Appendix I

Bills Committee on
Occupational Deafness (Compensation)(Amendment) Bill 2002

Paper No. CB(2)908/02-03(07)

The Administration's Response

Introduction

This paper provides information requested by members of the Bills Committee at the meeting held on 23 December 2002 on the following aspects –

(a) details of 43 work processes covered in noise surveys conducted by the Labour Department;

(b) enforcement and education efforts on noise control in the workplace; and

(c) legislation and practices in other countries with and without specified noisy occupations in their compensation schemes**.**

(A) Details of 43 work processes covered in noise surveys conducted by the Labour Department (LD)

The Study

2. The Occupational Hygiene Division of LD conducted noise surveys in respect of 43 work processes/posts and studied a survey report on the noise hazard to employees in discotheques in Singapore published by the Department of Industrial Health of Singapore. The 43 work processes/posts were identified on the basis of feedback on alleged noise at work from employees who approached the Occupational Deafness Compensation Board (the Board), views expressed by concerned groups to the Board, and the comments of a

Working Group[1] appointed by the Commissioner for Labour to conduct a review of the Occupational Deafness Compensation Scheme (the Scheme). The noise surveys were conducted between mid-2000 and March 2001.

3. The purpose of the noise surveys is to assess the noise exposure of employees in these work processes/posts for reference by the Working Group in reviewing the Scheme.

4. Under the Scheme, an occupation is specified as a "noisy occupation" if the mean daily personal noise exposure over a continuous period of eight hours reaches 90 dB(A) or above. If the mean daily personal noise exposure over a continuous period of eight hours is 100 dB(A) or above, the occupation will be considered as "more noisy". The benchmark noise exposure level of 90 dB(A) is the commonly accepted criterion for defining noisy occupations in most countries such as Singapore, the United Kingdom and the United States.

Methodology

5. The personal daily noise exposure ($L_{EP,d}$) of workers was evaluated by taking into consideration the noise levels and exposure patterns measured by a Type 1 or Type 2 integrated sound level meter or personal dosimeter. Basically, the assessment method follows the procedures as described in the Guidance Notes on the Factories & Industrial Undertakings (Noise at Work) Regulation. A copy of the Guidance Notes is attached at Annex I.

Results

6. The results of the noise surveys show that the mean daily personal noise exposure of disc jockeys, waiters/waitresses and bartenders in discotheques, and substitute players in mahjong parlours is above 90dB(A) and

[1] Members of the Working Group included an audiologist, medical professionals and representatives of employers, employees, the Board, the then Education and Manpower Bureau and the Labour Department.

below 100 dB(A). For kitchen workers in Chinese restaurants who work near cooking stoves with blower fan, their mean daily personal noise exposure is 84 dB(A). A summary of the results of the noise surveys is attached at Annex II.

Additional Noise Surveys

7. Arising from a referral from a Legislative Council Member concerning the noise exposure of maintenance workers at air-conditioning/ventilation plant rooms, the Occupational Hygiene Division of LD has conducted a critical study on the noise hazard in air-conditioning plant rooms of buildings from June to September 2002. The results revealed that the mean value of the daily noise exposure of workers who had to work near noisy machines in air-conditioning/ ventilation plant rooms is 87.6 dB(A).

8. In response to enquiries by members of the Bills Committee on the noise levels for salespersons in retail outlets of electrical appliances and CDs/records, the Occupational Hygiene Division of LD has conducted detailed noise surveys on 13 establishments in late December 2002. The results revealed that the mean daily personal noise exposure of the salespersons is 74 dB(A) which is well below the exposure threshold of 90dB(A). Therefore, it is considered that salespersons in retail outlets of electrical appliances and CDs/records should not be included in the list of specified noisy occupations.

(B) Enforcement and education efforts on noise control in the workplace

Statutory requirements on noise control at work

9. The Occupational Safety & Health Ordinance (Cap. 509) stipulates the responsibilities of employers and employees to ensure safety and health at work through, inter alia, the prevention of noise-induced hearing loss. The Factories and Industrial Undertakings (Noise at Work) Regulation (the Regulation) also lays down specific requirements for control of noise at work. The Regulation sets a requirement for employers to conduct noise assessment and to reduce noise level as far as practicable other than by the provision of approved ear protectors to the employees.

Enforcement efforts

10. In enforcing the aforementioned pieces of legislation, Occupational Safety Officers of the LD regularly conduct inspections to workplaces all over the territory. In 2002, a total of 13 419 inspections on noise hazards were conducted, among which 275 detailed noisy surveys were carried out to collect evidence for enforcement purposes. Arising from the results of these detailed noise surveys, the Department issued 80 written warnings, 24 improvement notices[2] and took out 4 prosecutions for breaches of the statutory requirement.

11. The Department has been regularly reviewing and updating the noise at work legislation. The Regulation was last amended in 1994 and the list of approved ear protectors was updated in May 2002. The legislation presently in force is considered adequate in setting the standard of requirement on protection of hearing of employees and in controlling the noise hazards at the workplace. We would step up enforcement actions against non-compliance with statutory requirements in relation to noise at work.

Education efforts

12. Education is always better than punitive actions, especially in the context of hearing conservation. Throughout the years, the Department has placed as much effort in education for the purpose of prevention as in enforcement. We have collaborated with the Occupational Deafness Compensation Board and other occupational safety and health organisations in organizing a large number of promotional projects and activities on prevention of occupational deafness. The major educational/promotional activities undertaken in 2002 include bazaars, exhibitions, talks and site visits to selected trades. In these activities, earplugs and informational leaflets on hearing

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[2] An improvement notice is served on an employer or occupier of premises where a workplace is located under Section 9 of the Occupational Safety and Health Ordinance when the Commissioner for Labour is of the opinion that he is contravening or is likely to continue or repeat in contravening that Ordinance or the Factories and Industrial Undertakings Ordinance. By the improvement notice, the employer or occupier is required to remedy the contravention within a specified period of time.

conservation were widely distributed to the employees. Simple hearing assessments were also conducted on the spot.

13. Moreover, we are developing a guide for the entertainment industries to promote awareness among workers in the trade that loud music is also a culprit for noise-induced hearing loss and to assist the trade in preventing noise hazards at work.

(C) Legislation and practices in other countries with and without specified noisy occupations in their compensation schemes

Countries studied

14. A study on the legislation and practices in five countries including the United Kingdom (UK), Singapore, Malaysia, United States of America (USA) and Australia (three states, namely, Queensland, Victoria and Western Australia are covered), in respect of compensation for occupational noise-induced hearing loss has been conducted. In Malaysia, noise-induced hearing loss arising from employment is not an occupational disease and hence no compensation for such loss is payable. For the remaining countries studied, compensation for noise-induced hearing loss resulting from employment is laid down in statute. A summary of our findings, together with the practice adopted in Hong Kong, are given below.

Major observations

15. Among the countries surveyed, UK has in place an occupational deafness compensation system that requires the claimants to have worked in any of the 24 listed occupations for at least 10 years. The occupational deafness compensation system in HK has similar occupational requirements whereby a list of 25 noisy occupations are stipulated in legislation and another 4 noisy occupations proposed to be added.

16. Furthermore, in UK, compensation for occupational deafness is paid from a social security system financed from general taxation. Whereas in HK, the Scheme is operated on employers' collective liability.

17. In Singapore, USA and Australia, it is the employer's individual liability to pay compensation to his employees. This means that employees in these countries have to prove their employer's responsibility for causing the noise-induced deafness and therefore liable to pay compensation. Therefore, these countries have not laid down a list of noisy occupations in the law. In practice, the insurance/compensation agencies in these countries still have a list of noisy occupations for internal reference to facilitate the processing of claims for compensation. Some employers in these countries have kept detailed records of noise level in the workplace in order to reduce their liability in the event that employees claimed against them for compensation. On the other hand, we have adopted a system of employers' collective liability on the basis of local circumstances in Hong Kong. Given the Scheme in Hong Kong, we specified a list of noisy occupation in the law for transparency and assurance to employers and employees of the entitlement to compensation if other conditions laid down in the law are met.

18. In UK, Singapore and the state of Queensland in Australia, they have specified the minimum requirement for employment in the occupation concerned. In UK and Singapore, the minimum requirement is 10 years' employment. In Queensland, the requirement is for at least 5 years' experience and the employee has to prove his employer's liability for compensation. In the majority of states in USA, there is no such requirement but the employee has to prove his employer's liability and provide evidence on his exposure to hazardous noise at work.

19. In UK, Singapore, USA and the state of Queensland in Australia, they have stipulated a time limit for employees to apply for compensation. With the exception of USA, the rest of the aforesaid places require claimants to apply within 12 months after leaving the noisy occupation(s). In USA, the majority

of states set a time limit from 12 to 24 months counting from the date of leaving the alleged noisy occupation.

Reasons for setting out a list of specified noisy occupations in UK and HK

20. According to medical advice, sensorineural hearing loss could be caused by a number of factors including exposure to excessive noise in the work and non-work environment, old age or disease. Given that it is not practicable to ascertain the cause leading to the sensorineural hearing loss, UK has adopted the approach that an employee would be presumed to be suffering from occupational deafness and therefore entitled to compensation if the employee suffering from sensorineural hearing loss has worked in the listed occupation(s) for the required number of years. The list of noisy occupations can facilitate the establishment of a causal link between the claimants' noise-induced hearing loss and his occupation. Without such a list, the burden would be on the claimants to prove that their hearing loss is due to excessive exposure to noise at work.

21. HK has modeled on UK in setting out the specified noisy occupations due to its merits of openness and transparency.

Labour Department

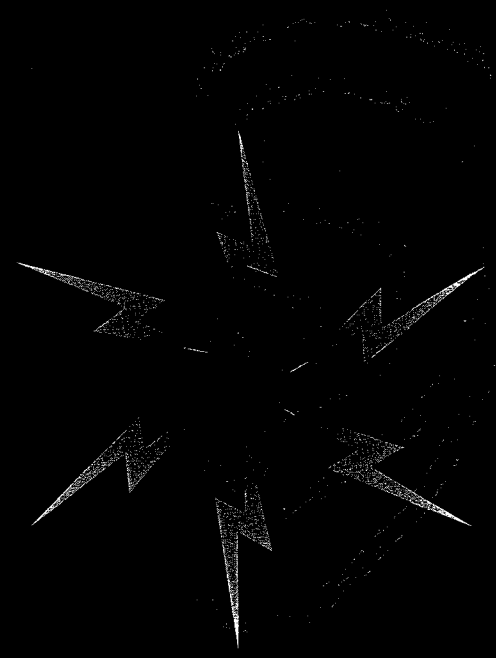
January 2003

Annex I

Printed by the Printing Department 1411804—60L—9/98
(Printed on paper made from woodpulp derived from renewable forests)

Guidance Notes

Factories and Industrial Undertakings (Noise at Work) Regulation



Occupational Safety and Health Branch, Labour Department

Guidance Notes
Factories and Industrial Undertakings
(Noise at Work) Regulation

Occupational Safety and Health Branch
Labour Department

This guidance notes is prepared by the
Occupational Safety and Health Branch
Labour Department

This edition *September 1998*

This guidance notes is issued free of charge and can be obtained from offices of the Occupational Safety and Health Branch. Addresses and telephone numbers of the offices can be found in the booklet "The Labour Department Offers You its Services" or by telephone 2559 2297.

Contents

Introduction

Noise may be defined as sound undesired by the recipient. Besides being a nuisance, noise may interfere with working efficiency, by hindering communication between employees; it may also be a cause of accidents, by masking warning signals; but most importantly, it may damage our hearing.

2. Excessive noise can result in permanent hearing damage. Short exposure to extremely loud noise, such as an explosion, can result in instant deafness through rupture of the ear drum. In contrast, regular exposure to high noise levels over a long period of time may result in destruction of certain inner ear cells and a loss of hearing which is permanent and incurable.

