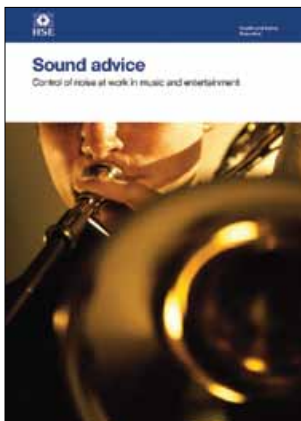


Sound advice

Control of noise at work in music and entertainment



This is a free-to-download, web-friendly version of HSG260 (First edition, published 2008). This version has been adapted for online use from HSE's current printed version.

You can buy the book at www.hsebooks.co.uk and most good bookshops.

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Sound advice contains practical guidance on the control of noise at work in music and entertainment, including concert halls and theatres, amplified live music venues, pubs/clubs and studios. It has been put together by representatives from a wide range of music and entertainment sectors in Britain, including Environmental Health Officers and the Health and Safety Executive (HSE).

Sound advice aims to help you control or reduce exposure to noise at work without stopping people from enjoying music, whether you're an employer, freelancer or employee. It sets out a range of simple and cost-effective actions that can reduce workers' average daily or weekly exposure to noise. Regular, long-term exposure to noise can lead to permanent, incurable hearing damage.

Part 1 of *Sound advice* tells you what you need to know about the Control of Noise at Work Regulations 2005, which came into force for the music and entertainment industries in April 2008. Part 2 contains advice for specific sections of the industry. There is also a related website at <http://soundadvice.info>.

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Members of the Music and Entertainment Sector Working Group

- ARUP Acoustics
- Association of British Orchestras (ABO)
- Association of British Theatre Technicians (ABTT)
- BBC, Occupational Risk Management
- BBC, Symphony Orchestra
- BECTU (Broadcasting Entertainment Cinematograph and Theatre Union)
- British Beer and Pub Association
- Cameron Mackintosh Consultants
- Chartered Institute of Environmental Health
- Concert Promoters Association
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- Ministry of Defence (MOD)
- Musicians' Union
- National Entertainment Safety Association (NESA)
- Noctis
- Production Services Association (PSA)
- Royal Opera House
- Society of London Theatre (SOLT)
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Foreword

This book contains practical guidelines on the control of noise at work in music and entertainment, including concert halls and theatres, amplified live music venues, pubs/clubs and studios. It has been drafted and supported by representatives from a wide range of music and entertainment sectors in Britain, as well as Environmental Health Officers and the Health and Safety Executive (HSE).

In April 2008 the existing Regulations protecting workers in the music and entertainment sectors from exposure to excessive noise were replaced by the Control of Noise at Work Regulations 2005 (the Noise Regulations). For other industries, these Regulations have been in force since April 2006. The European Directive (2003/10/EC) on which the Regulations are based allowed the music and entertainment sectors a two-year transitional period. This recognised that music is unusual as it is noise deliberately created for enjoyment and therefore practical guidelines are necessary to help workers, employers and freelancers in the music and entertainment sectors protect their hearing.

The aim of *Sound advice* is to help you to control or reduce exposure to noise at work without stopping people from enjoying music, whether you are an employer, freelancer or employee. It is important that you read Part 1 of the book, which explains the requirements of the Noise Regulations, before reading the specific 'Sound Advice' sections in Part 2. There is also a web version of *Sound advice*, based on this guidance, at <http://soundadvice.info>.

Sound advice concerns exposure to noise, and therefore takes account of the duration of workers' exposure and not simply the noise level. It sets out a range of simple and cost-effective actions that can reduce workers' average daily or weekly exposure to noise. Regular, long-term exposure to noise can lead to permanent, incurable hearing damage.

Sound advice does not provide guidance on the law, which can be found in *Controlling noise at work: The Control of Noise at Work Regulations 2005* L108 available from HSE Books. Useful general guidance on noise and HSE free leaflets are available from www.hse.gov.uk/noise.

Finally, I would like to thank members of the working group, both past and present, for their hard work in drafting over the last four and a half years and the HSE staff involved.

David Adams

Chair of Music and Entertainment Sector Working Group

Part 1

What you need to know about the Noise Regulations

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Introduction and hearing damage

Overview

Risk assessment
The Noise Regulations
How sound is measured
Noise action and limit values
Noise exposure
Exposure when not at work
Symptoms of hearing damage

Introduction

1 Music is perceived as pleasant but can sometimes be loud to produce its effect, while the sound of a jet engine, for example, is regarded as unpleasant. However, both are physically the same thing as far as the ear is concerned. If a sound level is too high or carries on for too long, your hearing may be damaged. This book aims to help prevent damage to the hearing of people working in music and entertainment from loud noise, including music.

