteeing a good sound quality.

Problem

High noise levels in small concert clubs are common and put musicians, workers and listeners at risk of hearing disorders, such as hearing loss, tinnitus, hyperacusis and hearing distortion. There is a growing need for information and practical interventions.

Henriksberg is a typical rock club with high noise levels, which welcomes up to 250 listeners. The noise issue in a concert club is multi-factorial and therefore difficult to tackle, factors include:

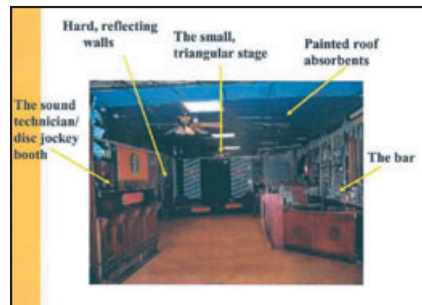
- Room acoustics
- The technology used
- Work organisation
- Awareness and human factors

Room acoustics

All the sound energy produced by the music is concentrated in a closed and small room with poor acoustic properties. The walls are hard and sound reflective. The ceiling is low and the roof absorbents are painted, which makes them useless.

Technology used

Since the small rock club business is typically not very well off, often the public-address (PA) system is old or cheap. In the case of Henriksberg, loudspeakers are actually placed in two large racks just beside the small stage. Most direct sound from the stage is radiated from drums and brass instruments. As a result, the noise level varies a lot within the venue and the audience standing in front of the stage is exposed to extremely high noise levels during performances, while people



The venue before the rebuilding started



Prevention of risks from occupational noise in practice

further back in the room are exposed to lower levels. In addition, the stage is small and musicians are very close to each other when playing, so they are exposed to very high noise levels. There is also acoustic radiation from the PA system itself and leakage from the monitoring system placed on the stage floor.

Work organisation

Since the bar is located in the very concert room, bartenders and waitresses are exposed to noise during concerts and discos. Therefore, not only do the noise recommendations set by the Socialstyrelsen (National Board of Health and Welfare)⁽¹⁷⁾ apply to the club as a public leisure place, but also the Arbetsmiljöverket (Swedish Work Environment Authority)⁽¹⁸⁾ sound level restrictions have to be followed with respect to the staff.

Awareness and human factors

Factors contributing to high noise levels in music clubs include: poor awareness of noise and its effects; poor expertise in implementing practical solutions for reducing noise in the sector; poor knowledge of responsibility issues; and musicians and a very complex music business that tend to refuse noise control measures and disbelieve that noise limits are achievable in smaller clubs.

Solution

The National Institute for Working Life, West and AMMOT (Artists and Musicians against Tinnitus)⁽¹⁹⁾ initiated a project aimed at reducing staff and audience exposure to noise at the Henriksberg and involving different interest groups: musicians, sound technicians, sound technology suppliers, acousticians, the event organizers association, the Swedish musicians union⁽²⁰⁾, the environmental department of Gothenburg city, and the Board of Culture.

The aim was to reach an equivalent A-weighted sound level of maximum 100 dB L_{Aeq} and 115 dB(A) during live music performances, while ensuring that the musical articulation of musicians was not inhibited.

A computerised simulation was used to calculate which types of absorbents should be positioned where in the concert room in order to achieve an optimal sound absorption. Noise levels and frequency spectra of acoustic radiation from drums as well as the influence of different heights of polycarbonate screens were measured in an echo free lab. The effects of different monitor and loudspeaker positions on stage were also assessed. Dose meter measurements were carried out during concerts both before and after the intervention. An exhaustive full inventory of existing techniques was drawn up, based on which the project group, together with the sound technology suppliers and the house technician, designed a completely new PA system.

As a result, the following measures were implemented:

- the small, three-cornered stage was rebuilt into a rectangular one;
- 1.4 cm thick absorbents were fixed on the walls and the roof around the stage. Additional 5 cm roof absorbents located on other parts of the room significantly reduced sound reflections;
- the monitors on stage were lifted and directed towards the musicians;

(17). <http://www.socialstyrelsen.se/>

(18). <http://www.av.se/>

(19). <http://www.ammot.se/>

(20). <http://www.musikerforbundet.se/>



- a new sound distributed loudspeaker system with four speakers placed in the roof resulted in a much smaller risk for the audience standing close by. The distributed system resulted in a small sound level variation in the venue;
- the bar was moved from the concert room to a terrace upstairs in order to minimise the staff exposure to noise during performances;
- the house sound technician was trained in sound level measuring techniques.

The club management was actively involved in all steps of the project. All activities were carried out through an open dialogue with musicians and further groups concerned.

In order to share information about this solution, the project group has also:

- created a website diary with facts concerning the project, news and relevant information for noise reduction in venue clubs⁽²¹⁾;
- produced a non-technical manual to promote exchange of good practice information between music clubs, available on the same web site;
- produced an information flyer on the project, to be distributed, for example, at meetings at the venue;
- hung two framed posters at the club, one in Swedish and one in English.

Results

The measures implemented have led to a reduction of the noise exposure at the music club:

- Sound levels emitted by drums on stage were attenuated by 3-4 dB after action (97 dB before, 94 dB after). A 80 cm high polycarbonate screen round drums attenuated a further 4 dB (= 90 dB) and the sound leakage from the singer monitor was attenuated by 7 dB.
- The intervention resulted in greatly reduced noise levels during live. Dose meter measurements showed values at, or well below, 100 L_{pAeqT} (dB), 115 L_{pAF} max (dB) after action, as compared to around 110 L_{pAeqT} (dB), 120 L_{pAF} max (dB) before action.

In order to evaluate musicians', workers' and listeners' satisfaction with the sound quality and the measures implemented, three questionnaires were designed, each targeted at a specific group, with questions related to perception of sound levels and sound quality, to hearing disorders, hearing protection and to the work environment. Thirty-six listeners 'from the floor', 18 musicians and four staff members were invited to fill in the questionnaires immediately after concerts. Attendees were offered a beer or a wine coupon for their participation. The survey results showed very positive reactions from all respondents with regards to the intervention.

The club Henriksberg has become a reference of good practice for other clubs that aim at implementing noise-reducing solutions. Being a model in this sector, the venue will host the practical part of a short university course for self-trained sound engineers organised by the Swedish musicians union and the school of music and music education of Göteborg University.

The acoustical, technical and organisational measures taken in the small club venue have resulted in lower noise levels, better sound quality and more satisfied staff, musicians and listeners. Training has been offered and information has been distributed. As a result, the risks of hearing disorders have been reduced and the club has been turned into a better working environment and a more pleasant place to enjoy music. The hope is that other clubs will now see what is possible and be encouraged to follow the example.

(21). Available at: <http://www.ammot.se> (search for "Akustikprojektet");



Comments

This case of good practice concerns a sector and a type of business where noise problems are well known but where the application of the occupational safety and health legislation may new and little has been implemented to reduce noise. The example presents an interesting solution to this problem. The approach followed is holistic and includes technical design, work organisation, awareness-raising and information activities. The project has been carried out in consultation with different groups (unions, workers, audience). This case study is a good example of practical action that can be taken in the entertainment sector to comply with 2003 Noise Directive.



8

AWAY WITH NOISE! REDUCING NOISE HAZARDS IN THE WORKPLACE

Prevent Sweden – Management & Labour Improving Work Environment

Box 20133
SE-104 60 Stockholm
SWEDEN
<http://www.prevent.se>



Issue

Communicating information and good practice by social partners.

Problem

Swedish social partners have identified noise as a problem. Seeking to reduce the risks to workers, a major initiative aimed at reducing noise in the workplace, the CD “Sound and Noise”, was launched.

Noise remains a major safety and health problem in many workplaces. It can be directly harmful to hearing or else disruptive and capable of causing impaired concentration and being a causal factor in work-related stress, tinnitus, and other adverse health outcomes.

To overcome the problems of noise in the workplace, Prevent⁽²²⁾ and the social partners in Sweden – the Svenskt Näringsliv (Confederation of Swedish Enterprise)⁽²³⁾, the Landsorganisationen i Sverige (Swedish Trade Union Confederation (LO))⁽²⁴⁾ and the PTK (Federation of Salaried Employees in Industry and Services)⁽²⁵⁾ – have taken steps to improve the standard of training in this area and to disseminate good practices for overcoming noise problems. The results of this initiative include the CD “Sound and Noise”, for which funding support was provided by the AFA Trygghetsförsäkring insurance company⁽²⁶⁾.

Solution

The CD “Sound and Noise” offers training material and facts about noise, as well as practical solutions to noise problems. The CD is addressed to several different target groups and contains:

- a case histories section;
- a training section.

(22). <http://www.prevent.se>

(23). <http://www.svensktnaringsliv.se>

(24). <http://www.lo.se/>

(25). <http://www.ptk.se/>

(26). <http://www.afa.se>



Prevention of risks from occupational noise in practice

Representatives of various industries and enterprises, as well as noise and programming experts, have helped to produce the CD. A large number and variety of undertakings were visited in order to document good solutions to noise problems. The resultant CD, for example, contains an unmatched collection of solutions to noise problems.

The content of the CD can be used both as teaching material and for reference. The programme includes sections on:

- elementary acoustics – covering topics such as sound pressure, frequency, reverberation time, and sound absorption;
- harmful effects of noise - hearing damage, tinnitus, impaired concentration, etc.;
- noise abatement methods: at source, along the distribution path, at the recipient etc.; national and EU requirements;
- systematic noise prevention - work organisation, mapping, analysis, remediation etc.;
- sound measurement – covering topics such as sound and exposure measurement, frequency analysis, and sound meters;
- creating a good acoustic environment when constructing or altering facilities;
- procurement of noise-generating machinery.

The case studies

The CD presents a large number of case studies indicating solutions to various noise problems and measures actually taken (about 150 altogether) in various industries and workplaces. The examples come from more than 30 different undertakings, schools, day nurseries, hospitals, restaurants and sports centres. Some more industry-related case studies illustrate examples from the engineering, steel, paper, wood conversion, automotive, food, printing, foundry and pharmaceutical industries.

Each case study contains a description of the problem, remedial action and outcome. The case studies can be searched by different headings such as:

- main area (e.g. industry, offices, schools);
- activity (e.g. food manufacturing, steel, machinery manufacturing);
- noise problems (e.g. flue gas fan); and
- remedial measure (e.g. fan wheel replacement).

The free-text search function enables to rapidly obtain the required information about relevant problems and solutions. The examples are linked to the theory, or training section, in which the causes of the noise are described.

Examples of case studies on the CD

Company manufacturing potato crisps, cheese doodles etc.

Noise problem: pneumatic ejection of defective crisp bags.

After the crisps have been packed the bags are checked. Leaky ones are weeded out from the conveyor by compressed air. This generates a sound level of about 88 dB(A) at close quarters. The noise is due to high air velocity through the air nozzles.

Remedial measure: air knife

Substitution of an air knife for the original noise-generating air nozzles reduced the noise by about 10 dB(A). The air knife is pneumatically powered. The difference is due to the nozzle being wider.



Sawn timber enterprise*Noise problem: saw-sharpening machine*

The saw blades are sharpened in a room in the sawmill building, using a grinding machine. The grinding operation generates high-frequency noise, which to the operator is “piercing” and very annoying. An equivalent sound level of 90 dB(A) was recorded and the maximum sound level was 101 dB(A).

Remedial measure: attenuated saw blade

Magnetic plastic strips were applied to the blade and the maximum sound levels fell by 3-5 dB(A) as a result of resonance reduction, and the operator found the noise less “piercing”.

The training section

The training is intended for target groups with different levels of previous knowledge:

- for those with no particular prior knowledge of the subject; and
- those with theoretical qualifications, mainly in mathematics and physics at high school level.

The “short version” gives a general description of sound and noise and requires no particular previous knowledge. This version is suitable for everyone dealing with work environment issues, such as decision-makers, safety delegates, safety committee members, project groups and persons buying and making procurement decisions.

The “full version” offers a deeper study of sound and noise topics. This requires previous knowledge, above all of mathematics and physics. This version also includes calculation formulae for greater understanding of noise abatement methods, contexts and problems. Target groups for this version include not only work environment engineers, technical designers, and technicians but also students taking certain high school and post-secondary study programmes.

In the training, which may also be used by target groups with different levels of knowledge, interactivity can be applied to facilitate learning. Use is also made of established pedagogical stratagems such as speaker texts, illustrations, summaries, and sound effects. The training employs the best available methods of instruction, and can also be based on reading computer printouts of texts and images.

The contents of the training section are as follows:

- The economic consequences of noise to the undertaking, the individual and the community.
- Review of the physical factors underlying sound and acoustics: explanation of various terms such as sound pressure, sound level, dB(A), structure-borne sound, frequency, soundproofing, sound absorption, reverberation time etc.
- Harmful effects of noise – a description of various types of hearing damage and tinnitus, negative effects in the form of stress, impaired concentration and learning capacity. Different degrees of hearing impairment are demonstrated.
- Review of different abatement methods: at source, along the distribution path, at the recipient and by change of working method. Among others, the examples presented show how force, pressure and velocity can be reduced; how silencers work; how noise can be enclosed; and tackle the efficiency of hearing protectors.

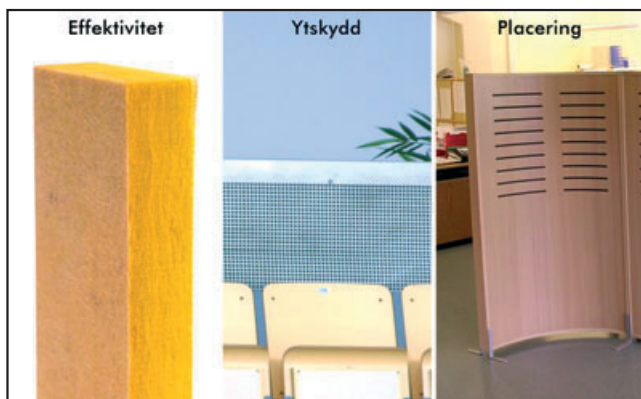


- Sound measurement: this section describes how ordinary sound meters are constructed and how sound and exposure measurement (noise dose meter measurements) are to be conducted.

- Taking sound aspects into account in the construction or alteration of premises: a good acoustic environment can be

created if sound aspects are taken into consideration from an early stage. This section describes the stipulations concerning issues such as levels, insulation, and design.