3. Sound is produced by pressure changes in the ear. The unit of sound pressure is pascal (Pa). Since the range of sound pressures encountered in noise control work is very wide, it is convenient to employ sound pressure level (SPL) which is defined as:

$$\text{SPL} = 20 \log_{10} \left(\frac{P}{Po}\right) \text{dB}$$

where P = the sound pressure in Pa

Po = reference sound pressure of 2×10^{-5} Pa

Pa = Newton/metre^2

dB = decibel

Hence when P = 200 Pa (peak action level),

$$\text{SPL} = 20 \log_{10} \left(\frac{200}{2 \times 10^{-5}}\right)$$

$$= 20 \times 7$$

$$= 140 \text{ dB}$$

4. The apparent loudness that we attribute to a sound varies not only with the sound pressure but also with the frequency. This effect is taken into account by "weighting networks" designated as A, B, C, etc. For industrial noise measurement, frequency A-weighting network is used as it corresponds to the frequency response of the human ear and also has a good correlation to the risk of noise-induced hearing loss (NIHL). Measurement of noise levels are expressed in "decibels weighted on the A-scale" or dB(A).

5. The Factories and Industrial Undertakings (Noise at Work) Regulation provides for the requirements on protection of hearing of employees in industrial undertakings. This guidance notes other than explaining the main provisions of the Regulation in simple language, it affords technical guidance for proprietors to discharge their legal obligation. Whilst every care has been taken in the preparation of this guide, the Regulation remains to be the sole authority of the provisions of the law explained.

Section 2—Interpretation

6. There are three action levels of noise defined in Section 2:

(*a*) "First action level"—a daily personal noise exposure ($L_{EP,d}$) of 85 dB (A)

(*b*) "Second action level"—a daily personal noise exposure ($L_{EP,d}$) of 90 dB (A)

(*c*) "Peak action level"—a peak sound pressure level of 140 dB or peak sound pressure of 200 Pa.

7. The formal mathematical definition of $L_{EP,d}$, expressed in dB(A), is:

$$L_{EP,d} = 10 \log_{10} \left\{ \frac{1}{To} \int_{0}^{Te} \left[\frac{P_A(t)}{Po} \right]^2 \right\} dt$$

where To = 8 hours or 28,800 seconds

Te = the duration of the person's personal exposure to sound

Po = 20 μPa

$P_A(t)$ = the time-varying value of A-weighted instantaneous sound pressure in pascals in the undisturbed field in air at the atmospheric pressure to which the person is exposed (in the locations occupied during the work day), or the pressure of the disturbed field adjacent to the person's head adjusted to provide a notional equivalent undisturbed field pressure.

8. Generally, $L_{EP,d}$ can be regarded as the total exposure to noise throughout the working day, taking account of the average noise levels in working areas and the time spent in them, but taking no account of the effect of any ear protectors worn. In practical situation, the $L_{EP,d}$ values can be readily obtained by using integrating sound level meters or noise dosemeters complying with recognised standards. The equation in paragraph 7 need not be used.

9. The peak pressure is the highest pressure reached by the sound wave, for example the peak pressure of the sound impulse generated by a cartridge-operated fixing tool.

10. The Regulation requires the proprietor to take certain basic steps where an employee is likely to be exposed to noise at or above the first action level.

These, together with additional action, must also be taken where an employee is likely to be exposed at or above the second or peak action level.

11. In practice, action will usually be determined by the average noise level over the working day, from which the value of $L_{EP,d}$ can be determined, except where employees are exposed to infrequent but loud impact or explosive noise, e.g. from cartridge-operated fixing tools, which might cause the peak action level to be exceeded even though $L_{EP,d}$ is below the second action level.

12. Where it is difficult or impracticable to establish $L_{EP,d}$ for the whole working day, it might be necessary to base action on the noise over some shorter sampling period or the area noise level of the workplace (see paragraphs 21 & 22).

Section 3—Assessment of noise exposure

13. The first step of a hearing conservation programme is to measure and evaluate the noise. Section 3(1) requires proprietor to arrange for a noise assessment wherever an employee is likely to be exposed at or above the first or peak action level. The assessment will need to:

(*a*) identify all employees likely to be so exposed; and

(*b*) provide enough information to enable appropriate action to be taken.

Deciding whether an assessment is needed

14. A preliminary decision on whether an assessment is needed can usually be reached without making detailed noise measurements.

15. As a rough guide, the first action level might be reached and an assessment of $L_{EP,d}$ will usually be needed wherever people have to shout to be heard or have difficulty being heard clearly by someone about 2 metres away, or they find it difficult to talk to each other. If some measurements of the noise in a few representative places suggest that any employee might be exposed to the first action level or more, it will be necessary to go on to a more comprehensive assessment.

16. As a result of a comprehensive noise survey across the industry, the Labour Department has drawn up a list of noisy machinery which normally will emit noise exceeding the first action level. A noise assessment is usually required when such noisy machinery is installed. A list of such machinery is given in Appendix 1.

17. Assessments of peak sound pressure are most likely to be needed where employees are exposed to loud explosive noises, such as cartridge-operated

fixing tools. They might also be needed where there are high levels of impact noise, such as from heavy hammering on metal.

Assessment

18. An assessment will be adequate if it meets the objectives set out above. It will need to be based on reliable information about work patterns and noise levels, so the affected employees should be consulted; this will also help ensure their co-operation with any control measures that might turn out to be needed.

19. An adequate assessment can usually be made without making a detailed measurement of each employee's exposure, for example:

(*a*) where groups of employees are employed in an area throughout which the noise level is reasonably uniform, the assessment might be based on noise levels measured in the working area and the length of the time that employees are likely to spend there;

(*b*) where groups of employees perform similar tasks sample measurements on a group of activity basis might be adequate provided that it is representative of individuals within the group;

(*c*) sometimes a calculated noise exposure will be adequate if sufficient information is available about the noise the machines produce during operation, and the nature and duration of tasks carried out by the employees. For example, where employees use noisy portable tools it may be possible to measure the noise level in typical jobs and assess the exposure produced by different patterns of use.

20. Detailed advice on noise surveys is given in Appendix 2: Equipment and procedures for noise assessments in working environments.

Variable exposure to noise

21. Some employees are exposed to noise levels which vary considerably either during the day or from one day to another, for example because they visit a number of noisy areas, or because they do a variety of jobs requiring intermittent use of noisy tools and machines. Sometimes it will be impracticable or of little use to make an accurate measurement of $L_{EP,d}$ for these persons.

22. In these circumstances the best course will be usually to treat all working areas where the average noise level (or "equivalent continuous sound level", Leq) is 85 or 90 dB(A) or more as places where the corresponding action levels are likely to be exceeded (see also paragraphs 45 & 54), until a better assessment can be made.

Review of assessments

23. Section 3(2) requires the proprietor to ensure that the noise assessment is kept up to date and adequate for the purposes of noise control and hearing protection programmes. A new assessment should be made whenever there is a significant change in the work to which the assessment relates or where the proprietor has reason to believe that the assessment is no longer valid. Changes that might create the need for a review include:

(*a*) installation or removal of machinery;

(*b*) substantial changes in workload, work pattern, or machine speeds;

(*c*) changes in building structure or machine layout;

(*d*) machine wear or general deterioration;

(*e*) modifications to machinery and introduction of automation; and

(*f*) the noise control programme (such as change in control equipment).

24. Even where there have been no obvious changes workplaces should not be left for long periods without checking to discover whether there is in fact any need for a review, for example because of a gradual increase in noise level due to machine wear. Spot checks can be made by establishing a few selected locations where the noise is measured periodically such as places where exposure is high or a gradual increase is likely. The interval between checks will depend on local circumstances, but for most kinds of machinery the maximum would be about 2 years (see also paragraphs 66 & 67).

Competent persons

25. Noise assessments have to be made by a person who, by reason of his training and experience, is competent to carry out such assessments meeting the objectives in paragraph 13. The competent person will not have to make all noise measurements personally; often he or she have to supervise collection of information on noise levels and exposure, and its use in the final assessment.

26. The competent person will need to be capable of not only measuring noise but of bringing together and presenting enough information about the noise exposure to enable the proprietor to make correct decisions on what should be done to comply with the Regulation, or of advising on whether additional specialist support is needed. Knowledge alone will not be sufficient; the person should possess experience and skill appropriate to the situations to be handled. He should know:

(*a*) the purpose of the assessment;

(*b*) his or her own limitations, whether of knowledge, experience, facilities or resources;

(*c*) how to record results and explain them to others;

(*d*) the reasons for using various kinds of instrument and their limitations; and

(*e*) how to interpret information provided by others, for example on the noise generated by tools and the jobs done with them, to calculate probable exposures.

27. The level of expertise needed will depend largely on the complexity of the situation to be assessed. Where employees are regularly exposed to steady noise throughout the working day (for example in a weaving shed), or to intermittent but regular periods of steady noise, the task is straightforward and requires little beyond the ability to handle simple instruments and to relate their readings to the requirements of the Regulation. Those who are to assess irregular exposures, or situations where employees intermittently use a variety of different machines will need a better understanding of techniques.

28. The ability to understand relevant guidance to make an assessment meeting the objectives in paragraph 13 is more important than formal qualifications. Many engineers, scientists and other technical staff will have gained sufficient skill to carry out a proper assessment through practical experience of making noise measurements and using the results. Some will, however, need further training. They may obtain the necessary training by attending short courses, for example, the Certificate of Competence in Workplace Noise Assessment Course provided by the Occupational Safety and Health Council (OSHC). The industry trade association and OSHC may offer some advice to help proprietors find competent persons.

29. Graduates of the following courses are considered competent to carry out noise assessments:

(*a*) Hong Kong Polytechnic Associateship in Noise and Vibration Control/Post-experience Diploma in Noise and Vibration Control Course;

(*b*) The Chinese University of Hong Kong Diploma in Occupational Hygiene Course;

(*c*) Hong Kong Polytechnic Certificate of Proficiency in Industrial Safety/Post-experience Certificate in Industrial Safety Course; and

(*d*) Construction Industry Training Authority Construction Safety Officer Course.

30. Section 3(3) requires the competent person after carrying out an assessment to complete an assessment report in a form specified by the Labour Department. A copy of the form is given in Appendix 3.

31. Section 3(4) requires the proprietor to send a copy of the assessment report to the Labour Department within 28 days after completing an assessment.

32. Section 3(5) requires the proprietor to make sure that the appropriate assessment report is kept and readily available for inspection by the Factory Inspectorate.

Section 4—Ear protection zones

33. "Ear protection zone" means any part of an industrial undertaking where the employees are likely to be exposed to the second action level or above or to the peak action level or above. Wherever practicable, the proprietor has to mark ear protection zones with signs showing that they are areas where suitable approved ear protectors must be worn (Figure 1). The signs need to be located at all entrances to the zones, with repetition as necessary within them. The proprietor has to ensure as far as is practicable that all who enters or remains in these zones wear suitable approved ear protectors. With clear demarcation, the invisible noise hazards will become "visible", making proprietors and employees more aware of the need to take preventive measures.

34. This Section does not apply to construction sites. Control of noisy machinery in construction sites is by means of Section 5.

Section 5—Specification of distance for noisy machines or tools

35. When employees are exposed to hazardous machinery noise but where it is not practicable to demarcate ear protection zones, such as in construction sites or where the noisy machine or tool is moved about frequently from time to time (other than inside a demarcated ear protection zone), the proprietor is required to:

Fig. 1 Sign for informing that approved ear protector must be worn (white on a circular blue background)

(*a*) appoint a competent person to carry out a noise assessment to specify a distance within which an employee is at risk of damage to his hearing unless a suitable approved ear protector is worn;

(*b*) attach a sign or label to the machine or tool requiring that a suitable approved ear protector be worn by every employee who operates or assists in the operation of the machine or tool within the specified distance; and

(*c*) ensure that every employee mentioned in subparagraph (*b*) wears suitable approved ear protector.

36. The distance so specified by the competent person will be determined by the sound level of the machine and the exposure time. Again with clear labelling, the invisible noise hazards will become visible, facilitating control. For example, a portable pneumatic concrete breaker is operated by one

employee and assisted by another in a construction site. The $L_{eq,T}$ of the operator is measured to be 103 dB(A) and the operating time is about 2 hours. Then the distance to be specified by the competent person will be the distance where the measured $L_{eq,T}$ is 96 dB(A) which is equivalent to 90 dB(A) $L_{eq,8h}$ (second action level) and is the hearing damage risk criterion.