2 The music and entertainment industries are unique in that high noise levels and extremely loud special effects are often regarded as essential elements of an event. High levels of sound are common, for example in bars, nightclubs, orchestras, theatres and recording studios. However, loud sounds, whatever their source, can damage hearing. Hearing damage is permanent, irreversible and causes deafness – hearing aids cannot reverse it. Performers and other workers in music and entertainment are just as likely to have their hearing permanently damaged as workers in other industries.

3 Reducing noise risks in music and entertainment is not about destroying art, but about protecting people – artists, performers and ancillary workers equally. The hearing of performers is critical and needs to be protected. There are cases of performers being unable to carry on their profession because of hearing damage as a consequence of their work. With properly implemented measures, the risk from noise in the workplace and the risk of damage to workers' hearing will be reduced.

This book

4 The purpose of this book is to provide practical advice on developing noise-control strategies in the music and entertainment industries to prevent or minimise the risk of hearing damage from the performance of both live and recorded music. It will also help performers and other workers and employers meet their legal obligations under the Control of Noise at Work Regulations 2005¹ (the Noise Regulations). It has been produced by a working group of industry stakeholders with the support of the Health and Safety Executive. It supplements the general HSE guidance on the Noise Regulations (L108) *Controlling noise at work: The Control of Noise at Work Regulations 2005*.²

5 This guidance will help:

- venue owners;
- venue designers and builders;
- venue operators and managers;

- musicians, performers and entertainers and their employers;
- promoters and producers;
- technical, production, service and support staff and their employers;
- suppliers of sound equipment;
- those involved in musical education;
- anyone whose work may create a noise hazard in the music or entertainment industry.

Risk assessment

6 Risk assessments of the work should identify those people who are likely to be at risk. These will include musicians and performers, technical staff and others working directly on the entertainment, but also may include staff involved in work activities connected to the entertainment, for example ushers, security, front of house, bar and catering staff etc, depending on their location and length of time spent in the noisy environment. A more comprehensive list of people likely to be affected is in Appendix 1.

7 Everyone in the production chain has a role to play in managing the noise risks – whether it is the promoter selecting a balanced line-up, a performer working with reduced monitor levels or stagehands using their earplugs. The main responsibility rests with the employer, but everyone should help reduce noise exposure and take a range of simple steps to protect themselves and others from the hazards of loud noise or lengthy exposure to noise at work.

The Noise Regulations

8 The Control of Noise at Work Regulations 2005 (the Noise Regulations) require employers to prevent or reduce risks to health and safety from exposure to noise at work, so far as is reasonably practicable. Employees have duties under the Noise Regulations too. The Regulations specify the minimum requirements for the protection of workers from the risks to their health and safety arising, or likely to arise, from exposure to noise at work.

9 The duties in the Noise Regulations are in addition to the general duties set out in the Health and Safety at Work etc Act 1974 (the HSW Act). These general duties extend to the safeguarding of the health and safety, including the risk of hearing damage, of people who are not your employees, such as contractors and members of the public. Employees also have duties under the HSW Act to take care of their own health and safety and that of others whom their work may affect and to co-operate with employers so that they may comply with health and safety legislation. This guidance does not address protection of the public – for more information, look at *The event safety guide*.³

10 This guidance applies to premises where employees or the self-employed are present, where live (whether amplified or not) or recorded music is being played for entertainment purposes at noise levels which will result in performers' or other workers' daily personal noise exposure being likely to exceed the exposure levels in the Noise Regulations. Anyone whose work may create a noise hazard has a responsibility to themselves and to anyone else who may be affected.

How sound is measured

11 Noise is measured in units called decibels, shown as dB. Some sounds, which can be measured, cannot be detected by the human ear. For example,

people cannot usually hear bats communicating at very high frequencies or when whales use very low frequencies. To account for the way that the human ear responds to sound of various frequencies a frequency weighting, known as the A-weighting, is commonly applied when measuring noise. The exception is when measuring peak noises, where a C-weighting is applied to ensure that proper account is taken of the sound energy in the peak sound.

12 In this book, all noise levels are given in units of decibels (dB). Unless stated otherwise, values representing average, typical or representative noise levels have been measured using an A-weighting and values representing peak noise with a C-weighting. The terms dB(A) and dB(C) are not used, but where noise has been measured using the C-weighting, these are referred to as 'peak'.