- Procurement of noise-generating mechanical equipment: when procuring machinery and equipment, stipulations can be made which reduce the noise level to a minimum.
- National and EU requirements - Descriptions of Arbetsmiljöverket (Swedish Work Environment Authority)⁽²⁷⁾ and EU requirements⁽²⁸⁾ and their implications for noise of different kinds.
- An account of systematic noise prevention based on work organisation, mapping of problems, effective remedial measures and outcome verification.



Results

The result of the project is a useful CD that can be used in a variety of ways by a range of end users, across a broad spectrum of workplaces, with information that is readily transferable.

Comments

The national jury was impressed by the project making available a wide range information for a different target groups, making it a unique product.

(27). <http://www.av.se/>

(28). <http://osha.eu.int/legislation/>

9

REDUCING NOISE WHEN MANUFACTURING CONCRETE VATS BY IMMERSION OF VIBRATING TRESTLES IN WATER

URVOY

16, rue de Guingamp – Kernandour
22140 BEGARD
FRANCE

Issue

Reducing noise in the manufacturing industry of prefabricated concrete units for construction purposes.

Problem

Employing 60 people, the company manufactures, among other things, concrete vats. The production of prefabricated concrete units is a noisy business. The manufacturing technique commonly used consists of vibrating the mould into which concrete has been poured so as to compress the concrete. The mould is placed, by means of a travelling crane, on metallic beams covered with shock-absorbing material, commonly called 'trestles'. The trestles are uncoupled from two other perpendicular beams attached to the floor by elastic studs. Two vibrators are located under each trestle, causing the entire unit to vibrate.

This activity generates extremely loud noise: on some moulds, noise pressure levels of 111 dB(A) were recorded at the workstation over the course of several production cycles. Daily noise exposure (Lex,d) estimated on the basis of these measurements amounts to 103 dB(A). Workers assigned to these workstations or working in the immediate surrounding were therefore exposed to a real risk of hearing loss.

No intervention method had been proven to deal really efficiently with the problem. Traditional measures to reduce noise, such as a noise enclosure or keeping workers away from the workstation during the noisy phases of the working process, are of limited use because of the lack of space in the working areas, the need for workers to handle moulds during the working process and, above all, because of the very short duration of production cycles.

Solution

Aware of the high noise level generated by this activity, the company's mechanical maintenance engineer came up with the idea of damping the system with water, namely, to create a pit in the floor filled with water, in which to immerse all the vibrators, trestles and mould base, known as the base plate. The proposal was presented to the company's management and accepted for the manufacturing of 4 000-litre and 5 000-litre moulds, which are produced in a specialised workshop.

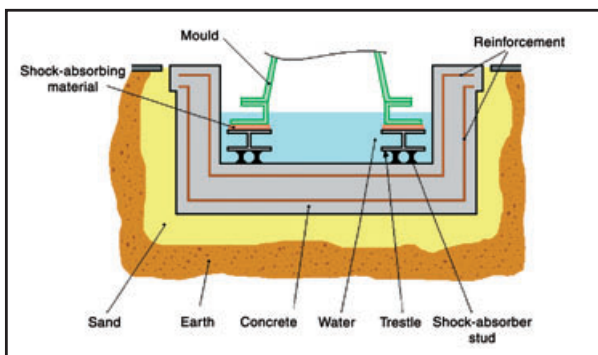


The comité d'hygiène, de sécurité et des conditions de travail (CHSCT), or workplace health and safety committee, and the workers, particularly aware of the risks they were exposed to, have supported this approach.

This first pit was created entirely in-house. During the first tests it was immediately clear by listening to noise levels at the workstation that they had been considerably reduced. In the course of these testing phases, the pit filling method was optimised step by step with a view to satisfy three criteria:

- to reduce the noise level;
- to maintain the quality of the vats produced; and
- to ensure the same production time.

On the basis of these initial observations, the CHSCT approached the Centre Inter-régional de Mesures Physiques de l'Ouest (interregional physical measurement centre in the West Region - CIMPO)⁽²⁹⁾ of the Caisse Régionale d'Assurance Maladie (regional health insurance fund - CRAM)⁽³⁰⁾ in order to assess the acoustic benefits of this particularly original initiative. Measurements confirmed the initial observations: a reduction of 20 dB(A) during the production cycle for 5 000 litre moulds, and 14 dB(A) for 4 000 litre moulds, had been achieved.



Cross-section of a modified installation after intervention



A 4 000 litre mould in a pit filled with water

Given these positive results, the company decided to install new pits in the neighbouring workshop in which further vat sizes are produced (3 000, 2 000, 500 and 300 litres). Following a prevention diagnosis and on the basis of the exemplary nature of the example they were able to obtain a funding contract to partially finance the project from the regional health insurance fund, the company. The whole activity was approved by the CHSCT.

Acoustic measurements carried out on these new vat-manufacturing installations indicated that the noise reduction was not as great for them as for the 4 000 and 5 000-litre moulds. In an attempt to explain these differences and, above all, to find a way to enhance the effectiveness of the measures implemented, the physical measurement centre decided to seek the assistance of the national research and safety institute (Institut National de Recherche et de Sécurité (INRS))⁽³¹⁾.

First, INRS carried out a vibro-acoustic diagnosis of the moulds in order to understand the physical phenomenon reducing the noise emission. The noise generating mechanism was identified as

(29). http://www.cram-pl.fr/risques/moyens_prevention/Pages/cimpo.htm

(30). <http://www.cramif.fr/>

(31). <http://www.inrs.fr>

impact noise between the mould and the trestles resulting from the detachment of the mould from the trestles. The water viscosity and its incompressibility hinder this process, so reducing the impact. When immersed into water, the mould detachment results in water first being drawn between the mould and the trestles and then released when the mould falls back on the trestles. Furthermore, shock-absorbing material between the moulds and the trestles also reduced the impacts.

In the next step, based on the analysis measurements, INRS proposed measures to obtain equally great noise reduction levels regardless of the type of mould vibrated. The measures proposed were:

- limiting the vibration level transmitted to the moulds;
- modifying the base plates of some types of moulds so as to maximise their contact surface with the trestles and thus obtain a maximum cohesion effect. This can easily be achieved by welding 10-mm thick metal plates over the entire length of the mould and the entire width of the trestles;
- completely covering the contact surface of the trestles with the moulds with shock-absorbing material.

Following the implementation of these measures, final measurements by INRS showed that, regardless of the type of mould, a 20 dB(A) noise reduction had been achieved at the workstation during the vibration phase, with production conditions remaining the same in both qualitative and quantitative terms. The company therefore enlarged all mould base plates and replaced the bands of shock-absorbing material on the trestles.

Results

A noise reduction of approximate 20 dB(A) during the production cycle has been achieved regardless of the type of mould. Given the extent of the production, the daily noise exposure level is estimated at 83 dB(A) for a 3 000-litre pit after the intervention, as compared to 103 dB(A) before the intervention. This value is below the relevant exposure limit value of 87 dB(A) for daily noise exposure set by the 2003 Noise Directive. The intervention has not increased the production time of vats.

Furthermore, the intervention has resulted in improved workers' postures at the workstation as the moulds have been lowered by approximately 0.50 m, resulting in a better working height for workers.

Modifying an installation costs 17 500 €. This includes the civil engineering work for creating the pit (11 500 €) and the enlargement of the base plates of 60 semi-moulds (6 000 €). However, the main benefit of this new vibration technique is the reduction of the risk of hearing disorders at the workstation. The average direct cost of occupational hearing loss cases that are recognised and compensated by the general health insurance system in France is estimated at 100 000 €, to which indirect costs must be added.

Comments

Workers themselves have designed the technical intervention, based on their practical experience. Water has very good damping properties and is cheap, hence the ingenuity of the method. The workers' exposure to noise has been reduced very significantly, by 20 dB(A). The intervention has been developed with the active support and participation of the regional health insurance fund (Caisse Régionale d'Assurance Maladie (CRAM) which is the regional network of the national salaried workers' health insurance fund (Caisse Nationale d'Assurance Maladie des Travailleurs Salariés (CNAMTS))⁽³²⁾, and of the national research and safety institute (Institut National de Recherche et de Sécurité (INRS)). The workers who devised the solution have also received an award from the regional health insurance fund.

(32). <http://www.ameli.fr/>



10

MECHANISM FOR PREVENTING NOISE RISK IN AN ENERGY SERVICE COMPANY

DALKIA France

Quartier Valmy 33, place ronde
92 981 Paris la Défense
FRANCE
<http://www.dalkia.com>

ACMS

55, Rue Rouget de Lisle
92 158 Suresnes Cedex
FRANCE

Issue

Reducing noise exposure in maintenance operations in the energy sector

Problem

Dalkia, Europe's leading energy service company, provides local authorities, industrial firms, health care institutions, as well as the tertiary and residential sectors with the operation and maintenance of over 50 000 thermal power plants. The workers have identified exposure to noise as a cause for concern. As the conditions under which work is carried out may vary considerably, depending on the location, installations and equipment where maintenance is required, the issue is difficult to tackle.

As part of its mission to promote health at work, the Association interprofessionnelle des Centres Médicaux et Sociaux (ACMS) monitors the health of the 2 800 staff at Dalkia Île-de-France. It also performs risk prevention activities at a number of sites operated by Dalkia.

In accordance with its maintenance contracts, Dalkia dispatches its staff to the sites where its assistance is required. Dalkia provides maintenance on a wide range of installations, including co-generation plants, boilers and chillers of varying age and design. Exposure to noise varies according to season, time of day, place, to the type of assistance required and to the tools used. The age and design of equipment, such as boilers and chillers, differ greatly from one site to another and may affect noise levels. The conditions under which Dalkia's staff provide assistance vary considerably, depending on the season, the noise level at the time of assistance, the number of staff involved, the equipment where maintenance is required, and so on. As Dalkia's workers are often on site



at other employer's workplaces, Dalkia cannot always take action at source to prevent or control noise exposure. A sonometry study revealed noise levels exceeding 115 dB(A).

Exposure to such noise from installations, tools and instruments, and the general working environment can result in deterioration in hearing, aggravated risk of accidents, impaired concentration, work-related stress, and may be a causal factor in cardio-vascular disorders. Warning signs of deterioration in hearing were observed among a number of staff during regular medical examinations.

Dalkia launched participative measures for the prior identification and evaluation of risks, providing each staff member with a survey instrument to identify the potential risks to which they feel they are exposed. Noise was the third most frequently cited risk, after falls from a height and bumping into projecting parts in the workplace.

The issue raised in the project conducted by Dalkia France can be defined as follows: "How can we eradicate the noise risk to which workers who provide assistance to customers on installations producing a wide range of random noises are exposed?"

Solution

At the request of the health and safety manager of the Dalkia Group, a 'noise' commission has been set up. It is composed of staff representatives, five Dalkia safety engineers and one occupational physician who coordinates 56 ACMS physicians responsible for monitoring the health of all staff at Dalkia Île-de-France.

Dalkia France has five regional workplace health and safety committees (Comités d'Hygiène de Sécurité et des Conditions de Travail – CHSCT)), which include staff representatives and internal and external experts, who attend regular meetings chaired by the employer. These specialised committees support the project and are regularly informed of the state of progress. A general overview is given of the prevention activities performed within the company at an annual meeting of workplace health and safety committees and at a meeting of the central works council, a social dialogue body operating at Group level.

Solutions in the implementation phase include:

- devising a module for training staff exposed to noise risk;
- publishing an awareness-raising leaflet produced by the ACMS;
- evaluating the prevention measures: The findings of the epidemiological study currently underway will be used as a basis, in 2010, to confirm a probable decline in the deterioration of hearing among exposed staff.

In compliance with the general of prevention, Dalkia devised realistic, feasible collective protection solutions to reduce risks at source. To that end, Dalkia:

- Performs the evaluations, site mapping, and dosimetries.
- Carries out awareness raising by providing information on noise risk, presenting and validating



technical solutions geared to the particular site and installations (acoustic screens, enclosures, etc.).

In addition to its activities among its customers, Dalkia also carries out the following measures:

- Informing staff about risks by means of:
 - CHSCT relays,
 - Safety talks on-site,
 - Awareness-raising leaflets,
 - A CD-ROM on safety in day-to-day work,
 - Putting up signs on the relevant sites.
- Reinforcing prevention instructions among workers with:
 - Prevention booklet produced in collaboration with the CHSCT,
 - Prevention sheets (60 000 copies),
 - Staff training on noise risks and the wearing of personal protection, including personal hearing protection.
- Adapting the work organisation of work by, for example:
 - Not repainting a boiler room during the heating period,
 - Encouraging staff to perform administrative tasks outside technical premises,
 - Promoting remote maintenance and remote surveillance.
- Providing each staff member with a basic kit containing personal protective equipment including, for example with regards to noise protection, a helmet and earplugs. For each site, a general catalogue of personal protective equipment allows the right PPE to be selected for each scenario and provides instructions for use.
- Increased health monitoring of staff exposed to noise, including annual medical examinations with regular pure-tone audiometries. In addition, 56 occupational physicians from ACMSare carrying out an epidemiological study among the 2 800 staff of Dalkia's Île-de-France entity.
- In collaboration with the CHSCT, monitoring the effectiveness of the prevention strategy (regarding noise and associated psychosocial risks) and updating the preventive measures required.

Results

The staff welcomed the fact that the noise issue was tackled in the project and expressed a very positive feedback with regards to the result of the actions. The measures taken have resulted in a better use of personal protective equipment, including personal hearing protection among staff.

The methodology is being extended to other entities of the Dalkia Group in France and Europe (approx. 30 000 staff). The enterprise is looking to adapt the measures, methodology and instruments so they can be used by other enterprises operating in the same sector. Many very small firms, i.e. those with fewer than 10 workers, as well as small and medium enterprises and industries from the secondary and tertiary sectors could benefit from the models devised by the Dalkia and ACM Steams.

Comments

The national jury considered that this example showed a global, comprehensive approach to the prevention of risks caused by noise, providing genuine added value in a high-risk sector, and demonstrating a sound partnership between experts and workers.