Section 6—Ear protection

37. Wearing suitable ear protectors may be considered as the most common noise control measure and Section 6 deals with the provision of good quality ear protection.

The need for ear protectors

38. The proprietor's duty to provide suitable approved ear protectors depends on the exposure level:

(*a*) *Between first and second action levels*
Where employees are exposed between the first and second action levels, Section 6(1) requires the proprietor to provide suitable approved ear protectors to employees who request for them.

(*b*) *Second and peak action levels*
Section 6(3) requires the proprietor to provide suitable approved ear protectors to all employees likely to be exposed at or above the second or peak action levels.
Note: Under Section 9(1)(*a*), the proprietor has to ensure these ear protectors are properly used.

39. The proprietor will have to ensure that the required ear protectors are provided as far as is practicable. This means he will need to make sure that the arrangements for their selection and issue follow good practice, as outlined below.

Choosing a suitable type of ear protector

40. Only those ear protectors approved by the Labour Department under Section 7 can be used. To ensure that they are suitable for the conditions where they will be used and are efficient in providing protection, attention should be paid to:

(*a*) the level and nature of the noise exposure. The 'assumed protection' (defined in Appendix 4: Types and selection of suitable ear protectors) should be at least 5 dB(A) or the amount by which the exposure exceeds the second or peak action levels, whichever is the greater;

(*b*) the job and working environment. These can affect comfort, hygiene, etc;

(*c*) compatibility with any other protective equipment or special clothing worn;

(*d*) the fit to the wearer; and

(*e*) any difficulty or discomfort experienced by the wearer.

41. Detailed advice on types of ear protector and their selection is given in Appendix 4.

Arrangements for the issue of ear protectors

42. The arrangements for issuing suitable approved ear protectors will need to include:

(*a*) the provision of information on why they are being issued, where they should be used, how replacements can be obtained and the proper way to wear and look after them (see under Sections 4, 5 & 9).

(*b*) Measures to ensure that employees can readily obtain ear protectors and replacements when they need them. Such might include personal issue to the individual employee. Personal issue of ear plugs should normally be arranged for obvious hygiene reason. If ear muffs need to be re-used, they should be adequately cleaned and disinfected first. Alternatively, dispensers from which employees can take disposable ear protectors as they need them might be used. The dispensers will need to be so located that the employees can conveniently use them and be kept topped up

(*c*) personal choice where this can be reasonably be arranged. Individuals differ in what they find comfortable so wherever possible users should be given a personal choice of ear protector. The proprietor will need to make sure the choice is made from suitable and efficient types.

43. Before ear plugs are first issued the user should be asked whether he or she has any ear trouble such as irritation of the ear canal, earache, discharging ears, or is under treatment for any ear disease. Persons who report such troubles should be referred to a doctor for an opinion on whether they may use the devices with safety.

44. Some people tend to speak quietly when they are wearing ear protectors in noisy areas because they can hear their own voice more clearly, and instinctively lower its volume. This can cause communication problems, so the user should be advised to remember to speak up when wearing the ear protectors. Some users tend to remove ear protectors when speaking to others

in noisy areas—it should be explained to them that once they are used to the situation, communication will be easier with ear protectors than without them.

Employees with variable noise exposure

45. The proprietor should make sure that the employee has suitable ear protectors adequate for the worst situation likely to be encountered and knows when and where to use them (see also paragraphs 21 & 22).

Exemption

46. Section 6(2) provides an exemption from requiring a proprietor to provide a suitable approved ear protector to an employee who is exposed between the first and second action levels where use of ear protector might cause risk to the safety of the employee or of any other person, for example, by making warning sound less noticeable such as when driving a truck in construction site.

Section 7—Approval of ear protectors

47. Ear protectors provided with reasonable noise attenuation data will be approved by the Labour Department. For the purpose of this Regulation, only approved ear protectors can be used. Up to now, more than 130 types of ear protector are suitable for approval. They are listed in Appendix 5. It is important to note that not every approved ear protector is suitable for all situation in noisy working environment. Detailed advice on the selection and types of ear protector is given in paragraph 40 and Appendix 4.

Section 8—Reduction of noise exposure

Programme of measures

48. Where employees are exposed at or above the first or peak action levels, the proprietor will have to reduce exposure as far as is practicable by means other than provision of approved ear protectors. To achieve this, the proprietor will need to implement a programme of control measures. Where adequate reduction is not practicable in the short term, the programme should continue to operate as long as necessary, and should include regular reviews of the feasibility of further noise reduction, taking account of development in noise control techniques.

49. The most reliable way of limiting exposure is to reduce the noise level itself. An effective programme will:

(*a*) identify the noise sources;

(*b*) identify practicable steps to reduce noise level by engineering means;

(*c*) establish priorities for action;

(*d*) ensure that action is taken; and

(*e*) reassess noise exposure.

50. In establishing priorities, the aim should be to identify where action will bring most benefit. In general, higher priority should be given to the more cost-effective measures. Factors to take into account are:

(*a*) the number of people who would benefit from the noise reduction measures;

(*b*) the noise exposure levels involved;

(*c*) the likelihood that engineering effort will produce worthwhile results; and

(*d*) any factors which make reliance on personal ear protection especially undesirable, such as strenuous work in a hot, dirty environment.

51. Programme to control noise by engineering means will only be effective if the staff working on them are competent in noise control engineering, or are advised by someone who is. Sometimes, however, the noise can be obviated by more fundamental changes, such as using a different, quieter process. Here, knowledge of the process and alternative ways of doing the job may be more important.

52. There are many ways of reducing noise; no single technique will be correct for every situation. Some of the measures that should be considered are outlined in Appendix 6: Industrial noise control. Reference should be made to the literature on noise control engineering for more detailed information on techniques. Any successful engineering programme will include a systematic approach to identifying & introducing the right measures, assessment after installation, and further action if needed to overcome any unforeseen practical difficulties that may arise.

53. Limiting the time spent in noisy areas can also help to restrict daily personal noise exposure but usually only to a limited extent—halving the exposure time will reduce $L_{EP,d}$ by only 3 dB(A). Moreover, if it is to be relied upon for this purpose the exposure time will need to be effectively controlled. Nevertheless, any opportunity to obtain short periods out of noise, such as a noise refuge, will help by providing some relief from high noise levels and the need to wear ear protector continuously, even if this does not significantly reduce $L_{EP,d}$.

Employees with variable exposure to noise

54. Where noise exposure is highly variable, either from day to day or job to job (for example construction work or in premises where employees must move about a great deal) it might be difficult to identify how far it is practicable to reduce exposure. However, the assessments should have identified the sources of noise exposure, and appropriate measures might then include:—

(*a*) quietening noisy equipment or tools or replacing them with quieter types, perhaps phased in over time; and

(*b*) making special arrangements to limit noise exposure, particularly if the area visited is not usually occupied, for example by arranging for repairs in a normally unattended machine room to be done when other noisy machinery is shut down.

New machinery

55. Long term noise reduction programmes are only likely to be effective if they include a positive purchasing policy which makes sure noise is taken into account when selecting new machinery. When making enquiries purchasers should ask potential suppliers about information on the noise emission of machines likely to cause exposure at or above the first or peak action level.

56. Data provided by suppliers will usually be the results of tests made under standardised conditions of installation and load. It should be used when comparing different machines, before deciding which to buy, and to predict where noise assessments will be needed when the machines are brought into use.

57. It is preferable for the tests to be carried out in accordance with recognised standards (for example BSI or international standards), where they exist, as this makes it easier to compare information provided by different potential suppliers. Where non-standard procedures are used the supplier should be asked for a clear explanation of them, and even then, skilled interpretation will probably be needed to compare the results of different kinds of test.

58. The machine maker's test data might also be useful for predicting the likely noise levels in working areas when the machines are brought into use. However, because the tests are normally made under standardised conditions skilled interpretation will probably be needed to use the data for this purpose, and the noise will in any case need to be checked after installation.

59. As an alternative to relying on standard tests data arrangements might be made with the supplier for machines to be delivered with a guarantee that the noise after installation will not exceed an agreed value. If this is done the noise should be checked when the machine is brought into use.

60. Where it is necessary to purchase machinery causing employees to be exposed over the action levels, a record of the reasons for the decision will help

guide future action, for example by providing those responsible for future machine specifications with information on where improvements are needed.

Section 9—Maintenance and use of equipment

61. Section 9(1) deals with the proprietor's duty to ensure, as far as is practicable, that approved ear protectors and noise control equipments provided to or installed for the benefit of employees under Section 4, 5, 6 & 8 are properly used and maintained. This will involve following good practice outline below.

Use of equipment

Noise control equipment

62. Regular checks will be needed to find out whether noise control equipment is being properly used. Any deficiencies should be put right promptly. There will also need to be a system enabling employees to report any defects or problems to someone with authority and responsibility for remedial action.

Programme to encourage use of ear protectors

63. People are often reluctant to use protectors, and even where they have been accepted, use tends to fall off over time. Proprietors should have a systematic programme to maintain usage, taking into account the following:

(*a*) the company's safety policy. This should include a firm commitment on personal protection;

(*b*) signs and warning notices—to ensure awareness of where and when protectors should be used (see under Section 10);

(*c*) clear responsibilities. The proprietor should identify who is responsible for the ear protection programme, and the distribution and maintenance of protectors;

(*d*) information, instruction and training for all employees on the risks and the action they should take (see under Section 10);

(*e*) records. These should detail issue of protectors, arrangements for ensuring users know where and how to use them, and any problem encountered in their use;

(*f*) monitoring including spot checks to find whether the protectors are being use. A record should be kept, and deficiencies reported to a person with responsibility and authority for remedial action. Where an employee is not using protection properly he or she should be asked why, and either the difficulty should be resolved or a verbal

warning given and recorded. Where people persistently fail to use protectors properly they should be given a written warning and normal disciplinary procedures should be followed.

Maintenance of equipment

Ear protectors

64. Re-usable protectors will need to be inspected periodically and repaired or replaced if necessary. Where disposable protectors are used checks should ensure that supplies are continuously available, with dispensers topped up regularly. The arrangements should include a system for employees to report and damaged, defective or lost protectors.

65. Proper provision should be made for clean storage of re-usable protectors, such as storage bags for ear muffs or clean lockers where they can be kept with other clothing, and strong cases for ear plugs. Where special cleaning materials are needed these should be kept available to users.

Noise control equipment

66. Noise control equipment such as silencers or enclosures should be checked periodically to make sure they are kept in good condition. Their effectiveness also needs to be monitored; usually spot checks of the noise level at preselected locations will be adequate (see paragraph 24).

67. The results of these checks should be reported to someone with responsibility and authority for taking remedial action.

Employees' duties

68. Programmes for controlling noise exposure are likely to succeed only where there is co-operation between proprietor and employees. Section 9(2) deals with the employee's duty to use the ear protectors provided by the proprietor under the Regulation. Such duty will include:

(*a*) wearing suitable approved ear protectors provided at or above the second or peak action levels, in areas marked as ear protection zones or within the specified distance when operating noisy machinery. It is in their own interest to use ear protectors made available, on request, for exposure between the first and second action levels;

(*b*) taking care of suitable approved ear protectors; and

(*c*) reporting, in accordance with the proprietor's procedure, any defect found in approved ear protectors.

Section 10—Provision of information to employees

69. Where employees are likely to be exposed at or above any action level, the proprietor has to provide adequate information, instruction and training as regards:

(*a*) the likely noise exposure and the risk to hearing that may arise;

(*b*) how to report defects in approved ear protectors;

(*c*) what the employee should do to minimise the risk, such as the proper way to use ear protectors and other equipment, how to look after them, and where ear protectors should be used; and

(*d*) the employee's duties under the Regulation.

70. Employees should also be advised that if any symptoms appear, such as difficulty in understanding speech or using the telephone, or permanent ringing in the ears, it is in their own interest to seek medical advice.

