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Real world use and performance of hearing protection

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Real world use and performance of hearing protection

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This report considers the effectiveness of hearing protectors in everyday work situations. The study reported here was undertaken in two parts. The first consisted of interviews with employers to discuss management of noise and hearing protector use, and on site observation of hearing protector use. The purpose of these visits was to see:

- how well hearing protection was used;
- the training provided;
- the use of other PPE and equipment that may limit attenuation;
- behavioural factors affecting use, taking into account the noise exposure of employees and the environment in which the hearing protection is worn.

The second part was objective laboratory measurements of hearing protector insertion loss. The purpose of these measurements was to quantify the reduction in protection due to poor fitting or maintenance for a range of hearing protectors. Earmuffs were tested using the MIRE (microphone in real ear) method while earplug insertion loss was measured using a head and torso simulator with a simulated pinna and ear canal.

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EXECUTIVE SUMMARY

Objectives

Hearing protection effectiveness is normally estimated from laboratory test data. HSE requested the Health and Safety Laboratory consider the effectiveness of hearing protectors in everyday work situations. This study was undertaken in two parts. The first consisted of interviews with employers to discuss management of noise and hearing protector use, and on-site observation of hearing protector use. The second part was objective laboratory measurements of hearing protector attenuation to quantify the attenuation lost due to factors including poor fitting or maintenance.

Main Findings

Three of the twelve companies that allowed on site observation of hearing protector use during normal working, and one out of four groups of outdoor workers seen had problems with ensuring correct use such that the hearing protection use was ineffective (nil protection) for all or the majority of workers. In addition in premises where the majority of workers were seen making effective use of hearing protection one in seven workers were still seen to be not using hearing protection when and where its use was required. This proportion suggests that possibly only 60% of workers supposedly using hearing protection are in fact protected.

Reduced audibility was a common reason given by users for not wearing hearing protection. None of the employers seen were aware of the availability and benefits of flat response, communication and sound restoration hearing protectors.

Hearing protection was also seen in use where there was no risk. One employer had set an entire building as a hearing protection zone even though quiet areas work areas were included. Another employer also considered he should issue hearing protection as a blanket measure rather than assessing the actual risk.

All employers visited by appointment were providing hearing protection of a suitable type for the work environment and compatible with other personal protective equipment (PPE) worn. Hearing protection was visibly in a good condition apart from extremely dilapidated earmuffs that were the only protection supplied by one employer. In two out of four unplanned encounters with outdoor workers earmuffs were worn over clothing or other PPE that would have resulted in reduced attenuation.

Less than half of employers supplied hearing protection as part of a comprehensive noise control programme or selected hearing protection according to the attenuation required. As a consequence most heavy-duty hearing protection used would be predicted to provide too much protection (over protect). Only two workers were seen wearing hearing protection predicted to provide insufficient protection (under protect) according to the manufacturers' data.

Employers requiring earplugs with metal tracers were unable to source mid or low attenuation devices. Available earplugs containing tracers all provided high attenuation

80% of the employers visited provided some training on the use of the hearing protection provided. One group of outdoor workers had also received training. The type of training varied from simply the provision of written instructions to hands-on training in small groups.

Compressible foam earplugs were poorly fitted by just over half of the users seen. Most users were unaware of how to compress the earplug before fitting. Laboratory tests showed incorrectly compressed earplugs may not fill the ear canal when fitted resulting in a measured SNR of 9dB or less. Moulded or foam push in type earplugs were said by users to be easier to fit and were generally observed to be well fitted.

Laboratory tests showed earmuffs deteriorate with use due to reduced headband tension likely to result in under protection in some real world conditions without obvious visible deterioration of the earmuff.

RECOMMENDATIONS

Hearing protection is often considered as the first and only solution where a noise risk exists. Users need to be aware that it is not a simple or reliable solution.

Most employers did not select hearing protection according to the attenuation required. It would be beneficial if information on the approximate upper and lower sound levels for which the protector is likely to be suitable was included on the hearing protector packaging and with any advertising. The information could take account of likely real world attenuation. This information could be provided in addition to the attenuation data currently provided.

A maximum lifetime, in terms of approximate duration of use, should be provided for all reusable hearing protection. Hearing protector attenuation deteriorates with use and this deterioration may not be apparent to the user.

Compressible foam earplugs are generally poorly fitted, as users are generally unaware of how these should be compressed before fitting, or unaware of the importance of correct compression. An incorrectly compressed earplug may give virtually no attenuation. Correct use requires a high level of training, supervision and motivation. Employers providing this type of protection, and users, need to be aware of these potential problems, and of the existence of alternative types of earplug such as the foam push-to-fit type.

There needs to be greater awareness of the types of protectors that can assist audibility and communication.

Earplugs with tracers are required in a wider range of attenuation than is currently available.

There is a need for clothing compatible with correct earmuff fitting for outdoor workers. Earmuffs worn over conventional hats and hoods can only provide limited attenuation.

1 INTRODUCTION

This report considers the effectiveness of hearing protectors in everyday work situations. The study reported here was undertaken in two parts. The first consisted of interviews with employers to discuss management of noise and hearing protector use, and on site observation of hearing protector use. The purpose of these visits was to see:

- How well hearing protection was used;
- The training provided;
- The use of other PPE and equipment that may limit attenuation;
- Behavioural factors affecting use, taking into account the noise exposure of employees and the environment in which the hearing protection is worn.

The second part was objective laboratory measurements of hearing protector insertion loss. The purpose of these measurements was to quantify the reduction in protection due to poor fitting or maintenance for a range of hearing protectors. Earmuffs were tested using the MIRE (microphone in real ear) method while earplug insertion loss was measured using a head and torso simulator with a simulated pinna and ear canal.

2 METHOD FOR EMPLOYER INTERVIEWS AND OBSERVATION OF HEARING PROTECTOR USE

Employers were contacted by telephone and asked if they used hearing protection, and if they would be willing to help with this study. Fifteen employers agreed to help, and all of these were interviewed on hearing protector use at their premises. Out of these fifteen, thirteen gave access to working areas to observe hearing protector use. Of the two who did not allow access: one only had dispersed outdoor teams using hearing protection, and one could not allow access for hygiene reasons.

The participating employers consisted of four small premises with no more than 10 staff working in noisy areas, six medium size employers with no more than 100 staff on site and five employers with more than 100 employees on site. The premises are listed in Table 1.

Interviews were arranged by appointment with a manager or safety officer. In some cases they were able to provide their noise risk assessments or safety files for additional information during the interview.

The following topics were considered during the interviews:

- Choice of hearing protection
- Factors considered in hearing protector choice
- The availability of the hearing protection
- Other head-worn clothing and PPE used with hearing protection
- Problems associated with hearing protector use
- The training and consultation of staff on noise hazards and hearing protection use
- Maintenance of correct hearing protector use
- Other noise controls
- Results of health surveillance if used

Where possible a visit was made to noisy working areas after the interview. These visits were normally accompanied by the person seen in the interview or by a works supervisor. Hearing protector use was checked visually, noting the type, how well it was fitted, and how consistently it was used. Checks of noise levels in work areas were also made. Where possible individual employees gave their views on hearing protector use, but in some premises employees were reluctant to speak about this.

In addition to these planned visits to employers, four unplanned encounters with outdoor workers seen using earmuffs are included in this report.

Table 1 Summary of hearing protection and conditions at premises visited and for outdoor workers seen

Full site visit details are provided in an appendix at the end of this report. References to the relevant appendix subsections are given in the table.

Note – the single number rating (SNR) value is provided for all CE marked hearing protectors (HP). The manufacturer's quoted SNR values are shown in the table below. The SNR provides a simple estimate of the protection when corrected for the frequency content of the noise.

Appendix	*Site*	*HP and PPE available*	*SNR*	*HP fit/ condition*	*Sound level where HP used dBA*	*Training*	*Availablity*	*Maintenance*	*Health Surveillance*
9.1	Vehicle brake manufacturer 650 employees 50 to 60 working in >85dBA each day 150 to 200 with custom moulded earplugs	Neckband earmuff Over head earmuff Foam earplug Flanged earplug Flanged earplug Custom moulded	31 30 37 25 30 Variable	Not seen 1 well fitted 3 poor, 1 well fitted Not seen Not seen 5 well fitted 3 no HP	91 86 to 91 85 to 90 86 to 87	With induction	Earplug dispensors Earmuffs on request Custom moulded where HP compulsory	Custom moulded serviced annually 70 staff on Dupont Stop Oberservation programme Radios or personal stereos banned hearing protection zones where >85dB(A)	No NIHL reported
9.2	Metal fabricated buildings manufacturer Employs 40 in factory, 10 outside	Banded earplugs Flange earplug + visor Flange earplug Custom moulded + visor Foam earplug Over head earmuff	23 30 30 23 33 27	Not seen 3 well fitted 4 well fitted 4 well fitted 1 poor fit 3 well fitted	82 95 82 106 81 81 to 82	Training within last month in groups of about 6 noise control fitting care of HP	Custom moulded to all staff earplug dispensors	Whole area hearing protector zone Radios still to be dealt with Noise assessment made	Just started No results yet
9.3	Bottling plant (plastic bottles only) 80 staff working shifts Working 4 x 12 hour days every 8 days No hygiene restriction on choice of HP	Foam corded earplug Foam corded earplug Earmuffs (engineers) Hair nets and hoods worn	34 35 Unknown	HP not required due to plant shut down	<75 85 to 90 when running	With induction	Dispensors and hand washing at entrances	> 85dB HP zones Shift leaders do daily safety checks Regular safety audits	Only fork lift drivers No details
9.4	Vehicle servicing and repair centre 10 staff seen 8.5 hour day	Over head earmuffs with goggles Foam earplugs with respirator	26 37	Only seen used after instructed by safety officer User unable to fit	95 to 98 when using power tools	With induction plus written instructions Said by safety officer to be ineffective	New earmuffs on show but not enough to go round	None	Body shop staff only NIHL reported
9.5	Joinery workshop 4 employees 8 hour working day	Two pairs of broken earmuffs shared between staff	Unknown	Ineffective due to severe damage	85 to 91 when using machines	None	No replacement HP	None	None
9.6	Vehicle accident repair centre 10 employees in workshop	Foam earplug Overhead earmuffs Visors, goggles, and safety glasses also used	28 27	Moderate fit Not seen in use/ moderate condition	Bgd 72 HP used with power tools	External safety training on PPE and safe use of tools	Earplug dispensers Personal issue of earmuffs	PPE checked every month Tools requiring HP identified Purchasing quiet tools 6 monthly health and safety meeting Aware problems getting staff to use protectors	All staff No NIHL reported
9.7	Iron work restoration 19 employees on shop floor	Overhead earmuff Overhead earmuff Foam earplug Helmets with integral earmuffs used off site Eye protection also used	27 24 28	1 poor fit Not seen 1 moderate fit Not seen	Bgd 76 to 78 HP used with power tools	With induction including when and why HP required	Personal issue of earmuffs Staff had supply of earplugs	Registar of issue, regular replacement procedure Buying quiet tools	None

Table 1 (continued) Summary of premises visited and outdoor workers seen

Appendix	*Site*	*HP and PPE available*	*SNR*	*HP fit/ condition*	*Sound level where HP used dBA*	*Training*	*Availablity*	*Maintenance*	*Health Surveillance*
9.8	Printers 6 employees seen in print room	Overhead earmuff Foam earplug	25 36	1 poor fit	81 to 83	No training	Personal issue of earmuffs Supply of earplugs	Signs on machines	None
9.9	Confectionary manufacture Over 600 employees	Earmuffs used by engineers Foam earplug Foam earplug	Unknown 32 36	No access to factory area	<80 to 95	Training on induction	Not seen	Not seen	None
9.10	Joinery factory 82 employees	Overhead earmuffs Foam earplug with rigid centre Flanged earplug Use earmuff covers when hot and sweaty	30 23 30	Well fitted Poor or deliberate misfit Moderate to well fitted 90% with HP	85 to 100	Training on use of HP when first provided, risks explained around factory	Foam earplugs at entrance	Ineffective - most users wearing foam earplugs in outer ear outside ear canal	None
9.11	Small plant manufacturer 125 on shop floor, 95 in noisy areas	Foam earplug with rigid centre Foam earplug with rigid centre Foam earplug Flange earplug Foam earplug with rigid centre Foam earplug with rigid centre Foam earplug Flange earplug No hearing protection	29 27 28 30 29 27 28 30	None seen 3 good, 2 poor fit 2 poor fit 2 moderate fit None seen 7 moderate to good fit and 2 poor fit 2 good fit 2 good fit 10	73 to 75 73 to 75 73 to 75 73 to 75 84 to 92 84 to 92 84 to 92 84 to 92 84 to 92	Induction, and ext consult ant runs training every 2 months Risk assessments for all work	Earplug dispensers at entrance for foam plug with rigid centre and EAR classic	Monthly safety audits by external facilitator	Just started for 85% of workers
9.12	Small sheet metal workshop 4 to 5 staff on shop floor	Foam earplugs with rigid handle Earmuffs	35 28	2 good fit Good condition not in use	80 to 85	No training. Staff said they knew how to use hearing protection	From workshop office		
9.13	Local Authority (office interview) Countryside service (chainsaws, brush cutters and strimmers) Highway maintenance	Combination visor, helmet and earmuffs Earmuffs EAR banded	Unknown 26 23	Not seen in use		Training demos on how to fit All road workers trained in last 12 months Planning 1 week induction training for new road workers Looking at refresher		Policy to buy low vibration tools No noise policy Said supervision on site is weakest link Audibility a problem esp. highway maintenance	Voluntary in last 3 years plus referral where cause of concern (eg claim) NIHL found
9.14	Pressure system component manufacture Hot pressing Machining putting together 3 shift system 24 hour operation	Earmuffs Flanged earplug Foam	27 30 28	All using earmuffs or earplugs well fitted	83 to 98	Induction Use printed instructions for fitting No checking of actual fit or hands on training	No dispensers seen	HP zones clearly marked	

Table 1 (continued) Summary of premises visited and outdoor workers seen

	Site	*HP and PPE available*	*SNR*	*HP fit/ condition*	*Sound level where HP used dBA*	*Training*	*Availability*	*Maintenance*	*Health Surveillance*
9.15	Cement works 150 on site including contractors Problem with both noise and dust	Foam earplug Flanged earplug Custom moulded (on trial) Foam earplug with rigid stalk Earmuff helmet mounted Earmuff helmet mounted Eye protection, dust masks, hard hats also worn on site	28 28 38 30 34	Unseen Unseen Unseen Unseen Unseen Good fit, dusty condition	 89 to 94	Induction Tool box talks every 6 months Don't actually show users how to fit	Foam earplug dispensors at entrances to noisy areas	Supervisors and colleages will check on hearing protection Managers and supervisors have additional safety training	Just started this year NHL found
9.16	***Outdoor workers***								
	Grounds maintenance Strimming	Helmet, visor and earmuff combination	Unknown	Good fit and condition	95				
	Grass cutting, mower and strimmer self employeed gardener	Optime III over head	35	Good fit and condition	90 to 95	Advice from health and safety advisor (personal friend)			
	Community punishment team	Unidentified overhead earmuff for wearing with visor	Unknown	Good condition, not used	95 (subjective estimate)	Initial safety training provided	Only one pair available for 3 workers using strimmers	Earmuffs were shared and not issued to individuals. None Team members hygiene concerns prevented use but were considered unimportant by management	
	Road maintenance 2 workers private contractor	Earmuffs over cap, jacket hood. and eye protection Earmuffs over fleece hat mask, eye protection	23 31	Poor fit and condition, seals cracked, no band tension Good condition, poor fit	97 107	No training	No alternative protectors available	None known to workers seen	

3 ANALYSIS OF INTERVIEWS AND OBSERVATIONS

3.1 CHOICE OF HEARING PROTECTION

Compressible foam, push in foam, flanged, and custom moulded earplugs were seen in use. Earmuffs seen were either headband or helmet mounted types. Employers also reported providing neckband earmuffs and banded earplugs or ear canal caps but none of these were seen in use. No specialist flat-response, sound restoration, or communication hearing protection was provided at any site visited.