13 Noise can contain many different frequencies. However, when considering ways to control noise, low-frequency noise needs to be treated differently to high-frequency noise. So the division of the A-weighted measurement into its constituent frequencies (frequency analysis) becomes necessary. It is also very important, particularly in music and entertainment, when selecting personal hearing protection, to ensure the correct type for protection from the most damaging frequencies identified during a noise risk assessment. For more information see L108.

Example

The Noise Regulations mean operators of entertainment premises must protect their employees' hearing to a higher standard than the 1989 Noise at Work Regulations, which they replace.

Employers are required to reduce exposure to noise and provide hearing protection and health surveillance including hearing checks (where appropriate) to employees directly involved with loud noise, such as musicians, DJs and bar staff.

One Council has worked hard over the last two years to raise awareness of this change in the law and encourage bars, clubs and theatres to carry out workplace assessments and plan any changes needed to comply with the new Regulations.

The Council recognises existing licensed premises may find it difficult to carry out major building modifications immediately, but officers do expect employers to assess how best to protect employees from loud noise and come up with short-, medium- and longer-term solutions. Changes would then need to be implemented on an agreed timescale.

New businesses will be expected to incorporate noise-control measures during the design stage.

The Council wishes to take a staged and proportionate approach to enforcement although it will use statutory powers if employers fail to meet their obligations.

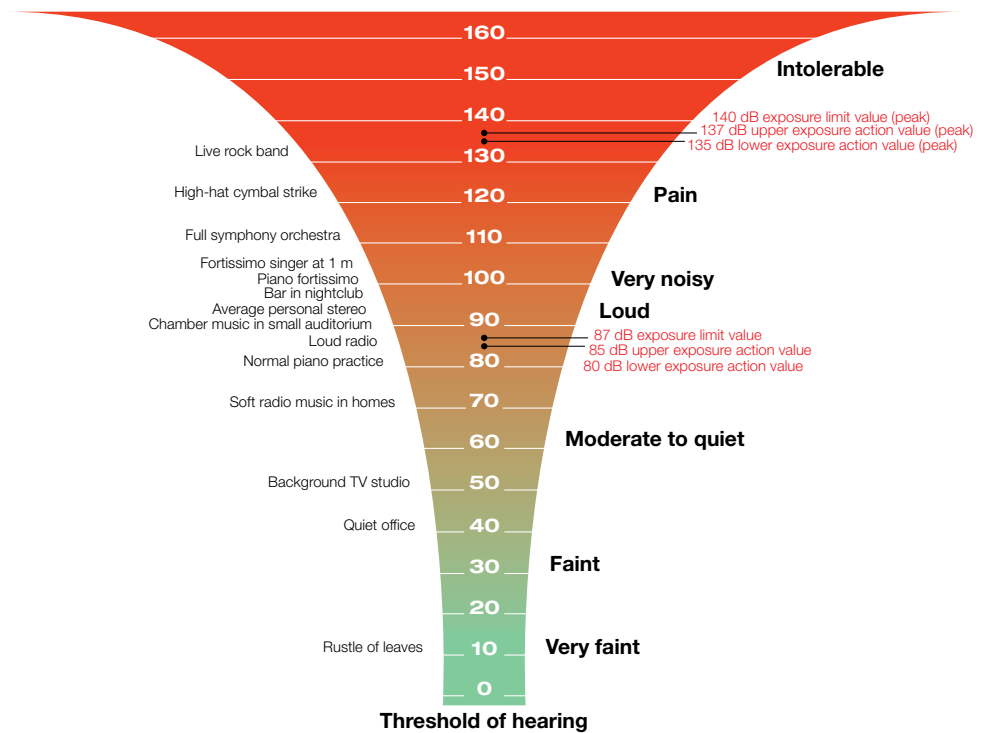


Figure 1 Typical noise levels in decibels

Noise action and limit values

14 The Noise Regulations require employers to take specific action at certain action values. These relate to:

- the levels of exposure to noise of employees averaged over a working day or week; and
- the maximum noise (peak sound pressure) to which employees are exposed in a working day.

15 The values are:

- lower exposure action values (LEAV):
 - daily or weekly exposure of 80 dB;
 - peak sound pressure of 135 dB;
- upper exposure action values (UEAV):
 - daily or weekly exposure of 85 dB;
 - peak sound pressure of 137 dB.

16 There are also levels of noise exposure which must not be exceeded (but take account of any reduction in exposure provided by hearing protection):

- exposure limit values (ELV):
 - daily or weekly exposure of 87 dB;
 - peak sound pressure of 140 dB.