71. Information, instruction and training can be provided by health and safety staff and managers in various forms, including:

(a) oral explanations;

(b) individual counseling and training;

(c) leaflets and posters;

(d) films, video tapes and sound recordings; and

(e) short local training sessions.

No single form will be suitable for all circumstances, and reinforcement from time to time will be needed.

72. The proprietor should make sure that information is given in a form the employees understand.

Section 11—Exemption

73. This Section allows the Labour Department to exempt the proprietor of an industrial undertaking or class of industrial undertaking:

(*a*) from a requirement under this Regulation if compliance with it would not be reasonably practicable; and

(*b*) from ensuring that suitable approved ear protectors are provided under Section 6 or are worn under Section 4(2)(*c*) where the full and proper use of an approved ear protector would cause risk to the safety

and health of the user or compliance with those sections would not be reasonably practicable.

74. Situations where exemptions can be considered are broadly:

(*a*) where there is concern that compulsory use of ear protectors might increase danger overall, outweighing the risk of hearing damage, for example by making a warning sound less noticeable.

(*b*) where it is not reasonably practicable to use ear protectors meeting the general standard required by Section 6 (i.e. to reduce the risk of damage to below second or peak action level).

Section 12—Offences

75. The proprietor of an industrial undertaking, if convicted of an offence under:

(*a*) Section 3(1), 3(2), 4, 5, 6(3), 8 or 9(1) is liable to a fine of $50,000;

(*b*) Section 3(4), 3(5), 6(1) or 10 is liable to a fine of $10,000.

76. The competent person who contravenes Section 3(3) commits an offence and is liable to a fine of $10,000.

77. An employee who contravenes Section 9(2) commits an offence and is liable to a fine of $10,000.

List of common noisy machinery of which noise assessment is usually required

1. Abrasive cutting machinery
2. Circular cutting machinery
3. Extruding and granulating machinery
4. Glass grinding machinery
5. Marble cutting machinery
6. Metal grinding machinery
7. Paper corrugating machinery
8. Plastic granulating machinery
9. Percussive pile driving machinery
10. Power press
11. Rock/concrete breaking machinery
12. Screw/nail making machinery
13. Shuttle weaving machinery
14. Shuttleless weaving machinery
15. Spinning machinery
16. Woodworking machinery (such as circular saw, planing machine, spindle moulding machine, thicknessing machine)

Guide on Equipment and procedures for noise assessment in working environments

Introduction

Noise assessment is the very first step of an effective hearing conservation programme. This guide contains advice on measuring industrial noise exposure, signposting the need for further action in order to fulfil the objectives described in paragraph 13 of the Guidance Notes.

What is measured

2. For the purposes of the Noise at Work Regulation, any audible sound is treated as noise. The exposure to noise at the workplace comprises the noises produced there and the noises arriving from the environment. Where employees are in a noisy environment, the noise should be measured in the working areas they occupy, using a procedure which obviates or minimises the effects of reflections of sound from the employee, as described in paragraphs 12–16.

3. Daily personal noise exposure ($L_{EP,d}$) can be established from the measured equivalent continuous sound level ($L_{Aeq,T}$) during a sample time interval T, and the duration of exposure at work.

4. Depending on the type of noise, additional measurement quantities such as the unweighted octave band sound pressure levels or the peak sound pressure level (L_{peak}) might be required.

Instruments

Integrating sound level meters

5. The most convenient instrument for general purpose use is an integrating sound level meter complying with at least the requirements for a type 2 instrument given in IEC 804 (or BS 6698). Type 1 instruments are preferred. This will be capable of measuring the value of equivalent continuous sound level over the whole day, or over sample periods from which $L_{EP,d}$ can readily be calculated. As shown in Table 1, the 4 grades specified in the standards vary not only in precision but also in the range of amplitude that can be measured on any setting. Overall accuracy will depend on the particular characteristics, particularly the frequency of the noise.

BS/IEC grade	*Typical use*	*Amplitude range on a single setting (dB)*	*Typical overall accuracy (dB)*
0	laboratory reference	70	±0.5
1	laboratory & field	60	±1.0
2	general field	50	±1.5
3	field survey	50	±3.0

Table 1—Typical accuracy of sound level meters

Simple sound level meters

6. Simple sound level meters complying at least with the requirements for a type 2 instrument given in IEC 651 (or BS 5969) are suitable for measurement of continuous or intermittent periods of steady noise (for example in a weaving shed). They are very convenient for making routine spot checks when reviewing assessments (see para 24 of the Guidance Notes).

Noise dosemeters (Personal sound exposure meters)

7. These are worn by the person whose exposure is being determined, to measure the total noise dose over the whole working period. The microphone usually has to be located very close to the person's body so reflections may affect the result. The British Standard for these meters is BS 6402. In order to avoid the instrument being overloaded by the peak sound pressure, instruments incorporating an overload indication are preferred.

Peak pressure

8. A very rough check to estimate whether measurements of peak pressure with more sophisticated instruments are needed can be made with a simple sound level meter set to 'Fast' response. If the reading exceeds 125 dB(A) it should be assumed that more accurate measurements ought to be made. To do this an instrument with a rise or onset time of 100 microseconds or less will be needed. The equipment should have an unweighted response to the main audible frequencies, but exclude frequencies too high or too low to be significant. C-weighting will be suitable for this. The 'LIN' characteristics can also be used although if the instrument has an extended frequency response, it might respond to frequencies outside the main audible range, resulting in a higher reading.

9. Sound level meters complying with IEC 651 with type 1 specification and set to Peak Hold will meet the above requirement. Note that there are very few situations where an exposure above the peak action level does not yield an $L_{EP,d}$ greater than 90 dB(A).

Calibration and checking

10. Each time before and after noise measurements, the acoustic properties of the sound level meter should be checked by means of an acoustic calibrator or pistonphone with an accuracy of at least 0.5 dB.

11. A full calibration of equipment can only be verified in a properly equipped laboratory, and this should be done periodically. Normally the interval should not exceed 2 years.

Measurement procedure

General

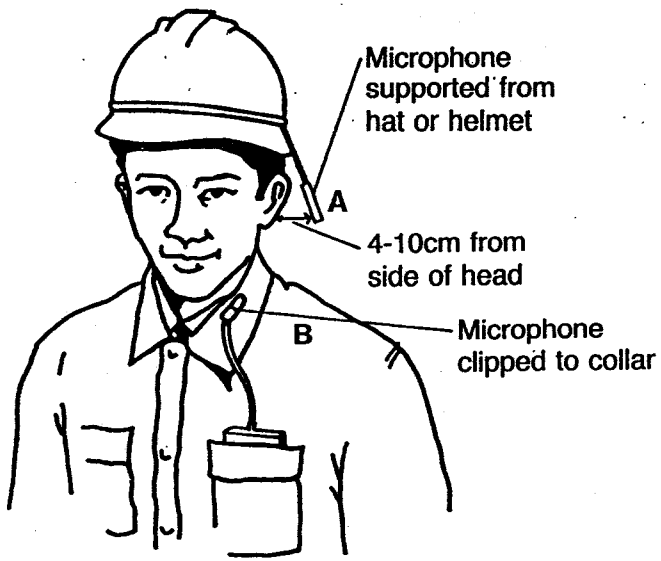
12. The measurement should provide typical quantitative description of the characteristic potential noise exposure of employees in the workplace. To achieve this, a sufficient number of independent measurements (samples) by integrating sound level meter must be performed. The measurement duration should be long enough for the resulting noise exposure level to be representative of the activities performed by the employees. The duration should be either the entire length of an activity, a portion thereof, or several repetitions of the activity, as required to obtain a steady meter reading within 0.5 dB. In any case, the integrating time should be at least 15 seconds. The integrating sound level meter should be set at 'Fast' response and held at arm's length to avoid reflections and blocking of sound from some directions. Windshield must be used when measurement is done outdoor in order to reduce wind noise, dust and humidity effects.

Microphone location

13. Ideally the measurements should be made in the 'undisturbed field', i.e. in the absence of the person whose exposure is to be measured, with the microphone located in the area normally occupied by the person's head.

14. Often operators need to be present while the measurements are made, for example to control the machine. Measurements should be made with the microphone positioned close enough to the operator's head to obtain a reliable assessment of the noise to which they are exposed, but preferably not so close that reflections from them cause errors. The results are unlikely to be significantly affected by reflections if the microphone is kept at least 4 cm away from the operator. The microphone should be placed on the side subject to most noise.

15. When using a personal noise dosemeter, the microphone has to be mounted very close to the person's body, reflections from the body will reduce measurement accuracy. Locations very close to the outer ear are particularly affected and should be avoided if possible. The usual locations of microphones for dosemeters are shown in Figure 1. When the microphone is at the 'B' position, a slightly higher readings (about 2 dB(A)) will be obtained.



A – head-mounted microphone
B – collar or shoulder-mounted microphone

Fig. 1 Location of microphones for dosemeters

16. Occasionally a microphone within, or very close to, the external ear has to be used, for example when using microphone to measure the sound pressure level under a headset, headphone, or inside a shotblasting helmet. This will produce results which are difficult to compare directly with the First and Second Action Levels because the measured values might need to be adjusted to obtain a notional undisturbed field pressure level. The technique is still being developed and should be carried out by someone with specialist knowledge.

Single site measurements

17. When the exposure to noise of an employee who works at an approximately fixed location relative to the noise source has to be determined, measurements in terms of $L_{Aeq,T}$ should be made in one of the following ways:

(*a*) with the employee absent, the microphone being located at approximately head height at the employee's normal working position; or

(*b*) with the employee present, the microphone being located close to the side of the head having the higher sound level.

Area measurements

18. When a number of employees work in an area of approximately equal sound level the following procedure may be used to determine the average sound level to which the employees are exposed.

19. Measurements in terms of $L_{Aeq,T}$ should be made at not less than 4 locations which are representative of the positions occupied by the employees, and well distributed over the area to be tested. Normally the microphone should be placed about 1.5 metres above the floor for standing employees and 0.8 metre for seated employees. The sound levels should be averaged to obtain the level for the area. The locations should be selected to enable the worst likely exposure to be calculated.

20. The highest sound level to which employees are exposed within an area should differ from the lowest by less than 5 dB(A). Any place occupied by employees where the sound level differs by more than this should be treated as a separate site or area. This will provide useful information to indicate for each separate area its respective levels of exposure.

Employees who move about with highly variable exposures

21. If employees move from one area to another or perform various jobs, their daily personal noise exposures may be measured by monitoring the sound level to which they are exposed as they perform their work. A portable magnetic tape recorder, a noise dosemeter, or any other apparatus capable of measuring the personal sound exposure of the employee may be used for this purpose, provided that the equivalent continuous sound level can be determined from the instrument readings.

22. As an alternative to monitoring the sound level during normal work, it may be possible to determine the 'fractional exposure' resulting from each of the jobs carried out by the employee. The daily personal noise exposure can then be determined by combining the various exposures from each job, using the rules set out below.

Method of calculating $L_{EP,d}$

23. To obtain $L_{EP,d}$, measurements in $L_{Aeq,T}$ will need to be adjusted to take account of the length of time an employee is likely to be exposed to the noise. One way is to use the nomogram in Fig. 2.