3.1.1 Choice and compatibility with other personal protective equipment (PPE)

Where the need for hearing protection is occasional or intermittent earmuffs are generally more suited because they can be removed and fitted easily. Earmuffs were available at all workplaces where hearing protection was required for the occasional use of noisy tools, with one exception. This exception was the manufacturer of small plant machinery where only earplugs were available.

During planned visits earmuffs were occasionally seen worn with goggles or safety glasses but where more intrusive PPE was worn such as visors and helmets, earplugs or helmet-mounted earmuffs were used.

In the unplanned encounter with a community punishment team the earmuffs provided were incompatible with the face visors they used. No alternative protectors were available.

In summary:

- Most employers were providing hearing protection that is compatible with the nature of the work and other head worn PPE.
- Earmuffs were once seen used over other PPE that would compromise the effectiveness of the protection.

3.1.2 Choice and environmental factors

The confectionary manufacturer reported that the hot, dusty environment made hearing protector use difficult and uncomfortable. Dusty and hot conditions also existed at the cement works. In both premises it was said earplugs were generally preferred because earmuffs were difficult to keep clean and comfortable.

Hygiene was the main factor affecting choice of hearing protection at the confectionary manufacturer. Disposable, corded earplugs were used that included metal tracers. The metal tracers can be detected should the earplugs enter food products. The chosen earplugs potentially provided overprotection: that is unnecessarily high protection and hearing impairment. The employer had not been able to find lower attenuation earplugs with tracers. This limited availability was later confirmed by a web search.

Another alternative sought by the confectionary manufacturer was banded earplugs. However only bands with detachable plugs were known to be available, and these had the potential to enter the confectionary products. Fixed, banded earplugs had not been found.

Compressible foam plugs were available at 11 out of the 15 premises visited. These require compression by rolling before insertion into the ear but few places visited were aware of the need to use them with clean hands. The bottling plant did provide hand-washing facilities by the earplug dispensers but no similar hand-washing facilities were seen at the other sites visited.

Outdoors workers were only seen using earmuffs. Road maintenance workers were seen on a cold day using earmuffs over hats and hoods. No alternative protectors, or compatible clothing was available to them.

In summary:

- Hot or dusty conditions were reported to make earmuff use difficult and uncomfortable.
- Awareness of the need to fit earplugs with clean hands was not widespread. Only one premises provided hand-washing facilities by earplug dispensers.
- Earmuffs are likely to be worn over clothing in cold conditions. Although integral earmuffs are available for use with head worn PPE, specific compatible clothing is not generally available.

3.1.3 Choice provided to employees

A choice of hearing protectors is important so that users can select a protector that fits them and is comfortable. As some users have difficulty inserting earplugs, and earplugs are not suitable for someone suffering from an ear infection, a choice including both earplugs and earmuffs is preferred.

Out of the fifteen employers visited:

- **Two provided** no choice – The small joinery workshop had only two pairs of damaged earmuffs to share between four workers. A vehicle servicing and repair centre had provided one type of earmuff for general use, and one type of earplug for use by the paint spray operator.
- **Three provided earplugs only** – For hygiene reasons a confectionary manufacturer and a bottling plant only allowed the use of disposable earplugs for staff working on production. The manufacturer of small plant machinery provided a choice of four types of earplug but no earmuffs.
- **Six provided a choice of three or more protectors** including both earmuffs and earplugs.
- **All those using hearing protection with helmets provided helmet-mounted protectors** – Three employers required hearing protection to be used with a helmet. All three provided helmet-mounted protectors; one employer provided a choice of two helmet-mounted protectors.

In summary:

- Employers are able to provide a choice of hearing protection.
- Choice may be limited by hygiene requirements, and compatibility with other PPE.
- Two small employers provided no choice and were unaware of any need to do so.

3.1.4 Selection according to attenuation required

As a pragmatic means of ensuring noise exposure is less than 85dB and in accordance with the recommendations in EN 458:2004 for the selection of hearing protection HSE's guidance to the Control of Noise at Work Regulations states that hearing protection should be selected that will reduce the A-weighted level at the wearer's ear to between 70 and 85dB. Where levels are reduced below 70dB the user will be overprotected and experience an unnecessary hearing impairment that also has safety risks.

Out of the 15 employers:

- **Four had selected hearing protection according to the attenuation.** These were all medium to large employers; the metal fabricated buildings manufacturer, the large joinery factory, the county council, and the cement works. The metal fabricated buildings manufacturer and the cement works had used the HSE calculator, the large joinery factory had used the services of a hearing protector manufacturer to survey the factory and prescribe suitable protection. The local authority used standard selection methods and had chosen hearing protection for road workers with low attenuation to allow maximum audibility of moving traffic.

- **Five considered the attenuation had been a factor in the choice.** These were small to large employers: the vehicle component manufacturer, the accident repair centre, the ironwork restorer, the manufacturer of small plant, and the pressure system component manufacturer. They had noted the attenuation data provided for the protector but no estimate of the attenuation provided or required in their work situations had been made. Workers employed by the small plant manufacturer were seen wearing earplugs in work areas where for sustained periods A-weighted noise levels were below 75dB. These low noise areas had been included in an extensive hearing protection zone making hearing protector use mandatory.

- **Six had not considered the attenuation.** The confectionary manufacturer required earplugs with tracers and these types of protector were only available as high attenuation earplugs so attenuation was not an available choice. The bottling plant had noted the attenuation but confessed to using what they had always used. The remaining four were all the small employers; the car servicing centre, the specialist joinery workshop, the printers, and the sheet metal workshop. They had insufficient understanding of attenuation to use the data provided with the protectors.

Figures 1 and 2 show graphically the sound pressure levels where the hearing protectors were seen in use, plotted against the hearing protector SNR value. (The single number rating (SNR) value is provided for all CE marked hearing protectors. The SNR provides a simple estimate of the protection after correction for the frequency content of the noise.) Figure 1 shows the results for earplugs; Figure 2 the results for earmuffs. The bars show the sound level range at each employer or outdoor situation where the hearing protector was used and the centre marker on the bar indicates the median sound pressure level. A marker on its own indicates a single value where the sound level for only one operation was recorded.

Over the results in Figures 1 and 2 are red lines marking boundaries of the SNR value likely to be suitable for different levels of noise. The range marked by the red lines is an approximate guide given in HSE's guidance to the Control of Noise at Work Regulations, not a standard method for selecting appropriate protection. Data points within these lines correspond to hearing protection estimated to provide an appropriate level of protection. Data points below the lines correspond to possible over protection (too much protection). Data points above correspond to possible under protection (insufficient protection).

In summary:

- Most employers were issuing hearing protection without considering whether the level of protection was appropriate. Figures 1 and 2 show that in about half of the cases seen wearers are potentially overprotected, especially where earplugs are used. This problem reflects poor selection.

- Hearing protection was sometimes being over used because hearing protection zones were too extensive.

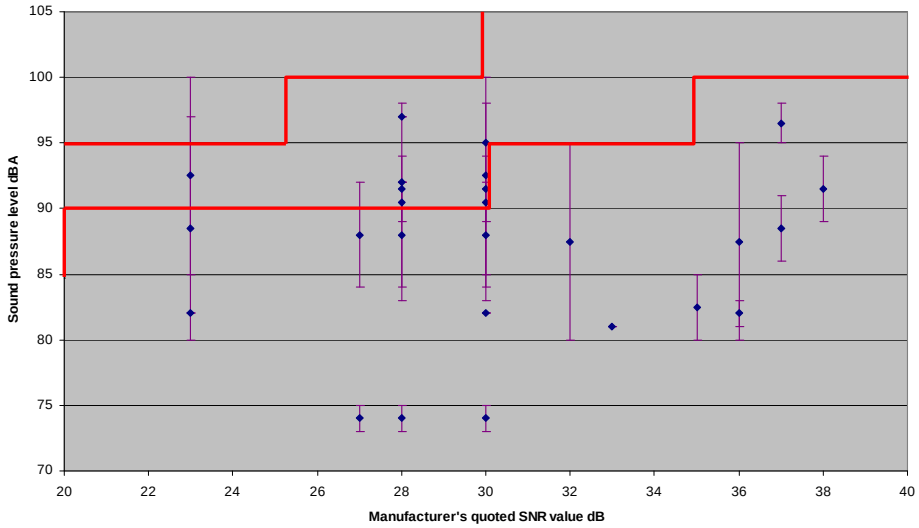


Figure 1 Sound level where earplugs were worn against quoted SNR value

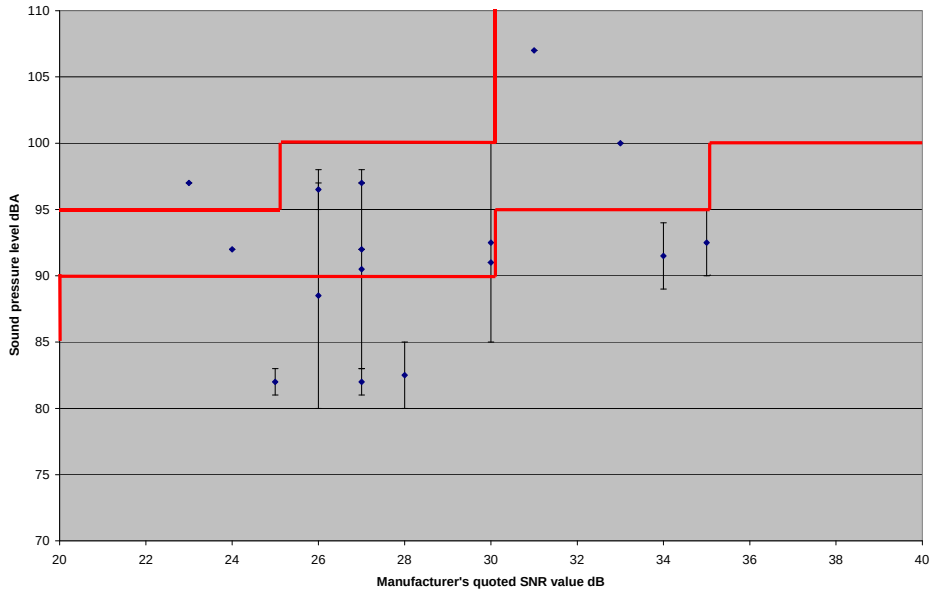


Figure 2 Sound level where earmuffs were worn against quoted SNR value

3.1.5 Selection according to audibility requirements

Only the county council safety team mentioned the problem of audibility as a factor in their choice of hearing protection. They reported the highway maintenance team's view of hearing protection was, *"I'd rather be deaf than dead"*. Low attenuation earmuffs and banded plugs had been provided; but safety staff were unaware of the possible benefits of flat frequency response protectors or sound restoration protectors. As a result of the visit they trialled these types of protector in 2008.

The metal fabricated buildings manufacturer mentioned the problem of a hearing aid user. Passive earmuffs over the aid tended to increase the condensation causing the ear tubes of the aid to block, leaving the user with very little hearing. Again the employer was unaware of the possible benefits of sound restoration earmuffs with features designed to enhance hearing for those with a hearing loss.

In summary:

- Audibility was not a factor generally considered when selecting hearing protection.
- Where audibility was known to be important there was little awareness of the availability or benefits of specialist hearing protection.

3.2 USE OF HEARING PROTECTION

3.2.1 Use as part of a noise control programme

HSE says hearing protection should be used as part of a noise control programme, rather than a stand-alone measure. It is the first consideration when a risk is identified, but in the longer term noise controls should be implemented and hearing protection should only be used where a risk remains.

Hearing protection should only be provided with training on its use and the noise risk, together with consultation on its use.

Only 6 out of the 15 employers visited had introduced hearing protection as part of a more comprehensive noise control programme. These six included large, medium and small employers. These six had introduced noise controls or had a policy of purchasing quiet tools and machinery. Two other employers wanted to ban radios to reduce noise levels. The remaining seven premises that had no existing or planned noise controls included large, medium, and small employers.

3.2.2 Training, consultation and maintenance of use

Out of the 15 employers seen:

Two small employers and one medium size employer had provided no training and one small employer provided training known to be ineffective. These were the specialist joinery workshop, the sheet metal workshop, the printers, and the vehicle service centre.

The manager/ owner of the joinery workshop commented:

"Training, what training, I just give them the muffs"

The vehicle service centre safety officer said:

"I give them a two hour safety talk when they start and everybody gets a folder with the company safety policy. If they don't understand it, if they don't read it it's their fault. I've met the law".

At both the joinery workshop and vehicle service centre there were no signs advising where hearing protection was required. Hearing protector use was uncontrolled at the joinery workshop and at the vehicle service centre the only person seen using hearing protection seemed unfamiliar with it and only used it when shouted at by the safety officer.

The sheet metal workshop and the printers also provided no training. There were no signs about hearing protection at the sheet metal workshop but the employees had previous experience of using hearing protection and were well motivated. Hearing protection here was worn consistently and well with hand held power tools. Noisy machines were clearly labelled at the printers. The staff were well motivated and had been consulted on the choice of hearing protection. The two operators required to wear hearing protection used it consistently but they did not know how to fit the compressible foam earplugs provided.

Five provided training on induction but no follow up training. These were medium to large employers. Hearing protector use was seen in use during normal working at only three of these five sites; the vehicle component manufacturer, the ironwork restorer, and the pressure system component manufacturer. Of the remaining two, the bottling plant was shut down, and the confectionary manufacturer did not allow access.

At the pressure system component manufacturer hearing protectors, earmuffs and earplugs, were consistently used and well fitted. Induction training on hearing protection covered care of the protectors and advice on fitting. The advice on fitting was taken from the instructions provided with the protectors. Staff were consulted on the choice of hearing protection.

At the vehicle component manufacturer three out of ten staff seen in a hearing protection zone were not wearing hearing protection. Those using custom moulded earplugs and earmuffs had them well fitted, but three out of four staff using compressible foam plugs had them poorly fitted. The company had 70 staff on a Dupont Stop Observation programme.

Only one person at the ironwork restorer was engaged in noisy work during the visit and he was using over-the-head earmuffs with the band around the back of the head, although there was no apparent reason preventing proper fitting. Another employee was able to demonstrate that they could fit the compressible foam earplugs moderately well. The company kept a register of hearing protection issued and ensured replacement on a regular basis.

Six had recently provided training or provided training on a regular basis. These included small to large employers; the metal fabricated buildings manufacturer, the vehicle accident repair centre, the joinery factory, the manufacturer of small plant machinery, the county council, and the cement works. No site visit was made with the county council to see hearing protector use.

The metal fabricated buildings manufacturer had recently recruited a new safety officer. She had trained all staff in groups of six within the previous month. Hearing protection was being used consistently and well; apart from one person seen with compressible foam plugs poorly fitted.

The staff at the large joinery factory had received recent training from the manufacturer supplying the hearing protection. However staff had objected to the imposition of hearing protection and attempts to ban radios and most staff were seen wearing the push in foam

earplugs with a rigid centre, across the pinna rather than in the ear canal. The less popular flanged earplugs and overhead earmuffs were being worn correctly.