17 Look at Appendix 2 for a table of the actions required based on a comparison of exposure action values and exposure limit values.

Noise exposure

18 The noise exposure level (often referred to as the 'noise dose') takes account of both the sound pressure level and how long it lasts. Generally the potential for hearing to be damaged by noise is related to the noise 'dose' a person receives. Being exposed to a noise level of 105 dB (a not unusual sound level for a pub band, or that generated by a brass or woodwind instrument at full blast) for 5 minutes would be the same dose as being exposed to 94 dB (a nightclub bar) for 1 hour, or 88 dB (chamber music) for 4 hours.

19 Each 3 dB added doubles the sound energy (but this is only just noticeable to a listener). When 10 dB is added, the energy is increased ten-fold, while adding 20 dB is a hundred-fold increase. Therefore:

- If the sound intensity is doubled, the noise level increases by 3 dB.
- Two instruments with the same noise level of 85 dB together produce 88 dB.
- A noise level reduction of 3 dB halves the sound intensity (and reduces its propensity to damage).

20 Halving the noise dose can be achieved either by halving the exposure time, or by halving the noise level, which corresponds to a reduction of 3 dB. These noise exposures are identical:

- 80 dB for 8 hours
- 83 dB for 4 hours
- 86 dB for 2 hours
- 89 dB for 1 hour
- 92 dB for 30 minutes

21 Table 1 gives an indication of how quickly a particular noise dose is reached.

Table 1 How long it takes to reach a particular noise dose

Average noise level	Time taken to receive a dose equivalent to the upper exposure action value (85 dB)
85 dB	8 hours
95 dB	45 minutes
100 dB	15 minutes
105 dB	5 minutes
110 dB	Under 2 minutes
115 dB	Under 30 seconds

Exposure when not at work

22 It is important that people consider noise exposure when not at work because cumulative exposure leads to hearing damage, whether or not it is work-related.

Sound exposure includes all the sounds heard during each day. Common off-hours exposure to high noise levels may include audio and video equipment (personal car stereos, computer speakers, televisions), concerts, clubs and cinemas, sporting events, power tools and noisy hobbies. In general, an employer needs only to consider the work-related noise exposure when deciding what action to take to control risks. However the employer needs to consider whether risk-control measures need to be adapted in certain situations, for example if it is known that an employee is exposed to noise during other employment.

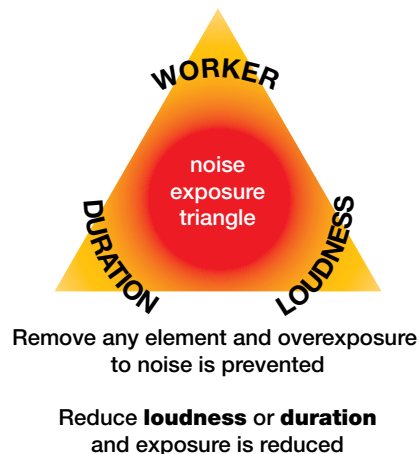


Figure 2 The noise triangle

Symptoms of hearing damage

23 Hearing loss can be temporary or permanent. People often experience temporary deafness after leaving a noisy place such as a night club or a rock concert. Although hearing recovers within a few hours, this should not be ignored. It is a sign that if you continue to be exposed to high levels of noise your hearing could be permanently damaged. Permanent hearing damage can be caused immediately by sudden, extremely loud, explosive noises such as caused by pyrotechnics. Remember that the hearing of young people can be damaged as easily as the old.

24 Hearing loss is usually gradual because of prolonged exposure to noise. It may only be when damage caused by noise over years combines with hearing loss due to ageing that people realise how deaf they have become. This may mean their family complains about the television being too loud, they cannot keep up with conversations in a group, or they have trouble using a telephone. Eventually everything becomes muffled and people find it difficult to catch sounds like 't', 'd', and 's', so they confuse similar words. Musicians may suffer loss of discrimination between tones.

25 Hearing loss is not the only problem. People may develop tinnitus, a distressing condition that can lead to disturbed sleep. Other rarer conditions include hyperacusis (a general intolerance or oversensitivity to everyday sounds) and diplacusis (a difference in the perception of sound by the ears, either in frequency or time). Danish research among symphony orchestras suggests more than 27% of musicians suffer hearing loss, with 24% suffering from tinnitus, 25% from hyperacusis, 12% from distortion and 5% from diplacusis. However, there are other studies which give a range of figures from 10-60% for hearing damage among musicians.

