

Evaluation of the current practices of noise-induced hearing loss (NIHL) awareness training in the South African mining industry

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ABSTRACT

This study aimed to evaluate the current practices in relation to best practice criteria and make recommendations for improvements to noise-induced hearing loss (NIHL) awareness training in the South African mining industry. A survey tool based on findings of a literature review on best practice for NIHL awareness training was developed for use in interviews, with managers responsible for NIHL awareness training at the mines. Thirty managers were interviewed in the survey at mines representative of different sizes and different commodities. Results indicate that NIHL awareness training is not treated as a priority training area. Only 20% of NIHL awareness training programmes had a theoretical basis in health promotion or adult education. Employees received, on average, 15 minutes of training per annum. Evaluation of employee knowledge only occurred at 40% of the mines surveyed.

Recommendations were made to address the factors identified in the evaluation of the current practices in the South African mining industry regarding NIHL awareness training needing to be aligned with best practice.

Keywords: noise-induced hearing loss, hearing conservation programme, health behaviour theories, awareness training

INTRODUCTION

Noise-induced hearing loss (NIHL) continues to plague the mining industry. Education, motivation and training of employees who are exposed to the risk of NIHL in the workplace should be an integral part of an effective hearing conservation programme (HCP).¹ The South African National Standard 10083:2012,² which guides hearing conservation, requires the inclusion of an NIHL awareness training programme that ensures that the worker:

- has knowledge about the risks of the noise hazard
- is well informed about the effects of noise on hearing health and safety
- has the motivation to protect his/her hearing and prevent hearing loss, and
- receives training on how to use and care for hearing protection devices effectively.

With these requirements in mind, it is important that, in NIHL awareness training, the content and methods used take cognisance of the latest knowledge about health promotion, behaviour change theories and adult education.³ From the perspective of a health-promotion theoretical framework, the following areas should be considered when designing an NIHL awareness training programme:

- Intrapersonal factors, including the effect of an individual's personality, which includes their beliefs, attitudes and knowledge, on how they view NIHL
- Interpersonal factors, which deal with how the individual employee associates with other employees in the mine which, in turn, influences how he/she behaves within an HCP and towards NIHL, and
- Community factors which include the effect of the mine

policies and the HCP regulations on employees.³

A literature review on research relating to NIHL awareness training showed that the Mine Health and Safety Council (MHSC) has funded several projects to investigate best practice in hearing conservation in the past 15 years. The various studies have investigated the development of awareness, educational and motivational material in order to prevent NIHL⁴ as well as methods to implement an effective HCP.¹ The levels of noise exposure in the mining industry were measured in the SIM 06-06-01 project of 2011⁵ and a detailed audit tool for companies to use to evaluate their HCPs was developed. After 12 years, the awareness, education and motivational materials developed in 1997 had become outdated and the materials were therefore improved and supplemented in the SIM 05-05-01 study conducted in 2009.⁶ In 2010 the previously developed audit tool was streamlined into a user-friendly checklist.⁷

More recently, the MHSC initiated a study to evaluate the future needs of the mining industry with regard to NIHL awareness training. The study identified 10 criteria, highlighted in the literature as measures of best practice for NIHL awareness training.⁸

Criteria for evaluation of best practice

In order to apply these 10 criteria identified as best practice for NIHL awareness training in a practical approach in a mine, the authors grouped them into three main categories:

- Commitment to HCP
- Awareness training
- Evaluation

The categories and criteria are schematically shown in

Figure 1 and outlined in the following sections.

Commitment

The first identified category for best practice in NIHL awareness training is commitment. A high level of commitment is needed on the part of the company's management to implement an NIHL awareness training programme that will empower workers to protect their own hearing and will ensure zero harm to the workers' hearing. Evidence of this commitment can be measured in a company if:

- There is a specific policy for NIHL awareness training
- There are sufficient resources, such as finances, infrastructure and people, set aside for the HCP
- There is integration of the NIHL awareness training outcomes with the audiometric results and the noise exposure measurements, and
- The company's managers show visible leadership in the awareness of NIHL and its prevention.