The manufacturer of small plant machinery provided training on induction and two monthly safety training sessions using an external consultant. Hearing protector use was mixed, earplugs were well fitted by 11 out of 13 users one noisy area, however all 10 staff seen working in another area within the hearing protector zone, where A-weighted noise levels exceeded 85dB, were not using hearing protection. Workers were also seen using hearing protection in areas designated hearing protection zones where A-weighted noise levels at the time of the visit were between 73 and 75dB.

The accident repair centre used a training provider for regular safety training and held 6-monthly health and safety meetings with the staff. All PPE issued was checked each month and tools requiring the use of hearing protection were all identified. Despite this the manager said motivating people to use the hearing protection was a problem. No noisy activities were seen during the visit but the staff demonstrated that they could fit earmuffs and compressible foam earplugs moderately well. All staff were seen to have earmuffs marked with their name.

The cement works provided toolbox talks on different health and safety issues every six months and more detailed training to managers and supervisors. Supervisors and workers were instructed to ensure everyone was using hearing protection correctly. Two incidences of well-fitted heavy-duty helmet mounted earmuffs were seen at the cement works, no other workers were seen in the noisy areas.

The county council provide training demonstrations on how to fit hearing protection and had trained all road workers in the previous 12 months. A new one-week induction training was being planned together with refresher courses on health and safety. The council safety officers considered that supervision of hearing protector use was the weakest link as supervisors on site preferred to be seen as part of the team rather than a heavy handed manager.

Of the outdoor teams seen it was confirmed that the community punishment team received a two-hour initial training session on the use of the machinery and necessary PPE.

In summary:

- Training on its own did not guarantee the good use of hearing protection.
- Good hearing protector use also requires the cooperation of the staff.
- Good hearing protection use was seen where no formal training had been provided.
- Poor hearing protector use was seen where recent training had been provided but where there were poor relations between staff and management over the issue of noise control.
- Three small employers were unaware that training was required.

3.2.3 Use of earmuffs

12 out of 15 employers included earmuffs in the choice of protectors available. Earmuffs were seen in use at eight of the fifteen employers visited. All four groups of outdoor workers encountered only had earmuffs available.

The earmuffs at the small specialist joinery workshop and those seen worn by a road worker were in poor condition with dilapidated seals and poor tension. In addition the joinery

workshop earmuffs had damaged cups and glued head band joints preventing any flexibility (see Figure A1 in Appendix subsection 9.5).

The manager of the joinery workshop said, "*They can't have new equipment until they can take better care of it*".

The community punishment workers were reluctant to use the earmuffs provided because they were shared and although they appeared in good condition they were unsure if they were ever cleaned.

When other head-worn PPE or clothing was used earplugs were generally used instead of earmuffs. However two outdoor workers were seen on a cold day wearing earmuffs over hats, hoods, eye protection and facemasks (see Figure 10 in Appendix A). The earmuffs provided for the community punishment teams fitted poorly over the face visors also being worn. Earmuffs had been chosen for the community punishment teams on the basis of cost, rather than compatibility with other PPE.

One person was seen with over-the-head band of his earmuffs worn behind the head during the planned visits to premises, and one outdoor worker was seen with his muffs similarly worn incorrectly. This is likely to provide a poor fit and reduced attenuation.

Apart from these exceptions, earmuffs seen were generally in good condition and worn correctly.

Where helmets were also worn helmet mounted earmuffs were the only option seen in use.

In summary:

- Earmuffs seen in use were generally but not universally in good condition and properly worn.
- Where hearing protection was required with other headworn PPE, integral earmuffs or earplugs were the preferred choice.
- Two workers were seen wearing earmuffs over outdoor clothing, and in another case earmuffs were provided for use with a visor that prevented a proper fit.
- The problem of outdoor workers wearing earmuffs over clothing is a difficult one to resolve without an available solution. Clothing that can accommodate the wearing of earmuffs underneath is not obviously available.
- Some employers allow, either by act or omission, dilapidated and ineffective hearing protection to be kept in use.
- Some employers were requiring use of shared earmuffs without the means to ensure they were cleaned between use. HSE guidance recommends use by one person only, or where earmuffs are kept for visitors cleaning for each new wearer.

3.2.4 Use of earplugs

Earplugs were seen in four main types:

- **Custom-moulded** where an ear-plug is produced in a durable plastic to the shape of the ear canal and pinna of the user.

- **Compressible foam** where the earplug is entirely made of a foam that is compressed to allow insertion into the ear canal, and then expands to fill the canal.

- **Push-in-foam** where the earplug is made of foam around a rigid centre core, or as foam attached to a rigid handle. This type is pushed into the ear canal without precompression.

- **Flanged** is a preformed plastic plug with increasing diameter flanges around a centre core. It is pushed into the ear canal.

14 out of the 15 employers provided earplugs.

3.2.4.1 Custom moulded

The vehicle component manufacturer and the metal fabricated buildings manufacturer provided custom-moulded earplugs containing filters to control the attenuation provided. The vehicle component manufacturer had been using custom moulded earplugs for 15 years and provided these to staff working in areas where hearing protection use was compulsory after completion of 6 months employment. The metal fabricated buildings manufacturer provided them to all staff. The cement works was also trialling custom-moulded earplugs.

Where custom-moulded earplugs were used they appeared to be well fitted, but not universally preferred. Some workers still preferred foam or flange type disposable earplugs for comfort. The vehicle component manufacturer reported that some users did not find them comfortable and that they were sometimes found to be defective at the annual service.

3.2.4.2 Compressible foam

Compressible foam plugs were available at 12 premises visited. A visual inspection showed that out of 14 people seen with them fitted, only 6 had inserted the plug well into the ear canal. When asked to demonstrate fitting the most common incorrect method seen was to roll one end into a point and to then attempt to push the plug into the ear canal. They were unaware of the need to compress the plug along the whole length. From a visual inspection compressible foam earplugs appeared to be the least well fitted of the earplug types available.

3.2.4.3 Push-in-foam

These were available at 4 of the 15 premises visited. The most common type seen was the type with the rigid core. In the joinery factory these earplugs were deliberately worn across the pinna by all but one employee. If this premises is discounted then out of 16 people seen wearing this type of earplug 12 appeared to have them fitted well into the ear canal.

3.2.4.4 Flanged

These were available at 6 out of the 15 premises visited. All those seen wearing this type appeared to have them well fitted into the ear canal.

In summary:

- Some users found custom moulded earplugs uncomfortable. This suggests that these earplugs may sometimes be providing a poor fit.

- Compressible foam types were the most commonly provided earplug type and from a visual inspection these were more likely than others to be poorly fitted. The push in

plugs, both foam and flange types appeared to be better fitted, with a greater depth in the ear canal, suggesting that they were easier to fit.

3.2.5 Reasons for not wearing hearing protection

During planned visits to premises most workers were seen using hearing protection during noisy work and in hearing protection zones, but there were instances of workers not using hearing protection.

The reasons given for not using hearing protection were:

- *Cleaners aren't given hearing protection as hearing protection zones don't apply to them.*
- *I want custom moulded earplugs; foam earplugs make it too hard to hear.*
- *I don't know who last used them (earmuffs). We have to share and they aren't cleaned.*
- *Earplugs stop you hearing the radio.*
- *Nothing has been done to make things quieter. They just give us earplugs and take away our radios.*
- *I'd rather be deaf than dead.*

Audibility of warning sounds and radios is a reason.

- Users were reluctant to use hearing protection when they perceive that the reduced audibility is an immediate risk. Roadworkers in particular mentioned audibility of moving traffic as a factor.
- In repetitive work hearing the radio was important to workers.
- No employer visited had considered alternative hearing protection with radio or facilities for enhancing communication, such as sound restoration or flat frequency response protectors. This appeared to be due to lack of awareness rather than the additional cost involved.

Peer pressure is a reason.

- In the large joinery factory push in foam earplugs were the most common choice and these were deliberately worn across the pinna with only one worker seen with them fitted correctly in the ear canal.
- In the small plant machinery factory most workers were seen wearing hearing protection except for all ten workers on the same noisy production line.

Management and worker attitude is a reason.

- At the specialist joinery workshop, noise was considered by the owner to be part of the job and hearing protection was not in a fit state to be used.
- At the vehicle-servicing centre the safety officer considered safety was about being seen to meet the regulations. On the day of the visit the earmuffs in the workshop areas were all new, but use was poor. As staff were unaware of when to use them, whose earmuffs

were whose, and even where to find them immediately it seems likely the earmuffs had only been provided because of the visit.

- The community punishment management were aware that their teams were reluctant to use hearing protection because it was shared, but said they were unable to pay for individual issue of PPE.

3.2.6 Hearing protection use where there is no risk

Three employers issued hearing protection without having made a noise assessment or a risk assessment (vehicle service centre, specialist joinery workshop, sheet metal workshop). The ironwork restorer management was unsure whether an assessment had been made. All other employers visited had identified the tasks and areas where hearing protection was required from a risk assessment.

Without a risk assessment there is a danger of inappropriate hearing protection use. The vehicle service centre safety officer wanted the valeting team to use hearing protection when using vacuum cleaners. The noise from the vacuum cleaners was measured on the day of the visit and found to be below 80dB when used inside a vehicle.

Hearing protection was also being used excessively at the manufacturer of small plant machinery. The noise risk assessment had been used to designate whole buildings as hearing protection zones because they contained localised areas where personal noise exposure could be between 80 to 85dB. These hearing protection zones also contained work areas where levels were below 80dB. In these areas hearing protection was seen in use where levels were between 73 and 75dB.

In summary:

- Hearing protection was used where there was no risk to hearing. This occurred when an employer had made a large area a hearing protection zone, in response to a risk in only parts of the area.

- One employer also considered issuing hearing protection as a blanket measure rather than assessing the actual risk.

4 LABORATORY TESTS OF EARMUFF INSERTION LOSS

4.1 MIRE INSERTION LOSS TEST METHOD

Measurements were made of the insertion loss of earmuffs (difference in level at the ear with and without the earmuff worn) when new, aged or damaged, and when worn with other head worn PPE. All measurements were made using a MIRE (microphone in real ear) method.

Four test subjects from the staff of the noise and vibration and the personal protective equipment teams were used. All were familiar with using PPE.

Each subject was seated in a diffuse sound field of pink noise. A miniature microphone at the entrance of each ear canal recorded the sound level and spectrum with and without the earmuffs worn. The difference in level with and without the protector provided the insertion loss of the earmuff in each frequency band. A listing of the test equipment is given in Section 7 of this report.

In the standard test (BS EN 24869-1) used to provide the protection data for CE marked hearing protection subjects are asked to adjust the protector against a background noise until they perceive they have achieved optimum protection. In these tests subjects were asked to fit the protector as they would normally but then not to adjust the position. When fitting with other head worn PPE subjects were asked to fit the protector in the best way they felt was secure and comfortable. No assistance was provided with fitting.

4.2 EARMUFFS SELECTED FOR TESTING

Eight models of earmuffs were selected for inclusion in the tests, representing the range of earmuffs on the market. A range from lightweight low attenuation earmuffs to heavy-duty high attenuation earmuffs was chosen. The earmuffs are listed in Table 2 with the SNR value provided by the manufacturer of the earmuff and the cost.

Table 2 Models of earmuff tested

Earmuff number and model	***Description***	***SNR dB***	***Cost***
1 Basics Supamuff	Lightweight, multi position plastic band	23	£4
2 Basics E Muff	Lightweight, multi position plastic band	28	£5
3 Bilsom Viking V1	Lightweight, multi position plastic band with optional head strap	30	£7
4 Bilsom Clarity C2	Midweight, multi position plastic band with optional head strap	30	£10
5 Peltor Optime II (headband)	Midweight, wire type band fixed in over head orientation	31	£12
6 Peltor Optime II (neckband)*	Midweight, wire type band fixed in behind neck orientation	31	£12
7 Peltor Optime II (helmet-mounted)	Midweight, helmet-mounted	30	£13
8 Peltor Optime III	Heavyweight, wire type band fixed in over head orientation	35	£14

* Earmuff 6 (Peltor Optime II) has a band designed to be worn around the neck only. This earmuff used a fabric head strap to provide additional support. Three examples of this earmuff bought for testing had faulty straps that sometimes prevented the subjects from securing the earmuffs correctly.

4.3 TESTING EARMUFFS WORN WITH OTHER PPE AND CLOTHING

Earmuffs in their new condition were tested with and without other head worn PPE and clothing. Where no PPE was used the earmuffs were worn with the headband in the overhead orientation except for earmuff 6, which could only be worn with the band around the neck. When worn with other PPE the best orientation of the earmuff headband was left to the test subject's discretion.

Earmuffs 3 and 4 were tested with and without their fabric head strap when worn with the helmet.

The attenuation results with and without PPE and clothing are given in Table 3. Figure 3 shows the PPE worn in these tests.

Figure 3 PPE and clothing worn with earmuffs during laboratory tests

4.4 TESTING EARMUFFS IN DIFFERENT CONDITIONS AND ORIENTATIONS

In addition to testing new earmuffs with and without other head-worn PPE, the effects of damage and wear were also investigated. These conditions were:

- simulated use and ageing,
- punctured cup seal (where a liquid seal was provided),
- broken seal,

- headband stretching.

Each condition was tested with the band worn over the head and behind the head, with the exception of the Peltor Optime II neckband and helmet mounted versions that were only worn in the proper orientation.

4.4.1 Simulated use and ageing

Samples of all earmuff models were placed in a temperature of 40°C, over a spacer simulating the tension during normal wearing, for seven days. This simulated approximately four weeks wearing of the earmuff for 40 hours a week. Figure 4 shows untreated new earmuffs on the left and the treated earmuffs on the right (the helmet mounted earmuff 7 is not included in the photograph). There is a visible slackening of headband tension on earmuffs 1 to 4 that have the plastic headband when compared to the new earmuffs. There is no visible change to earmuffs 5, 6 and 8 with the wire headbands.

Figure 4 New (left) and artificially aged earmuffs (right)

4.4.2 Stretching of headbands

The wire banded earmuffs (numbers 5, 6 and 8) can be stretched by pulling out the curved band. New models of these earmuffs were stretched by holding them flat for one minute. They were then left to recover for at least a day before measurements of the insertion loss were made.

4.4.3 Puncture to cup seal

The Peltor Optime II models have a seal containing foam over a sealed liquid layer. All other earmuffs tested had a foam seal only. The Optime II models (earmuffs 5, 6, and 7) were tested after a small puncture was made in the liquid seal.

4.4.4 Break in cup seal

Slitting the outside and removing about an eighth of the circumference of the inside foam as shown in Figure 5 provided simulation of a severe break in the cup seal. The additional liquid seal in the Peltor Optime II earmuffs was also cut.

Figure 5 Break to cup seal simulating seal damage

4.5 EARMUFF PERFORMANCE RESULTS

Earmuff insertion loss was recorded for third octave bands from 50Hz to 10kHz. To allow a simple comparison the SNR value for each ear was calculated from these results. Figures 6 and 7 report the mean and range of the SNR results for each ear of each subject. Figure 6 gives the results for new earmuffs worn with and without other PPE. Figure 7 gives the results for new, artificially aged and damaged earmuffs in overhead and around the neck orientations. Table 3 (following Figure 6) and Table 4 (following Figure 7) report the same results in a numerical format with results for damaged or aged earmuffs, and new earmuffs worn with other PPE given as values relative to the mean result for a new earmuff worn without other PPE.