26 The HSE Noise website (www.hse.gov.uk/noise) provides an audio demonstration of hearing loss. The hearing loss simulations all include the effects

of noise exposure and ageing. At the end of each simulation the hearing level undamaged by noise for the age of the person is demonstrated.

CASE STUDY

For many years Martin worked as a sound engineer, carrying out a range of duties. He often operated stage monitors with a wide range of performers and show formats, including at festivals where he would act as the 'house' engineer – mixing a number of the bands himself and acting as a 'babysitter' to visiting monitor engineers.

Martin first noticed he had a problem when the ringing in his ears after a show never really disappeared, but became a permanent and very annoying feature of life. After a couple of months the condition worsened and it became difficult to do his job. He eventually plucked up courage to go to his GP, and was diagnosed with noise-induced hearing loss, tinnitus and a condition called diplacusis where the two ears hear a given pitch as two distinct tones – definitely not a good attribute for musical work.

For the most part Martin has had to give up live engineering and has had to make a living as a 'system tech' and administrator for a PA rental company. He now actively avoids loud social environments such as pubs and even parties.

'I now wear moulded earplugs for every show I work on. I wish I'd taken a few basic steps to protect myself fifteen years ago when I first started in the business – but wearing earplugs back then would have marked you out as a very strange engineer. Still, I'd rather have dealt with that than have to give up the job I loved and have my social life seriously affected.'

Responsibilities

Overview

General responsibilities
Responsibilities of employers
Responsibilities of employees
Responsibilities of self-employed people

General responsibilities

27 Everyone involved in music and entertainment has a responsibility to help with noise management: from the promoter or venue operator through to performers, technicians, bar staff, stewards and DJs. The normal arrangements of employer/employee are sometimes difficult to determine and often vary with each engagement or show. Add to this the large number of self-employed people working as performers, sound engineers or technical crew and the picture can become very confused.

28 Because of these complexities, everyone working at live music events needs to take personal responsibility to think about their own noise exposure and take reasonable care not to damage their own hearing or that of other people. Simply relying on an overall 'employer' may not always be the most effective approach. It is important that the people who can most readily control sound levels, such as conductors, musical directors, sound engineers and sound technicians, recognise their responsibility for providing a safe workplace.

Responsibilities of employers

29 The primary responsibility for complying with the Noise Regulations rests with the employer. Employers in the music and entertainment sectors may include, for example, concert promoters, event organisers, theatrical producers, contractors and publicans. Employers must:

- assess the risks to employees from noise at work;
- take action to reduce the noise exposure that produces those risks;
- provide employees with hearing protection if the noise exposure cannot be reduced enough by using other methods;
- make sure the legal limits on noise exposure are not exceeded;
- provide employees with information, instruction and training. It is important that employees understand that the Noise Regulations also apply to them;
- carry out health surveillance where there is a risk to health.

30 To help meet the requirements of the Noise Regulations employers are advised to:

- consult with their staff and with employee or safety representatives where they exist;
- ensure their documented health and safety policy makes clear the specific noise responsibilities of staff from senior management downwards;
- ensure their health and safety policy specifies the arrangements for managing noise risk assessments and controlling the risk;
- communicate this policy to their staff, management colleagues and boards and trustees.

31 The Noise Regulations place duties on all the employers involved in work at the same workplace. Employers have responsibility for their own employees and, so far as is reasonably practicable, to any other person at work who is affected by the work they do. Employers should exchange information and collaborate to ensure that they fulfil their duties without unnecessary duplication.

32 Engagers/contractors, fixers and freelancers engaging 'deps' (substitutes) or extras should ensure that the risks and control measures in place are communicated to replacement and temporary workers.

People at particular risk

33 Some workers should be given particular consideration when making a noise risk assessment, for example people with a pre-existing hearing condition, those with a family history of deafness (if known), pregnant women, children and young people.

New and expectant mothers

34 Employers have duties under the Management of Health and Safety at Work Regulations 1999⁴ (the Management Regulations) towards new and expectant mothers in their workforce. Employers must assess the nature, degree and duration of exposure of pregnant workers to risk (including noise) and ensure that where there is a risk it is controlled.

Young people and children

35 The Management Regulations restrict the employment of young people (those under 18) where there is a risk to health (including noise). Children (those under the compulsory school age) must not be employed where there is any risk to their hearing from noise. Employers must also ensure that young people employed by them are protected against any risks to their health and safety at work that are due to their inexperience, immaturity and lack of awareness of risk.