11

MAKING HYPOACUSIS VISIBLE IN THE BASQUE COUNTRY

Dpto de Salud Laboral de CC.OO. Euskadi

C/Uribitarte, 4 Bilbao

SPAIN

<http://www.ccoo-euskadi.net>

Issue

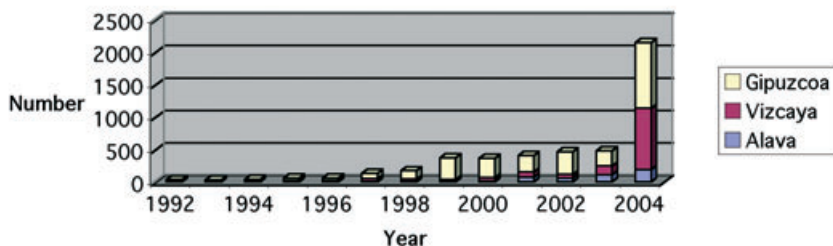
Campaigning to raise awareness of hearing loss to stimulate preventive measures

Problem

Raising awareness of the hazards and risks associated with noise is an essential part of preventing harm to workers. In this example, a trade union takes action to raise workers' awareness of hearing loss and to eliminate the origin of the risk at source, using the perspective of the discomfort caused by personal protective equipment including personal hearing protection. This cross-industry project covers metal, chemical, paper, wood, quarries, construction, cement factories, and fisheries sectors.

Noise at work is a significant risk factor, the consequences of which affect a large number of workers. It is distinctive in that related diseases are sometimes not detected by prevention services. It is often not feasible to adopt measures that achieve the elimination of noise sources in undertakings and, more specifically, at workstations. Furthermore, the very nature of noise and the lack of awareness of its effects often results in affected workers considering hypoacusis caused at work as part and parcel of the job.

**Occupational illnesses without sick leave - mostly hypoacusis
in the Autonomous Community of the Basque Country (Source: CAPV)**



Prevention of risks from occupational noise in practice

At the end of the nineties, CC.OO. Euskadi (Comisiones Obreras, Basque Country)⁽³³⁾, aware of the problem, analysed the situation and estimated that 40 000 people in the Basque Country alone were affected.

Solution

Given the severity and extent of the problem, the Occupational Health Section of CC.OO. Euskadi decided that public awareness of the reality of the illnesses experienced by people exposed to intense noise was an essential prerequisite for the promotion of measures to eliminate and reduce workers' risk of exposure to noise, in order to prevent hearing damage.

Step 1: detecting and diagnosing cases of hypoacusis

The first step was to have all detected and diagnosed cases of hypoacusis acknowledged, in order to generate the knock-on effect in prevention: one suggestion was to raise workers' awareness of the consequences of work in environments where noise levels exceed the maximum limits allowed. An information campaign was carried out to present and explain, among other things, the audiometric test chart.

Diagnoses confirming hearing loss were carried out prior to beginning procedures for applying for compensation. In order to do so, it was necessary to engage the participation of the enterprises where workers had been diagnosed with hearing loss from occupational exposure to noise, to complete the 'Parte de Enfermedad Profesional sin Baja' (report on an occupational illness without sickness leave).

These examinations led to an increase in statistics relating to occupational illnesses, and this raised the alarm about the emergence of the problem.

Following the increase in the number of cases of compensation paid out, the social security, began to draw the attention of enterprises to noise prevention, the promotion of obligatory use of personal hearing protection at work. Nonetheless, there were many cases where the discomfort of protection measures led workers to request changes to the preventive measures (prevention at source or collective measures).

Step 2: campaigning for awareness among workers.

Several informative talks were organised between the trade union delegates, members of the undertakings (metal industries and workshops, chemicals, paper, wood, quarries, construction, cement factories, fisheries, etc.) in towns and regions.

CC.OO. produced and distributed explanatory leaflets, which appeared in the press, urging workers to approach the union with medical screening or health monitoring reports that included audiometric test charts.

Audiometric test charts were drawn up by the public health service, Osakidetza, and hundreds of workers began to understand and identify hearing loss in the audiometric test chart, distinguishing between hearing loss produced by noise and those derived from common illness.

(33). <http://www.ccoo-euskadi.net/> see also <http://www.ccoo.es/istas/>



Several press releases, debate forums and reports were prepared, as well as union publications on the campaign.

As an outcome of the campaign and its results, contacts were made with enterprise, the labour inspectorate, the public health service, Osakidetza, invalidity assessment teams and even the courts.

Thus, in 2000, statistics in the region of Alava relating to the recognition of hypoacusis originating in the workplace began to increase. Their recognition, and the visibility of the damage caused by an unsafe environment that this gives, is a significant step towards the objective of implementing the necessary preventive measures. This objective is being reached, as many undertakings are now recognising the need to implement organisational, technical and management measures in order to solve the problems of noisy environments.

Results

Overcoming some initial resistance, CC.OO. processed some 6 000 cases of hypoacusis recognised and compensated by the Instituto Nacional de la Seguridad Social (INSS)⁽³⁴⁾ [National Institute for Social Security] and OSALAN⁽³⁵⁾ (Basque Country Institute for Occupational Health and Safety). Identifying 6 000 cases of hidden occupational illness is of significant social benefit although it is difficult to quantify this.

The successes of the campaign included:

- a marked change in workers' attitudes, in particular with regard to the awareness of losses incurred in sharp frequencies;
- the participation of undertakings, with various occupational illnesses reports, in the activities to reduce the accident rate.

Comments

This trade union campaign achieved success by focusing on real cases to raise awareness, and promote action.

(34). <http://www.seg-social.es/>

(35). <http://www.osalan.net/>



12

NOISE REDUCTION AND ACOUSTIC IMPROVEMENT OF THE CONTROL ROOM IN THE COMBINED HEAT AND POWER STATION – TE-TOL, LJUBLJANA

Termoelektrarna Toplarna Ljubljana, d.o.o., Ljubljana

Toplarniška 19
SI – 1000 Ljubljana
SLOVENIA
<http://www.te-tol.si>



Issue

Addressing low frequency noise problems to improve “human factors” at a power station

Problem

Termoelektrarna Toplarna Ljubljana (TE-TOL), d.o.o., Ljubljana is a company for production of electricity, hot water and steam. It is municipal and state owned, employing about 300 workers, 140 in production and 100 in maintenance services. Although once situated in the outskirts of town, keeping good relations with neighbourhood was always an important point in the company policy. TE-TOL has been investing a lot in improving its out-of-date technology to fulfil all new directives and regulations.

Plant operation in TE-TOL is monitored and controlled from the main control room by seven operators. Efficiency and reliability of the plant operation and safety of TE-TOL workers depends on operators' performance demanding timely perception of signals and undisturbed communication ability. The work in such room requires a quiet and acoustically suitable working environment. Due to the high levels of low frequency noise the working process was disturbed. According to Slovene noise legislation demands, the noise level for such operations must be reduced to acceptable values below 55 dB(A).



The TE-TOL plant



High noise levels are present in machinery rooms of the power plants. The main sources of this noise are usually the turbine - generators assemblies.

At the TE-TOL power station in Ljubljana, the control room was equipped with standard glass walls. Being placed between two noise sources – the machine and boiler room – unacceptable noise levels exceeding 65 dB(A) were being recorded. Worse, the tonal nature of the noise, where 50 Hz and their harmonics were emphasized, led operators to complain about a disturbing working environment.

An examination of the control room showed that it had poor room acoustics and the audibility of speech frequencies meant that verbal communication between operators was disturbed. This was caused by:

- Transmission of sound energy through double glass walls, with relatively low sound insulation (not exceeding 25 dB(A), while at 50 and 100 Hz not exceeding 12 dB).
- Poor acoustic insulation in the ceiling in the eastern part of the control room, where noise levels are the highest and reach values between 92 and 94 dB. The results of measurements also indicated high reverberation times exceeding 3 seconds in frequency bands between 50 and 100 Hz, which contributed to overall low-frequency standing waves and to noise in the control room.

Solution

The suggestion for the noise reduction originated from the operators who complained about disturbing noise. Based on performed measurements and risk assessment, the company was able to determine further steps for noise reduction and acoustic improvements. Long-term noise control measures are planned at noise sources in machinery room in order to reduce both environmental and occupational noise. However, most of such measures will first be implemented over the next years. Therefore secondary noise reduction measures were taken without delay, such as improving the sound insulation and sound absorption of the control room. Due to the presence of very low frequencies (50, 100 Hz), noise levels could not be reduced with the common measures. Indeed, existing standards do not deal with sound insulation procedures for frequencies below 100 Hz. A wide-band sound-absorption solution was adopted, based on a combined sound-absorption system consisting of resonating panels and porous absorbers.

Resonating panel absorbers

Resonating panel absorbers were constructed as lightweight plates, which were mounted parallel to rigid concrete ceiling. The air mass contained in the space between the plates and the ceiling acts as a spring. Such a “spring system” has a resonant frequency where oscillation occurs using sound energy, which thus decreases. The porous part of absorber presents a lower part of a combined absorber. It is primary intended for absorption of middle and high frequencies.

Membrane resonator (absorber) in the ceiling

Sound insulating material (glass wool with a thickness of 50 mm and density of 25kg/m³) was inserted into the middle space between the resonator plate and the concrete plate. The absorber thus created reduces the noise in a wider range with a middle frequency of 50 Hz. A half-rigid plate, elastic installation, adequate surface density and surface hardness were required. Therefore, it was decided to use a solid plaster cardboard plate (Knauf plate) with a proper surface density and reinforced with fibreglass.

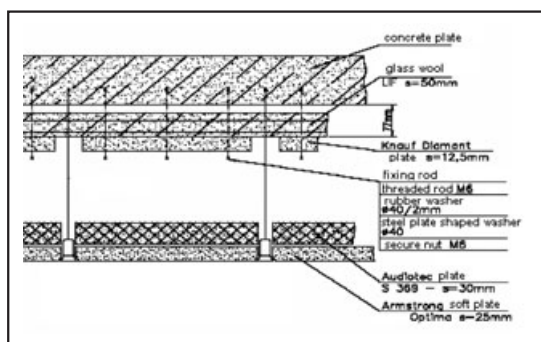


Prevention of risks from occupational noise in practice

For the plate to resonate at the desired frequency, its dimensions and the installation must be chosen properly. The optimal dimensions of a single plate are 1200 mm x 800 mm. Each plate is attached to the concrete ceiling plate with three screws. The screws are fixed into the concrete plate on the upper side and through a hole in a Knauf plate with a rubber and steel washer added, both plate-shaped, as well as with a secure nut on the screw under the plate on the other side.

Distances between the points where the resonating plate is hanging exceed 500 mm in order to enable the plate to oscillate when triggered with frequency of 50 Hz, to which it is dimensioned. These screws enable to set the distance between the upper concrete plate and of the membrane absorber at exactly 7.7 cm. Since the concrete plate is not completely straight, it has to be seen to it that this distance between the membrane absorber and the concrete plate during installation is respected.

Porous absorber in suspended ceiling



Cross section of the suspended ceiling

After considering the design of the suspended ceiling and the desired improvement of acoustics in the control room, soft absorbing panels made by Armstrong were chosen as they have a good sound absorption coefficient in the middle and high frequency range.

Furthermore, 30 mm thick sound absorbing laminate plates made of Audiotec were added on top of the Armstrong plates in order to increase the thickness of the porous absorber.

Additional Audiotec plates consisting of three layers with different absorptive material densities move the frequency absorption spectrum toward a lower part of the frequency spectrum. The resulting porous ceiling absorber is tuned to a frequency of approx. 200 Hz and above. Audiotec and Armstrong plates have the same dimensions and were installed sequentially one on top of another with no space in between.

Porous absorber on the wall

On the semicircular part of the wall facing the boiler room wooden vertical bars were installed above the electronic cabinets in order to fill the room between the cabinets and the ceiling. Steel sheets were mounted on the bars, but this structure had poor sound insulation properties for noise penetrating into the control room from the boiler room through adjacent walls. For this reason additional absorbing surfaces were, which improved the sound insulation and the aesthetic appearance of the control room at the same time. Soft sound absorbing Audiotec plates made of melamine resin were used. They have a very good sound absorption in the middle and high frequency region. When glued on a base they act as an efficient sound insulator. By installing these absorbing panels a shorter reverberation time inside the control room was achieved, which further contributed to a better audibility of speech frequencies.

Sound insulating glass wall

The two existing glass walls, which enabled visual control of the turbine and boiler part of the



plant, were insufficient for sound insulation and were therefore replaced. The dimensions of new glass walls were chosen so as to offer a sound insulation over 20 dB at the problematic frequency of 50 Hz as well.

Installation of the glass wall

The type of glass wall was chosen based on acoustic calculation. This resulted in a noise reduction of about 10 dB(A) as compared to the situation before treatment. As required the whole glass wall was elastically mounted on the existing concrete construction. On the upper side a sound-insulating panel (Knauf construction) was installed. This construction was build-up of two layers of polyurethane-lead plates, type Noisedamp, reinforced two times with three solid plaster-cardboard plates where the upper part of the glass construction was attached.

The desired noise insulation was achieved thanks to this combination of polyurethane-lead plate (Noisedamp) and plaster cardboard plate. Good results were obtained, although there was no concrete plate above the glass wall.

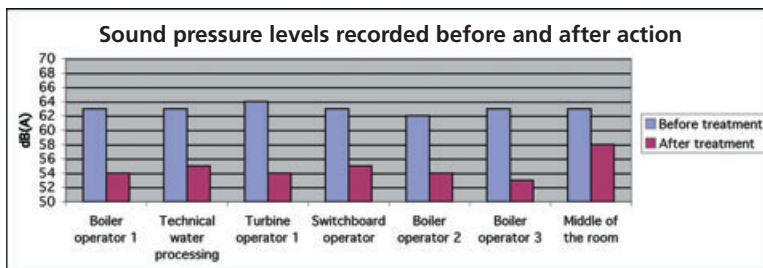
The whole glass wall and the concrete structure must be elastically connected, so a layer of rubber was required (silicon or EPDM rubber profile with a thickness of 3-5 mm) in order to avoid shock transfer from a concrete structure to the glass. This helped preventing the noise emission of such a membrane inside the control room. A rubber insulating layer was thus installed on the whole width of the window aluminium profile and the rest of the air left between the aluminium profile and the concrete structure was carefully filled with a permanent elastic mastic along the whole width of the profile. Because of strong vibrations a firm (screw) connection of the glass wall with the concrete structure of a control room was not allowed. After the permanent elastic (acrylic) mastic was fully dried temporary screw connections were removed and the openings were filled with a rubber material and permanent elastic mastic.

Described noise control measures were realised as a part of the project for the improvement of the control-room working environment, including also replacement of existing air-conditioning and lighting. Operators were involved in project planning and coordination since the plant operations were not allowed to be disturbed or stopped during works, which were carried out in 14 days during overhaul when the number of operators present in the control room was at minimum.