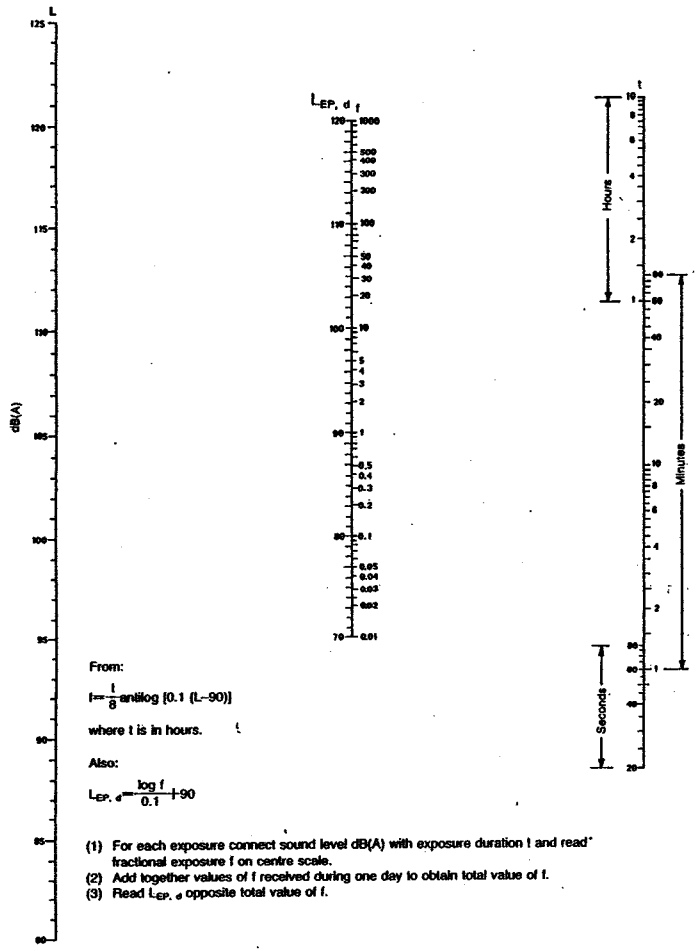


Fig. 2 Nomogram for calculation of $L_{EP,d}$

Where there is only one significant level of noise during the day

24. The $L_{EP,d}$ value can be obtained from the nomogram in Fig 2 by drawing a straight line connecting the measured value on the L scale with the exposure duration on the t scale. $L_{EP,d}$ can be read at the point of intersection with the centre scale.

Example 1. An employee is exposed to a sound level of 103 dB(A) for 3 hours per day. During the rest of the day the level is about 76 dB(A) which may be ignored.

From Fig. 2, $L_{EP,d}$ = 99 dB(A) (rounded up to the next higher dB)

When there is more than one significant noise level

25. Exposure at each significant level can be converted to a value of 'fractional exposure (f)' using Fig. 2. The values of 'f' obtained during one day should be added together, and the total value of f converted to $L_{EP,d}$ using the centre scale of the nomogram.

Example 2. An employee is exposed to the pattern of noise in the first 2 columns of the table below. The third column shows the corresponding values of f which are added together and converted to $L_{EP,d}$:

Noise level dB(A)	*Exposure duration*	*f (from Fig. 2)*
112	30 min.	10
108	45 min.	6
95	1 hour	0.4
	TOTAL	16.4

From Fig. 2, $L_{EP,d}$ = 102 dB(A) (to the nearest whole dB(A))

26. Alternatively, $L_{EP,d}$ can be calculated by the following formula:

$$L_{EP,d} = 10 \log \frac{1}{8} \left[\sum_{i=1}^{n} t_i \times 10^{\frac{L_{PAi}}{10}} \right]$$

where t_i = exposure duration in hour of the i th measurement

L_{PAi} = noise level in dB(A) of the i th measurement

Example 3. Using the data in Example 2,

$$L_{EP,d} = 10 \log \frac{1}{8} \left[\frac{30}{60} \times 10^{11.2} + \frac{45}{60} \times 10^{10.8} + 1 \times 10^{9.5} \right]$$

= 102 dB(A) (to the nearest whole dB(A))

Single event noise

27. For some machines, such as cartridge-operated fixing tools, it may be convenient to establish the noise dose caused by a single operation of the machine. This can be achieved by using an integrating meter capable of measuring the Leq over a sample period, or some other measure of the total noise such as Sound Exposure Level (SEL), to measure the noise when the machine is operated a known number of times.

Example 4. The noise from a device producing an impact had the characteristics illustrated in Fig. 3. To establish the dose, the noise was measured with an integrating meter and the fractional exposure caused by each operation calculated as follows:

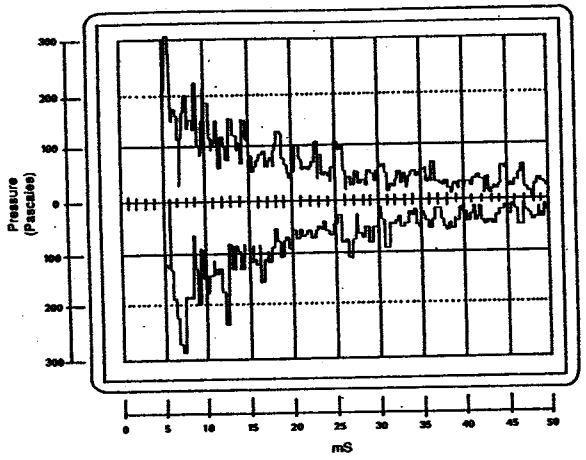


Fig. 3 Time history of an impact noise

(*a*) The meter was switched on and the device operated 10 times.

(*b*) After 5 minutes (a period arbitrarily chosen for convenience in operating the device and reading the meter) the meter indicated a value of Leq of 99 dB(A).

(*c*) The background noise was measured over a similar period and found to be 60 dB(A) which can be neglected.

(*d*) From Fig. 2, a level of 99 dB(A) for 5 minutes will cause a fractional exposure of 0.08.

(*e*) Therefore fractional exposure for a single operation of the device is 0.008 (i.e. 125 operations will cause a fractional exposure of 1 or an $L_{EP,d}$ of 90 dB(A)).

Value of $L_{EP,d}$ caused by repeated single event noise

28. If the value of 'f' known for a single operation, this can be multiplied by the number of operations per day to obtain the total daily exposure which can then be converted to $L_{EP,d}$ using Fig. 2.

Example 5. The tool used in Example 4 is operated 800 times per day. Other noise is negligible.
Total daily value of f = 800 × 0.008 = 6.4
From the centre scale of Fig. 2, $L_{EP,d}$ = 98 dB(A)

Records of assessments

29. Records of assessments should be entered in the appropriate Noise Assessment Report (see Appendix 3). A copy of the report should be sent to the Labour Department within 28 days after completing the assessment.

Appendix 3

Noise Assessment Report
Factories and Industrial Undertakings (Noise at Work) Regulation

Name of Industrial Undertaking: _____

Address: _____

Date of survey: _____ Ref. No.: _____

Survey made by: _____ Occupation: _____ Training/experience: _____

Item No.	Brief description of area/location machinery/plant activity/task	Noise level		Daily exposure period	$L_{EP,d}$ dB(A)	No. of employees exposed	Description of ear protector if provided	Description of demarcated ear protection zone (comment if not demarcated)
		$L_{Aeq,T}$	Lpeak (where appropriate)					

General comments: _____ Signature: _____

Instruments used: _____ Date: _____

Date of last calibration: _____

Note: This report must be sent to Commissioner for Labour within 28 days of completing the assessment

Guide on
Types and selection of suitable ear protectors

Introduction

This Appendix provides detailed advice on types of ear protectors and their proper selection. It must be stressed that only those types of ear protectors approved by the Labour Department are to be used in accordance with this Regulation.

Types of ear protector

Ear muffs

2. These are normally hard plastic cups which fit over and surround the ears, and are sealed to the head by cushion seals filled with a soft plastic foam or a viscous liquid. The inner surfaces of the cups are covered with a sound absorbing materials, usually a soft plastic foam.

3. Various kinds of headband are used to hold and press the muffs to the head. They need to be treated with care to avoid overbending or distorting the pressure straps, which will degrade the acoustic performance.

4. Ear muffs have several advantages compared with ear plugs. One size will fit most people and they are easy to remove and replace—an advantage for people who frequently move from a noisy to a quiet place. However, they tend to make the ears hot, are bulky and less convenient if slipped around the neck when not in active use.

5. Communication equipment can be built into ear muffs, receiving signals from a wired or aerial system. This allows information to be relayed to the wearer, and may encourage wearing. In some circumstances however, they might detract from overall safety. The following safety points must be watched:

(*a*) the sound level produced inside the muffs need to be limited to avoid creating a new noise hazard;

(*b*) where the muffs are used to receive spoken messages the microphone should, where possible, be switched off when not in use to avoid spurious background noise;

(*c*) checks should be made to make sure that it is possible to hear necessary warning sounds above the sounds introduced into the muff. If necessary a louder alarm, or one with a more distinct character, should be used; and

(*d*) alarms need for safety should not normally be relayed through the system because of the risk of system failure, unless it can be designed to 'fail-safe'.

6. The headsets supplied with personal stereos usually provide little or no attenuation of external noise and should not be relied on to provide ear protection.

Ear plugs

7. Ear plugs fit into the ear canal. They sometimes have a cord or neck band to prevent loss. Some types are intended to be used for a very long time (permanent), some to be thrown away after one use (disposable) and others to be used just a few times (reusable).

8. Ear plugs will probably not be suitable for persons suffering from ear disease.

Permanent rubber or plastic plugs

9. These are usually available in a range of sizes. To obtain a good seal in the ear canal it is essential that the correct size is used, resulting in a slightly tight fit. Some people need a different size plug for each ear.

10. So-called 'universal-fitting' ear plugs are also available. These have administrative advantages because one size can fit most people, but they are usually less reliable than plugs supplied in various sizes. They are also prone to misuse because they can be retained in the ear even when not fully inserted, resulting in little protection.

11. 'Custom moulded' ear plugs are made from a material such as silicone rubber individually moulded to fit a person's ears. This can give good results and are comfortable. They must be made by someone trained in the process.

12. Reusable plugs need to be cleaned regularly and replaced when they have lost efficiency. The material will degrade with age, resulting in loss of fit and protection, so the proprietor's programme needs to include provision for regular replacement. The supplier should be asked for advice on suitable methods of cleaning and the life expectancy of the ear plugs.

Disposable and 'reusable' ear plugs

13. These are convenient to issue and widely used. They are made from various compressible materials such as plastic foam, or fine mineral down (often contained in plastic membrane). They have the advantage of being able to fit most people without requiring specialist fitting.

Semi-inserts

14. These are pre-moulded ear caps attached to a headband which presses them against the entrance of the ear canal. To make an effective seal the headband needs to press the caps firmly into the ear canals, and some people find the pressure intolerable, especially over long periods. Other find them convenient because they can be slipped off easily in quiet periods.

Special types of ear protector

15. Various other types of ear protector are available designed to deal with specific problems. They include frequency selective, amplitude sensitive, active attenuation and noise-excluding helmets. However, they are not suitable for general use in industry.

Suitability for the individual, fitting and training

16. Whichever type of ear protector is used, it will only provide the assumed protection if it is in good condition, it fits and is suitable for the individual and is worn properly.

17. All permanent ear plugs, including the 'universal fitting' type should be initially fitted to the individual by a trained person who should instruct the user the correct method of insertion.

18. Ear muffs do not need specialist fitting, but the fit should be checked to make sure that they completely surround the ear, and the seal is in contact with the head all round.

19. The necessary information, instruction and training provided to employees on use of ear protector include:

(*a*) how to insert ear plugs;
(*b*) the importance of correctly fitting ear muffs; and
(*c*) the importance of clearliness in preventing infection and how to clean ear protectors.

Maintenance

20. Ear protectors must be maintained in good condition. Points to check include:

(*a*) the condition of ear muff seals, which may be torn or become hardened with age;
(*b*) the tension of headbands;
(*c*) unauthorised modifications such as holes drilled in ear muffs;
(*d*) resilience and softness of ear plugs; and
(*e*) general cleanliness

With experience simple checks can be made by inspection and feel. It is a good practice to keep a set of ear protectors in new condition to provide a basis for comparison.

Comfort

21. All ear protectors are likely to be somewhat uncomfortable, especially in hot, sweaty conditions. Careful selection can minimise this, but it is necessary to strike a balance between comfort and other requirements such as durability, degree of protection and suitability for the job.

22. The main factor affecting the comfort of ear muffs is the pressure of the seals on the head. This can be kept low by using seals which need only a low headband force. A high contact area between seal and head also helps, but in hot conditions a low contact area helps to reduce sweating. Liners which fit between seal and head can absorb sweat, but may reduce protection; the assumed protection (see para 27) should be calculated from test data which take their use into account. Other important factors include the weight of the muffs (the lighter the better) and cups large enough to clear the wearer's external ear.