Figure 6 Measured SNR values (mean and range) for new earmuffs worn with and without other PPE

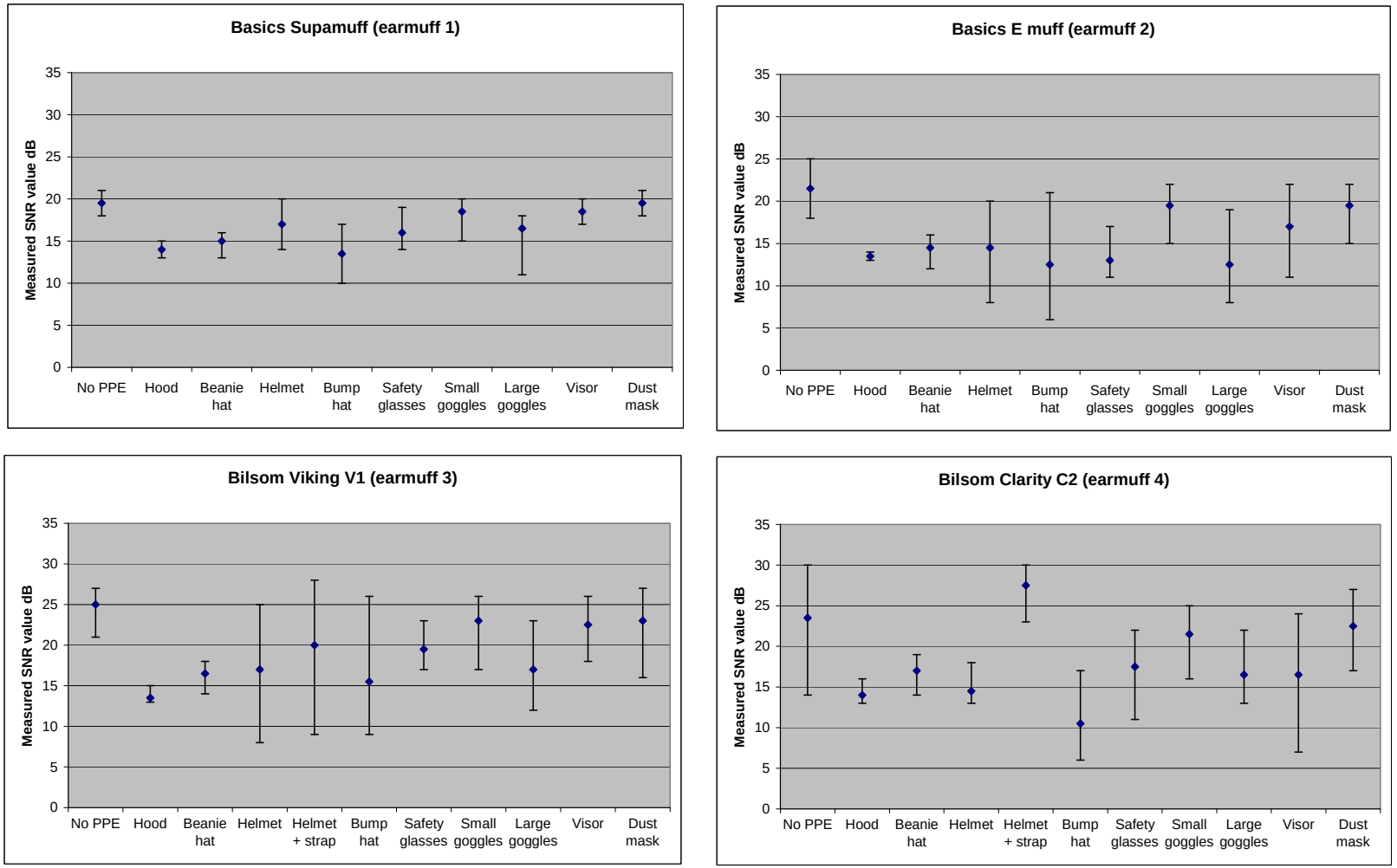
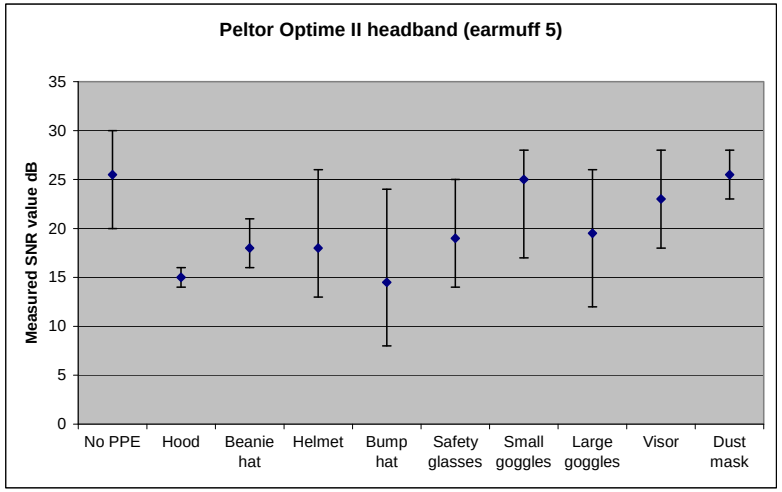
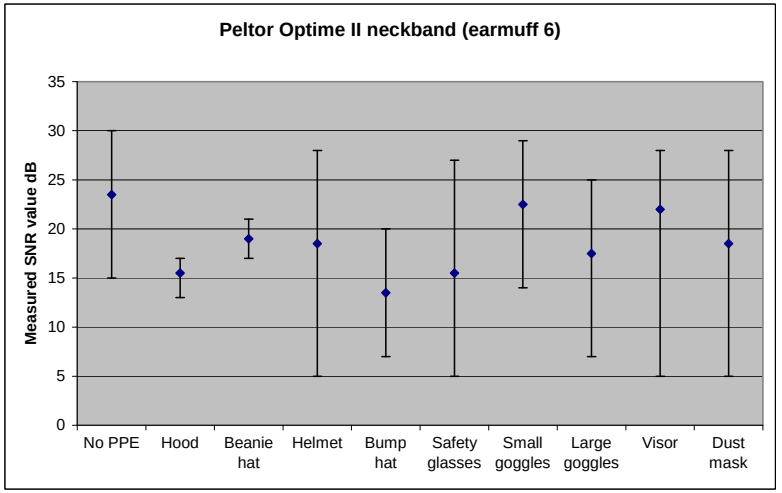
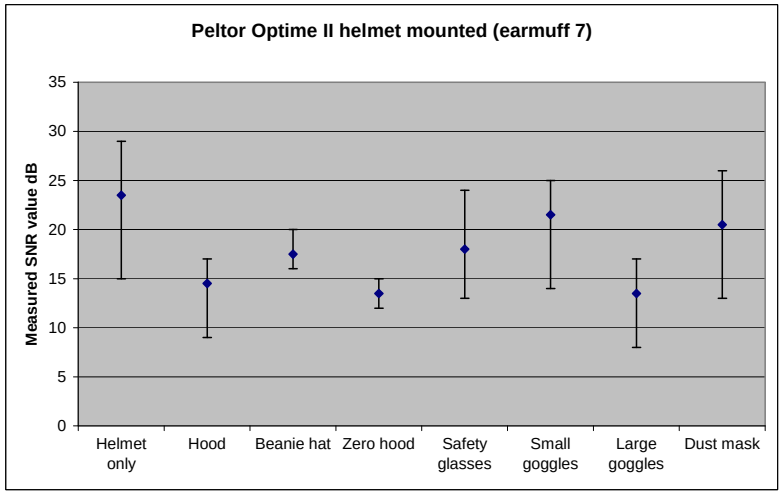


Figure 6 (continued) Measured SNR values (mean and range) for new earmuffs with other PPE







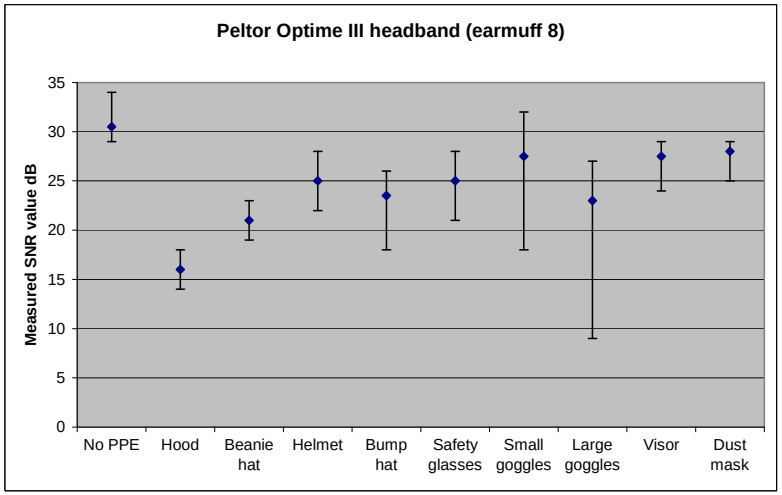


Table 3 Change of earmuff SNR value as mean (shown in bold) and spread from mean when worn with other PPE

Note 1: For earmuffs 1 to 6 and earmuff 8 the reference condition is the result without additional PPE. For earmuff 7 (helmet mounted) all measurements, including the reference condition, is with the earmuffs worn on the helmet.
Note 2: Earmuffs 3 and 4 are reported with and without the earmuff headstrap when worn around the neck with the helmet.
Note 3: Column 2 gives the manufacturer's SNR value obtained in accordance with BS EN 24869-1.

Ear-muff no.	***Man. SNR***	***Reference***	***Hood***	***Beanie hat***	***Helmet and "zero" hood***	***Helmet***	***Bump hat***	***Safety glasses***	***Small goggles***	***Large goggles***	***Visor***	***Dust mask***
1	23	**19.5** +1.5, -1.5	**-5.5** +1.0, -1.0	**-4.5** +1.0, -2.0		**-2.5** +3.0, -3.0	**-6.0** +3.5, -3.5	**-3.5** +3.0, -2.0	**-1.0** +1.5, -3.5	**-3.0** +1.5, -5.5	**-1.0** +1.5, -1.5	**0.0** +1.5, -1.5
2	28	**21.5** +3.5, -3.5	**-8.0** -0.5, +0.5	**-7.0** +1.5, -2.5		**-7.0** +5.5, -6.5	**-9.0** +8.5, -6.5	**-8.5** +4.0, -2.0	**-2.0** +2.5, -4.5	**-9.0** +6.5, -4.5	**-4.5** +5.0, -6.0	**-2.5** +3.0, -4.0
3 strap	30	**25** +2.0, -4.0	**-11.5** +1.5, -0.5	**-8.5** +1.5, -2.5		**-8.0** +8.0, -9.0 **-5.0** +8.0, -11.0	**-9.5** +10.5, -6.5	**-5.5** +3.5, -2.5	**-2.0** +3.0, -6.0	**-8.0** +6.0, -5.0	**-2.5** +3.5, -4.5	**-2.0** +4.0, -7.0
4 strap	30	**23.5** +6.5, -9.5	**-9.5** +2.0, -1.0	**-6.5** +2.0, -3.0		**-9.0** +3.5, -1.5 **+4.5** +2.5, -4.5	**-13.0** +6.5, -4.5	**-6.0** +4.5, -6.5	**-2.0** +3.5, -5.5	**-7.0** +5.5, -3.5	**-7.0** +7.5, -9.5	**-1.0** +4.5, -5.5
5	31	**25.5** +4.5, -5.5	**-10.5** +1.0, -1.0	**-7.5** +3.0, -2.0		**-7.5** +8.0, -5.0	**-11.0** +9.5, -6.5	**-6.5** +6.0, -5.0	**-0.5** +3.0, -8.0	**-6.0** +6.5, -7.5	**-2.5** +5.0, -5.0	**0.0** +2.5, -2.5
6	31	**23.5** +6.5, -8.5	**-8.0** +1.5, -2.5	**-4.5** +2.0, -2.0		**-5.0** +9.5, -13.5	**-10.0** +6.5, -6.5	**-8.0** +11.5, -10.5	**-1.0** +6.5, -8.5	**-6.0** +7.5, -10.5	**-1.5** +6.0, -17.0	**-5.0** +9.5, -13.5
7	30	**23.5** +5.5,-8.5	**-9.0** +2.5, -5.5	**-6.0** +2.5, -1.5	**-10.0** +1.5, -1.5	reference condition +5.5, -8.5		**-5.5** +6.0, -5.0	**-2.0** +3.5, -7.5	**-10.0** +3.5, -5.5		**-3.0** +5.5, -7.5
8	35	**30.5** +3.5, -1.5	**-14.5** +2.0, -2.0	**-9.5** +2.0 -2.0		**-5.5** +3.0, -3.0	**-7.0** +2.5, -5.5	**-5.5** +3.0, -4.0	**-3.0** +4.5, -9.5	**-7.5** +4.0, -14.0	**-3.0** +1.5, -3.5	**-2.5** +1.0, -3.0

In summary

- The reference SNR values, obtained without additional clothing or PPE, were on average 5.5dB less than the manufacturer's SNR values. The manufacturer's value is based on the mean minus one standard deviation that corresponds to the minimum protection for 84% of wearers in the BS EN 24869-1 standard test.
- The SNR value generally decreases when earmuffs are worn over other PPE or clothing. However the SNR of earmuff 4 did not decrease when worn in the behind the neck orientation with the helmet when the supporting head strap was also used, and the decrease in the average SNR values for the test earmuffs when worn with the small goggles was less than 3dB. This confirms that some

compatible hearing protection and PPE combinations are available that minimise the possible loss of earmuff attenuation.

- The attenuation of an earmuff worn over clothing appears to be relatively independent of the stated attenuation for that protector. All results for earmuffs worn over the hood or beanie hat lie close together. This may be due to limiting of the maximum attenuation by the layer of fabric between the earmuff seal and the head.
- There is a wide variation between the attenuation achieved by different subjects when earmuffs are worn with PPE with a protruding part that passes under the cup breaking the seal, or with PPE that prevents the correct fitting of the headband. The results for earmuff 6 (neckband Peltor Optime II) show some very low SNR values were obtained when worn with other PPE. This is due to increased difficulties fitting the defective earmuff head straps with other PPE.
- The small goggles gave a mean reduction in SNR of less than 2dB. However the glasses and goggles were more obtrusive and reduced earmuff SNR by as much as 10dB.