Results

The actions performed achieved good airborne sound insulation and sound absorption at problematic low frequency bands, and resulted in a:

- reduction of the noise level inside the control room by 5 to 10 dB(A);
- reduction of the total A-weighted level, 50 and 100 Hz components;
- decrease of the effect of standing waves, which was outstanding before the treatment.



For an outlay of approximately 85 000 €, the following benefits were accrued:

- noise levels have been reduced below Slovene legislation values;
- a better work performance of the operators is expected;
- operators' satisfaction has increased due to better work environment;
- a reduction of costs due to better performance of operators is expected,

though difficult to determine. If a fault is prevented that otherwise would have caused a plant shutdown, then all costs are immediately compensated.



The modified control room

Comments

This case is interesting because of the actions against low frequency noise.



13

COURSES FOR NOISE MONITORS

JobLiv Danmark as

Esbjergvej 24
6000 Kolding
DENMARK
<http://www.bstdanmark.dk>

Issue

Reducing noise in children's institutions

Problem

A lot of children gathered together create noise problems that many people have found is almost impossible to do anything about. Noise in day care centres, kindergartens and after-school centres is a problem that had appeared again and again among the inquiries from clients received by JobLiv Danmark. The problem was not new to the institutions themselves, as many had tried to solve the problems with the aid of traditional soundproofing, but in many cases this was insufficient to solve the problem.

Solution

Training to reduce noise using physical and social/behavioural interventions

A number of Danish municipalities have trained personal as noise monitors (persons especially trained to focus on noise) in recent years. JobLiv Danmark wanted to build on this and take the concept a step further. An important input to the project was the existing material from the Danish Ministries of Social Affairs⁽³⁶⁾ and Education⁽³⁷⁾ and Local Government⁽³⁸⁾.

The focus of the courses for noise monitors was perceived noise, not the recorded noise levels, for three reasons:

- Noise impacts not only on the physical working environment, but also on the social environment, especially in children's care centres. If noise is experienced as a problem, employee well-being is affected, irrespective of whether or not the noise limits are exceeded.
- The premise that it was possible to run courses that would generate results with few resources.
- That in their experience, there is generally a relationship between perceived noise and an actual noise levels. In the day care centres the human ear was therefore considered a valuable indicator for identifying where to make meaningful noise reduction actions.

(36). <http://social.dk/>

(37). <http://uvm.dk/>

(38). "Støj i daginstitutioner", Ulla Søgaard Thomsen et al., 2001. See http://www.social.dk/tvaergaende_indgange/udgivelser/Publikationsdatabase/SM/SM01/Stoej_i_daginstitutioner.html



Prevention of risks from occupational noise in practice

They decided to develop a course that extended the way in which noise problems are traditionally addressed, by also focusing on where, when and how noise is experienced, and then discussing how noise can be prevented by:

- addressing attitudes;
- changing children's and adults' behaviour;
- planning the work.

The general goal of the course is to train an employee to act as noise monitor in their own institution. The focus is not just restricted to the physical environment, but is also placed to a high degree also on teaching arrangements. The model also aims to ensure that noise and the everyday situations that can give rise to it are paid attention to and discussed on an ongoing basis.

Focus on action at the workplace

The course takes place on two separate days at an interval of one month. Both days are formulated as an interaction between theory, including an introduction to noise-reducing methods with practical examples, and the exchange of experiences. Participants carry out work between the two course days, analysing noise problems at their own workplace. An important aspect is that this should provide the incentive for starting concrete actions to provide solutions their own workplaces.

The object of the first course day is to:

- provide the noise monitors with the knowledge and the tools to implement noise reduction measures on their own initiative on the basis of the institution's building layout, furnishings and fittings, playground equipment and organisation of teaching;
- give participants a knowledge of the risks associated with noise;
- provide a forum for exchange of experiences with colleagues from other institutions;
- focus on how the work can be organised so that noise is prevented.

A form is handed out on the first day of the course that the participants complete before the second course day. The form contains questions about noise in relation to both the physical and social working environments. Course participants thus consider possible technical improvements and appropriate arrangements and organisation of the teaching. This homework is reviewed together on the second course day and experiences are exchanged between the participants and JobLiv Danmark. An individual plan of action is then prepared for each workplace so that the noise monitor is ready to initiate and continue the work independently.

A mixture of participants facilitating exchange of experiences

Both managers and employees attend the courses. Some have been members of the safety committee and others have not. This provides an opportunity for exchange of experiences between a variety of managers and employees, who face very similar problems. Many experiences in creating improvements can be transferred directly from institution to institution.

A catalogue of good practice proposals

The noise monitor course supports the creation of concrete and feasible improvements, and many can be generated with minor investments or with none at all. A concrete result of the courses has been the development of a 'concept catalogue' that contains a large number of proposals for how noise can be prevented or reduced in various daily situations (see box).



Concept catalogue

This catalogue is a list of some of noise problems and prevention options, which have been used with success to reduce noise in day care centres.

Noise in the dressing room

- Small groups at a time
- Let the children dress themselves and give them as much time as they need
- The bigger children can help the little ones
- Each child finds its clothes before they queue up
- Provide a low chair for the teacher

Noise in the bathroom (big room, many children playing)

- Avoid a lot of children in the bathroom at the same time
- Put sound insulation on the top of the wall and the ceiling
- Have an adult on duty in the bathroom
- Prohibit playing in the bathroom

Noise from small children running

- Place obstacles in the way and avoid long passageways without physical obstacles
- One adult looks after the children
- Teach them to play
- Move the playing outdoors
- Prohibit running
- Install noise insulation at child height

Noise in workshops (drawing, painting, playing with beads etc.)

- Install extra partitions in the room
- Make acoustic adjustments, e.g. sound-absorbing walls

Controlling noise during play

- Have the computer/play station in a separate room, and limit the number of children in the room
- Ensure that there is soft underlay in play areas where wooden blocks and similar toys are used
- Line wood/plastic toy boxes with pieces of carpet or other soft material
- Buy wicker baskets for toy storage
- Place noisy games in rooms where noise is allowed and where it is not a nuisance; the room must have good acoustics with insulation at child height
- Control the play options, planning which children may play where and when; provide different options to occupy children
- Limit the number of children permitted in a play room, and provide sound insulation where lots of noise is permitted



Noise while dining

- Discuss themes while eating
- Hold the meal outside, weather permitting
- Divide up the noisy children – give them the same place every day
- Divide the children into several rooms
- Get the children to stand in a circle before they eat so that they calm down
- Eat when the children want to
- Ensure that all required items are in place; put e.g. the refuse pail on the table
- Ensure that the children have been to the toilet before eating
- Let the adult sit with her back to the next table so she is more attentive to the children at her table

Noise from the adult environment

- Allocate a cordless telephone to a person who will take calls
- Put the office technology (e.g. photocopier) in a room where its noise will not be a nuisance
- Agree that the copier will be turned off except at specific times
- Improve the acoustics of the staff room, e.g. by the use of insulating material

Reducing general noise from children

- Encourage the use of footwear with soft soles by speaking to the parents
- Install thin rubber edging so the noise is muffled with the door is slammed
- Put felt caps on the doors
- Put felt caps under chairs
- Consider noise when purchasing furniture such as chairs
- Ensure that nervous children have something that makes them feel safe when they are in a vehicle to stop them crying
- Stop a child crying by taking them for a walk, perhaps to another room
- Use a simple noise meter (e.g. "noise ears") to make children aware of the noise they make
- Study noise as a topic to raise awareness

Results

Raised awareness, reductions in noise

The course is currently being held in two North Jutland municipalities, for about 20 employees from Åbybro's various institutions and for an equivalent number of employees from institutions in Sejlfjord. The course in Åbybro was subsequently followed up in an evaluation meeting, with positive feedback: the employees have experienced significant improvements; they have indicated that it is useful to focus on noise; they are now thinking about the problem more in their everyday work, and they are more aware of what else can be done to make improvements; and they are also finding that they are less tired when they come home from work.



Benefits for teaching, children and the working environment

It is well known that many children suffer hearing damage because of exposure to noise. The interventions that result from the training mean that the children too benefit from a reduction in noise exposure and as behaviour is tackled as part of the solution, this helps them to gain an appropriate attitude and behaviour towards noise from an early age.

The noise monitor course has also led to benefits in relation to teaching. The subsequent interventions help the children's concentration, and the development of their social skills towards one another. Some interventions have also resulted in a reduction of inappropriate working postures have been reduced.



An example of creating small niches in group rooms. Such niches are dividing the children in smaller groups

Comments

This course helps to empower employees to find and implement solutions to noise in their own workplaces, taking a holistic approach to prevention. The trained noise monitors receive a much wider understanding of noise problems than just the technical. The establishment of a catalogue of solutions promotes the exchange of good practice.



14

NOISE IN AGRICULTURE TOOLS TO EVALUATE EXPOSURE AND FIND BENEFICIAL SOLUTIONS

The Sector Work Environment Council for Agriculture

Torsøvej 7
8240 Risskov
DENMARK
<http://www.barjordtilbord.dk>

Issue

A systematic investigation of significant noise sources spread among dairy farmers, pig farmers and plant breeders was carried out and several tools produced to help employers and employees in the agriculture sector to prevent and minimize harmful noise in the workplace.

Problem

Farms are noise places, and the workplaces are often small and difficult to access. A Danish study in 2000 has shown that 37 percent of all Danish farmers have a hearing loss or tinnitus. No analyses of noise sources were available in the sector at that time. Consequently, The Sector Work Environment Council for Agriculture decided to carry out a campaign concerning noise in agriculture, and the "Støj i landbruget" project was the result.

Solution

An investigation into noise sources in agriculture was carried out, measuring more than 60 noise sources at approximately 30 farms (small farms, big farms, "hobby-farmers", organic farmers, machine pools). Prior to each visit telephone interviews were conducted. During the visit to the farm it was discussed with the farmer as to which noise sources should be measured on his farm. The investigative method was based on checklists established with the aid of farmers and experts. The results are published in the report "Støj i landbruget – en eksempelsamling" (Noise in Agriculture – case studies)⁽³⁹⁾.

Feature day

Information concerning the results was given to the agricultural consulting profession at a feature day in February 2004. The feature day also contained information about general noise, harmful noise and the prevention of noise exposure in agriculture.

(39). http://www.barjordtilbord.dk/upload/081203_landbrugsrapportprint1.pdf



Information leaflet

A leaflet, entitled “Støj i landbruget – er det et problem?” (Noise in Agriculture. – is it a problem?)(40) was published and distributed to employees in the agricultural sector.

The leaflet is directed towards employees in the agricultural sector and contains:

- a short review of measurements of noise exposure;
- basic knowledge of noise and relevant noise control measures;
- examples of a typical working day for a pig farmer and a dairy farmer, and a typical working year for a plant breeder;
- typical levels of noise exposure at the different jobs are given.



Leaflet entitled “Noise in agriculture – is it a problem?”

By reading the leaflet and going through the examples it is possible to make an assessment of one's own noise exposure.

Web-site

An essential part of the project is the creation of a web site(41). It has been translated into English in order to reach employees that do not speak Danish(42). It is an interactive web-site about noise, directed to employees in agriculture.

The web site is innovative as it is possible to assess one's own noise exposure without measurement. One can fill in a form with actual tasks and exposure times, from which the homepage will calculate the time limit for risk of noise-induced hearing loss. It is possible to make calculations with or without hearing protectors. The web site has more innovative teaching methods e.g. “Listen to a hearing loss” and “Hearing and seeing” examples of the variation of noise levels using a “noise barometer”. Furthermore the web site gives information about basic noise knowledge and guidance to prevention. However, the innovative part of the web site is the possibility of evaluating one's own risk for hearing loss while sitting in a living room, classroom or workplace.

Results

Total costs of the project were around 140 000 €. It is not possible to determine the economic benefits of the project (for reasons such as it is not possible to know how many people visited and read the website), but the work will reduce the number of cases of hearing loss in Danish agriculture.

Comments

The Danish Steering Committee chose the project “Noise control in agriculture” as the best, most of all because of its original approach by creating a website which makes it possible for a farmer to evaluate his own exposure to noise without measurement.

(40). http://www.barjordtilbord.dk/upload/st%C3%B8jfolder_a5grund_til_pdf.pdf

(41). <http://www.stojilandbruget.dk>

(42). <http://www.agrinoise.com>



15

THE NOISE REDUCTION FACTOR (GRF)

Verbond Papier & Karton

Postbus 731
2130 AS Hoofddorp
THE NETHERLANDS
<http://www.verbondpk.nl>

Issue

Calculating the most cost-effective noise reduction measure.

Problem

People working in the paper, cardboard and corrugated cardboard producing and processing industry are exposed to high – sometimes very high – levels of noise, which are usually the result of acoustically highly complex situations. Much of the work in these plants cannot be done from protected control rooms. In the processing departments in particular, people can be exposed to noise for long periods.

There are quite a number of technical and organizational ways of reducing noise. For many companies, the problem is to know which measure will be the most effective in terms of reducing noise and controlling costs. Smaller companies in particular are not at all sure which measure will achieve the most cost-effective noise reduction.

Verbond Papier en Karton has developed a tool to help them decide: the Noise Reduction Factor (GRF). This tool, a calculation formula, applies objective criteria to test the effectiveness and efficiency of a reduction measure and to determine whether a measure should be implemented. It weighs the cost of the measure against the reduction in noise level and the feasibility and applicability of the measure. The number of employees involved is also factored into the calculation. With this excellent approach, which focuses on the source of the problem, Verbond has shown that a sector-wide approach can work well at company level.

The tool was developed in collaboration with sector employers and employees. This type of approach can easily be used in other sectors and is certainly applicable to small and medium sized companies. After all, the results achieved with this tool were primarily obtained in small and medium enterprises. The tool gives a company the chance to put a measure in place that is in keeping with its operations, without losing sight of the health of its employees. The sector takes its responsibility for health at work.

A large group of employees were experiencing high levels of exposure for virtually the whole of their shift. The indiscriminate implementation of different kinds of noise measures is an expensive



and ineffective solution. After considerable investment the effect often turns out to be far weaker than expected. So employers tend to be less than enthusiastic about doing something about noise. How can employers and employees be assured that every euro spent will effectively help to reduce exposure to noise?