CASE STUDY

To protect its child workers from noise risks, a TV company decided to limit the noise exposure of children to less than half that of adults, for example, if the adults might be exposed to an average of 78 dB over 8 hours, any children would only be exposed over a maximum of 4 hours.

36 There are also obligations on employers under the Management Regulations to:

- co-operate and co-ordinate where two or more employers share a workplace (whether on a temporary or permanent basis). These obligations also apply to employers sharing a workplace with self-employed people and to self-employed people sharing a workplace with other self-employed people. See also Sound Advice 1 'Freelancers';
- establish appropriate procedures to be followed if there is serious and imminent danger to people at work in their undertaking. These procedures should enable the people concerned to stop work and immediately proceed to a place of safety.

Part-time workers

37 It is important that employers who engage workers on a part-time basis work with them to ensure that their exposure to noise is properly managed. Where part-time workers work alongside full-timers doing the same work, they should be subject to the same protective measures. Where it is known that part-time workers are exposed to noise during other employment, employers should consider the

overall risks to those people in deciding how to protect their hearing, and not just look at their noise exposure during the specific periods when they are employed by them.

Responsibilities of employees

38 Under the HSW Act, employees must take reasonable care for their health and safety and that of others while at work and co-operate with their employer to enable the employer to carry out their legal duties. Employees should take care to avoid actions that might damage their hearing or the hearing of others.

39 Under the Noise Regulations employees should:

- use control measures in accordance with their employer's instructions;
- wear hearing protection in accordance with their employer's instructions;
- take care of hearing protectors and noise-control equipment;
- report faults and difficulties in using noise-control equipment;
- make themselves available for health surveillance.

Responsibilities of self-employed people

40 The HSW Act defines a self-employed person as an individual who works for gain or reward but is not under a contract of employment. Under the Act, self-employed people must conduct their work in such a way to ensure their own health and safety and that of others. Under the Noise Regulations they have the same responsibilities as employers and employees for their health and safety arising from the exposure to noise and for other people whose hearing might be damaged by their 'acts or omissions'. Although self-employed people are not required to provide themselves with health surveillance, it is recommended that, where appropriate, they consult an occupational health service provider. Many performers and sound operators are self-employed. Note, however, that the members of the self-governing orchestras are regarded as employees for health and safety. See also Sound Advice 1 'Freelancers'.

Noise risk assessment and planning

Overview

Risk assessments for noise
Is it too noisy?
Who might be harmed and how?
Estimate the noise exposure
Weekly exposure
Identify what needs to be done to control the risks
Regular monitoring
Reference positions
Review risk assessments
Planning
Communications
Recovery periods
Multiple employers
Policy statements
Touring

Risk assessments for noise

41 The aim of a noise risk assessment is to help decide what measures are necessary to ensure the health and safety of employees who are exposed to noise. It is more than just taking measurements of noise – sometimes measurements may not even be necessary. But it needs to be drawn up by someone who is competent to carry out the task and be based on advice and information from people who are competent to provide it. This could be someone from within the organisation. Noise risk assessments should:

- identify where there may be a risk from noise and who is likely to be affected;
- contain a reliable estimate of the noise exposure and compare this with the exposure action and limit values;
- identify what noise-control measures are needed and whether hearing protection is needed and, if so, where and what type;
- identify any employees who need to be provided with health surveillance and whether any are at particular risk.

Is it too noisy?

42 In many cases it should be possible to come to a decision quite quickly using what is known about the work going on, or by making simple observations. Other parts of this book provide information to help identify those people in specific sections of the music and entertainment industry who are likely to be at risk from the playing of live or recorded music.

43 The following 'listening checks' may be useful in deciding whether there are likely to be noise risks. As a simple guide you will probably need to do something about the noise if any of the following apply:

- Does the work involve lengthy exposure to music either live or recorded, for example, pubs, clubs, live music venues, orchestras, or using headphones?
- Is the noise intrusive – similar to the noise from a busy street – for most of the working day?
- Do people have to raise their voices to carry out a normal conversation when about 2 m apart for at least part of the working day?
- Are noisy tools used, such as during rigging, for more than half an hour a day?
- Are there any loud effects such as pyrotechnics or maroons?

44 Even extremely short exposure to very loud noise is dangerous. Some percussive or explosive sounds last for a very short time, but are at such a level that hearing damage can occur. Exposure to such noises is uncommon in the normal environment, however pyrotechnics, fireworks and even loud sound systems can deliver peak noise levels in excess of the 140 dB exposure limit value set by the Noise Regulations.