Figure 7 SNR values for new, aged and damaged earmuffs

Worn in both overhead and behind neck orientation

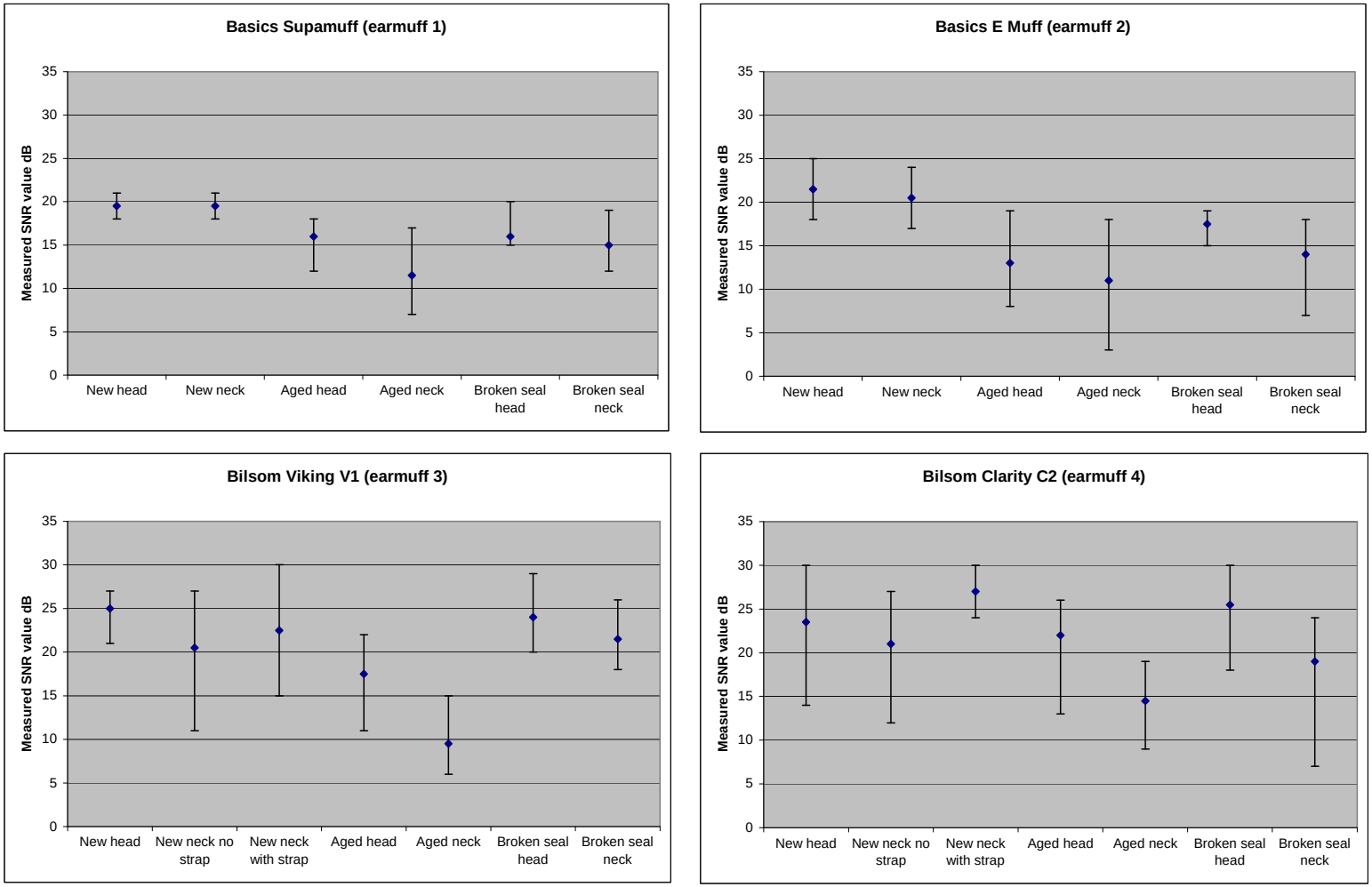
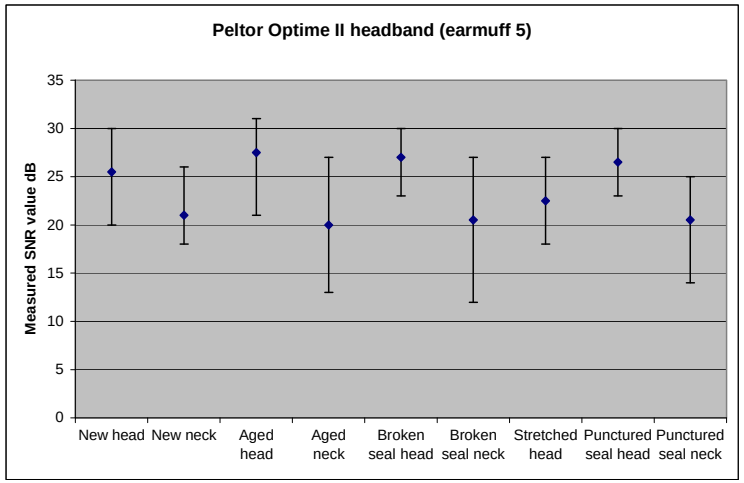
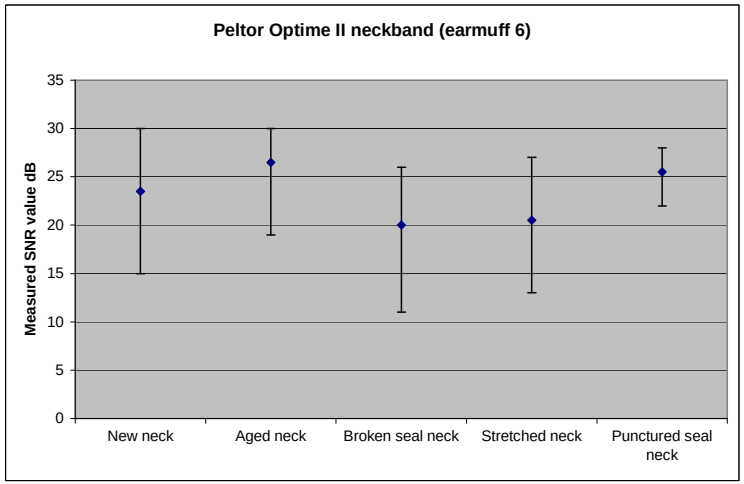
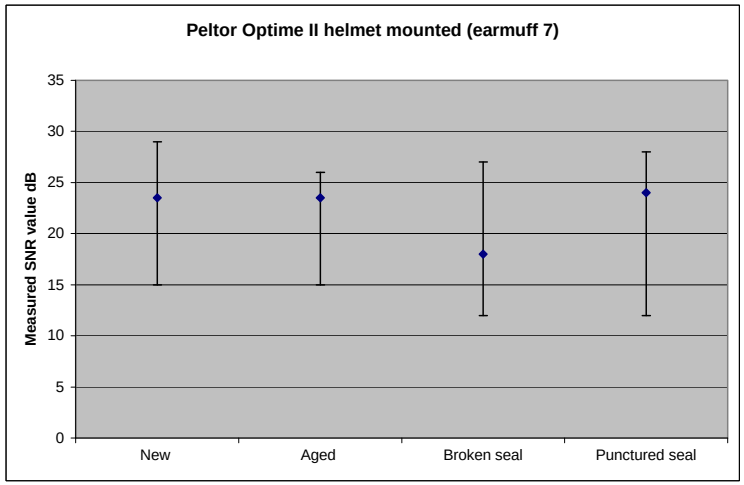


Figure 7 (continued) SNR values for new, aged and damaged earmuffs

Worn in both overhead and behind neck orientation except for neckband and helmet mounted earmuffs







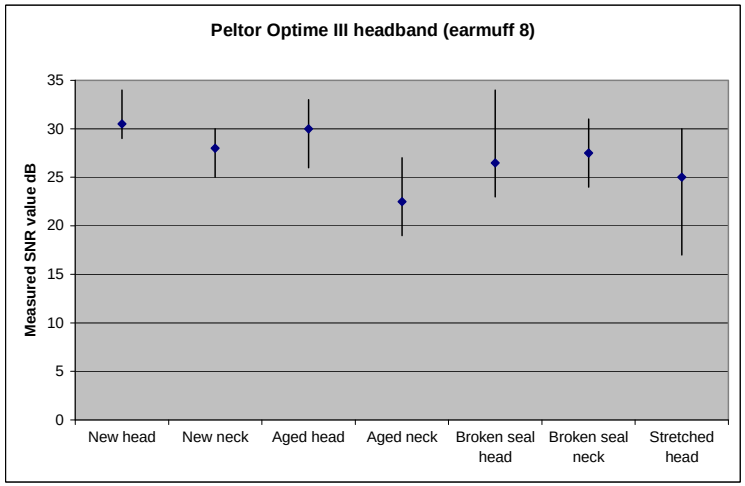


Table 4 Change of earmuff SNR value when worn in different orientations and when aged or damaged

Note 1: The mean value for each earmuff reference condition is reported as the actual SNR value. All other mean values for the earmuff are reported as the difference from the reference condition. All mean values are shown in bold.
Note 2: The spread around each mean value is shown in ordinary type and is the subject variation around the specific condition mean value above.
Note 3: For earmuffs 1 to 5 and earmuff 8 the reference condition is the result for a new earmuff worn in the over head orientation. Earmuffs 6 and 7, that are neckband and helmet mounted types, could only be worn in their intended orientation and the reference condition is therefore for a new earmuff worn in that intended orientation.
Note 4: Earmuffs 3 and 4 are reported with and without the earmuff headstrap when worn around the neck in the new condition.
Note 5: Column 2 gives the manufacturer's SNR value obtained in accordance with BS EN 24869-1.

Ear-muff No	***Man. SNR***	***New***		***Aged***		***Broken seal***		***Stretched band***		***Punctured seal***	
		Head (ref)	***neck***	***head***	***neck***	***head***	***neck***	***head***	***neck***	***head***	***neck***
1	23	**19.5** +1.5, -1.5	**0.0** +1.5, -1.5	**-3.5** +2, -4	**-8.0** +5.5, -4.5	**-3.5** +4, -1	**-4.5** +4, -3				
2	28	**21.5** +3.5, -3.5	**-1.0** +3.5, -3.5	**-8.5** +6, -5	**-10.5** +7, -8	**-4.0** +1.5, -2.5	**-7.5** +4, -7				
3 + strap	30	**25** +2, -4	**-4.5** +6.5, -9.5 **-2.5** +7.5, -7.5	**-7.5** +4.5, -6.5	**-15.5** +5.5, -3.5	**-1.0** +4, -4	**-3.5** +4.5, -3.5				
4 + strap	30	**23.5** +6.5, -9.5	**-2.5** +6, -9 **+3.5** +3, -3	**-1.5** +4, -9	**-9.0** +4.5, -5.5	**+2.0** +4.5, -7.5	**-4.5** +5, -12				
5	31	**25.5** +4.5, -5.5	**-4.5** +5, -3	**+2.0** +3.5, -6.5	**-5.5** +7, -7	**+1.5** +3, -4	**-5** +6.5, -8.5	**-3.0** +4.5, -4.5		**+1.0** +3.5, -3.5	**-5.0** +4.5, -6.5
6	31	Reference condition behind neck	**23.5** +6.5, -8.5		**+3.0** +3.5, -7.5		**-3.5** +6, -9		**-3.0** +6.5, -7.5		**+2.0** +2.5, -3.5
7	30	**23.5** +5.5, -8.5 helmet mounted		**0.0** +2.5, -8.5 helmet mounted		**-5.5** +9, -6 helmet mounted				**+0.5** +4, -12 helmet mounted	
8	35	**30.5** +3.5, -1.5	**-2.5** +2, -3	**-0.5** +3, -4	**-8.0** +4.5, -3.5	**-4.0** +7.5, -3.5	**-3.0** +3.5, -3.5	**-5.5** +5, -8			

In summary

- Simulated use and ageing gave a visible loss of headband tension for the earmuffs with a plastic headband (earmuffs 1 to 4). As a consequence the mean SNR value, for the plastic headband aged earmuffs, dropped by between 1.5 and 8.5dB relative to the new reference condition, when worn in the overhead orientation. A greater loss of attenuation occurred for the behind the neck orientation.
- For the wire band earmuffs (earmuffs 5 to 8) simulated use and ageing caused no visible loss of headband tension and no significant reduction in attenuation. However deliberate stretching of the wire headband on earmuffs 5, 6 and 8 caused a loss of between 3 and 5.5dB relative to the new condition, when each earmuff was worn in the intended orientation.
- The loss of tension, whether by ageing or stretching, has caused a similar or more severe reduction in attenuation than the more obvious damage to the earmuff seal. The loss of attenuation caused by a broken seal relative to the results for the new, undamaged condition was a negative loss of 2dB (actual increase in attenuation) down to a loss of 4dB for the plastic headband earmuffs. For the wire headband earmuffs the loss was from a negative loss of 1.5dB (increase in attenuation) down to a loss of 5.5dB.
- Removal of an eighth section of the earmuff seal is a more obvious sign of damage, but only caused a mean drop of 2dB in earmuff SNR.
- Earmuffs 3 and 4 were supplied with a supporting headstrap, for use when worn in the behind the neck orientation. Without the headstrap the attenuation reduced by 2 and 6dB. Models of earmuff 6 (Optime II neckband) were supplied with defective headstraps that were too short to be used by every subject. This earmuff has a wider spread of attenuation between subjects than the wire headband earmuffs (earmuffs 5 and 8) when worn in their intended over head orientation. The proper use of the headstrap is therefore essential to obtain the optimum attenuation.

5 LABORATORY TESTS OF EARPLUG INSERTION LOSS

5.1 INSERTION LOSS TEST METHOD FOR EARPLUGS

Measurements were made to compare how the attenuation of earplugs varied with different methods of fitting and insertion depth. Measurements were made of the sound level in a diffuse field of random noise at the eardrum of a simulated ear on a KEMAR (Knowles Electronics Manikin for Acoustic Research) head and torso simulator. The difference in level with and without earplugs fitted was recorded as the attenuation. From the attenuation in octave bands the SNR value for the earplug was calculated.

5.2 EARPLUGS SELECTED FOR TESTING

A range of earplugs were selected. The range was chosen from those known to be commonly in use, and representative of the different types available: banded earplugs, banded earcaps, compressible foam, push in foam, flanged and bulb shaped earplugs.

Table 5 shows the range of earplugs tested.

Table 5 Range of earplugs/ canal caps tested

Earplug model and number	*Description*	*SNR dB*	*Cost*
1 EAR Caboflex	Banded tapered canal cap	19	£4
2 EAR Ultrafit 20	Corded premoulded flange earplug	20	£2
3 Howard Leight QB3	Banded round ear canal cap	23	£3
4 Howard Leight Quiet	Premoulded bulb shape earplug	28	30p
5 EAR Classic	Compressible foam earplug	28	20p
6 EAR Express Pod	Foam earplug on stalk	28	50p
7 EAR Ultrafit	Premoulded flange earplug	35	£1
8 Howard Leight Max	Compressible foam earplug	37	20p

5.3 COMPARISON OF RESULTS FOR AN EAR SIMULATOR AND HUMAN SUBJECTS

The attenuation of an earplug or canal cap in an ear simulator often exceeds the performance achieved by human subjects as the earplug is fitted into a smooth cylindrical ear canal simulator. The SNR value obtained by the standard EN 24869-1 method, supplied with the earplug by the manufacturer, is therefore a better indication of the attenuation of a well fitted earplug worn by a human subject. When an earplug is poorly fitted the difference between simulator and the human subject performance will decrease as the achieved attenuation is less dependent on the ear canal condition.

The results of the earplug insertion loss measurements obtained with KEMAR are shown in Table 6. It should be remembered that the measurement method gives an indication of the optimum attenuation for any fitting, and the predicted attenuation when worn by a human subject will be lower.

Table 6 Earplug SNR taken from insertion loss measured with KEMAR ear

Earplug	*Earplug number*	*Man. SNR*	*Fitting/ compression*	*Deep insertion*	*Halfway insertion*	*Edge of canal*
Compressible foam	5	28	Whole length rolled according to instructions	42	41	27
	8	37		45	44	42
	5	28	Folding along length or squashing	9	4	
	8	37		4		
Foam on stalk	6	28	Pushed into canal	44	32	28
Premoulded bulb	4	28		40	33	Variable <34
Flanged (low attenuation)	2	20		20	20	0
Flanged (high attenuation)	7	35		44	20	0
Banded ear canal caps	1	19	Ear cap inserted according to instructions	37		
	3	23		30		
	1	19	Ear caps only held against canal by tensioned band	0		
	3	23		0		

In summary:

- To achieve the optimum attenuation, premoulded plugs must generally be inserted fully to the intended insertion depth. However the low attenuation flanged earplug (number 2) gave the same attenuation when fully inserted and when only inserted to about half its full depth.
- Foam plugs should be rolled as specified by the manufacturer so they expand fully in the ear canal. When folded or squashed they may not fill the ear canal when expanded and so give virtually no protection even if deeply inserted.
- Banded ear canal caps must be partially inserted into the ear canal as shown by the fitting instructions. Caps held only against the canal entrance by the band may give no protection.