Solution

Applying the GRF protocol gives an insight into which measures or package of measures are the most cost-effective in reducing exposure. In this way, companies have a guarantee that available funds are spent in the most worthwhile way. The business management considerations in these kinds of investment decisions are incorporated into a relatively simple calculation model. All the parameters relevant to a decision, such as the number of employees involved, the reduction achieved, the cost, and the feasibility and applicability of the measure, are factored in, as are the effects of logarithmic calculation in the case of noise, and the relatively more serious damage caused by higher exposure levels.

The GRF Protocol

The protocol consists of two parts:

- A so-called “noise reduction factor” based on a number of criteria is calculated for the measures about which a decision has to be made.
- Two limiting values are used to decide whether a measure is to be implemented or not, or whether further research is required before a decision can be made.

The noise reduction factor (GRF) is calculated using the following formula:

$$\text{GRF} = \frac{\Delta L}{\text{kfl}} \cdot \text{ET} \cdot \text{UV}$$

In which:

$\Delta L = \sum_i \text{FTE}_i \cdot x \Delta L_i$ is the weighted cumulative reduction in the workplace noise level

ΔL_i = the noise reduction produced by the measure in workplace i

$\text{FTE}_i^* = 0$ at a prevailing noise level of 80 dB(A) or less

$\text{FTE}_i^* = \text{FTE}_i \cdot x \text{GN}_i$ at a prevailing noise level of 80 dB(A) or more

$\text{GN}_i = 10^{\frac{(L_{p,i} - L_{p,ref})}{10}}$

FTE_i = the number of FTEs involved based on an 8-hour work period per shift at workplace i

ET indicates the prevalence of the measure:

ET = 1 for measures that are rarely applied elsewhere;

ET = 1.15 for measures that are regularly applied elsewhere;

ET = 1.25 for measures that are often applied elsewhere.

UV is the feasibility of the measure:

UV = 1 for measures that are difficult to implement;

UV = 1.25 for measures that are not abnormally difficult to implement.

kfl represents the cost of the measure in thousands of guilders.



The following limiting values are used in this protocol:

Kfl in thousands of guilders:

- GRF < 3.4: do not implement the measure;
- GRF > 3.4 and GRF < 4: further research required;
- GRF > 4: implement the measure.

Kfl in thousands of euros:

- GRF < 7.5: do not implement the measure;
- GRF > 7.5 and GRF < 8.8: further research required;
- GRF > 8.8: implement the measure.

These limiting values should, if necessary, be further refined on the basis of more extensive research into measures to which this decision-making protocol is applied. For the time being, the limiting values given are the values being used.

Any changes to the limiting values will be made by the sector supervisory committee following submission of the noise level improvement plans for each company.

Examples of protocol use

Source or receiver measure

This example assumes that there are 8 FTEs in the workplace and that the measure that brings about a reduction of 3 dB costs 10 000 guilders. The measure is regularly applied elsewhere and is difficult to implement. The variables used to calculate the GRF are shown in the following table.

Calculation of the GRF for a source or receiver measure

Workplace	A1
Employee's shift [hours]	8
Operation time [hours]	8
Noise level LAeqw [dB(A)] during the employee's shift and machine operation time	82
Noise reduction as a result of the measure	3
Time correction factor [dB]	0
Partial dose [dB(A)]	79
Daily dose [dB(A)]	79
Number of FTEs in workplace i	8
GN _i	0.8
FTE _i *	6.4
FTE _i * x ΔL _i	19.1
ΔL	19.1
Cost of the measure [thousands of guilders] Kfl	10
ET (prevalence 1, 1.15 or 1.25)	1.15
UV (feasibility: 1 or 1.25)	1
Noise reduction factor (GRF)	2.2



According to the decision-making protocol, a GRF of less than 3.4 means the measure would not normally be implemented.

Organizational measure

As the example shows, a reduction in the operation time from 8 to 4 hours would reduce the daily dose by 3 dB. Calculation Example 2 is also based on 8 FTEs, the measure is regularly applied elsewhere and is difficult to implement. The difference between this and the previous example, however, is that this measure only costs 5 000 guilders.

Calculation of GRF for an organizational measure

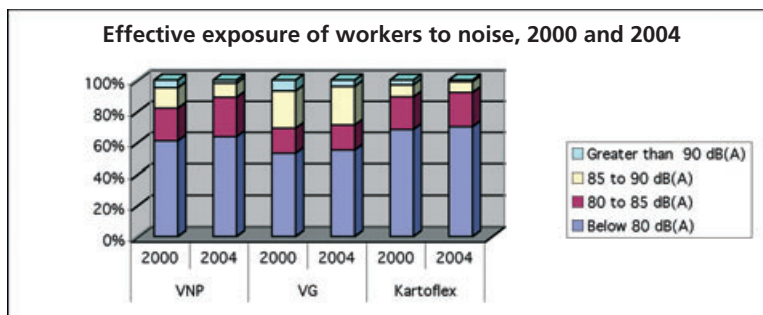
Workplace	A1
Employee's shift [hours]	8
Operation time [hours]	8
Noise level LAeqw [dB(A)] during the employee's shift and machine operation time	82
Noise reduction resulting from the measure	3
Time correction factor [dB]	0
Partial dose [dB(A)]	79
Daily dose [dB(A)]	79
Workplace	A1
Number of FTEs in workplace i	8
GN _i	0.8
FTE _i * ¹	6.4
FTE _i * x ΔL _i	19.1
ΔL	19.1
Cost of the measure [thousands of guilders] K _{fl}	5
ET (prevalence 1, 1.15 or 1.25)	1.15
UV (feasibility: 1 or 1.25)	1
Noise reduction factor (GRF)	4.4

The GRF resulting from this calculation is 4.4. In this example, a measure that costs 5 000 guilders rather than 10 000 and reduces noise by the same amount has a GRF of more than 4. According to the decision-making protocol, this measure should be implemented.

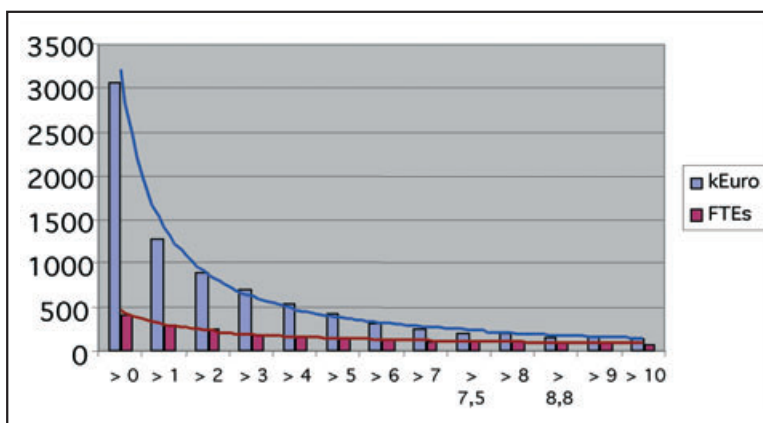
Results

The method has been applied on a large scale in the sector and has produced good results, as the first interim measurements indicate. The results were checked in practice in a sample survey of 25 companies. The most striking improvement was a reduction in exposure to the highest noise levels. These interim measurements shows that exposure to levels above 90 dB(A) has been halved and exposure to levels between 85 and 90 dB(A) has been reduced by around 30%.





The fact that the occupational health and commercial aspects are fully incorporated into the methodology guarantees a good cost/benefit ratio. The graph below shows quite clearly that, depending on the outcome of the protocol, either the costs no longer outweigh the benefits or a reduction in exposure levels can only be achieved through extremely high investment. In the covenant, there is an agreement that measures with an outcome of more than 8.8 will be implemented and those with an outcome below 7.5 will not. The relevant limits were tested in a practical study.



Comments

This tool, a calculation formula, applies objective criteria to test the effectiveness and efficiency of a reduction measure and to determine whether a measure should be implemented. It weighs the cost of the measure against the reduction in noise level and the feasibility and applicability of the measure. The number of employees involved is also factored into the calculation. With this excellent approach, which focuses on the source of the problem, Verbond has shown that a sector-wide approach can work well at company level. The tool was developed in collaboration with sector employers and employees. This type of approach can easily be used in other sectors and is certainly applicable to small and medium enterprises. After all, the results achieved with this tool were primarily obtained in such enterprises.

The tool gives a company the chance to put a measure in place that is in keeping with its operations, without losing sight of the health of its employees. The sector takes its responsibility for health at work.



16

THE VOIVODSHIP PROGRAM OF HEALTH PROMOTION: "CORPORATE PROGRAM FOR HEARING PROTECTION" FOR THE YEARS 2000-2005

Wojewódzki Ośrodek Medycyny Pracy (WOMP) The Voivodship Centre for Industrial Medicine

25-663 Kielce, ul. Olszewskiego
POLAND
<http://www.womp.lublin.pl>

Issue

A regional programme to protect workers' hearing.

Problem

Job-related hearing impairment caused by noise remains the second most frequent of all job-related diseases, both in the Świętokrzyskie Voivodship (province), and in Poland, with full consequences for employees, enterprises and local communities. It is estimated that about 20% of occupational diseases involve occupational hearing impairment. This situation has led to the need for activities aimed to protect employees' hearing from the harmful effects of noise at the workplace.

As many as 20 942 people employees exposed to noise exceeding 80 dB(A) in 1999, which is 16.8 % of the entire population employed in Świętokrzyskie Voivodship, according to data of the Provincial Sanitary Station. In the same year, 343 occupational diseases were reported, including 56 cases of occupational hearing impairment.

Despite the progress of medical competence and the systematic improvements in working conditions (for example by the introduction of new technologies), occupational diseases continue to pose serious problems, both in Poland and in the Świętokrzyskie Voivodship. Noise does not only affect the hearing organ. It influences the entire human being, affecting the health condition and functions of particular organs and systems. Reduced hearing ability increases the probability of suffering accidents, both in and outside of the workplace.

Solution

The Wojewódzki Ośrodek Medycyny Pracy (WOMP), or Voivodship Centre for Industrial Medicine, having analysed appropriate statistical data, initiated a Health Promotion Program called Zakładowy Program Ochrony Słuchu (ZPOS), or "Corporate Program for Hearing Protection", aimed to protect the hearing of employees exposed to noise at the workplace. The Program is proprietary to WOMP, and so far it has been the only program of that type in Poland. Financed by local government, it



has also received subsidies from the Narodowy Fundusz Zdrowia (NFZ), or National Health Fund.⁽⁴³⁾ and the National Centre for Promotion of Health at the Workplace.

The Program has been conducted since 2000, and it covers the working environment of selected enterprises, while it is possible to expand it to cover all the employers of the Świętokrzyskie Voivodship (province) where exposure to noise is a factor. ZPOS implements the National Health Plan with respect to limiting exposure to harmful factors in living and working environment and is in line with a government program "Safety and Health Protection in Working Environment".

The beneficiaries of the programme are workers in enterprises in Świętokrzyskie Voivodship who are exposed to noise. At present, there are 23 companies taking part. These are mainly small and medium enterprises – power plants, mines, foundries, steel mills, metal works, cement plants, furniture producers. The program is based on voluntary participation for all employers. Actions that follow from the program, such as modernising machinery, technological upgrades, introducing means of collective health protection or purchasing personal protections, and also business trips and medical examinations were financed from own resources of program participants. The programme is implemented by WOMP, along with:

- Podstawowe Jednostki Służby Medycyny Pracy (PJSMP), or industrial medicine services,
- Państwowa Inspekcja Pracy (PIP), or State Inspectorate of Labour, and
- Państwowa Inspekcja Sanitarna (PIS), or State Sanitary Inspectorate.

The primary objective of the program is to protect employees' hearing against exposure to noise at the workplace, by:

- Decreasing noise emission and exposure of employees to noise in the working environment,
- Dissemination of behaviour patterns enhancing the protection of hearing of employees exposed to noise at work, and by
- Improving the quality of prevention activities relating to hearing loss, rendered by the PJSMP.

The expected results of the program include:

- Limiting noise emission to safe levels,
- Conscious use of optimum hearing protection by employees exposed to noise,
- Decreasing the number of employees with a diagnosed noise-related hearing impairment, and
- Decreasing the number of new cases of hearing loss at work in Świętokrzyskie Voivodship.

The detailed goals of the programme are:

- Reducing noise emission and exposure of employees to noise at the workplace.
 - Securing full accessibility of personal hearing protection that meet the requirements of effectiveness and are accepted by employees.
 - Limiting the noise level generated at the workplace through technological improvements.
 - Limiting the noise exposure through changed work organisation.
- Proliferation of behaviour contributing to hearing protection among employees exposed to noise at the workplace.
 - Shaping employee attitudes that contribute to implementation of hearing protection activities in the course of the work process.
 - Creating socio-organisational mechanisms to stimulate employees and get them involved in protecting the hearing at the workplace.
- Improving the quality of preventive services provided by the PJSMP and related to the protection of hearing.

(43). <http://www.nfz.gov.pl/>



- Improving the quality of hearing impairment diagnosis as part of preventive examinations of employees.
- Developing and implementing the system of preventive actions of the PJSMP – resulting from the assessment of the condition of employees' hearing organs.

The strategy used in applying the programme was to:

- Involve the industrial medicine service, with the voluntary enrolment of doctors and nurses.
- Acquire allies, including Wojewódzka komisja do spraw Ochrony Pracy (WKOP), PIS, PIP, and the Trade Unions.
- Collaborate with the labour inspectorate and other bodies in the implementation of the programme in workplaces with noise exposure.
- Prepare Health Promotion Leaders (their roles will mainly be played by health service employees, fulfilling those tasks as voluntary social work, without any remuneration).

There has been annual evaluation of the programme throughout its life, and there will be a final evaluation of the programme in 2005 with a questionnaire to employers and employees. The results of this questionnaire will be compared to the opening questionnaire.

The program is closing as planned in 2005. Discussions aimed to prolong the project are under way. Irrespective of their final outcome, authors of the program are convinced that the "network" of units created in its course will not perish. Training for leaders will continue, too, and they keep passing the knowledge on to enterprises. The achieved growth of awareness of employees and employers knowledge will determine the long-term results of the project.

Results

It was assumed that implementing the program would have the following effects:

- reducing emission of noise (down to 75 dB);
- conscious use of personal hearing protection by employees exposed to noise;
- observing health and safety regulations by both employees and employers;
- reducing the population exposed to noise;
- reducing the number of employees with diagnosed noise-related hearing impairment;
- reducing the number of new cases of occupational diseases of hearing organs in the Świętokrzyskie Voivodship.