23. The comfort of ear plugs will mainly depend on the pressure on the contact area between ear canal and ear plug. Types which can conform readily to the wearer's ear canal, and 'custom moulded' plugs will usually be found most comfortable.

24. Comfort is a matter on which people vary considerably. Some prefer ear plugs in hot environments, but others find any ear plug extremely uncomfortable and prefer muffs. Wherever possible the proprietor should select more than one type of suitable ear protector and allow the user a personal choice among them.

Efficiency of protection

25. The 'assumed protection' calculated from test data can only be provided if the ear protectors fit and are properly worn. In practice, many factors militate against this, such as:

(*a*) Interference with ear muff seals. As illustrated in Fig. 1, anything between the seal and head is likely to reduce performance. Goggles and spectacles should have thin frames, or should be held by straps which do not pass under the seal. Long hair and beard can also reduce the performance of muffs.

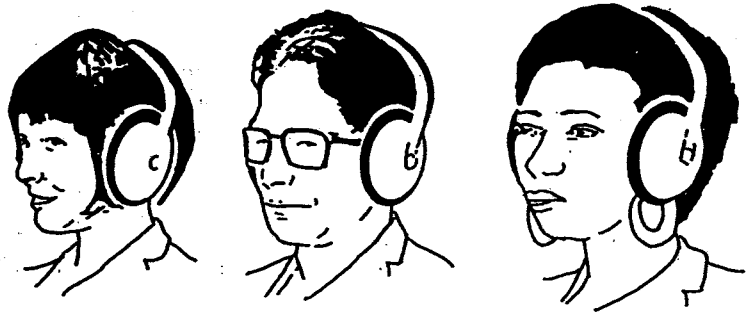


Fig. 1 Some reasons why the seals of ear muffs do not always work properly

(*b*) Ear muffs incompatible with other equipment worn. Helmets and face shields might prevent ear muffs fitting correctly if there is insufficient space between them and the muffs. Where ear muffs have to be worn inside a helmet, such as shotblaster's helmet, the wearer's ability to move their head comfortably will need to be checked. Ear plugs and often the easiest way of avoiding compatibility problems.

(*c*) Poor seating of ear plugs. Ear plugs need to be properly inserted into the ear to make a good seal.

(*d*) Failure to use ear protectors all of the time in noisy areas. If the protectors are removed in noisy places, even for short periods, the amount of protection provided will be severely reduced. For example, if a very efficient protector with an assumed protection of 30 dB(A) is removed for 30 minutes per day, the actual reduction in noise dose received by the user will only be about 12 dB(A), i.e. a loss of 18 dB(A) protection. Table 1 shows the protection actually received if protectors are not worn for periods in an 8-hour shift.

Hours worn in 8-hour shift	*8*	*7*	*6*	*5*
Protection provided by ear protector dB(A)	Nominal protection		Actual Protection	
	30	9	6	4
	20	9	6	4
	10	7	5	3.5

Table 1 Protection provided by ear protector with exposure time

To calculate the protection provided using test data

Test data on attenuation

26. All approved ear protectors are provided with attenuation data complying with BS 5108 or other national standards. The data are supplied as the mean value with a standard deviation for each frequency tested.

Calculating 'assumed protection' from the data

27. It can be assumed that the protection given to most people (about 84%) is equivalent to the mean attenuation minus the standard deviation at each test frequency, see Example 1 below.

Example 1. BS 5108 test data for an approved ear protector is given below. The assumed protection is obtained by subtracting the standard deviation from the mean value.

Frequency (Hz)	*63*	*125*	*250*	*500*	*1K*	*2K*	*4K*	*8K*
Mean attenuation (dB)	21.7	22.0	21.3	20.3	23.0	29.8	44.9	43.3
Standard deviation (dB)	4.4	4.9	5.8	5.1	4.6	5.5	4.2	5.2
Assumed protection (dB) (rounded to the nearest whole no.)	17.	17	16	15	18	24	41	38

28. The overall assumed protection will depend on the frequency composition of the noise, and will be equal to the difference between the actual noise exposure and the assumed protected level (APL) calculated as below.

Assumed protected level of exposure (APL)

29. To calculate APL, a frequency analysis of the measured noise will be needed. This is best done as octave band values of $L_{EP,d}$. Selection can also be based on an eye-average value of octave band sound pressure levels for the noisiest period, using a simple sound level meter provided the fluctuations do not exceed 5 dB(A) when the instrument is set to 'Slow' response.

30. The assumed protection for each frequency should be subtracted from the measured values of octave band sound pressure levels, to obtain values of APL, which should be converted to an A-weighted value of APL using the procedure explained below.

Method 1

31. The procedure is as follows:

(*a*) The A-weighting correction given in Table 2 is added or subtracted arithmetically to each octave band sound pressure level.

Octave band centre frequency (Hz)	*63*	*125*	*250*	*500*	*1K*	*2K*	*4K*	*8K*
A-weighting correction	– 26	– 16	– 8.5	– 3	0	+1	+1	– 1

Table 2 A-weighting corrections

(*b*) The A-corrected octave band levels are summed in a pair-wise fashion starting from the lowest levels, using Table 3:

Difference in dB(A) between two sound levels being summed	*Amount of dB(A) to add to the higher sound level*
0 to 0.5	3.0
1.0 to 1.5	2.5
2.0 to 3.0	2.0
3.5 to 4.5	1.5
5.0 to 7.0	1.0
7.5 to 12.0	0.5
more than 12.0	0

Table 3 Summation of sound levels

(*c*) The final total sound level is rounded to the nearest whole dB(A) with values of 0.5 or more being rounded upwards.

Example 2. A noise with a level of 110 dB(A) has octave band sound pressure levels as shown below. Values of assumed protection from Example 1 are used to obtain octave band levels of APL.

Column 1	Column 2	Column 3	Column 4	Column 5
Octave band centre frequency (Hz)	*Octave band sound presure level (dB)*	*Assumed protection (dB) (from Example 1)*	*A-weighting correction (dB) (from Table 2)*	*A-corrected octave band level (dB) (Column 2– Column 3+ Column 4)*
63	89	17	–26	46
125	91	17	–16	58
250	95	16	–8.5	70.5
500	100	15	–3	82
1K	102	18	0	84
2K	105	24	+1	82
4K	104	41	+1	64
8K	98	38	–1	59

To sum the A-corrected octave band levels (column 5), take the two lowest levels (46 & 58) as the first pair for adding as below and then take the result of this adding and the next lowest level from the remaining levels for further adding, until all levels are similarly added:

(*a*) Find the difference between them i.e. 12 dB(A)

(*b*) Read from Table 3 the figure to be added (i.e. 0.5 dB(A), the corresponding figure for the difference of 12 dB(A))

(*c*) Add this figure to the higher sound level, i.e. 58 + 0.5 = 58.5 dB(A)

(*d*) Add this result to the next lowest level (59) of the remaining levels, i.e. 58.5 dB(A) + 59 dB(A)
= 59 + a figure corresponding to a difference of 0.5 dB(A)
= 59 + 3
= 62 dB(A)

(*e*) Add this result to the next lowest level (64) of the remaining 5 levels, i.e. 62 dB(A) + 64 dB(A),
= 64 + 2 (for a difference of 2 dB(A))
= 66 dB(A)

(*f*) Add this result to the next lowest level (70.5) of the remaining 4 levels, i.e. 66 dB(A) + 70.5 dB(A),
= 70.5 + 1.5 (for a difference 4.5 dB(A))
= 72 dB(A)

(*g*) Add this result to the next lowest level (82) of the remaining 3 levels, i.e. 72 dB(A) + 82 dB(A),
= 82 + 0.5 (for a difference 10 dB(A))
= 82.5 dB(A)

(*h*) Add this result to the next lowest level (82) of the remaining 2 levels, i.e. 82.5 dB(A) + 82 dB(A),
= 82.5 + 3 (for a difference 0.5 dB(A))
= 85.5 dB(A)

(*i*) Add this result to the remaining level,
i.e. 85.5 dB(A) + 84 dB(A)
= 85.5 + 2.5 (for a difference of 1.5 dB(A))
= 88 dB(A)

This approved ear protector is considered suitable for the working environment provided the total exposure time is not more than 8 hours, i.e. exposure is below the second action level when used.

Method 2

32. The sum of the A-corrected octave band levels can be obtained by the following formula:

$$\text{Sum} = 10 \log_{10} \left[\sum_{i=1}^{n} 10^{\frac{L_{PAi}}{10}} \right] \text{dB(A)}$$

where L_{PAi} = noise level in dB(A) of the i th band

Example 3. Using the data in Example 2,

$$\text{Sum} = 10 \log_{10} [10^{4.6} + 10^{5.8} + 10^{7.05} + 10^{8.2} + 10^{8.4} + 10^{8.2} + 10^{6.4} + 10^{5.9}]$$

$$= \underline{\underline{88 \text{ dB(A)}}} \text{ (rounded to the nearest whole dB(A))}$$

Dual protection

33. Situation may arise where the noise level is extremely high, such that the best ear muffs or plugs available, used alone, might not be capable of providing enough value of assumed protection. This problem is likely where $L_{EP,d}$ exceeds about 115 dB(A), especially if there is substantial noise at frequencies less than 500 Hz.

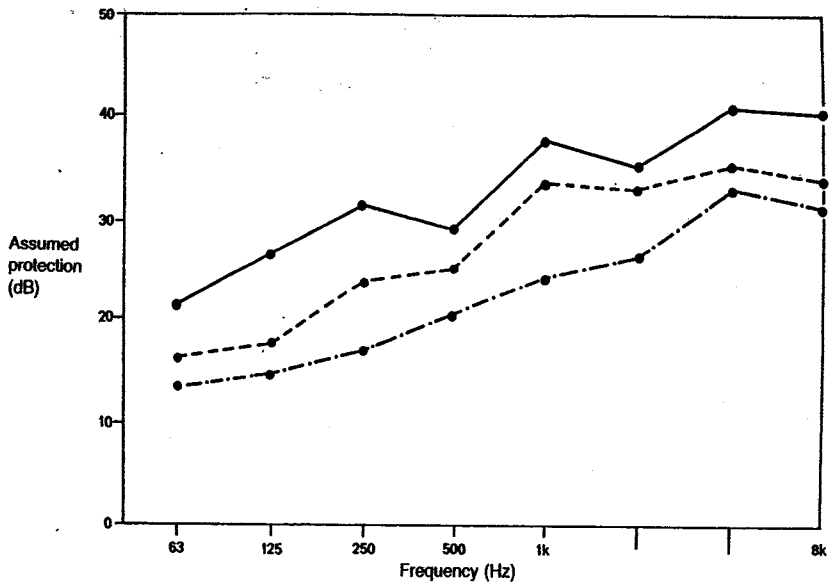
34. Improved protection can be obtained by wearing a combination of ear muffs and plugs. Figure 2 shows the improvement obtained in one particular combination. The value of assumed protection will depend on the particular muff and plug used. In general, the most useful combination is a high performance plug with a moderate performance muff—a high performance ear muff adds a little extra protection but is likely to be less comfortable.

35. There is no general rule for using the test data provided with ear muffs and plugs to estimate the assumed protection they will provide in combination. Each combination will need to be tested using a recognised procedure such as BS 5108.

'Single number' ratings for attenuation

36. To avoid the need for a frequency analysis of the noise and simplify selection of ear protectors, several systems have been proposed in which the assumed protection is given as a single overall number. One system is used in the USA, where all ear protectors carry a 'Noise Reduction Rating' (NRR value). At present however none of the systems is recommended in connection with the Regulation.

37. When these systems are designed there is usually a conflict between simplicity and accuracy. Simple systems do not forecast the protection accurately, and in making sure that errors are usually on the safety side leaving many people overprotected, and expected to wear ear muffs heavier and less comfortable than really required. More accurate systems tend to be more complicated to use.



●-·-·-● Assumed protection of the ear plugs worn alone (high performance conformable).
●- - - ● Assumed protection of the ear muffs worn alone (high performance).
●——● Assumed protection of the ear plugs and ear muffs in combination.