6 QUANTIFYING THE EFFECTIVENESS OF HEARING PROTECTION SEEN IN USE

Observation of hearing protector provision, use, and condition confirmed in some premises use was ineffective and likely to provide no protection for the majority of workers requiring protection. In other premises some workers were seen without hearing protection where hearing protection was required.

Laboratory measurements tested the reduced attenuation of earmuffs worn with other PPE and clothing, and the effect of ageing and damage. On site observation showed the problems of wearing of earmuffs over other PPE was mostly avoided by choosing integral PPE or earplugs rather than earmuffs, but the use of earmuffs over clothing by outdoor workers was a clear problem.

Most earmuffs seen in use showed no obvious visual defects but the loss of headband tension due to normal wear and ageing or by slight stretching is identified in laboratory tests as significant factor.

Laboratory tests of earplugs were less conclusive because the normal variations due fit in a human ear canal were difficult to reproduce using the simulated ear canal of the KEMAR manikin. These tests did however highlight the negligible attenuation achieved by compressible foam earplugs if incorrectly compressed before fitting.

The four factors given are above are considered below, in terms of frequency of occurrence or estimated loss of attenuation, in order to quantify hearing protector effectiveness to the majority of workers seen.

6.1 INEFFECTIVE USE OF HEARING PROTECTION

One outdoor team had only one pair of earmuffs for three workers using strimmers, and these were not worn because workers considered these shared earmuffs unhygienic.

In three out of the twelve companies that allowed on site observation of hearing protector use during normal working, use was ineffective. In the first (the vehicle servicing and repair centre) this was due to the workers being unaware of when and where hearing protection should be used, in the second (the joinery factory) the majority of workers were wearing their earplugs outside the ear canal, and in the third (the joinery workshop) the earmuffs provided had broken bands and severely damaged cups. The first two of these companies claimed to have provided training on hearing protector use, the third company had been unaware any training was required.

In five companies that had majority effective use of hearing protection there were areas where hearing protection was required continuously. In two of the five hearing protection was unworn by 3 out of 13 workers, and 10 out of 25 workers seen within noisy areas. In the other three no one was seen not wearing hearing protection. The estimated ratio of those not using protectors combined across all five companies, is one in seven.

There is insufficient information from this study to assess the incidence of occasional hearing protector use.

Summary

One in four employers seen had ineffective use of hearing protection, such that the majority of workers had nil protection.

An estimated one in seven workers, in companies with majority effective use of hearing protection, failed to wear hearing protection when required.

6.2 UNDER PROTECTION

The laboratory measured SNR of earmuffs was on average 5.5dB below the quoted value. The HSE method for selection of protectors derates the quoted attenuation by 4dB. The measured SNR of plastic banded earmuffs reduced by a further average 5.5dB with the reduction in headband tension caused by simulated ageing, and by an average of 4dB with a one minute stretch of a wire banded earmuffs. Thus the typical attenuation of earmuffs in good condition that have lost some tension due to normal use or stretching may on average be a further 6dB less than predicted.

Figure 2 (shown previously) placed the sound level and quoted SNR value against the approximate suitable SNR values given in HSE's guidance to the Control of Noise at Work Regulations. Figure 2 showed one user wore an earmuff predicted to under protect. Figure 8 below, shows graphically the sound pressure levels where hearing protectors were seen in use, plotted against the SNR with a 6dB derating superimposed. The red lines indicate the boundary of the approximate suitable SNR values given in the HSE's guidance. Data points extending over the top red line indicate probable under protection, data points below the lower red line indicate probable over protection. There are 5 data points out of 16 where the hearing protector SNR value is insufficient for the average sound pressure level and users are likely to be underprotected. 2 data points out of 16 show over protection.

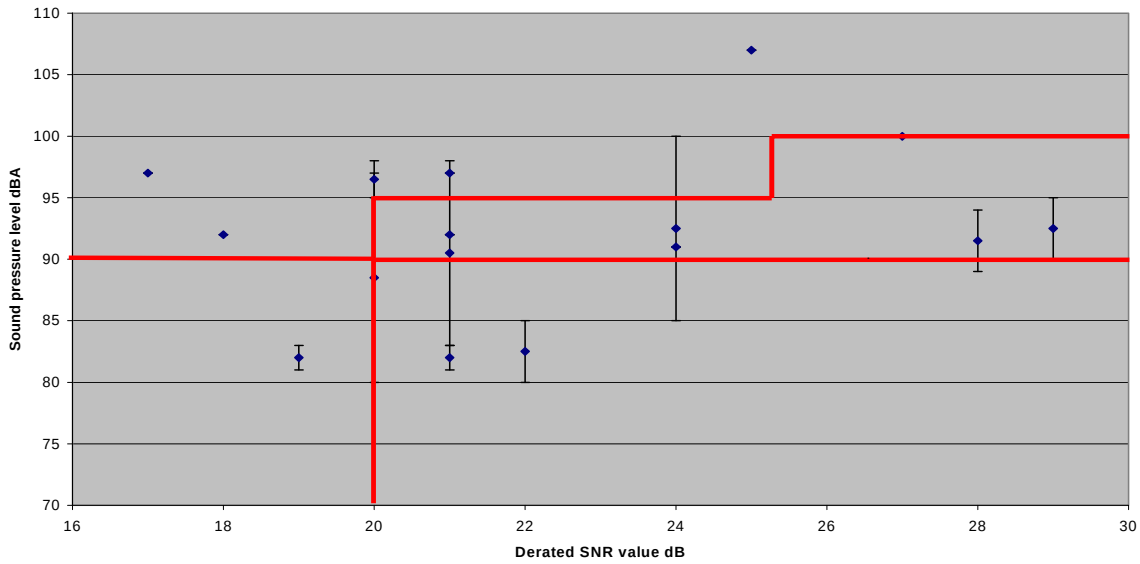


Figure 8 Sound level against earmuff SNR value derated by 6dB for possible ageing and headband stretching

Two outdoor road-workers wore earmuffs over clothing. The laboratory test results show new earmuffs worn over clothing achieved an average SNR of no more than 21dB. The wearing of earmuffs over clothing is common practice amongst outdoor workers in cold weather. A protector with an SNR value of less than 20dB is only recommended by the HSE guidance for use in sound levels below 90dB, clearly insufficient when large power tools are used.

Compressible foam earplugs were available in 12 of the 15 premises visited although where there was a choice they were not the preferred choice of workers. 6 out of 14 workers seen using compressible foam earplugs wore them only shallowly inserted, and most users asked to demonstrate fitting did not compress them before fitting according to the manufacturers' instructions. Laboratory tests show that an incorrect compression may prevent the earplug expanding to fill the ear canal. Laboratory measurements show SNR values of less than 9dB for incorrect compression. Compressible foam earplugs are specified with SNR values from 28 to 36. However it is possible that these earplugs are providing insufficient protection for a significant proportion, and possibly a majority of users.

Summary

Laboratory tests show earmuff headband tension reduces with use, and stretching. Laboratory tests suggested a reduction of 6dB from the manufacturer's SNR value could be typical of earmuffs with only moderate use. A 6dB reduction is estimated to result in a third of the earmuffs seen in use under protecting.

Workers wearing earmuffs over clothing are likely to be under protected, as earmuff SNR values are likely to be reduced to less than 21dB.

Most users of compressible foam earplugs fail to compress them according to the manufacturer's instructions. Laboratory tests show the earplug SNR can be reduced to 9dB and below where incorrect compression is used.

7 CONCLUSIONS

7.1 WORKERS RECEIVING NO PROTECTION

A quarter of companies seen during normal working and one out of the four outdoor worker teams were seen to have ineffective hearing protector use likely to result in negligible or zero protection for the majority of workers.

In addition one in 7 workers in companies with majority effective hearing protector use were seen without hearing protection when and where hearing protection was required.

Overall this suggests only 60% of workers expected to be using hearing protection are receiving any protection.

One other factor likely to result in ineffective use is poor fitting. Most workers using foam earplugs fitted them incorrectly. The laboratory tests show this may result in only negligible attenuation (SNR values of less than 9dB) even if the earplug is deeply inserted.

7.1.1 Reasons for workers choosing not to use hearing protection

Workers cited needing to hear traffic and radios, and communication difficulties as reasons for not using hearing protection.

Peer pressure is also a factor. Individuals were also less likely to use hearing protection when those around them chose not to. Employers also reported, and it was apparent during observations of hearing protector use, that supervisors were sometimes reluctant to enforce wearing of hearing protection.

Worker attitude is another factor. Workers in one premises visited chose not to cooperate with hearing protector use because they perceived it had been imposed without fair consultation. Here earplugs were worn in the pinna and outside the ear canal, only a few were seen wearing earplugs in the ear canal.

7.1.2 Factors in employers' failure to ensure effective use

General lack of compliance and awareness was the common factor. The quarter of companies that had ineffective hearing protector use had introduced hearing protection as the sole control measure without a more comprehensive noise control programme. Two companies had also made no assessment of exposure.

Inadequate provision was a factor in two cases. One employer had provided just two pairs of broken earmuffs and had refused to replace them. One outdoor team had just one pair of earmuffs for three workers operating noisy tools.

7.2 WORKERS USING HEARING PROTECTION WHEN NOT REQUIRED

At one site hearing protection was used where there was no risk to hearing. The employer had made a whole building a hearing protection zone, in response to a risk in only part of the building. Another employer was considering requiring hearing protection in all areas rather than assessing the actual risk.

7.3 PROVISION OF HEARING PROTECTION

7.3.1 As part of noise control programme

40% of employers seen during the planned visits were supplying hearing protection as part of a comprehensive noise control programme. These employers had introduced noise controls or had a policy of purchasing quiet tools and machinery. Hearing protector use was effective for the majority of workers in these companies.

7.3.2 Provision of choice

2 out of the 15 employers visited, and one outdoor team had no choice of hearing protection. These three employers were unaware of the need to provide a choice.

7.3.3 Provision with training, supervision, and worker cooperation

80% of the employers visited said they provided some training in hearing protector use. The type of training varied from hands on training in small groups to simply providing a copy of the company safety policy. One manager said he was aware the training provided was ineffective, but he considered he had met his responsibilities.

Training on its own did not guarantee the good use of hearing protection. Hearing protection use was seen to be most effective in companies when combined with appropriate supervision and employee cooperation.

It is questionable whether full effective use can be achieved all the time. Two employers who had regular staff safety meetings, provided training and supervision, admitted they had difficulties in ensuring consistent use of hearing protection. One cited peer pressures on supervisors leading off-site teams.

7.4 CHOICE OF HEARING PROTECTION

7.4.1 As compatible with other PPE and clothing

All employers visited by appointment were providing hearing protection of a suitable type for the work environment and for other personal protective equipment (PPE) being worn.

Outdoor workers were seen wearing earmuffs over clothing on a cold day; in laboratory tests clothing limited attenuation, bringing SNR values down to 21dB or less.

Integral PPE and earmuffs were being provided, where required, with the exception of the community punishment team who had banded earmuffs for use over visors. Laboratory tests showed wearing over a visor gave on average a 3dB reduction in SNR, with increased variability of SNR between users.

With the exception of the outdoor workers seen earplugs were provided where other head worn PPE or clothing prevented proper use of earmuffs, and these were the preferred choice where hearing protection was worn for long periods or the workplace was hot and dusty.

7.4.2 According to estimated attenuation

Less than half of employers visited had selected hearing protection according to the attenuation required. As a consequence, in about half of the cases seen, the hearing protectors supplied were predicted to over protect according to the manufacturers' data.

Four employers visited had chosen hearing protection using standard methods or the HSE calculators.

One employer required earplugs with tracers, and this restricted their choice to high attenuation devices only.

7.4.3 With consideration of audibility and specialist hearing protection

One employer had considered audibility when selecting suitable hearing protection. There was no awareness amongst any employers visited of the availability of specialist hearing protection to help with audibility of important sounds within the workplace.

7.4.4 Hygiene considerations

Individual issue of earmuffs is normally recommended unless there is provision for cleaning. Two employers required shared use of earmuffs, and in one group of outdoor workers gave this as the reason for not using them.

It is essential earplugs are clean when inserted into the ear. Only one employer provided hand-washing facilities adjacent to earplug dispensers.

7.5 REAL WORLD ATTENUATION OF HEARING PROTECTION

7.5.1 Earmuffs

HSE recommends derating the attenuation of hearing protection by 4dB when estimating attenuation provided under real world conditions. Most earmuff users seen wore earmuffs with intact seals and cups, so appearing to be in good condition. However laboratory tests, show loss of headband tension with use or stretching is a more critical factor in deterioration of attenuation. Comparison of used earmuffs with new earmuffs will reveal this loss of head band tension, however this is unlikely to be seen as significant damage by the user

Laboratory tests demonstrated a 6dB mean decrease in SNR, above the 4dB derating normally assumed for earmuffs, with simulated moderate use (equivalent to one month of daily wearing) or a brief stretching of the headband. 5 out of 16 earmuff users seen would be under protected if a 6dB reduction in the earmuff SNR occurred.

Damage to earmuff seals is a more visible sign of deterioration, but the effect on attenuation is unlikely to be as significant as reduced headband tension. In laboratory tests removing an eighth section of the seal caused a mean drop of 2dB in the SNR.

In cold weather outdoor workers are likely to wear earmuffs over clothing. Laboratory tests showed the clothing limited the mean earmuff attenuation achieved to between 14 to 21dB.

In most cases where earmuffs were worn with multiple PPE, integral PPE was used. Eye protection and occasionally dust masks were worn with earmuffs. Laboratory tests showed small unobtrusive goggles or dust masks gave a mean reduction in earmuff SNR of 2dB however more obtrusive glasses and goggles could reduce SNR by as much as 10dB.

7.5.2 Earplugs

Laboratory tests showed depth of fit governed the attenuation for push in type earplugs; correct compression to ensure complete occlusion of the ear canal was the important factor for compressible foam types.

Custom moulded protectors were not included in the laboratory assessment. Employers and users seen viewed these as the best available. However employers with a history of using these reported that not all users found them comfortable.

Compressible foam earplugs were only partially inserted by just over half of the users seen. Most users were unaware of how to compress the earplug before fitting. Laboratory tests on an ear simulator showed the earplug SNR can be less than 9dB if incorrectly compress even if fully inserted into the ear.

Users generally preferred push in plugs, both foam and flange types, as they were easier to fit. Users were also seen to obtain deeper insertion into the ear canal.

Employers reported providing banded earplugs and ear canal caps but none were seen in use. Laboratory tests showed that these must be inserted into the ear canal entrance. If held only against the canal entrance by the band tension they give no protection.

8 RECOMMENDATIONS

Hearing protection is often considered as the first and only solution where a noise risk exists. Users need to be aware that it is not a simple or reliable solution.

Most employers did not select hearing protection according to the attenuation required. It would be beneficial if information on the approximate upper and lower sound levels for which the protector is likely to be suitable was included on the hearing protector packaging and with any advertising. The information could take account of likely real world attenuation. This information could be provided in addition to the attenuation data currently provided.

A maximum lifetime, in terms of approximate duration of use, should be provided for all reusable hearing protection. Hearing protector attenuation deteriorates with use and this deterioration may not be apparent to the user.