The first results of the program's implementation were as follows:

- interest of company management in improving health conditions of employees;
- equipping employees with the optimum personal hearing protection;
- conducting 32 checks and 8 visitations at workplaces where the program is carried out (information from health promotion cards developed by PIP);
- consistent compliance with health and safety regulations by employers and employees;
- limiting noise emission (replacement of machinery, equipment modernisation, liquidation of workstations with noise level above 85 dB(A), changes in work organisation);
- increasing the quality of audiometric studies;
- changes in the level of knowledge and in the behaviour of employees regarding hearing protection;
- implementing a system of preventive actions by occupational health services, related to protection of hearing organs.



Results from PIP

- all the plants subject to assessment have properly marked noise exposure zones;
- the enterprises do noise measurements in compliance with mandatory deadlines;
- 100% employees have completed their current preventive medical examinations, employees covered by the program have assured access to non-obligatory examinations as part of active medical advisory services;
- employers assess the level of occupational risk at the workplace characterised by over-normative noise; employees are informed about the outcome of such assessment;
- all employees covered by the program are equipped with personal hearing protection;
- employers, together with leaders, organise training sessions for employees, aimed to improve awareness and to support behaviour conducive to protection of hearing;
- employers achieve results through:
 - replacement/modernisation of machinery,
 - liquidation of workstations with over-normative noise,
 - changes of technologies to less noisy ones,
 - applying means of collective protection from noise (e.g. acoustic refuges).

Results from the occupational health service

- in 2001, 72% employees worked in exposed to over-normative noise, in 2004 - 68%;
- the number of employees with hearing impairment has not grown proportionally to the number of employees covered by the program;
- a program of active medical advice covered employees with hearing deficiencies, as well as those exposed to over-normative noise;
- in 2001, 72% employees worked in exposed to over-normative noise, while in 2004 - 68%. In the noise range of 75-85 dB, 28% of staff worked in 2001, while in 2004 the same ratio was 32% of those covered by the program.

Based on the analysis of information collected in the reports, one may draw the following conclusions:

- The population exposed to over-normative noise decreased, which may have resulted from reductions in the emission of noise through changed organisation of labour and machinery replacements.
- The number of work stages with the noise level above the highest allowed value was reduced, thanks to technological improvements introduced at enterprises.
- All employees working in the environment of noise exceeding 85 dB have guaranteed protections that comply with standards and are selected in an appropriate way.
- Awareness of employees regarding harmful effects of noise exposure increased; thanks to training sessions for employees positive attitudes to hearing protection increased, e.g. conscious use of best possible hearing protection.
- The number of employees with noise-related hearing impairment decreased.
- The number of new cases of occupational diseases of the hearing organs was reduced in the Świętokrzyskie Voivodship.



- Diagnosing quality regarding occupational diseases of hearing organs (as part of preventive examinations of employees) improved, as a result of training organised for occupational medicine specialists.
- A system of preventive actions by industrial medicine units was developed and implemented; moreover, employees covered by the program have guaranteed additional (non-obligatory) examinations as part of active advisory medical service.
- Employees and employers consistently follow current regulations regarding health and safety at the workplace.
- The number of employees exposed to noise in particular enterprises was relatively high at the moment when the program started, which confirms the sound selection of participating companies.

Advantages from ZPOS

For employees

- conscious responsibility for own health and for the health of one's family;
- perception of health as a value indispensable for achieving life's goals and aspirations, which finally leads to improvements in the quality of life;
- rational use of the best possible hearing protection by employees exposed to noise;
- consistent compliance with health and safety regulations by both employers and employees.

For enterprises

- employers are getting more and more conscious that their employees' health is also an asset of the company;
- upgrading the prestige of the organisation/employer in the opinion of employees and local institutions;
- improving relations between employers and employees, through indication of common goals to be achieved and of advantages for both parties;
- the staff equipped with the best possible hearing protection;
- improving effectiveness of human labour;
- promotion of 'good neighbourhood' practices, sharing the knowledge and experience.

For industrial health services

- improved quality of preventive examinations, including audiometric ones;
- more effective co-operation with employers, employees and internal company organisations aimed to improve the health condition and working environment;
- active participation of industrial medicine staff (doctors and nurses) in educating employees exposed to noise;
- experience in running a systematic preventive program that may be transferred and repeated in other projects of this kind;
- starting a co-operation with all the parties engaged in the work process (employers, employees, health and safety committees, trade unions) and – on the basis of such co-operation – gaining partners for further ventures.

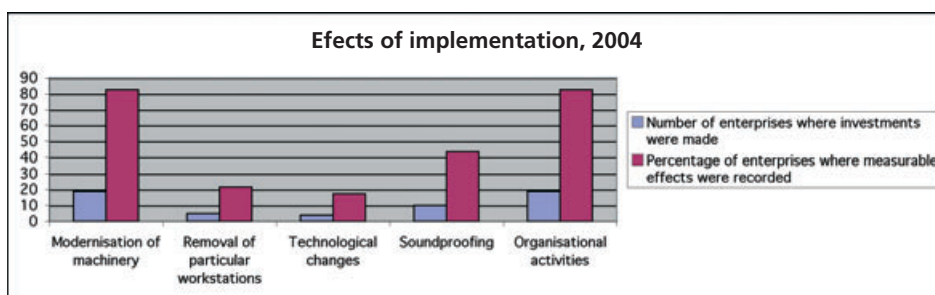


For the region

- improvement of the level of medical diagnostics;
- reducing the frequency of job-related hearing impairment, reducing financial outlays caused by workplace deficiencies.

Implementing the Corporate Program of Hearing Protection brings results at the following levels:

- Educational – based on the results of questionnaires from employees covered by the Program, leaders hold series of systematic workshops at companies. Such training workshops take place at least 2 times a year. The subject matter is suited to employees' needs. WOMP, as the program co-ordinator, holds training for: leaders from base units of the PJSMP, employers, managers and employees of industrial medicine laboratories. Besides, in case of 2 employers the Centre acts in a double role: as the co-ordinator and the implementing unit. The above activities have resulted in:
 - increased awareness among employees regarding damages connected with noise exposure at the workplace, and using optimum hearing protection;
 - improved quality of preventive services related to protection of hearing.
- Epidemiological – on the basis of analysing the Health Promotion Cards delivered from industrial medicine units, PIP, and PIS:
 - the population exposed to over-normative noise has decreased;
 - the number of work stages exposed to over-normative noise has been reduced;
 - all employees exposed to noise over 85 dB have guaranteed, properly selected hearing protection;
 - the number of employees with noise-related hearing impairment has decreased;
 - the number of new cases of hearing organ's occupational diseases has been reduced.
- Economic – costs borne by the state budget and related to disabilities were reduced.



Comments

This was a methodical programme with a reliable evaluation of the results. It seeks a limitation of occupational risk for many of employees, a significant increase of awareness among employers and employees, adds value – creating a network of leaders, organizations and enterprises, and is a transferable model.



17

OCCUPATIONAL NOISE REDUCTION IN CERTAIN POWER PLANT WORKPLACES

EDP Produção

Av. José Malhoa, Lt A-13
1017-157 Lisboa
PORTUGAL
<http://www.edp.pt>

**Issue**

Prevention of workers' exposure to noise in power plant electrical and mechanical workshops and other locations.

Problem

Power plants are noise places. As a result, it is essential to implement appropriate measures regarding the reduction of such levels in order to reduce the risks to workers' health. EDP's Setúbal Power Plant took several actions with this purpose, particularly in the mechanical workshops, focussing where the largest number of workers are exposed to permanent noise and where there is a permanent presence of workers.

Solution

A structured approach to the prevention of risks from noise for workers was taken, including:

- controlling noise at source;
- controlling noise by collective control measures;
- controlling noise by personal preventive measures.

Controlling noise at source

Among those actions of the noise programme are those that seek to control noise at source through a strategy of evaluation of the main noise source. Action took place:

- in the project/building phase;
- in the phase of industrial exploration.

During the project/building phase, the main noise sources were evaluated. Forced draught fan of Boiler 1 was identified as being a significant noise sources for the workshops, with acoustic interventions to reduce the noise emissions.

In the phase of industrial exploration, a proactive attitude to the prevention of noise generation by preventive maintenance was taken to reduce the possibility of noise level increases by wear and



Prevention of risks from occupational noise in practice

imbalance. In the case of the preventing noise in the workshops, this meant in particular examination of the draught motor fan of Boiler 1.

Controlling noise by collective control measures

Complementing actions for controlling noise at source, other actions were taken to prevent noise exposure to workers. These included:

- installation of protective insulating barriers against the noise in the ventilation grilles and “canaletes” (of the most exposed wall) of the workshops;
- design and installation of double door with noise insulation characteristics from outside to inside of the workshops.

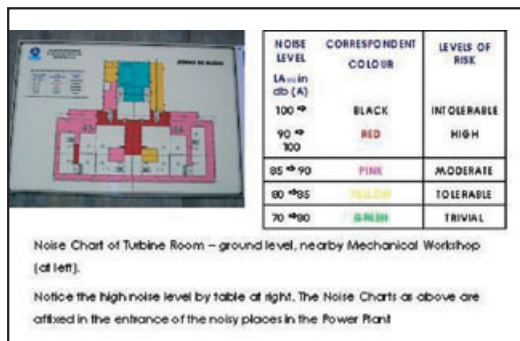
Controlling noise by personal preventive measures

Given the specific characteristics of Workshops working environment and as last solution, personal hearing protection measures were taken, including:

- the use of personal hearing protection, chosen to be as comfortable as possible;
- medical and audiometric surveillance of workers' hearing function with appropriate periodicity, for medical consideration, and more frequently than the legal requirements.

Further preventive measures

- “Training Actions” were ministered to workers in order to enlarge their knowledge and awareness in matters related to the minimization measures of their exposure to risk.
- The “Consultation and Involvement of the Workforce” with highlight to the regular meetings of Sub-Commission of OH&S (workers' representatives for OH&S and representatives of the Company, with highlights to the power plant's top manager and safety engineer, advised by the occupational doctor).



Results

In EDP's Setúbal Power Plant, full industrial activity began more than 20 years ago. The average age and working time in the plant are respectively 46 years old and 20 years. There has not been a single case of noise-induced hearing loss (NIHL) or other occupational hearing diseases amongst the power plant's workers.

Comments

The national jury believed that this is a good example where the existing noise problems, evaluation, and implemented solutions are very well characterised.



18

PROGRAMME OF PREVENTION OF EXPOSURE TO NOISE

Câmara Municipal de Lisboa (Lisbon Municipal Council)

Rua da Cruz Vermelha nº12
 1600-053 Lisboa
 PORTUGAL
<http://www.cm-lisboa.pt>

**Issue**

Assessing the exposure of street cleaners in a large city.

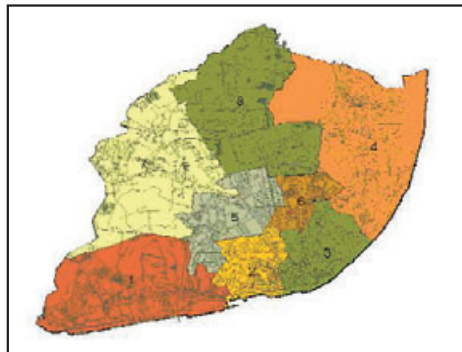
Problem

The Urban Cleaning Division (DLU) of the Câmara Municipal de Lisboa (Lisbon Municipal Council) is in charge of the depositing, collection, transport, valuation, treatment, and elimination of solid urban waste from Portugal's capital city. Approximately 1 700 DLU workers carry out large-scale and demanding work related to the cleaning of the municipality.

The work involves:

- Collecting undifferentiated urban waste
- Selective collection of glass, paper, and packaging
- Selective collection of large waste items
- Washing and sweeping of pavements and roads
- Collecting green waste from gardens and leaf sweeping
- Cleaning and unblocking street gutters and drains
- Cleaning and maintenance of waste paper bins

Waste handling may expose workers to a variety of risks, including biological and chemical hazards, musculoskeletal disorders, and noise. The Hygiene, Health, and Safety Division (DSHS) of the DLU monitored the noise levels during the collecting of undifferentiated and selective waste in order to develop preventive and/or corrective measures necessary to reduce the workers' exposure to noise and to improve the quality of both working conditions and the environment.



Map of the cleaning areas of Lisbon



Noise affects humans at the physical, mental, and social level. Exposure of workers to noise can cause discomfort along with physical and mental fatigue (e.g. contraction of blood vessels, muscular strain, irritability). Alongside this, noise can be a causal factor in accidents at work. Daily exposure at or above the legislative action level can lead to irreversible auditory trauma.

The harm caused by noise can have serious economic effects, both for the worker, and for the Lisbon Municipal Council too.

Solution

The DSHS carried out a complex and large scale monitoring programme by dosimetry in order to assess the amount of sound energy received by the worker, expressed as a percentage of the daily permitted amount (100%) and peak reading (maximum level of sound pressure for a given measurement period).

The results of the monitoring programme enabled the evaluation of the levels of noise exposure relating to:

- type of collection process;
- waste material concerned;
- number and type of receptacle in use;
- volume of material;
- type of material used in the collection process;
- route and location in the city; and
- professional group.

The results were categorised into four “colour groups” according to the recorded values of both the daily noise exposure value ($L_{ep,d}$) and the peak limit value (Max, P). This allows an assessment of the noise risks and the targeting of preventive and control measures for the specific risks to which workers are exposed.

Results

Date of monitoring	Collection Route	Type of waste	Professional group	Results				140dB
				Dose (%)	Dose 8h (%)	$L_{ep,d}$ (dB(A))	Max. P (dB(C))	
12/2/05	S2423	Paper and card	SC	11	21	83,2	133,8	Not exceeded
12/2/05	S2423	Paper and card	OHMSV	32	51	87,1	134,8	Not exceeded
2/3/05	D0610	Undifferentiated	OHMSV	18	33	82,1	143,8	Exceeded
2/3/05	D0610	Undifferentiated	SC	38	69	88,3	133,4	Not exceeded
2/3/05	D0610	Undifferentiated	SC	25	46	86,5	130,8	Not exceeded
5/3/05	D0607	Undifferentiated	OHMSV	7	15	81,7	136,9	Not exceeded
5/3/05	D0607	Undifferentiated	SC	6	13	81,1	130,6	Not exceeded
5/3/05	D0607	Undifferentiated	SC	13	28	84,5	139,7	Not exceeded
11/3/05	S3437	Packaging	OHMSV	20	31	84,8	127,1	Not exceeded
11/3/05	S3437	Packaging	SC	20	30	84,8	132,3	Not exceeded

Comments

This example illustrates a structured monitoring process of a large and complex work process. By breaking down the measurements according to a range of variables, it becomes possible to target preventive measures at the high priority areas.