Awareness training

The second category identified is related to aspects of NIHL awareness training such as the training material content and training methods used and the amount of training provided. In terms of this category, the company should measure how much NIHL awareness training is provided. Another important factor to be evaluated is whether the training material content is appropriate for the various audiences that receive training in relation to their work-related needs (e.g. a line manager needs to have skills and information to motivate subordinates) and educational needs (e.g. preferred language and literacy level). Also of importance is to establish who provides the training and how well-equipped they are to do so. Trainers with relevant health-related knowledge to teach health hazard issues in a way that is authentic and uses knowledge of health promotion theories and adult education methods are preferable.⁹

Evaluation

The third category is related to the evaluation of both the individual employee's knowledge about the HCP and NIHL, and the monitoring of the NIHL awareness programme's effectiveness, in order to facilitate the HCP's continual improvement in a manner that will positively impact on NIHL prevention.

METHODOLOGY

The study was a descriptive survey which combined both qualitative and quantitative research approaches, aimed at evaluating NIHL awareness training programmes. Before the study was conducted, ethics approval was obtained from the CSIR ethics approval committee.

The objective of the study was to evaluate the current practices of mining companies in relation to the criteria for best practice of NIHL awareness training.

Study sample

A convenience sample of six mining companies was selected from a list of mines obtained from the Department of Mineral Resources (DMR). An effort was made to include small, medium and large mines and mines that are representative of the different commodities mined in South Africa. Commodities represented in the study included gold, platinum, coal, diamond and titanium. The mines are located in the provinces

of KwaZulu-Natal, Gauteng, North West, Mpumalanga and Free State. The mines that agreed to participate employed approximately 115 000 permanent and contract employees among them. (See Table 1.)

All six mines agreed to participate in the study; 30 managers who were responsible for the HCP at the mine were interviewed. The managers included training managers, occupational hygiene managers, occupational health managers and human resource managers.

Development of survey tools

A survey tool in the form of a checklist (see Appendix) was developed on the basis of the information identified in the literature and by modifying and adapting questionnaires previously used in Mine Health and Safety Council (MHSC) projects that have addressed NIHL and HCP.^{1,6}

Data collection

Interviews were conducted with the nominated managers responsible for various aspects of the mine HCP. The questionnaires were emailed to them prior to the visit to alert them to the type of information required. The managers were then interviewed at their offices.

RESULTS

Commitment

In the category of commitment to NIHL awareness training, none of the participating mines had given awareness training sufficient attention as required by best practice (Table 2).

All the mines scored zero percent on each of the criteria in this category.

Training

Eighty percent of the mines could not specify any theoretical basis for the NIHL awareness training that they provide to employees. Of the respondents, 60% indicated that they used behaviour change theory. However, when asked for evidence of this theoretical basis, they were unable to provide it.

Of the NIHL awareness training programmes evaluated, 30% were presented in English only, 40% were provided in the employee's language of choice, and 30% in a combination of English and Zulu. In 40% of cases, it was reported that the trainers had received training on behaviour change and, in 30%, that the trainers had Education and Training Development Accreditation (ETDA).

Evaluation

The results presented in Figure 3 show that 60% of the mines surveyed do not evaluate employees' knowledge after they have received their training. In 80% of cases, mine management were reported to review the number of people who are trained.

DISCUSSION

The implications of the results of this survey are discussed under the three categories used for evaluation.

Commitment

From this survey, it appears that, in the participating mines, NIHL awareness training forms part of the general training that an employee receives when entering the mining industry, or annually when refresher courses for general safety are offered, but that, in general, NIHL awareness is not treated

as a priority training area. The inclusion in the general training does not provide methods for the outcome of the NIHL prevention training to be linked to the real test of success of training, namely whether the employee has been given the skills, and is motivated, to prevent his/her own hearing loss. The lack of senior leadership in NIHL prevention at mines will not result in best practice for HCP^{1,6,8}.

Evidence of commitment to NIHL best practice is shown when a company has a dedicated HCP co-ordinator, a specific policy drafted for the awareness training programme and integration of the awareness training results with audiometric results and noise exposure measurements. The mining industry has committed itself to continual improvement of health and safety systems.¹⁰ This requires employers to evaluate their practices relating to health issues against the research outcomes available and to make the necessary adjustments to ensure that workers can be protected while in the workplace.

With these points in mind, it is recommended that mine management responsible for hearing conservation develops specific policies on NIHL awareness training to improve the effectiveness of the training. This will require the appointment of a dedicated HCP co-ordinator who will be able to monitor or manage all aspects of HCP. In addition, the awareness training results will need to be integrated with audiometric results and noise exposure measurements to improve employees' motivation to protect their hearing.¹

Training

The number of employees in the mines surveyed represent approximately one quarter of the employees in the South African mining industry. The results of this survey therefore suggest that, for a large number of workers, the latest knowledge about health promotion, behaviour change theories and adult education³ is not taken into account when planning NIHL awareness training. One of the reasons is that insufficient attention is given to the need for language and literacy level-appropriate materials. Furthermore, the fact that the training material content is the same for managers and other levels of workers indicates that little attention is

given to the work-related needs of the audience, such as a line-managers' skills to be able to motivate subordinates to use hearing protection.