45 Sounds peaking above 140 dB are liable to cause immediate and lasting damage rather than accumulating over time. It is therefore crucial that a thorough noise-control strategy is in place before any exposure to loud noise might occur.

Who might be harmed, and how?

46 All employees who are likely to be affected by the noise should be identified. Consider not just people who are exposed to noise in relatively fixed locations, but also people who move between different jobs or types of work, and make sure you understand their patterns of noise exposure. Remember to include people who are not direct employees but who may be affected by the work, for example visitors or subcontractors.

47 In considering the potential for people to be harmed, it is mainly necessary to think about hearing damage. But it is also necessary to consider risks to safety which can arise from working in a noisy environment, such as noise interfering with communications or warning signals and the ability to pick up audible signs of danger.

Estimate the noise exposure

48 The daily personal noise exposure ($L_{EP,d}$) of workers at risk should be estimated and compared with the exposure action and limit values. It takes account of both the level of the sound and how long it lasts. Often a worker's daily noise exposure is made up of a number of periods of time exposed to different levels of noise, so this needs to be taken into account when estimating exposure.

49 It is essential that any estimate of employees' exposure is representative of the work that they do. It should take account of:

- the work they do or are likely to do;
- the ways in which they do the work;
- how the work may vary during the day or from one day to the next.

50 The estimates of the noise levels must be reliable enough to be able to assess whether any exposure action values are likely to be exceeded. Reliable information may include:

- noise measurements in the actual work situations;
- information from other similar work situations;

- information from other sources, for example information on typical noise levels and noise exposures which may be helpful.

51 Tools are available on the HSE website (www.hse.gov.uk/noise/calculator.htm) that allow noise exposure to be calculated based on information on likely noise levels and durations of exposure. There is a noise ready-reckoner chart (also see Appendix 4) and an electronic spreadsheet.

52 When in any doubt, assume that control measures are necessary and that hearing protection will be required until the control measures are sufficient to reduce the employees' exposure to below the upper exposure action value. If music is to be played (especially loud amplified music) it would be good practice to assume there is a risk and some noise controls will be necessary.

Weekly exposure

53 Where noise exposure varies markedly from day to day, the weekly noise exposure level may be used as an indicator of risk. It is only likely to be appropriate to use weekly exposure where:

- daily exposure on one or two working days in a week is at least 5 dB higher than the other days; or
- the working week comprises three or fewer days of exposure.

54 Using weekly exposure to indicate risk should not lead to the lowering of standards of protection on days where noise exposure is higher. Workers and their safety or employee representatives should be consulted on whether the use of weekly exposure is appropriate.

55 Tools are available on the HSE website (www.hse.gov.uk/noise/calculator.htm) that allow weekly noise exposure to be calculated based on information on levels of daily noise exposure. There is a noise ready-reckoner chart (also see Appendix 4) and an electronic spreadsheet.

56 Consult safety representatives about risk assessments along with any control measures. Where there is no formal representation, employers should liaise with the local Musicians' Union and Equity representatives or employee representative groups. Also tell staff about the significant findings of the risk assessment.

Identify what needs to be done to control the risks

57 An essential outcome of the noise risk assessment is to control the risks. In carrying out a noise risk assessment employers should:

- identify who is at risk and under what circumstances, and assess likely exposures. This allows prioritisation and planning of control actions;
- be aware of current good practice or the standard for noise exposure control within the relevant part of the music and entertainment sector, considering whether the control measures are applicable to their work and adopting them where it is reasonably practicable to do so;
- consider the advice on noise-control measures for sections of the music and entertainment industry in other parts of this book;
- record the significant findings of the risk assessment. Record in an action plan anything identified as being necessary to comply with the law;
- prepare an action plan setting out what has been done and what is planned, with a timetable. Say who will be responsible for the work and how this is to be communicated to those affected.

58 The action plan, as well as covering any ways of organising the work or technical measures needed to eliminate risks from noise or reduce noise exposure, should also cover issues such as:

- providing personal hearing protection to workers to deal with immediate and ongoing risks;
- arrangements for providing information, instruction and training; and
- health surveillance for workers.

59 In developing an action plan for noise, employers should consider what management arrangements are needed to ensure that the control measures put in place are working and being followed in practice. Consider also how to adapt or modify the control measures, for example where a music event may be undertaken in different venues, where differences are anticipated between rehearsal and performance, or where changes to the layout of the working environment are likely which could affect the risks from noise exposure.