19

A SOUND EAR: TRAINING AND AWARENESS RAISING OF NOISE EXPOSURE TO MUSICIANS

Association of British Orchestras

20 Rupert Street,
London W1D 6DF
UNITED KINGDOM
<http://www.abo.org.uk>



Issue

Looking for ways to reduce the noise levels in rehearsal and performance environments in order to protect orchestral musician's hearing.

Problem

Orchestral musicians are exposed to a varied and wide range of noise, including high frequency noise and excessive volume, for a significant period of time. This noise is generated by both the worker's own instrument and from other musicians in the ensemble.

The results of such exposure include general threshold shift, tinnitus, diplacusis and other forms of noise-induced hearing loss. Studies agree that brass musicians have the worst threshold shift, followed by woodwind and strings, whilst woodwind players are at the greatest risk of hyperacusis. Percussion players are a special case; while the players' doses are low, they experience as many peaks as brass and woodwind players.

The challenge facing the entertainment sector is that while in other work areas the noise produced is a "by-product" that can be eliminated or controlled, for live music performance, noise IS the product. This makes the control of exposure to musicians to noise very challenging. Furthermore, the exposure of a musician to noise can vary significantly, depending upon issues such as venue, work being performed, and conductors' interpretation.

Solution

The national industry body representing professional orchestras, the Association of British Orchestras (ABO) has been running a multi-faceted project to address the particular problems faced by this industry. In carrying out the project, the ABO has worked with the UK musicians' trade union⁽⁴⁴⁾ and the UK occupational safety and health authority, for example over policy development on noise for the sector. It has also shared its work with other, for example working with other orchestras

(44). <http://www.musiciansunion.org.uk/>



outside the group to transfer the system and training. Work so far undertaken includes expert research, a final report, seminars, conferences and special training.

Expert research

The ABO approached the issue by first commissioning research from experts. The final report, 'A sound ear', which draws on an extensive amount of both published and unpublished research, was published in 2001 confirmed that a problem existed, the extent of the problem and what could be done about it. Many and varied problems were uncovered, such as: practice at home and teaching increase exposure; freelance nature of much work; students often work in worse conditions; noise level depends on stage size; whether working in a pit; noise from and exposure of choirs; noise in recording sessions and type of headphones used. Subsequent actions were based on the results of this report. The report can be purchased through the Association's website.

Extract from risk assessment on noise by orchestra								
No.	Hazard Identification	Risk	Persons at risk	Existing control measures	c	IL	rR	Action required / responsibility
4	Excessive noise and vibration caused by much of repertoire performed, exacerbated by pit environment	Risk of hearing damage	Musicians and all staff working in pit	Hearing protection available from OHU.	4	4	16	Essential to obtain dedicated PC to download results of noise readings so as further appropriate action can be identified.
				Sound screens available and being monitored				Rotation within string sections to be considered to reduce individual exposure.
				Noise conservation programme in place				Noise levels being read.
				All staff trained in effects of noise exposure and hearing damage.				Further actions to be identified as noise programme progresses.
				Pit layout varied to minimise individual exposure				

Menu of control measures

There is no "one size fits all" solution for the problem of noise in orchestras, so a "menu" of control measures was suggested. These include collective control measures through work organisation (e.g. performing quieter pieces of music) and workplace design and layout (for example, using the appropriate type of screening, or physically raising the positioning of some players on stage) as well as personal preventive measures (such as custom-moulded earplugs).

The range of measures offers maximum flexibility when dealing with noise problems in a variety of different rehearsal and performance locations with differing types, sizes and flexibility of concert platforms, stages, acoustic shells and orchestra pits in different venues. The solutions also offer high sustainability as many options are cost neutral and encourage a complete culture change as opposed to 'quick fix' one-off solutions, all of which do not affect the artistic integrity and musical experience for the listener.

Expert teams

Given the number of people on whom some of these changes can impact, orchestras have been encouraged to create their own 'expert team' comprising players from across the orchestra, orchestra management, venue staff, technical staff and where possible planning and artistic staff, such as the conductor. This team should meet on a regular basis to discuss mid- to long-term planning



issues in terms of venues and repertoire and would be present (at least in part) at rehearsals and performances to advise or act on immediate concerns.

In order that teams can function effectively, the members need to receive training. They must be made aware of the risks to their hearing and what control measures are available. It was felt that a long-term, pro-active approach using existing knowledge, experience and comparisons was a requirement. The ABO therefore developed a training programme and in 2003, funding from the UK Musicians Benevolent Fund⁽⁴⁵⁾ enabled the ABO to present twelve two-day training courses aimed predominantly at symphony and opera/ballet orchestras around the UK, following which the 'noise teams' could be formally established.

Player training

The ABO developed more basic training for all players. Through the programme of education and training, musicians learn that hearing loss is no longer an unavoidable occupational hazard and that positive steps can be taken to create a safe working environment. The Musicians Benevolent Fund provided funding for the actual cost of the training so no additional expense was necessary from each orchestra. The cost of a further two 'sessions' or one day was required for members of the Noise Team. In practical terms the training costs each orchestra the equivalent of one rehearsal/performance.

Conferences and workshops

Since 2001, the ABO has run several successful conferences and workshops tackling the issue of noise exposure to musicians in its continued commitment to raise awareness of the problems and solutions available⁽⁴⁶⁾. This increased the dissemination of research outcomes and solutions beyond large orchestras to small and medium enterprises (SMEs) such as chamber orchestras, smaller ensembles and individual musicians. Updates on work of the orchestral sector will be highlighted in October 2005 to coincide with the European Week for Safety and Health at Work and further funding for the same training to smaller orchestras, individual musicians and other SMEs is being sought.

Results

As a member of Pearle* (European League of Performing Arts Employers)⁽⁴⁷⁾, the ABO has actively shared its knowledge with orchestra and theatre associations across Europe, most recently with the newest members of the EU25. When all the orchestras have completed their training, a formal evaluation will begin. As such, only anecdotal data exists on this programme.

Comments on the project

"[The training has created] much more awareness and consequently more co-operation. We are in the process of refurbishing our home theatre and the issue of noise has come to the top of the agenda when making decisions about the working environment."⁽⁴⁸⁾

(45). <http://www.mbf.org.uk>

(46). For example, see http://www.abo.org.uk/pdfs/events/symposia/SoundEar_Schedule.pdf

(47). <http://www.pearle.ws>

(48). Orchestra of Opera North



"Players and management are much more aware of the impact that venues, staging, etc. have on hearing. Musicians have also been pro-active in requesting that conductors be approached and alerted to the issue of noise damage. Hearing damage is now one of the factors in decisions regarding practicalities for all concerts. The Orchestra's staging practices have now been re-evaluated and noise control taken into account - the brass now sit in one line, further back from the strings, whenever possible. Percussion set-ups are also more carefully thought out, to avoid unnecessary noise exposure to percussionists and neighbouring players. The differences in riser heights have been increased. We are currently drawing-up an Orchestra noise policy."

"The LSO Noise Team, made up of LSO players, administration and Barbican staff, now looks at stage layouts and stage extension options far in advance to improve noise conditions for all players wherever possible without compromising the quality of music or programming. One very obvious change is in the increased riser heights, which spreads players out vertically to avoid playing into the back of colleagues' heads. Many players are trying different types of earplugs, and Perspex screens are still in wide use, although hopefully used in a more protective and sensible way following the training. As players and staff are now much more aware and informed of the risks and solutions, this is proving a good basis for quietly reducing noise damage."⁽⁴⁹⁾

Future actions

The ABO has had a clear commitment to keep 'noise' issues on its agenda. ABO is working with other stakeholders in the sector to develop a formal code of practice on noise control in the industry, for publication in 2006. The ABO's work on noise will feature amongst wider issues relating to "The Healthy Orchestra" during the ABO's Annual Conference 2006.

Comments

This sector organisation, recognising the special challenges that noise prevention posed in the complex area of an orchestra, took a proactive approach, first obtaining detailed expert advice, on which it has based a comprehensive, planned and ongoing programme of action. Those who create the noise are managing the problem and adapting the measures to different venues.



(49). London Symphony Orchestra

Annex: overview of examples



ANNEX: OVERVIEW OF EXAMPLES

Title	Country	Sector	Issue
Noise reduction for automated standard lamp production line No 234	Hungary	Manufacturing	Achieving noise reduction to prevent hearing loss along a complete production line in a light source factory
Participatory co-operation in preventing noise exposure in a planning and construction project for a new beverage plant	Finland	Food	Designing out noise while meeting food hygiene requirements in the creation of a new production plant
Comprehensive noise reduction programme and exposure management in broadcasting	Finland	Entertainment	Reducing noise exposure in broadcasting through a holistic management programme.
* Converting a system for manufacturing concrete blocks to a new concrete compression procedure with "harmonic vibration"	Germany	Concrete	Development of a low-noise method for concrete compression, based on harmonic vibration, that results in the broad impact vibration frequency spectrum usually produced by the vibrating process being converted into a single, easier to dampen, vibration frequency band
Introduction of noise management to enable the recording, implementation and evaluation of all opportunities for noise reduction	Austria	Mining and quarrying	A structured management programme to reduce noise in mineral extraction.
Hearing protection from military rifle shooting noise	Greece	Defence	Reducing noise exposure and other risks during the testing of weapons.
* Sound design in a typical rock club, an interventions project	Sweden	Entertainment	Implementing technical and organisational measures aimed at reducing noise levels and staff exposure in a small club venue while guaranteeing a good sound quality.
Away with noise! Reducing noise hazards in the workplace	Sweden	Multi-sectoral	Communicating information and good practice by social partners.



Title	Country	Sector	Issue
* Reducing noise when manufacturing concrete vats by immersion of vibrating trestles in water	France	Concrete	Reducing noise in the manufacturing industry of prefabricated concrete units for construction purposes.
Mechanism for preventing noise risk in an energy service company	France	Power supply	Reducing noise exposure in maintenance operations in the energy sector
Making hypoacusis visible in the Basque Country	Spain	Multi-sectoral	Campaigning to raise awareness of hearing loss to stimulate preventive measures
Noise reduction and acoustic improvement of the control room in the combined heat and power station – TE-TOL, Ljubljana	Slovenia	Power supply	Addressing low frequency noise problems to improve “human factors” at a power station
Courses for noise monitors	Denmark	Education	Reducing noise in children’s institutions
* Noise in Agriculture – Tools to evaluate exposure and find beneficial solutions	Denmark	Agriculture	A systematic investigation of significant noise sources spread among dairy farmers, pig farmers and plant breeders was carried out and several tools produced to help employers and employees in the agriculture sector to prevent and minimize harmful noise in the workplace.
* The Noise Reduction Factor (GRF)	Netherlands	Paper	Calculating the most cost-effective noise reduction measure
The Voivodship Program of Health Promotion “Corporate Program for Hearing Protection” for the years 2000-2005	Poland	Multi-sectoral	A regional programme to protect workers’ hearing.
Occupational Noise Reduction in certain Power Plant Workplaces	Portugal	Power supply	Prevention of worker exposure from noise in power plant electrical and mechanical workshops and other locations.
Programme of prevention of exposure to noise	Portugal	Public services	Assessing the exposure of street cleaners in a large city.
* A Sound Ear: Training and awareness raising of noise exposure to musicians	United Kingdom	Entertainment	Looking for ways to reduce the noise levels in rehearsal and performance environments in order to protect orchestral musician’s hearing.

* Award winner



Index



- Åbybro, 60
- accident rate, 51
- accidents, 33
 - aggravated, 47
 - at work, 78
 - occupational, 27
 - probability, 69
- acoustic adjustments, 59
- acoustic computer modelling, 17
- acoustic environment, 40,42
- acoustic improvement(s), 52, 53
- acoustic interventions, 75
- acoustic properties, 35
- acoustic radiation, 36
- acoustic refuges, 72
- acoustic shells, 80
- acoustic signals, 27
- acousticians, 36
- acoustics, 35, 40, 41, 53, 54, 59, 60
- AFA Trygghetsförsäkring insurance company, 39
- after-school centres, 57
- agriculture, 62, 63
- air knife, 40
- air nozzles, 40
- air outlet sound attenuator, 29
- air velocity, 40
- Alava, 51
- Allgemeine Unfallversicherungsanstalt (AUVA), 27, 30
- amplifier systems, 21
- amplitude, 25
- Arbetslivsinstitutet (National Institute for Working Life), Sweden, 35
- Arbetsmiljöverket - Swedish Work Environment Authority, 36, 42
- Artists and Musicians against Tinnitus (AMMOT), 36
- Association interprofessionnelle des Centres Médicaux et Sociaux (ACMS), 46, 47, 48
- Association of British Orchestras (ABO), 79, 80, 81, 82
- attenuated saw blade, 41
- attenuation, 20
- audibility of speech frequencies, 53, 54
- audience, 20, 23, 35, 36, 38
- audiometric studies, 71
- audiometric surveillance, 76
- audiometric test chart, 50
- audiometries, 48
- Audiotec, 54
- auditory trauma, 78
- audits, 31
- Austria, 27
- away with noise!, 39
- ball mills, 29
- barriers, 76
- bartenders, 36
- biological and chemical hazards, 77
- blower pipes, 29
- boiler room, 48, 53, 54
- boilers, 46
- brass instruments, 35
- breeders, 62
- broadcast, 19, 21, 23
- broadcasting, 19, 20, 21
- building materials industry, 24, 25
- Caisse Régionale d'Assurance Maladie (CRAM), 44, 45
- calibration, 21
- Câmara Municipal de Lisboa, 77
- cameramen, 20, 21, 22
- Centre Inter-régional de Mesures Physiques de l'Ouest (CIMPO), 44
- checklists, 18, 30, 62
- check-ups, 18
- children, 57, 58, 59, 60, 61
- children's institutions, 57