The very low level of accredited trainers in this group of mines indicates a need for improved training of the trainers in their knowledge and skills of how to teach adults and how to best achieve health promotion and behaviour change.

In order to improve the compliance of mining companies with best practice for NIHL awareness training, it is recommended that the industry considers including the necessary requirements for employee training in a unit standard that is included in the Mine Qualifications Authority (MQA) process and accepted by educators and regulators in the mining industry. Similarly, included in the MQA requirements for trainers is the need for trainers to have adequate knowledge about health-related matters and to be accredited to train employees on health hazards.

A need exists for the development of NIHL awareness training materials that meet the language and educational needs of the various audiences. Training materials, suitable for various levels of mine employees, should be developed, e.g. line managers need to be able to motivate their teams to protect their hearing and senior managers need to be equipped to manage and motivate employees regarding NIHL prevention.

Evaluation

The mines in this survey appear to implement NIHL awareness training without measuring if what they are investing time and money in is achieving the goals, namely improved worker knowledge on the risks of the noise hazard, the effects of noise on hearing health and safety, how to care for their hearing protection equipment, and if they are motivated to prevent their own hearing loss. The opportunity for continued improvement of the HCPs will therefore be missed.

The evaluation results also indicate that, at the majority of mines surveyed, management reviews the number of people trained. However, these numbers do not appear to be linked to worker knowledge as the workers are not evaluated. The risk is that these reviews do not adequately inform managers on what aspects of an HCP needs improvement.

Testing employees after training helps to evaluate the effectiveness of the NIHL awareness training and to measure the employees' knowledge of the training content.^{1,11} It is recommended that fair and relevant evaluation methods be developed to ensure that efforts and costs in NIHL awareness training are worthwhile. Evaluation of the effectiveness of the NIHL awareness training should be aligned to the most recent standards set for best practice HCPs, which specify that, if after audiometric testing at the annual medical surveillance there has been a shift of 3.2% Loss of Hearing (PLH) or 6.4 PLH, interventions that include awareness training must be implemented and recorded.²

CONCLUSION

The results of this study provide evidence that South African mines do not currently comply with best practice for NIHL awareness training. If the battle against the scourge of NIHL is to be won, it will require improved commitment from mining companies, increased and more focused and targeted training on NIHL awareness, and integrated and meaningful evaluation of the efforts towards, and investments in, preventing NIHL amongst mine employees.

Table 1. Description of study sample

Commodity	Number of shafts	Number of employees	Province(s)
Gold	16	83 000	North West and Free State
Platinum	3	38 000	North West
Coal	3	6 550	Mpumalanga
Diamond	1	750	Free State
Titanium	1	720	KwaZulu-Natal
Contractors (different commodities)	1	10 000	KwaZulu-Natal

Table 2. Compliance with criteria for commitment to an effective HCP

Criteria	Compliance
Specific policy on NIHL training	0%
Integration of training outcomes with audiometric results and noise exposure measurements	0%
Dedicated HCP manager and sufficient management authority to enforce policy	0%
Apportioned resources and sufficient infrastructure	0%