Compressible foam earplugs are generally poorly fitted, as users are generally unaware of how these should be compressed before fitting, or unaware of the importance of correct compression. An incorrectly compressed earplug may give virtually no attenuation. Correct use requires a high level of training, supervision and motivation. Employers providing this type of protection, and users, need to be aware of these potential problems, and of the existence of alternative types of earplug such as the foam push-to-fit type.

There needs to be greater awareness of the types of protectors that can assist audibility and communication.

Earplugs with tracers are required in a wider range of attenuation than is currently available.

There is a need for clothing compatible with correct earmuff fitting for outdoor workers. Earmuffs worn over conventional hats and hoods can only provide limited attenuation.

9 REFERENCES

Controlling noise at work – Guidance on the Control of noise at work regulations 2005
HSE publication L108

10 APPENDIX A - INDIVIDUAL PREMISES VISITED

10.1 VEHICLE COMPONENT MANUFACTURER

Employs 650 people, 50 to 60 of whom are thought to have daily noise exposures over 85dB(A).

10.1.1 Noise levels

The safety officer reported noise levels from 70 to 95dB. During the visit the measured A-weighted levels reached 91dB. High levels were localised; background levels were below 85dB.

10.1.2 Hearing protection available

- Custom moulded earplugs available to staff working in hearing protection zones, after completion of 6 months employment.
- Dispensers provided two types of flanged and one type of compressible foam earplugs (SNR 25, 30, and 37dB).
- Overhead, and neckband earmuffs were available on request (SNR 30 and 31dB)

The safety officer had noted the hearing protection attenuation data provided with the protectors used, but the attenuation required had not been considered.

10.1.3 Hearing protector and other PPE use seen

Thirteen people were seen working in hearing protection zones where levels were between 85 and 91dB. Eye protection use was also compulsory in these areas.

- 5 using custom moulded earplugs, all well fitted
- 4 using compressible foam earplugs, 3 worn well out of the ear, 1 fitted correctly
- 1 using headband earmuffs, well fitted
- 3 cleaners were seen in areas without hearing protection. It was said that the hearing protection zones did not apply to them.

10.1.4 Problems with hearing protection

One person, without custom moulded earplugs, complained the hearing protection made communication too difficult.

The safety officer said some staff had difficulty using custom-moulded earplugs. Most but not all custom-moulded earplugs were found to be in a good condition at their annual service.

10.1.5 Training, consultation and maintenance of controls

All staff received training on noise and hearing protection use on induction. A Dupont “Stop Observation” programme had run since 1979 and involved 70 staff. Areas with levels over 85dB were designated hearing protection zones. Radios and personal stereos were banned.

10.1.6 Health surveillance

Health surveillance is used routinely, and it was claimed no hearing loss had been reported.

10.1.7 Observations/follow-up

This appeared to be a well-controlled environment where the workers accepted hearing protector use.

Lower attenuation hearing protectors were recommended and guidance was provided on the selection of hearing protection to avoid over protection.

10.2 METAL FABRICATED BUILDINGS MANUFACTURER

Employs 40 people on shop floor and 10 on off-site building construction.

10.2.1 Noise levels

The company's noise assessment reported daily noise exposures ($L_{EP,d}$) between 87 and 95dB, with noise levels reaching 107dB for some operations. On the day of the visit background levels were between 77 and 82dB. Measurements of sound levels at the operator's ear during welding and grinding were not possible and values reported here are from the company's risk assessment.

10.2.2 Hearing protection available

All hearing protection had been assessed against the noise from angle grinding (103dB) using the octave band method and 4dB de-rating recommended by HSE. The SNR value and predicted level at the ear from the factory risk assessment are:

- Custom moulded earplugs for all staff working in factory and construction. In use for 7 years but only recently supplied to all staff (81dB at ear, SNR value not available).
- Dispensers provided compressible foam earplugs (SNR 33dB, 73dB at ear), for visitors and contractors
- Overhead earmuffs for guillotine and angle grinding use (SNR 27dB, 76dB at ear)
- Banded earplugs used by people passing through factory area (SNR 23dB, 82dB at the ear)

In addition flanged earplugs were also seen in use, although these were no longer normal issue.

10.2.3 Hearing protector and other PPE use seen

Sixteen people were noted working where background noise levels were between 81 and 82dB and during welding operations between 95 and 106dB. Eye and face protection was also used.

- 4 using custom moulded earplugs, all well fitted
- 1 using compressible foam earplugs, poorly fitted and worn well out of the ear
- 3 using headband earmuffs, well fitted
- 7 using flanged earplugs, well fitted
- Foreman using banded earplugs, impossible to see fit.

10.2.4 Problems with hearing protection

One person used earmuffs instead of the custom moulded earplugs as he thought they gave better protection. The safety officer reported a hearing-aid user had problems with the aid blocking with fluid when used under earmuffs.

10.2.5 Training, consultation and maintenance of controls

The company safety officer was newly appointed. She had provided training to all staff in the previous month. Training was conducted in groups of about six, and covered noise control, fitting of all available hearing protectors, and care of hearing protection. The whole factory floor was a hearing protection zone. Radios were audible from outside the factory, but turned off during the visit to the factory floor. The safety officer was consulting with the staff about removing the radios.

10.2.6 Health surveillance

Health surveillance had been started one month before the visit. No results were available.

10.2.7 Observations/follow-up

The safety officer had only been in post a short time. Noise reduction measures were in progress and she was conscious of keeping the cooperation of the workers. Hearing protection had been selected correctly and there was effective training.

Advice on hearing protection suitable for a hearing aid user was requested. A sound restoration earmuff was recommended with a variable balance control to compensate for different levels of hearing in each ear, and an equaliser control to vary the frequency response of the reproduced sound as required.

10.3 BOTTLING PLANT

Employs 94 people in all. Plant operation is normally continuous with four shifts of 20 workers each.

10.3.1 Noise levels

The plant was shut down during the visit. The safety officer reported A-weighted sound levels of 85 to 90dB during operation.

10.3.2 Hearing protection available

- Dispensers provided two types of types of compressible foam earplugs (SNR 34 and 35dB) on cords. Hand washing was provided by the side of the dispensers.
- The maintenance engineers used earmuffs.

The safety officer had noted the attenuation data provided for the hearing protectors, but said the choice was based on what they had always used rather than considering the attenuation required.

10.3.3 Hearing protector and other PPE use seen

Due to the temporary plant shut down there were no noisy working areas at the time of the visit. Earplugs were worn despite the shut down. Some staff wore their earplugs by the ear (held within the hairnet), rather than in the ear. All staff wore hairnets, some wore hooded disposable boiler suits, and one person wore a face visor.

10.3.4 Problems with hearing protection

Due to hygiene requirements staff used corded disposable earplugs. The safety officer reported some initial resistance to using hearing protection throughout the plant areas.

10.3.5 Training, consultation and maintenance of controls

All new staff and contractors working on the site receive health and safety induction training. Staff are instructed to use hearing protection in “mandatory areas” and training is backed up by a short leaflet of instructions. Day shift leaders do a daily inspection on hearing protector use, and there are regular safety audits. Areas with continuous noise levels over 85dB are hearing protection zones.

Noise controls had been implemented in the bottle blowing area where levels were reported to be 90dB during normal working.

10.3.6 Health surveillance

Health surveillance is used routinely for forklift drivers and is being considered for all staff working in plant areas.

10.3.7 Observations/follow-up

Hearing protector use was difficult to judge as the plant was shut down. The hearing protection provided was likely to be over protecting in the noise levels reported during normal working. Information on correct selection and lower attenuation earplugs was sent to the company health and safety advisor.

10.4 VEHICLE SERVICING AND REPAIR CENTRE

Dealer providing car sales, with valeting, service and body-shop areas. 10 staff were seen working in these three service areas.

10.4.1 Noise levels

The safety officer reported noise was from vacuum cleaners, electric polishers, paint spraying, and air tools such as drills, nut runners and sanders. The company had no information on noise levels or the daily exposure of staff. A-weighted noise levels of 98dB were measured during the use of air tools in the service area, and 78dB during use of a vacuum cleaner in the valeting area.

10.4.2 Hearing protection available

- Personal issue of earmuffs for use during noisy activities was claimed. The earmuffs seen were of the same type with an SNR value of 26dB.

- Compressible foam earplugs (SNR 37dB) were available for use by the spray booth operator.

The attenuation had not been considered in the choice of hearing protection.

10.4.3 Hearing protector and other PPE use seen

Eye protection was seen in use, and the operator working in the paint spray booth used a respirator.

Only new earmuffs were seen in the service and body shop areas, with no personal identification. Earmuffs were only used when prompted by the safety officer. There were not enough earmuffs for personal use.

The paint spray operator could not fit the foam earplugs provided.

10.4.4 Problems with hearing protection

The paint spray operator compressed one end of the foam earplug into a point before inserting. He was unaware of how to fit the earplug correctly and said he had difficulty inserting them into his ears such that they stayed in.

10.4.5 Training, consultation and maintenance of controls

New staff receive 2 hours training with the safety officer as part of their induction and all staff had been given a written copy of the company safety policy to read. The safety officer considered these actions ensured the company met their legal requirements to provide training although he admitted they were ineffective. No signs were seen on tools or in work areas indicating hearing protection was required.

10.4.6 Health surveillance

Health surveillance was provided for body shop staff and noise induced hearing loss had been detected.

10.4.7 Observations/follow-up

The manager responsible for safety made it clear that he saw health and safety as an unreasonable inconvenience. He was concerned to meet the law but unconcerned if controls and safety measures provided were ineffective. He was unaware that effective controls were legally required.

The paint spray operator could not fit the earplugs provided. Information on alternative protectors was given. In addition a recorded demonstration of noise induced hearing loss was provided with advice on improving training on hearing protector use.

10.5 SPECIALIST JOINERY WORKSHOP

Three joiners and the owner/manager used woodworking machinery to manufacture doors and windows.

10.5.1 Noise levels

There had been no assessment of noise levels or noise exposure. A-weighted levels during use of machinery in workshop varied from 85 to 92dB at the operator's ear.

10.5.2 Hearing protection available

Two pairs of damaged sound restoration earmuffs, were the only protectors available. These earmuffs had damaged seals, broken headband joints repaired with wood glue, and holes in the muff cups where cable grommets and microphones were missing. The glued repairs impeded rotation of the muff cups on the headband. Figure 8 shows one pair of the hearing protectors.

Figure 9 Earmuffs used at specialist joinery (premises 5)

No replacement earmuffs were available. The manager said new protectors would not be provided until he could ensure staff would take good care of them.

10.5.3 Hearing protector and other PPE use seen

The manager used the earmuffs with eye protection while demonstrating machinery in the workshop.

10.5.4 Training, consultation and maintenance of controls

Staff had chosen the earmuffs provided. The manager was unaware any training on the use of the hearing protectors was required. There were no signs on equipment or in work areas advising where hearing protection should be used.

No deliberate noise controls were apparent, but the machinery was located in a separate workshop and this in itself was probably an effective control.

10.5.5 Health surveillance

Health surveillance was not provided.

10.5.6 Observations/follow-up

This company had very poor hearing protector provision and use. Use of the power tools was intermittent and no risk assessment had been made to estimate typical daily exposure. It is possible that use of the power tools was insufficient to give workers an exposure above the lower action value.

Information on suitable low attenuation earmuffs was provided. The earmuffs at the premises were exchanged for several pairs of replacement lightweight earmuffs in new condition.

10.6 VEHICLE ACCIDENT REPAIR CENTRE

Family business employing 10 people in the workshop, all working on-site.

10.6.1 Noise levels

Measured A-weighted background levels during visit were 72dB. No noisy tools were used during the visit.

10.6.2 Hearing protection available

- Compressible foam earplugs (SNR 28dB) were available in both corded and non-corded versions. Earplug dispensers were in the workshop area.
- Headband earmuffs were issued for personal use (SNR 27dB)

The owner/manager had considered attenuation in the selection of hearing protection but no estimate of the actual attenuation provided had been made.

10.6.3 Hearing protector and other PPE use seen

Earmuffs in workshop area were marked with the user name and were in a good but not new condition. The paint spray operator used earplugs in the booth, and was seen to obtain a reasonable fit. Face visors, goggles, and safety glasses were also used.

10.6.4 Problems with hearing protection

The manager said his main problem was ensuring the hearing protection was consistently used.

10.6.5 Training, consultation and maintenance of controls

All staff received training on PPE use and safe working of tools on induction from an external training provider. Tools that should be used with hearing protection were identified. Staff were required to confirm every month whether they had all the necessary PPE, and six monthly health and safety meetings were held with staff. The company had a policy to buy quiet tools and machinery.

The company risk assessment had recorded the sound level of each noisy tool and a simple sound level meter was used to routinely check sound levels.

10.6.6 Health surveillance

Health surveillance was used, and no hearing loss had been reported.

10.6.7 Observations/follow-up

This company although small appeared to be conscientious and capable of controlling the risks in their premises. An excellent example of what a small company can achieve.

10.7 IRONWORK RESTORER AND MANUFACTURER

19 people were employed on the shop floor, with occasional off-site working. Noisy activities were the use of hand tools including hot metal forging, small handheld power tools, power hammer, paint booth, and vehicle movements.

10.7.1 Noise levels

No assessment had been made of noise exposures. Managers thought daily exposures ($L_{EP,d}$) were under 85dB. A-weighted background noise levels of 76 to 78dB were measured during the visit

10.7.2 Hearing protection available

- Two types of headband earmuffs (SNR 27 and 24dB), and integral earmuffs with helmets for use off-site (SNR value unknown).

- Compressible foam earplugs (SNR 28dB).

The attenuation data for the hearing protection had been recorded but no assessment had been made of the attenuation provided or required.

10.7.3 Hearing protector and other PPE use

Two people were seen using hearing protection. One was wearing earmuffs with the headband around the neck, rather than over the head; the other was wearing the foam earplugs moderately well fitted. Hearing protection policy was to use protectors when using noisy machinery or when in the vicinity of noisy activities.

Operators had earplugs or earmuffs ready for use in their tool kits. Earmuffs were preferred in higher levels to earplugs, as they were perceived as giving higher attenuation.

Goggles were used during grinding. The painter used a respirator in the paint booth. Safety helmets with integral protectors were available for use off-site.

10.7.4 Problems with hearing protection

No problems were reported.

10.7.5 Training, consultation and maintenance of controls

New staff received training on the machinery, risks, and safety measures. Signs showed where hearing protection may be required and managers were said to walk around workshop areas checking safe working. A register was kept of the personal issue of PPE to ensure regular replacement. The company has a purchasing policy to buy quiet tools.

10.7.6 Health surveillance

The introduction of health surveillance was being planned at the time of the visit.

10.7.7 Observations/follow-up

This company had by chance selected earmuffs with appropriate attenuation. Information was provided on lower attenuation earplugs of the push in type.

10.8 PRINTERS

Six people were seen on working on the shop floor.

10.8.1 Noise levels

The company had completed a noise assessment. Two machines were known to give operator sound pressure levels between 80 and 85dB(A) and noise exposures were estimated to be 81 to 82dB(A). The areas around these machines were marked as hearing protection zones. Measured sound levels were confirmed as between 80 to 85dB(A) depending on operator location.

10.8.2 Hearing protection available

- Personal issue of headband earmuffs (SNR 25dB)
- Compressible foam earplugs (SNR 36dB).

The attenuation of the protectors had not been a factor in their selection.

10.8.3 Hearing protector and other PPE use seen

Only two operators needed to use hearing protection. The compressible foam earplugs were poorly fitted, the earmuffs were not seen in use.

10.8.4 Problems with hearing protection

Earmuffs were considered uncomfortable when it was hot, and earplugs were preferred for comfort. Users said there were problems with communication when using the protectors provided.