- club
 - concert, 35
 - music, 37
 - rock, 35
- code of conduct, 19, 21
- code of practice, 82
- Comisiones Obreras, Euskadi (CC.OO. Euskadi), 50, 51
- comité d'hygiène, de sécurité et des conditions de travail (CHSCT), 44, 47, 48
- communication ability, 52
- communication channel, 20, 21
- communication sound, 20, 22, 23
- compensation, 18, 50
- compressed air, 40
- compression procedure, 25
- compressor cooling system, 29
- concentration
 - childrens', 61
 - impaired, 39, 40, 41
- concert platforms, 80
- concerts, 19, 20, 22, 36, 37, 82
- concrete
 - blocks, 7, 24
 - compression, 24, 25, 26
 - industry, 26
 - vats, 43
- consultation and Involvement of the Workforce, 76
- control room, 20, 52, 53, 54, 55, 56, 84
- cost/benefit analysis, 25
- Dalkia, 46, 47, 48
- damping, 30, 43, 45
- day care centres, 57, 59
- day nurseries, 40
- Denmark, 57, 62
- design, 7, 14, 18, 33, 34, 35, 38, 42, 46, 54, 76, 80, 83
- deterioration of hearing, 47
- diplacusis, 79
- Directives
 - 2003 Noise, 6, 26, 38, 45
 - Framework, 6
 - Machinery, 6
 - Outdoor Machinery, 6
 - PPE, 6
 - Pregnant Workers', 6
 - Supply of PPE, 6
- diseases
 - irreversible industrial, 6
 - job-related, 69
 - occupational, 20, 22, 24, 31, 69, 71, 72, 73, 74
 - occupational hearing, 69, 76
 - occupational, of the hearing organs, 71, 72, 73
 - related, 31, 49, 69
 - work-related, 31, 47
- disorders
 - cardio-vascular, 46
 - hearing, 35, 37, 45
 - musculoskeletal, 77
- disturbing working environment, 53
- dizziness, 20, 32
- drums, 35, 36, 37
- ear canal, 20
- ear monitors, 21
- early retirement, 24
- earphone(s), 19, 20
- economic effects, 78
- EDP Produção, 75
- energy sector, 46
- entertainment sector, 38, 79
- epidemiological study, 47, 48
- European Agency for Health and Safety at Work, 7
- European Commission, 8
- European Foundation for the Improvement of Living and working Conditions, 6
- European Week for Safety and Health at Work, 81



- Euskadi – the Basque Country, 49, 50
- explosion, 32, 33
- exposure levels, 18, 20
- exposure to noise, 27
- F.C. Nüdling Betonelemente GmbH & Co. KG, 25
- farmers, 62, 63
- farms, 62
- fatigue, 32, 78
- Finland, 17, 19, 21
- Finnish Broadcasting Company (YLE), 19, 20, 21, 23
- Finnish Institute of Occupational Health, 21
- Finnish Radio Symphony Orchestra, 19
- Focal Points, 5
- food hygiene, 14
- food manufacturing, 45
- forklift trucks, 30
- France, 49, 52, 54, 55, 56, 57
- frequency, 40, 41, 53, 54, 55, 74
 - absorption spectrum, 54
 - analysis, 40
 - background noise, 20
 - bands, 53, 55
 - broad impact vibration spectrum, 24
 - range, 24, 25, 54
 - resonant, 53
 - sensitive range, 25
 - spectra of acoustic radiation, 36
 - uncomfortable ranges, 24
 - vibration band, 24
- GE Hungary Rt. Light Source Factory in Nagykanizsa, 10
- Germany, 24
- glass walls, 63, 54, 55
- good practice, 7, 8, 37, 38, 39, 58, 61
- Greece, 32
- grinding machine, 41
- guidelines, 27, 29, 30
- hammers, 29
- harmonic vibration, 24, 25
- Hartwall Ltd, 16, 17
- headaches, 20
- health and safety committees, 47, 73
- health effects, 27
- Health Promotion Cards, 71, 74
- Health Promotion Leaders, 71
- hearing damage, 17, 18, 20, 40, 41, 50
- hearing deficiencies, 72
- hearing distortion, 35
- hearing impairment, 6, 24, 41, 69, 70, 71, 72, 74
- hearing loss, 5, 10, 20, 35, 43, 45, 49, 50, 52, 53, 70, 76, 79, 81, 83
 - noise-induced, 6, 53, 76, 79
- hearing protection, 3, 17, 18, 19, 27, 29, 30, 31, 32, 37, 48, 49, 50, 69, 70, 71, 72, 73, 74, 76, 83, 84
- Henriksberg, 35, 36, 37
- high risk groups, 28
- hospitals, 40
- human voice, 20
- Hungary, 10, 13
- hyperacusis, 35, 79
- hypoacusis, 49, 50, 51, 84
- illnesses
 - occupational, 30, 49, 50, 51
- impact shocks, 25
- industrial medicine laboratories, 74
- information sheets, 28
- inspections, 29
- Institut für Fertigteiltechnik und Fertigbau, 24, 25
- Institut National de Recherche et de Sécurité (INRS), 44, 45
- Instituto Nacional de la Seguridad (INSS), Spain, 51
- insulation, 25, 42, 53, 54, 55, 59, 76
- intelligibility of speech, 20
- intercom devices, 19, 20, 21
- jet engine, 25



- jet mills, 29
- job satisfaction, 22
- JobLiv Danmark, 57, 58
- kindergartens, 57
- Knauf plate, 53, 54
- lamp production, 10, 12, 15
- Landsorganisationen i Sverige (LO) - Swedish Trade Union Confederation, 39
- learning capacity, 41
- legal requirements, 23, 76
- legislation, 7, 8, 33, 38, 42, 52, 56
 - Greece, 33
 - Slovenia, 56
- legislative requirements, 8, 23
- light engineers, 20
- limit value(s), 21
 - exposure, 45
 - peak, 78
- Lisboa, 75, 77
- loudspeaker(s), 35, 36
- low-frequency standing waves, 53
- Luzenac Naintsch Mineralwerke GmbH, 27
- machine operators, 24
- machine vibrations, 24
- maintenance,
 - 12, 21, 27, 29, 43, 46, 48, 52, 75, 77, 84
- management
 - change, 28
 - of sub-contracting, 29, 30
- manufacturing,
 - 10, 12, 24, 25, 33, 40, 43, 44, 83, 84
- mapping, 28, 40, 42, 47
- medical examinations, 47, 48, 70, 72
- microphone in real ear (MIRE), 20
- mineral extraction, 27
- minimization of risk, 29, 30
- mining and grinding industry, 27
- mixers, 20
- monitoring,
 - 21, 28, 29, 30, 31, 36, 47, 48, 50, 78
- muffling materials, 18
- music, 20, 21, 23, 35, 36, 37, 79, 80, 82
- musicians, 20, 23, 35, 36, 37, 79, 81
 - brass, 79
 - orchestral, 79
 - percussionists, 79, 82
 - woodwind, 79
- Musicians Benevolent Fund, 81
- musicians union
 - Sweden, 36
 - UK, 79
- Narodowy Fundusz Zdrowia (NFZ) - National Health Fund, 70
- Netherlands, 64
- new workers, 18
- NFDSZ trade union, 13
- noise
 - abatement, 17, 40, 41
 - airborne, 7, 32
 - ambient, 20, 23, 27
 - background, 20
 - barometer, 63
 - controlling at source, 57, 70
 - elimination of sources, 28, 29, 49
 - enclosure, 33, 43, 48
 - high-frequency, 54, 79
 - low frequency, 52, 55, 56
 - over-normative, 72, 74
 - perceived, 20, 57
 - pollution, 30, 34
 - reducing at source, 7, 19, 20, 25
 - tonal nature, 53
- noise monitors, 57, 58, 61
- Noise Reduction Factor, 64, 65, 66, 67
- Noise-Control-Hellas, 33
- noisy environments, 51
- North Jutland, 60
- occupational health services, 71
- occupational Hygiene Database, 28
- Occupational Safety and Health Act, Finland, 21



- offices, 40
- orchestra pits, 80
- orchestras, 79, 80, 81
- Osakidetza, 50
- OSALAN - Basque Country Institute for Occupational Health and Safety, 51
- oscillations in the air, 24
- PA system, 36
- Państwowa Inspekcja Pracy (PIP) - State Inspectorate of Labour, Poland, 70, 71, 72, 74
- Państwowa Inspekcja Sanitarna (PIS) - State Sanitary Inspectorate, Poland, 70, 71, 74
- paper, cardboard and corrugated cardboard producing and processing industry, 64
- Parte de Enfermedad Profesional sin Baja, 50
- Pearle - European League of Performing Arts Employers, 81
- performance, 6, 32, 52, 56, 79, 80, 81
- personal hearing protection, 17, 18, 27, 29, 30, 31, 48, 49, 50, 70, 71, 72, 76
 - earplugs, 22, 48, 80, 82
 - hearing protectors, 19, 20, 21, 22, 32, 41, 63
- personal intercom protectors, 22
- personal preventive measures, 8, 75, 76, 80
- personal protective equipment, 27
- pharmaceutical industries, 40
- piston blowers, 29
- piston compressor, 29
- pneumatic ejection of defective bags, 40
- Podstawowe Jednostki Słuchu by Medycyny Pracy (PJSMP) - industrial medicine services, Poland, 70, 71, 74
- Poland, 69
- porous absorbers, 53
- Portugal, 75, 77
- power plant(s), 46, 53, 70, 75, 76
- Prevent Sweden, 39
- prevention services, 49
- preventive actions, 71, 73
- preventive examinations, 71, 73
- preventive measures, 48, 49, 50, 51, 75, 76, 78, 80
- principles of prevention, 6, 8
- procurement, 6, 18, 40, 41, 42
- production agreements, 20, 21, 22
- production crew, 22
- PTK - Federation of Salaried Employees in Industry and Services, Sweden, 39
- public events, 19, 20
- purchasing, 18, 29, 60, 70
- quality of work, 22
- questionnaires, 37, 74
- rehearsal, 79, 80, 81
- remedial measure, 40, 41, 42
- resonance reduction, 41
- resonating panels, 53
- restaurants, 40
- reverberation time, 40, 41, 53, 54
- revolution speed, 25
- Rio Tinto, 29
- risk assessment, 7, 8, 15, 19, 20, 21, 25, 27, 28, 34, 53
- safety committee members, 41
- safety delegates, 41
- safety representatives, 21, 30
- sawn timber, 41
- saw-sharpening machine, 41
- schools, 40
- screens, 36, 48, 82
- Sector Work Environment Council for Agriculture, Denmark, 52
- Sejflod, 50
- shifts, 28
- shock-absorbing material, 43, 44, 45
- shooting noise, 32, 82
- short-term noise peaks, 20
- silencer, 33
- silencers, 29, 41
- silo trucks, 29
- Similar Exposure Groups (SEGs), 28, 30
- Slovenia, 52



- small and medium enterprises (SMEs),
26, 48, 64, 68, 70, 81
- social environment, 57
- social partners, 39
- social security, 31, 50
- Socialministeriet (Ministry of Social Affairs),
Denmark, 57
- Socialstyrelsen - National Board of Health and
Welfare, Sweden, 36
- sonometry, 47
- Sosiaali - ja terveystieteiden ministeriö (Ministry of Social
Affairs and Health, Finland), 21
- sound
 - level restrictions, 36
 - quality, 35, 37
 - structure-borne, 41
- sound absorption, 36, 40, 41, 53, 54, 55
- Sound Ear, 80
- sound energy, 32, 35, 53, 78
 - transmission of, 53
- sound leakage, 37
- sound level, 20, 21, 28, 36, 40, 41
 - A-weighted, 36, 55
- sound pressure, 40, 41, 55, 78
- sound quality, 35, 37
- sound technicians, 36
- sound technology suppliers, 36
- sound-absorbing walls, 59
- soundproofing, 14, 41, 57
- Spain, 49
- speaking voice level, 20
- sports centres, 40
- sports events, 19, 20
- staff representatives, 47
- stage managers, 20
- statistics, 28, 50, 51
- Støj i landbruget, 62, 63
- stone and earth industry, 25
- street cleaners, 77
- stress, 41
 - from intercom devices, 19
 - to hearing, 19
 - work-related, 39, 47
- strip curtain, 29
- studio productions, 20
- substitution, 40
- Svenskt Näringsliv - Confederation of Swedish
Enterprise, 39
- Sweden, 35, 39
- Świętokrzyskie Voivodship, 69, 70, 71, 72
- teaching, 40, 58, 61, 63, 80
- Termoelektrarna Toplarna Ljubljana, 52
- testing of weapons, 32
- Think before you act, 30
- threshold shift, 79
- timber cladding, 29
- tinnitus, 20, 35, 36, 39, 40, 41, 62, 79
- trade union(s), 13, 23, 39, 49, 50, 51, 71, 73,
79
- training,
 - 18, 21, 27, 29, 30, 31, 37, 39, 40, 41, 47,
48, 57, 61, 71, 72, 73, 74, 76, 79, 81, 82
- Undervisningsministeriet (Ministry of
Education), Denmark, 57
- United Kingdom, 799
- Urvoy, 43
- Uusimaa Regional Institute of Occupational
Health, 19
- value(s)
 - attenuation, 20
 - daily noise exposure, 78
 - lower exposure action, 26
- ventilators, 15, 29
- Verbond Papier & Karton, 64
- vibrating system, 25
- vibrating trestles, 43
- vibration process, 25
- voice signal, 21
- waitresses, 36
- wide-band sound-absorption, 53
- Wojewódzka komisja do spraw Ochrony Pracy
(WKOP), Poland, 71



Wojewódzki Ośrodek Medycyny Pracy (WOMP)
- Voivodship Centre for Industrial Medicine,
69, 70, 74
work organisation, 8, 21, 29, 35, 36, 38, 40,
42, 48, 70
working on stage, 20
working time, 22, 76
World Health Organization, 6
Zakładowy Program Ochrony Słuchu (ZPOS) -
Corporate Programme for Hearing
Protection, 69, 70, 73
zero-tolerance, 30



European Agency for Safety and Health at Work

Prevention of risks from occupational noise in practice

Luxembourg: Office for Official Publications of the European Communities

2005 - 96 pp. - 16,2 x 22,8

ISBN: 92-9191-153-4





In order to improve the working environment, as regards the protection of the safety and health of workers as provided for in the Treaty and successive Community strategies and action programmes concerning health and safety at the workplace, the aim of the Agency shall be to provide the Community bodies, the Member States, the social partners and those involved in the field with the technical, scientific and economic information of use in the field of safety and health at work.

European Agency for Safety and Health at Work
<http://ew2005.osha.eu.int>



European Agency
for Safety and Health
at Work

Gran Vía, 33. E 48009 Bilbao-Spain
Tel. +34 94 479 43 60
Fax +34 94 479 43 83
E-mail: information@osha.eu.int



ISBN 92-9191-153-4