NOTE: This shows the assumed protection provided by only one combination of muffs and plugs. Before reliance is placed on protectors used in combination, similar data should be obtained for the particular combination to be used.

Fig. 2 Dual protection—ear muffs and plugs worn in combination

Appendix 5

List of approved ear protectors

1. 3M 1100 Ear Plug
2. 3M 1110 Ear Plug
3. 3M 1200 Ear Plug
4. 3M 1210 Ear Plug
5. 3M 1220 Ear Plug
6. 3M 1230 Ear Plug
7. 3M 1400 Ear Muff
8. 3M 1410 Ear Plug
9. 3M 1420 Ear Plug
10. 3M 1450 Hard Hat Mounted Ear Muff
11. AO 1720 Ear Muff
12. AO 1776K Cap Mounted Ear Muff
13. AO Hear-Guard Ear Plug
14. AO Quiet Tip Ear Plug
15. AO Sound Out Ear Cap
16. Bilsom 202 Ear Plug
17. Bilsom 202S/202L Ear Plug
18. Bilsom 203 Ear Plug
19. Bilsom 203S/203L Ear Plug
20. Bilsom 303 Ear Plug
21. Bilsom 303S/303L Ear Plug
22. Bilsom 304 Ear Plug
23. Bilsom 304S/304L Ear Plug
24. Bilsom 715 Foldable Ear Muff
25. Bilsom 717 Ear Muff
26. Bilsom 718 Helmet Ear Muff
27. Bilsom 727 Ear Muff
28. Bilsom 728 Helmet Ear Muff
29. Bilsom 737 Special Ear Muff with liquid-filled cushions
30. Bilsom 747 Ear Muff
31. Bilsom Down Ear Plug
32. Bilsom ECO Ear Plug
33. Bilsom Form Ear Plug
34. Bilsom Perfit Ear Plug
35. Bilsom Perfit Detectors Ear Plug
36. Bilsom Perflex Ear Plug
37. Bilsom Perflex Detectors Ear Plug
38. Bilsom P.O.P. Ear Plug
39. Bilsom Quietzone Ear Plug
40. Bilsom Soft Ear Plug
41. Bilsom Ultra Soft Ear Plug

42. Bilsom Whisper Ear Plug
43. Bilsom Blue Ear Muff
44. Bilsom Comfort Ear Muff
45. Bilsom Compact Ear Muff
46. Bilsom Com Impact Ear Muff
47. Bilsom Green Ear Muff
48. Bilsom Impact Viking Ear Muff
49. Bilsom Loton Ear Muff
50. Bilsom Marksman-Pro Ear Muff
51. Bilsom Pocket Ear Muff
52. Bilsom Special Ear Muff
53. Bilsom Viking Ear Muff
54. Bilsom Blue Helmet Ear Muff
55. Bilsom Comfort Helmet Ear Muff
56. Bilsom Guard Helmet Ear Muff
57. Bilsom Viking Helmet Ear Muff
58. Centurion Helmet Mounted Type S41 Ear Muff
59. CIGWELD Noise Ban Ear Cap
60. CIGWELD Silenta Sport Mil Ear Muff
61. CIGWELD Silencer Ear Muff
62. CIGWELD Silenta Super-Mil Ear Muff
63. CIGWELD Silenta Bel II Ear Muff
64. CIGWELD Silenta Mil Ear Muff
65. CIGWELD Silenta Ergo Ear Muff
66. CIGWELD Silenta Ergo II Ear Muff
67. CIGWELD Silenta Universal Ear Muff
68. CIGWELD Silenta Super Ear Muff
69. CIGWELD Silenta Universal Helmet Mounted Ear Muff
70. CIGWELD Silenta Super Helmet Mounted Ear Muff
71. CIGWELD Air Soft Ear Muff
72. CIGWELD QB2 Ear Cap
73. CIGWELD Max-1 Ear Plug
74. David Clark Straightaway 10A Ear Muff
75. David Clark Straightaway 27 Ear Muff
76. David Clark Straightaway 310 Ear Muff
77. David Clark Straightaway 320 Ear Muff
78. David Clark Straightaway 705 Ear Muff
79. David Clark Straightaway 730 Ear Muff
80. David Clark Straightaway 731 Ear Muff
81. David Clark Straightaway 732 Ear Muff
82. David Clark Straightaway 805 Ear Muff
83. David Clark Straightaway 805V Ear Muff
84. David Clark Straightaway 850 Ear Muff
85. EAR Ear Cap
86. EAR Caboflex Model 600 Ear Plug

87. EAR E Z Fit Foam Ear Plug
88. EAR Ear Plug
89. EAR Express Pod Ear Plug
90. EAR Taperfit Foam Ear Plug
91. EAR Taperfit 2 Foam Ear Plug
92. EAR Tracers Ear Plug
93. EAR Ultrafit Ear Plug
94. EAR Model 820 Ear Muff
95. EAR Model 1000 Ear Muff
96. EAR Model 3000 Ear Muff
97. EAR Ultra 9000 Ear Muff
98. Earguard 204 Ear Muff
99. Earguard 258 Ear Muff
100. Earguard 290 Ear Muff
101. Earguard 304 Ear Muff
102. Earguard 970 Ear Muff
103. Eastern 509 Ear Plug
104. Eastern 510 Ear Plug
105. Eastern 510-2 Ear Muff
106. Eastern 511 Ear Muff
107. Eastern 512 Ear Plug
108. Eastern 513 Ear Plug
109. Eastern 986 Ear Plug
110. Eastern 987 Ear Plug
111. Fibre Metal 2011 Ear Muff
112. Howard Leight Max Ear Plug
113. Howard Leight Max-Lite Ear Plug
114. Howard Leight Laser-Lite Ear Plug
115. Howard Leight Quiet Ear Plug
116. Howard Leight Airsoft Ear Plug
117. Howard Leight QB 2 Ear Plug
118. Howard Leight QB 3 Ear Plug
119. Howard Leight LM-77 Ear Muff
120. Howard Leight LM-7 Ear Muff
121. Howard Leight LM-7H Cap Mount Ear Muff
122. Howard Leight QM-29 Ear Muff
123. Howard Leight QM-24 Ear Muff
124. Howard Leight LASER TRAK LT-30 Ear Plug
125. Howard Leight D-TEK DT-30 Ear Plug
126. Invincible, Helmet Mk II Mounted Ear Muff
127. Mine Ear Defenders Ear Plug
128. Mine Ear Defenders II Ear Plug
129. Mine Accu-Fit Ear Plug
130. Mine Noisefoe Mark II Ear Muff
131. Mine Noisefoe Mark IV Ear Muff

132. Mine Noisefoe Mark IV MC Ear Muff
133. Mine Noisefoe Mark V Ear Muff
134. Mine Comfo 500 Ear Muff
135. Moldex 6500 Pura-Band Ear Plug
136. Moldex 6800/6900 Pura-Fit Ear Plug
137. North Comfit Ear Plug
138. North Decidamp Ear Plug
139. North Peacekeeper Ear Plug
140. North Silent Band-It Ear Plug
141. North Silent Partner Ear Plug
142. North Sonic Ear Valve Ear Plug
143. Primex Airsoft Ear Plug
144. Protector Safety EP 29 Ear Plug
145. Protector Safety EP 35 Ear Plug
146. Protector Safety EML 10 Ear Muff
147. Protector Safety EMM 11 Ear Muff
148. Protector Safety EMH 12 Ear Muff
149. Protector Safety EMU 44P Ear Muff
150. Protector Safety EML 45 Ear Muff
151. Protector Safety EMLU 47 Ear Muff
152. Protector Safety EMCC 50 Helmet Mounted Ear Muff
153. Protector Safety EM 54 Helmet Mounted Ear Muff
154. Protector Safety EMLU 60 Ear Muff
155. Protector Safety EMM 71 Helmet Mounted Ear Muff
156. Racal Airsoft Ear Plug
157. Racal DBA Ear Plug
158. Racal QB2 Far Plug
159. Racal Auralgard 3 Ear Muff
160. Racal Sonogard Ear Muff
161. Racal Sonomuff Ear Muff
162. Racal Supamuff Ear Muff
163. Racal Ultramuff 2 Ear Muff
164. Racal Classic 1 Ear Muff
165. Racal Classic 2 Ear Muff
166. Racal Classic 3 Ear Muff
167. Silenta Bella Ear Muff
168. Silenta Bel II Ear Muff
169. Silenta Ergo II Ear Muff
170. Silenta Mil Ear Muff
171. Silenta Super Ear Muff
172. Silenta Sportmil Ear Muff
173. Silenta Supermil Ear Muff
174. Silenta Universal Ear Muff
175. Soniclip Helmet Mounted Ear Muff
176. Stephens-Itex Monarch E 15 Ear Muff

177. Stephens-Itex Muffler 1 Ear Muff
178. Tasco H-1 Inserts Ear Plug
179. Tasco RD-1 Safety Cones Ear Plug
180. Tasco Swivel Band Ear Cap
181. Tasco T-2 Slimline Ear Muff
182. Tasco T-100 Ear Muff
183. Tasco T-250 Ear Muff
184. Tasco T-275 Ear Muff
185. Tasco T-1000 Hardhat Mounted Ear Muff
186. Tasco T-2000 Hardhat Mounted Ear Muff
187. Tasco Tri-Fit Ear Plug
188. Tasco Tri-Guard Ear Plug
189. Takeda Untone Ear Plug
190. Uvex dB ex 2300+ Ear Muff
191. Uvex dB ex 2500+ Ear Muff
192. Uvex dB ex 2800+ Ear Muff
193. Willson #10 Sound Ban Ear Plug
194. Willson #20 Sound Ban Ear Plug
195. Willson Sound Silencer EP 100 Ear Plug
196. Willson Sound Silencer EP 101 Ear Plug
197. Willson Sound Barrier Model 155 Ear Muff
198. Willson Sound Barrier Model 155A Ear Muff
199. Willson Sound Barrier Model 351 Ear Muff
200. Willson Sound Barrier Model 351A Ear Muff
201. Willson Sound Barrier Model 358A Ear Muff
202. Willson Sound Barrier Model 365 Ear Muff
203. Willson Sound Barrier Model 365A Ear Muff
204. Willson Sound Barrier Model 381 Ear Muff
205. Willson Sound Barrier Model 381A Ear Muff
206. Willson Sound Barrier Model 390 Ear Muff
207. Willson Sound Barrier Model 390A Ear Muff
208. Willson Sound Barrier II Model 665 Ear Muff
209. Willson Sound Barrier II Model 665A Ear Muff
210. Willson Sound Barrier II Model 690 Ear Muff
211. JSP Big Blue
212. JSP Brooklands
213. JSP Donnington
214. JSP E Muff
215. JSP Economuff
216. JSP Goodwood
217. JSP J Muff
218. JSP Le Mans
219. JSP Monaco
220. JSP Monza
221. JSP Siverstone

222. JSP Thurxton
223. Peltor H10A Ear Muff
224. Peltor H10B Ear Muff
225. Peltor H10P3E Ear Muff
226. Peltor H9A Ear Muff
227. Peltor H9B Ear Muff
228. Peltor H9P3E Ear Muff
229. Peltor H7A Ear Muff
230. Peltor H7B Ear Muff
231. Peltor H7F Ear Muff
232. Peltor H7P3E Ear Muff
233. Peltor H6A/V Ear Muff
234. Peltor H6F/V Ear Muff
235. Peltor H6P3E/V Ear Muff
236. Peltor H6B/V Ear Muff
237. Peltor H3A Ear Muff
238. Peltor H3P3E Ear Muff

Appendix 6

Guide on Industrial Noise Control

Introduction

There are many ways of reducing noise in workplace and this Guide outlines some that should be considered. Application of noise control technology can be difficult and must be designed by someone with knowledge and skill. Noise control engineers will also need to understand the processes involved or collaborate with others.

Substitution of a quieter process or machine

2. Sometimes a noisy process can be replaced by a quieter one such as welding instead of riveting, hydraulic instead of percussive pile driving. Hence sometimes a working knowledge of the noisy processes and alternative ways of doing the jobs may be more important than specialised acoustic training.