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REFERENCES

1. Franz RM. Best practice for hearing conservation (Health 806). Johannesburg: Mine Health and Safety Council; 2005. Available at: www.mhsc.org.za (accessed 28 Mar 2013).
2. South African National Standards. Measurement and assessment of occupational noise for hearing conservation purposes. SANS 10083. Pretoria: SANS 2012. Edition 5.1.; 2012.
3. Sobel J, Meikle M. Applying health promotion theories to hearing conservation interventions. *Semin Hear.* 2008; 29:81-89.
4. Franz RM, van Rensburg AJ, Marx HE, Murray-Smith AI, Hodgson TE. Develop means to enhance the effectiveness of existing hearing conservation programmes (GEN 011). Johannesburg: Mine Health and Safety Council; 1997. Available at: www.mhsc.org.za (accessed 28 Mar 2013).
5. Edwards AL, Dekker JJ, Franz RM, van Dyk T, Banyini A. Profiles of noise exposure levels in South African mining. *J South Afr Inst Min Metall.* 2011; 111(5):315-322.
6. Franz RM, Edwards AL. NIHL Prevention Programme – Track C: Training and awareness, and HPD selection (SIM 05 05 01). Johannesburg: Mine Health and Safety Council; 2009. Available at: www.mhsc.org.za (accessed 28 Mar 2013).
7. Edwards AL, Geldenhuys P, Grove T, Khoza NN, Milanzi L. Noise-induced hearing loss and Silicosis prevention audit tools for use in the South African mining industry (SIM 10 06 01). Johannesburg: Mine Health and Safety Council; 2011. Available at: www.mhsc.org.za (accessed 28 Mar 2013).
8. Edwards A, Milanzi L, Letsoalo, S, Khoza N, Zungu I. Guidelines for optimising awareness training and hearing protection device practice for Noise-Induced Hearing Loss prevention (SIM 11 05 01). Johannesburg: Mine Health and Safety Council; 2011. Available at: www.mhsc.org.za (accessed 28 Mar 2013).
9. Stephenson MR. Hearing protection in the 21st century: they're not your father's earplugs anymore. *Semin Hear.* 2009; 30:56-64.
10. Department of Mineral Resources (DMR). Amendment of the broad based economic empowerment charter for the South African mining and minerals industry; 2010. Available at www.dmr.gov.za (accessed 30 Jan 2013).
11. Robson L, Stephenson C, Schulte P, Amick B, Chan S, Bielecky A, et al. A systematic review of the effectiveness of training & education for the protection of workers. Toronto: Institute for Work & Health; Cincinnati, OH: National Institute for Occupational Safety and Health; 2010. (DHHS (NIOSH) Publication No. 2010-127).
12. AL Edwards, LA Milanzi, NN Khoza, MS Letsoalo, LI Zungu. Improvement of noise induced hearing loss awareness to target audiences in the South African Mining industry (SIM 11 05 01). Johannesburg: Mine Health and Safety Council; 2012. Available at: www.mhsc.org.za (accessed 28 Mar 2013).

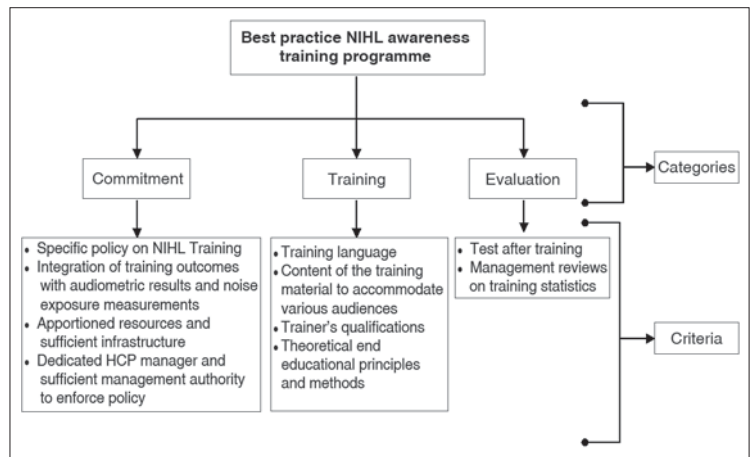


Figure 1. NIHL awareness training categories and criteria

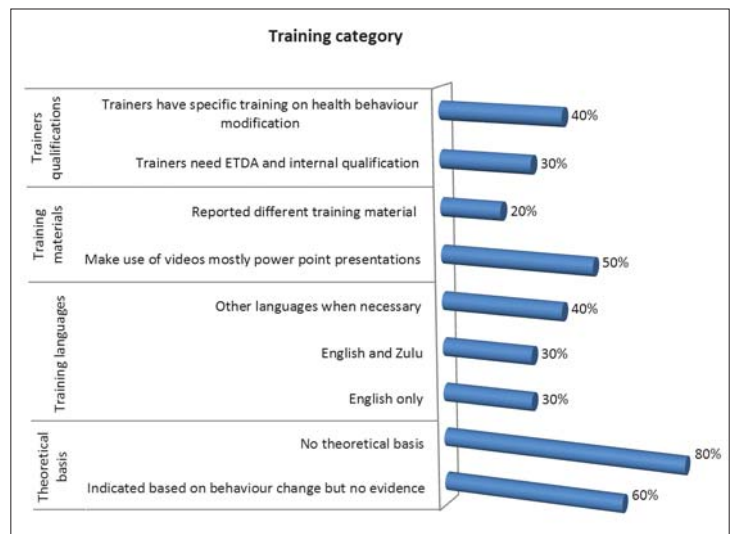


Figure 2. Average score of all participants on the training category for best practice NIHL awareness training