10.8.5 Training, consultation and maintenance of controls

No training was provided on hearing protection use. Staff had some awareness of proper use but not of correct fitting. Signs on machines indicate hearing protection was required.

10.8.6 Health surveillance

Not provided.

10.8.7 Observations/follow-up

During the visit a trial of a simple screen between the two machines where hearing protection was used showed noise levels could be reduced such that hearing protection was possibly no longer required. It was also suggested that carpet under and around the two machines would possibly provide a further noise reduction. No control measures had been tried before by the company.

Information on low attenuation lightweight hearing protectors was provided.

10.9 CONFECTIONARY MANUFACTURER

Employs over 600 people on single site. The newly appointed company safety officer and one staff member providing technical support gave information on hearing protection use. No access was allowed to production areas where hearing protection was used.

10.9.1 Noise levels

The company's noise assessment showed A-weighted noise levels in production areas varied from below 80 up to 95dB.

10.9.2 Hearing protection available

- Disposable compressible foam earplugs with tracers and cords used during production (SNR 32 and 36dB)
- Engineers use earmuffs – no information on type

The earplugs had been selected because they contained metal tracers and so were suitable for food manufacture. Attenuation provided had not been a factor in the choice.

10.9.3 Problems with hearing protection

Most staff in the production areas do not need to use hearing protection continuously but even so earplugs were said to be uncomfortable. It was said corded earplugs with tracers were not available with low attenuation, and this was confirmed by a later web search. Earmuffs were not used, as conditions were said to be too hot and dusty during production. The company wanted to use banded earplugs but none were available with the fixed earpieces necessary for food manufacture.

10.9.4 Training, consultation and maintenance of controls

New staff received safety training as part of their induction.

10.9.5 Health surveillance

No hearing tests were carried out.

10.9.6 Observations/follow-up

This company needed to find lower attenuation earplugs with tracers. Information on a tracer earplug with an SNR value of 24dB was found (JSP Megaplug) but no lower attenuation earplugs were available.

10.10 JOINERY FACTORY

Employs 82 people, in three large workshop areas. The factory has a high volume, mechanised production with workers having little variation in activity.

10.10.1 Noise levels

A-weighted noise levels reported by company were up to 105dB, measured noise levels during the visit were between 85 and 100dB. Staff work an 8.5 hour day. Daily exposure is likely to correspond to the sound levels at the workstations due to the lack of variation in activity.

10.10.2 Hearing protection available

- Push in foam earplugs with a rigid centre (SNR 23dB)
- Flanged earplugs (SNR 30dB)
- Headband earmuffs (SNR 30dB) (covers are available for use when it is hot).

A hearing protector manufacturer had carried out a noise assessment for the company. The hearing protection available was selected as a result of the assessment.

10.10.3 Hearing protector and other PPE use seen

All working areas were made available.

- The foam push in earplugs were the most popular choice. In general these were worn across the pinna rather than in the ear canal and so provided no protection.
- Flanged earplugs were generally well fitted
- Earmuffs were well fitted
- No one was seen working in the factory areas without hearing protection

10.10.4 Problems with hearing protection

The production manager said staff were unhappy about the imposition of hearing protection as it prevented them hearing their radios. Clearly there was little cooperation with the use of hearing protection at this site. The production manager also recognised this non-cooperation was linked to the failure of the company to plan or implement any noise controls.

10.10.5 Training, consultation and maintenance of controls

All staff had received training from the hearing protector manufacturer on the use of hearing protection and the risks had been explained for all areas of the factory.

Noise measurements had been carried by the hearing protector manufacturer supplying the hearing protection used, but no full noise assessment. There were no noise controls, but it was planned to reduce noise in the factory by removing the workers' radios.

10.10.6 Health surveillance

Hearing tests are not provided for staff.

10.10.7 Observations/follow-up

This company had poor relations with the workers over the issue of noise control. No action had been taken to control the noise other than the intention to ban the use of radios. The workers were clearly expressing their dissatisfaction by wearing hearing protection incorrectly. The management did not consider the incorrect wearing of the protectors as a problem that need concern them.

Noise measurements were made during the visit to provide an assessment of noise exposures. Following the visit information was provided on companies that might provide some control solutions for their woodworking machinery.

10.11 MANUFACTURER OF SMALL PLANT MACHINERY

Employs 125 people on the shop floor with 95 working in noisy areas. Noisy activities are cold fabrication and welding of metal sheet and tube.

10.11.1 Noise levels

The company's noise assessment reports A-weighted noise levels from below 80 up to 92dB in production areas. These sound levels were confirmed by measurements on the day of the visit.

10.11.2 Hearing protection available

- Two versions of push in foam plug with a rigid centre (SNR 27 and 29dB)
- Compressible foam plug (SNR 28dB)
- Flanged plug (SNR 30dB)

Dispensers for the foam earplugs were at the entrance to the work areas. The hearing protector attenuation data had been noted but the attenuation required or provided had not been considered.

10.11.3 Hearing protector and other PPE use seen

In areas where sound levels were between 73 to 75dB

- 5 wore the foam earplugs with the rigid centre, 3 with a good fit, 2 with a poor fit
- 2 wore flanged earplugs with a moderately good fit
- 2 wore the compressible foam earplugs fitted poorly.

In areas where sound levels were between 84 to 92dB

- 7 wore the foam earplugs with the rigid centre fitted well, 2 had a poor fit
- 2 wore the compressible foam earplugs fitted well
- 2 wore the flanged earplugs fitted well
- 10 were not using hearing protection

10.11.4 Problems with hearing protection

Hearing protection was being used where there was no risk because hearing protection zones were too extensive. In one area where levels were above 85dB hearing protection was not being used.

10.11.5 Training, consultation and maintenance of controls

Safety training was provided as part of the induction and every two months by a consultant. Whole buildings were marked as hearing protection zones because they contained areas where

levels were in likely to be above 80 to 85dB. An external facilitator audited a part of the factory once a month. Automation of processes had reduced the noise exposure of staff.

10.11.6 Health surveillance

Audiometry had been recently introduced for 85% of the staff. No results were available.

10.11.7 Observations/follow-up

This company had created over extensive hearing protection zones, requiring hearing protection to be used where there was no risk to hearing.

Information on suitable types of low attenuation hearing protectors was provided.

10.12 SHEET METAL WORKSHOP

Employs four to five people on the shop floor, three were seen on the day of the visit. The workshop had a modern punch press, laser-cutting machine, and a press brake. Most noise exposure was from the use of hand hammers, small hand grinders, and spot welding.

10.12.1 Noise levels

A-weighted background noise levels were 77dB mostly arising from the continual operation of the punch press. No noise assessment had been made; noise exposures ($L_{EP,d}$) were estimated to be between 80 to 85dB on the day of the visit.

10.12.2 Hearing protection available

- Push in foam earplugs with rigid handle (SNR 35dB)
- Headband earmuffs (SNR 28dB)

The attenuation of the hearing protectors had not been a factor in their choice.

10.12.3 Hearing protector and other PPE use seen

- The push in foam earplugs were well fitted by all staff seen in workshop.
- Earmuffs were only seen by a workstation that was not in use. These were dusty but otherwise in good condition.

10.12.4 Problems with hearing protection

The manager and staff were happy with the hearing protection they were using.

10.12.5 Training, consultation and maintenance of controls

No training had been given to staff. The staff seen all said they had experience of using hearing protection from previous employment.

10.12.6 Health surveillance

Hearing tests are not provided for staff.

10.12.7 Observations/follow-up

This company had staff who were already aware of the noise risks of the tools they were using. There were good relations between the manager and the staff and they appeared to take safety as a joint responsibility.

Earplugs with an SNR under 20dB were recommended.

10.13 COUNTY COUNCIL

Hearing protection is used in highway maintenance and construction, and countryside services (using chain saws, brush cutters, strimmers, and a mobile wood chipper). Only an interview of council safety staff was made, there were no site visits.

10.13.1 Hearing protection available

- Combination visor, helmet and earmuffs used by countryside staff (SNR value not available)
- Banded earplugs (SNR 23dB) used by highway maintenance
- Headband earmuffs (SNR 26dB) used by highway maintenance

Low to mid attenuation protection for highway maintenance staff had been selected because of their need to hear traffic movement.

10.13.2 Problems with hearing protection

Hearing approaching vehicles is a major concern for highway maintenance staff using hearing protection. The view of staff was "I'd rather be deaf than dead".

Enforcement or supervision of hearing protector use by outdoor teams was considered to be difficult.

One individual had reported problems with dermatitis when using hearing protection.

The safety staff interviewed wanted HSE to provide simpler information and aids for workers using hearing protection.

10.13.3 Training, consultation and maintenance of controls

Demonstrations on how to fit hearing protection and road worker noise awareness training had been provided in the previous 12 months. New starter and refresher training was in preparation. There were quarterly joint management/ TU health and safety inspections.

The council has a policy to buy low vibration equipment, but no similar purchasing policy applies to noise.

10.13.4 Health surveillance

A voluntary scheme plus mandatory checks for individuals where there is a cause for concern has existed for three years. Noise induced hearing loss had been found.

10.13.5 Observations/follow-up

Flat response and sound restoration hearing protectors were recommended for the highway maintenance teams where audibility of passing traffic is a prime concern. During 2008 the council trialled a range of these protectors.

10.14 PRESSURE SYSTEM COMPONENT MANUFACTURE

Hot-metal pressing and cold machining occurred in the manufacturing area. Seven workers were seen in the manufacturing area, seven in the warehouse and packaging area.

10.14.1 Noise levels

In manufacturing areas A-weighted background noise levels were between 83 and 87dB. Sound pressure levels at work stations were between 89 and 98dB. In packaging areas operator sound pressure levels were 88 to 90dB.

10.14.2 Hearing protection available

- Compressible foam plug (SNR 28dB)
- Flanged earplugs (SNR 30dB)
- Headband earmuffs (SNR 27dB)

The attenuation of the hearing protection provided had been noted but no assessment of the protection provided or required had been made.

10.14.3 Hearing protector and other PPE use seen

Hearing protection in use at all noisy locations. Earmuffs and earplugs all worn correctly.

10.14.4 Problems with hearing protection

No problems reported

10.14.5 Training, consultation and maintenance of controls

All staff received training during their induction period. Manufacturer's instructions were provided for fitting hearing protection, and instructions on the care of hearing protection was also provided. Hearing protection zones were clearly marked.

Only limited noise controls had been trialled on an auto-bagging machine. Simple controls to prevent impact noise and compressed air discharge noise were absent.

10.14.6 Health surveillance

No information was available.

10.14.7 Observations/follow-up

Simple noise controls to prevent impact noise, and reduce compressed air discharge noise were recommended. HSL made a follow up visit to assess hand-arm vibration exposure and possible controls to reduce both vibration and noise at the request of HSE.

10.15 CEMENT WORKS

Employs around 150 people in the production areas, including contractors. This large site has risks from both noise and dust in its working areas.

10.15.1 Noise levels

A-weighted noise levels measured on site were between 89 to 94dB in working areas. Measured $L_C - L_A$ values were between 8 to 9dB, confirming the noise was dominated by low frequencies .

10.15.2 Hearing protection available

- Compressible foam plug (SNR 28dB)
- Flanged earplugs (SNR 30dB)
- Push in foam plug with rigid handle (SNR 38dB)
- Two types of helmet mounted headband earmuffs (SNR 30 and 34dB)
- Trialling custom moulded earplugs
- Two types of banded earplugs (SNR 23 and 27dB)

All hearing protectors were available from the site store and earplugs were also available from dispensers at the entrances to site buildings. The HSE hearing protector calculator was used when selecting hearing protection.

10.15.3 Hearing protector and other PPE use seen

Staff were seen working wearing eye protection, dust masks, and helmet mounted earmuffs. The earmuffs were dusty but in good condition. No other hearing protection was seen in use.

10.15.4 Problems with hearing protection

Some staff disliked using earmuffs because of the dusty environment.

10.15.5 Training, consultation and maintenance of controls

Toolbox talks were given every six months on safety issues, and more detailed information was provided for supervisors and managers via HSIP implementation procedures. Supervisors were also expected to check on hearing protector use on the site.

A noise and dust survey was conducted every three years.

10.15.6 Health surveillance

Audiometry had been included in health surveillance from 2007, and hearing loss had been found. The company was using the results to re-evaluate control measures.

10.15.7 Observations/follow-up

This was a large site with a number of risks. Risks appeared to be well controlled, but the safety officer was in some cases unsure whether controls were adequate.

10.16 OUTDOOR WORKERS – RANDOM ENCOUNTERS

Outdoor workers seen using hearing protection were approached on a opportunistic basis. The sound pressure levels during noisy work were measured on two of these occasions and the workers were asked about hearing protection use. The self-employed gardener was seen on a regular basis and so the consistent hearing protector use was confirmed.

10.16.1 Noise levels

- Two grounds maintenance workers employed by service company using petrol strimmers giving a measured A-weighted noise level of 95dB
- Self-employed gardener using petrol mower and petrol strimmer (no noise measurements were possible at the time)
- Community punishment team using three petrol strimmers and hand tools (no noise measurements were possible at the time)
- Two road maintenance staff using road breaker and cut-off saw (97 and 107dB respectively).

10.16.2 Hearing protector and other PPE use seen

- Grounds maintenance - helmet, visor and muff combination (SNR value unknown) well fitted and said to be comfortable. Use of PPE required by employer when using strimmers.
- Gardener - Overhead earmuffs in good condition (SNR 35dB) chosen following guidance from a health and safety advisor. Wearing consistently when using noisy machinery.
- Community punishment team – face visors were worn but no hearing protection was being used. The team supervisor had only one pair of earmuffs available for the whole team. The community punishment management said training was provided to all team members before they started work.
- Road maintenance – Both workers wearing overhead earmuffs (see Figure 10).
    - Worker 1 using roadbreaker (noise level 97dB) wearing light-weight earmuffs (SNR 23dB) over cap, eye protection and jacket hood. Earmuffs had poor tension and damaged seals.
    - Worker 2 using cut-off saw (noise level 107) wearing mid-weight earmuffs (SNR 31dB) over fleece hat, eye protection, and facemask.

Figure 10 Road maintenance workers wearing hearing protection over clothing and other PPE

10.16.3 Problems with hearing protection

The road maintenance workers were seen on a cold day. The earmuffs they had available could not be worn under the hoods and hats they needed to wear. These workers also highlighted the problem that off site workers do not always have advice on or access to suitable hearing protection because of lack of supervision.

The community punishment team said they had no say in the PPE they were required to use and its condition. The earmuffs provided could not be fitted correctly with the visors used. The team had refused to use the earmuffs because other people had worn them. The supervisors were reluctant to stop those refusing to use the PPE from working as this could require them to be returned to court.

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Real world use and performance of hearing protection

This report considers the effectiveness of hearing protectors in everyday work situations. The study reported here was undertaken in two parts. The first consisted of interviews with employers to discuss management of noise and hearing protector use, and on site observation of hearing protector use. The purpose of these visits was to see:

- how well hearing protection was used;
- the training provided;
- the use of other PPE and equipment that may limit attenuation;
- behavioural factors affecting use, taking into account the noise exposure of employees and the environment in which the hearing protection is worn.

The second part was objective laboratory measurements of hearing protector insertion loss. The purpose of these measurements was to quantify the reduction in protection due to poor fitting or maintenance for a range of hearing protectors. Earmuffs were tested using the MIRE (microphone in real ear) method while earplug insertion loss was measured using a head and torso simulator with a simulated pinna and ear canal.

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