Reduction at source

3. For most industrial noise problems there will often be several sources which will need to be tackled, and it is good practice to establish the contribution that each makes to the total noise generated, and then to deal first with those that will produce noticeable improvements for least effort.

4. Noise control at source is the most effective approach for solving noise problems and should be considered first. Some of the methods of preventing noise generation that should be considered are:

(*a*) avoiding impacts, or arrangements to cushion them. Example includes rubber or plastic surface coatings to avoid metal to metal impacts;

(*b*) reducing the area of the vibrating surfaces. Example includes replacement of plain panel by perforated panel;

(*c*) reducing the magnitude of vibration of surfaces by increased damping. Example includes applying damping material to sheet metal;

(*d*) silencers to reduce noise generated by turbulence at air exhausts and jets. Example includes a porous silencer for the exhaust of a pneumatic cylinder;

(*e*) matching of air supply pressure to the actual needs of pneumatic equipment. By providing each unit with its own pressure reducing valve, the supply can be individually adjusted for a good compromise between reliable operation and noise;

(*f*) low noise air nozzles, pneumatic ejectors and cleaning guns constructed on good aerodynamic principles;

(*g*) arrangements to make sure that noisy devices are only used when actually needed. For example the pneumatic ejector on a power press need be on only for the short time required to eject the products;

(*h*) dynamic balancing of rotating parts;

(*i*) reducing noise by proper machine maintenance such as lubrication;

(*j*) improved design of fans and compressors and their accurate matching to the systems they supply;

(*k*) reducing the need for noisy assembly practices by better quality control, design and manufacturing procedures. For example precision casting reduces the need for chipping and grinding processes to rectify faults or trim surplus material; and

(*l*) attention to the stiffness of structural parts of machines, for example making sure that if a power press is intended to be used with tie bars, they are in fact fitted.

Modification of the paths by which noise reaches workplaces

5. The routes between the points at which noise is generated and the workplace can sometimes be modified to reduce noise exposure of employees. Some of the measures which should be considered are:

(*a*) acoustic enclosures of noisy machines and partial enclosures or covers around noisy parts of machines. Figure 1 shows the features of a typical machine enclosure;

(*b*) anti-vibration mountings or heavy bases under machines to reduce structure-borne sound;

(*c*) screens with sound absorbing material placed between employees and noisy areas;

(*d*) enclosure of the workplace by provision of a booth or 'noise refuge' (with proper attention to the ventilation and seating arrangement). If controls are brought into the booth it will be possible to reduce the need to enter noisy areas. Even where the employee still needs to use ear protector outside the noise refuge, it can help by providing relief from the need to wear the protector continuously; and

(*e*) sound absorbing material to control reflection within workplaces. As shown in Fig. 2 near to the source most sound is received by direct radiation from the machine, but further away the noise received via the direct and reflected paths is more nearly equal. Absorbing material should be attached to reflecting surface close to the noise source. Otherwise reduction is only effective further away from the source.

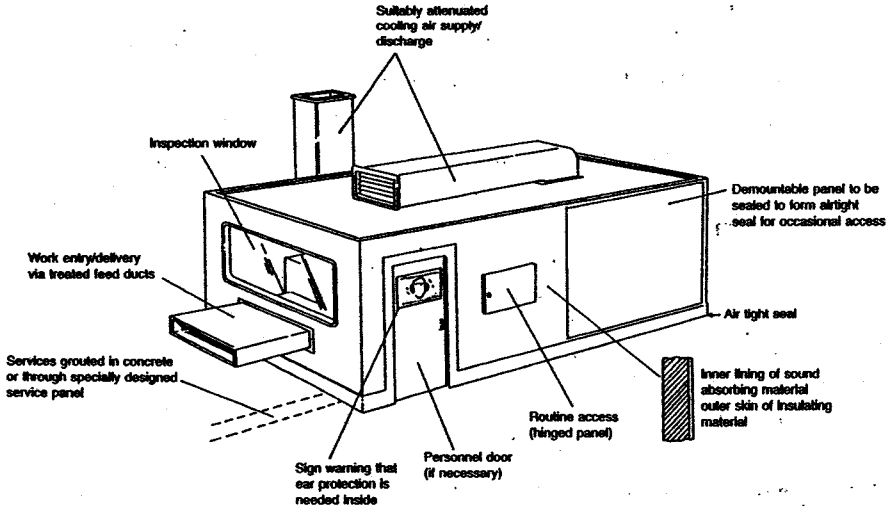


Fig. 1 A machine acoustic enclosure

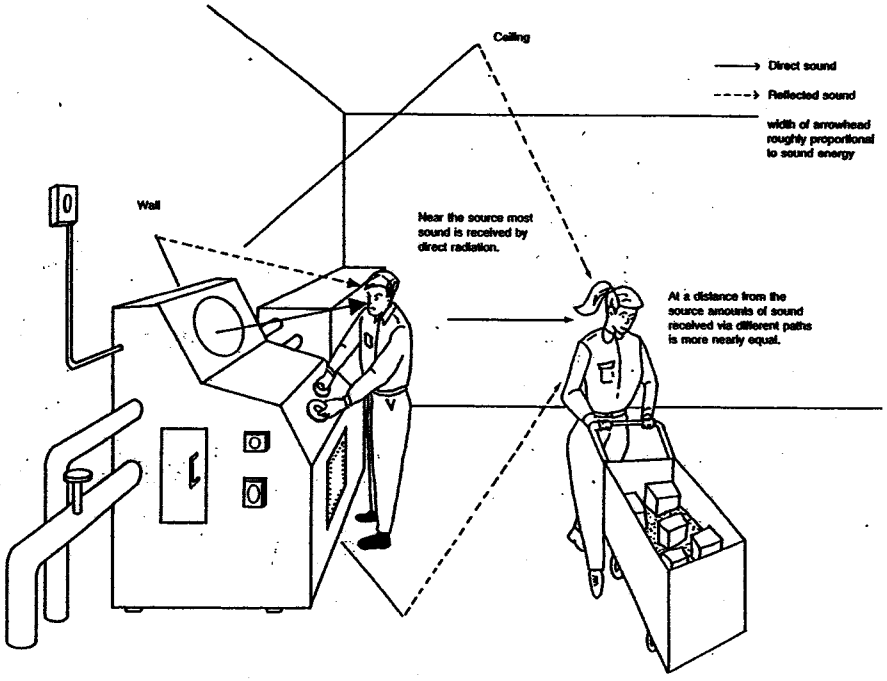


Fig. 2 Routes by which airborne noise reaches employees

6. Fig. 3 shows how the noisy parts of a power press are treated to reduce noise. The measures involved include acoustic panels, pneumatic silencers and damping materials. A noise reduction of about 20 dB(A) might be achieved.

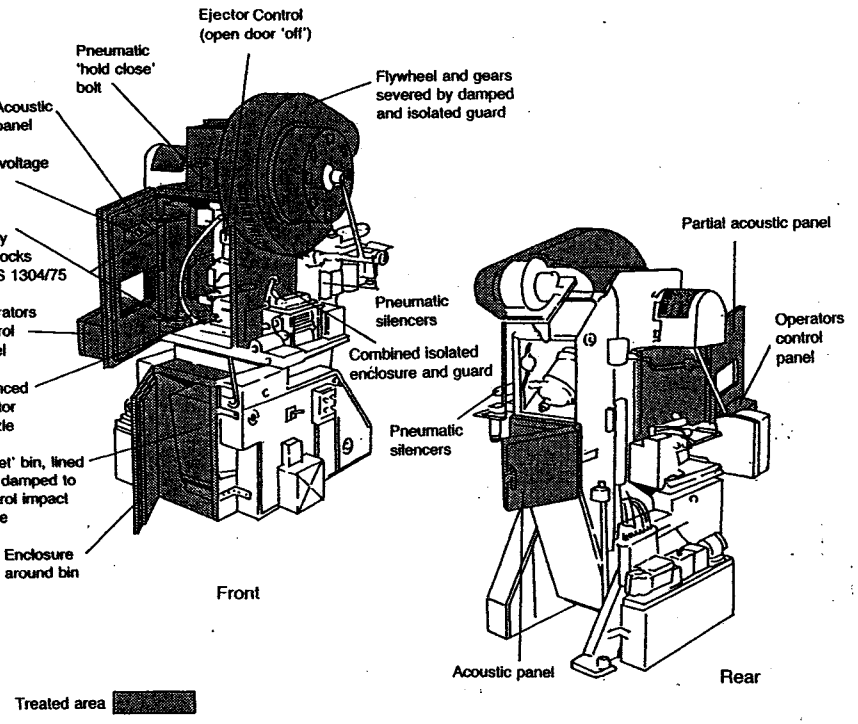


Fig. 3 Application of control measures to power press

Distance

7. Increasing the distance between a person and the noise source can provide considerable noise reduction (inverse square law). Some ways of achieving this are:

(*a*) arrangement for exhausts to be discharged well away from employees;

(*b*) segregation of noisy processes to restrict the number of employees exposed to high noise levels, for example engine testing in test rooms which only need to be entered occasionally; and

(*c*) use of remote control or automated equipment to avoid the need for employees to spend long time near to machines.

Active noise control

8. The principle of active noise control is the reduction or cancellation of one sound by the introduction of a second sound having equal amplitude but with reversed phase. The second sound is usually derived electronically from the original, with the aid of a microphone signal processing system and loudspeaker. There are considerable difficulties in designing and commissioning these systems and would normally be considered where other systems cannot yield satisfactory results.

Useful Information

If you wish to enquire about this guidance notes or require advice on occupational safety and health, you can contact the Occupational Safety and Health Branch through:

Telephone number : 2559 2297 (auto-recording after office hours)
Fax : 2915 1410
E-mail : laboureq@labour.gcn.gov.hk

Information on the services offered by the Labour Department and on major labour legislation can also be found by visiting our Home Page on the Internet. Address of our Home Page is http://www.info.gov.hk/labour.

Annex II

Noise Surveys Results

	Process/Machine/Post	Mean daily personal noise exposure ($L_{EP,d}$) dB(A)
1.	Computer label weaving	100
2.	Disc Jockey (discotheques)*	95
3.	Waiter (discotheques)	91
4.	Bar-tender (discotheques)	91
5.	Pig slaughtering machines	92
6.	Substitute player (mahjong parlours)	91
7.	Attendant (mahjong parlours)	88
8.	Cashier (mahjong parlours)	86
9.	Attendant (amusement game centres)	88
10.	Cashier (amusement game centres)	80
11.	Hydraulic crane of ocean-going vessels	86
12.	Carding machines	87
13.	Tobacco leaf shredding machines	86
14.	Cooking stoves with blower fan in Chinese restaurants	84
15.	Bowling centres	84
16.	Washing machines (laundry)	84
17.	Drying machines (laundry)	82
18.	Dry cleaning machines (laundry)	78
19.	Steam ironing machines (laundry)	82
20.	Ironing and folding machines (laundry)	82
21.	Pesticide sprayers (Agriculture, Fisheries and Conservation Department)	83
22.	Water treatment plants of Water Supplies Department	83

* The information is based on a survey report on the noise hazard to employees in discotheques in Singapore published by the Department of Industrial Health of Singapore.

	Process/Machine/Post	Mean daily personal noise exposure ($L_{EP,d}$) dB(A)
23.	Paper cutting machines	80
24.	De-feathering machines	80
25.	Tram driving	80
26.	Container handling (container port)	80
27.	Central air conditioner pump rooms	78
28.	Plastic moulding machines	78
29.	Alarm of fire engines (fire engines without air-conditioning)	77
30.	Alarm of fire engines (fire engines with air-conditioning)	74
31.	Slitting machines for button holes	76
32.	Air compressor of central air conditioner	75
33.	Shoe repair	75
34.	Sewing machines	74
35.	Dental suction unit	74
36.	Ventilation system	73
37.	QC machines/ process (electronic factories)	70
38.	Buffing of plastic prosthesis	69
39.	Mincers	67
40.	Spray guns (tailor)	66
41.	Coin counting machines	66
42.	Paging operators	64
43.	Stamping machines (bank)	61
44.	Microfilmers	61