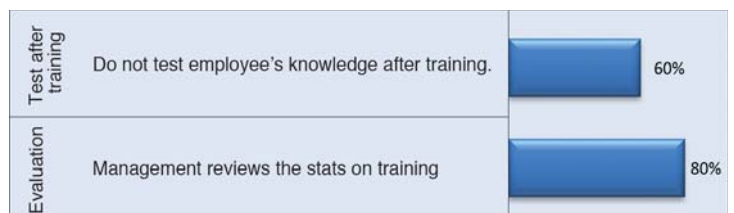


Figure 3. Average score of all participants on the evaluation category for best practice NIHL awareness training

Checklist to evaluate the current NIHL awareness training practices

Question	Yes/ No	Evidence
1 Does your company have a policy on the education, motivation and training for Noise-induced Hearing Loss (NIHL) awareness and Hearing Protection Device (HPD) use?	Yes/ No	Copy of policy
2 Who manages the Hearing Conservation Programme (HCP) in your company?	Name and designation	Dedicated HCP co-ordinator who oversees and integrates results from all sections of the HCP
3 Would you be able to give us an anonymous copy of the policy?	Yes/ No	Copy of policy
4 Are there specific sections in the policy dedicated to education on the hazard of noise to hearing health?	Yes/no	Outlined in policy
5 Are there specific sections in the policy dedicated to motivating workers to protect their hearing?	Yes/No	Outlined in policy
6 Are there specific sections in the policy dedicated to training workers to use HPDs effectively?	Yes/No	Outlined in policy
7 Please give an example of how workers are educated on the hazard of noise to hearing health.	Specific example	Effects of noise on hearing, permanence of NIHL, understanding the results of annual surveillance, understanding how to protect hearing. See answers to Question 23 too.
8 Please give an example of how workers are motivated to protect their hearing.	Specific example	Real life stories from deaf workers, effect on employability, hearing loss simulators.
9 Please give an example of how workers are trained to use HPDs effectively.	Specific example	Hands-on training, videos, fit-test methods.
10 Who developed the policy and procedures on NIHL awareness training and HPD use?		Signatures of stakeholders and evidence of consultation with workers recorded in the policy.
11 How often are the policy and procedures on NIHL awareness training re-evaluated?		Inclusion in policy of dates for re-evaluation and update by all stakeholders.
12 Was the NIHL awareness training programme designed with a theoretical model in mind?	Yes/No	
13 If so, please elaborate.		Behaviour change theory, health promotion theory, adult education theory.
14 How often is NIHL awareness provided for workers?		At least annually but more often for at risk workers and provision of opportunities to test HPDs and ask questions in interim.
15 Approximately how long does the NIHL awareness training take?	5 minutes/10 minutes/15 minutes/ 20 minutes/more than 20 minutes	Aligned to the extent of the risk and the effects on the hearing levels of workers.
16 What are the requirements for becoming an instructor of NIHL awareness training and HPD use in your company?		Need to understand at least the basics of hearing health and hearing loss. Formal training or in-service training to ensure ability to convey health-related principles in an adult education setting.
17 What language is used during instruction for NIHL prevention and HPD use?		Each worker's own mother tongue.
18 What training aids and training materials are used to enhance learning activities?		Videos, posters, simulators, small group discussions, one-on-one discussions.
19 Are workers trained to know how to identify areas in the workplace where the noise levels are dangerous?	Yes/No	
20 If so, can you provide an example?	Example	One metre shouting rule; tinnitus after work; painful ears.
21 Does the education on NIHL prevention include knowledge about signs for noise hazard?	Yes/No	Show workplace signs and posters.
22 Does the awareness training about NIHL prevention evaluate the employees for required competencies?	Yes/No	
23 If so, how are the competencies evaluated?	Written exam/computer-based test/personal interview/other	
24 If so, are there defined competencies for NIHL awareness training?	Yes/No	
25 If so, are the competencies linked to the requirements of SANS 10083:2012?	Yes/No	Extract from SANS 10083:2012 5.5 "All employees who work in a noise zone should be adequately and comprehensively informed and trained with regard to a) content and scope of the hearing conservation programme, b) potential sources of exposure to noise, c) potential risks to health caused by exposure to noise, i.e. covering the following: 1) Assessment of exposure, the purpose of noise monitoring, the necessity for medical surveillance and the long-term benefits and limitations of undergoing such surveillance. 2) Noise rating limit for hearing conservation and its meaning.

Question	Evidence
	<p>3) Procedures for reporting, correcting and replacing of defective personal hearing protection equipment and engineering noise control measures.</p> <p>4) The duties of persons who may be exposed to noise above the noise rating limit for hearing conservation.</p> <p>a) measures to be taken by the employer in order to protect employees against risk of exposure to noise,</p> <p>b) precautions to be taken by an employee to protect himself or herself against the health risks associated with exposure to noise, including the wearing and use of hearing protection equipment,</p> <p>c) the necessity, correct use, maintenance and potential limitations of hearing protection equipment, facilities and engineering control measures provided, and</p> <p>d) the necessity of audiometric testing and medical surveillance to monitor possible hearing impairment, together with appropriate explanation of results to the employee."</p>
26	<p>Are records of the content and dates and names of training evaluations kept for 40 years?</p> <p>Yes/No</p> <p>Extract from SANS 10083:2012 "NOTE 2 A record of all training provided should be kept for 40 years or in terms of the relevant legislation by the employer, including the content thereof, the names of employees trained and the dates on which training was conducted." During medical surveillance explanation, during work team meetings, during NIHL awareness training result feedback sessions.</p>
27	<p>How are opportunities created in the NIHL awareness training for employees' questions and concerns to be addressed?</p> <p>Yes/No</p>
28	<p>Are reports on education and training outcomes compiled for regular review and evaluation by mine management?</p> <p>Yes/No</p>
29	<p>If so, could you provide us with an example of the reports?</p> <p>Yes/No</p>
30	<p>Has your training programme for NIHL awareness and HPD use identified leading indicators of the success of the programme?</p> <p>Yes/No</p>
31	<p>If so, could you provide examples of the leading indicators used?</p> <p>Example</p> <p>Number of employees trained, number of employees who have passed within set categories, number of employees who have had HPDs fit tested, number of employees who have changed their HPDs, number of employees whose hearing thresholds have not deteriorated etc.</p>
32	<p>What are the constraints to effective NIHL awareness training and HPD education, motivation and training?</p>
33	<p>What steps could be taken to address these constraints?</p>
34	<p>Are there different types of training for different levels of workers and responsibility? If yes, continue to next section; if no, end audit here.</p> <p>Yes/No</p>
	<p>With regard to Supervisors:</p>
35	<p>Do supervisors routinely undergo education and training with regard to the noise hazard, at least once a year?</p> <p>Yes/No</p>
36	<p>Are supervisors educated and trained about how to motivate and supervise employees' adherence to use and care of HPDs?</p> <p>Yes/No</p>
37	<p>Are supervisors trained on how to include noise-related topics in their work team meetings?</p> <p>Yes/No</p>
38	<p>Are supervisors trained on the importance of setting an example by wearing their HPDs in noisy areas?</p> <p>Yes/No</p>
39	<p>Are supervisors held accountable in any way for encouraging and enforcing the use of HPDs in their areas of responsibility?</p> <p>Yes/No</p>
40	<p>If so, please provide examples.</p> <p>Example</p> <p>Lead by example, workplace talks, regular checks for compliance, affirmation for compliance, counselling for non-compliance, disciplinary action for non-compliance.</p>
41	<p>Do supervisors carry spare HPDs for employees who need replacements?</p> <p>Yes/No</p>
42	<p>Do supervisors counsel or refer for counselling employees who fail to wear HPDs?</p> <p>Yes/No</p>
43	<p>Do supervisors initiate disciplinary action for employees who repeatedly fail to wear HPDs, even after counselling?</p> <p>Yes/No</p>
	<p>With regard to Management:</p>
44	<p>Is there anyone at senior management level in your company who has specific training and knowledge of HCP design and management?</p> <p>Yes/No</p>
45	<p>Specify who and what training they have received.</p>
46	<p>Does management in your company participate in NIHL awareness training programmes designed to meet their knowledge and information needs relating to the noise hazard, including the impact of noise on safety, productivity, insurance costs and profitability, as well as key performance indicators for evaluating HCP elements?</p> <p>Yes/No</p>
47	<p>If so, could you provide us with examples of methods and material for this level?</p> <p>Example</p>