EXAMPLE

If an employee works behind the bar in a noisy nightclub, it is reasonable to assume that exposure will be greater than the upper exposure action value and therefore the necessary control measures should be implemented. It may be sensible to take noise measurements if these are needed to show that the exposure is lower than the upper exposure action value after the measures have been taken or, alternatively, that suitable hearing protection is provided and used.

Regular monitoring

60 Risk assessment is an ongoing process and regular checks are essential to make sure the control measures continue to be effective. This may also identify any further actions necessary. Any incidents, for example where it is found that control measures are ineffective or not being used or followed, should be investigated to find out why, and action taken. Record the results of monitoring.

Reference positions

61 Specific noise measurements conducted in the workplace can help identify the main sources of noise and make it easier to assess where further controls are necessary and when periods of wearing compulsory hearing protection are required.

62 It may be helpful to have one or two sound-level meters or noise dosimeters to estimate noise exposures, for example within the orchestra/band or on the dance floor. It may also be useful to establish reference position(s) to enable quick measurements to be made using a simple meter to verify that sound levels are under control.

63 This information can be recorded and compared with the assessment, and any relevant findings can be applied to future assessments. Examples of locations for reference positions are included in Sound Advice 4 'Rock and pop', Sound Advice 5 'Pubs and clubs' and Sound Advice 6 'Orchestras'.

Review risk assessments

64 The noise risk assessment should be reviewed regularly. There are various reasons why this should happen, including:

- there is any reason to think that the risk assessment does not reflect the current noise risks, for example changed working methods or different work patterns such as changes to the set, design or seating layout;
- health surveillance shows that workers' hearing is being damaged;
- control measures that could not be justified when originally considered (for example, on cost or practicability grounds) become reasonably practicable due to some changed circumstances.

65 Even if it appears that nothing has changed, the risk assessment should not be left for more than about two years without checking whether a review is needed.

66 A flowchart summarising the process of noise risk assessment is shown at the end of the 'Noise risk assessment and planning' section.

Planning

67 Every event needs to be properly planned, to ensure that health and safety requirements are fully considered. The degree of planning will vary according to the complexity of the event but every event will benefit, whether it is a pop concert, a gig in a pub, an orchestral concert or a club with a guest DJ. Larger venues may have a specific policy statement which may help with planning (see Sound Advice 2 'Venues').

68 Start to assess the likely noise levels as soon as possible to identify any potential noise risks. This is best done well before any music is played in rehearsal or performance. The employer, or the principal employer, for example the promoter or pub landlord, should decide whether the proposed event might lead to high noise exposure levels for those working there and what controls might be necessary. They should record and retain these results as part of their noise risk assessment.

69 Where appropriate consider:

- the nature of the event and music;
- the site/venue layout;
- the likely noise footprint/map (the area covered by the sound);
- where there may be a risk from noise and who will be affected;
- expected sound levels and expected durations;
- selection of loudspeaker types and other equipment;
- suitable control measures available for noise hazards;
- the need to allow for sufficient rehearsal time to identify and control any unforeseen risks before harm is caused.

Communications

70 Good communications are essential for good planning. The assessment process should involve the exchange of information between people who may be affected by the event, for example, promoters, venue operators, contractors, local authorities and recording companies. This should start at the earliest opportunity and continue. In the case of 'rock and pop' acts, wherever possible the performers should be involved in the planning process and become an integral part of the noise management plan.

71 Event organisers should ensure that everybody involved in planning an event is competent and capable of carrying out their duties. There may be a need to provide specific training for technicians and managers.

EXAMPLE

Sound levels too high

Individual musicians asking for higher and higher levels from their personal instrument amplifiers or monitors can cause problems. It has been known for audience members to complain that they could only hear one particular instrument during a show. This is not the fault of the sound engineer but the result of lack of communication with musicians.

In the case of one famous band, the guitarist left the group, in part due to hearing damage from ever-increasing sound levels. If stage sound levels are too high this can result in reduced enjoyment for the audience and cause serious hearing damage to performers, which could be prevented by proper communication and planning before the event.

Recovery periods

72 When planning events, allow time for a person's ears to recover from exposure to loud noise. The time required to recover fully from the temporary effects of noise is related to the level of noise and the duration of exposure. Musicians who have played at an evening performance need recovery time before rehearsing the following morning. As a practical rule higher levels of noise during the rest period may impede the recovery of hearing and might lead to permanent damage.

Multiple employers

73 Where there are several employers, all the employers involved should agree at the earliest possible opportunity which employer is to co-ordinate the measures necessary to comply with the Noise Regulations. (This will usually be the employer responsible for co-ordinating other health and safety responsibilities and is usually the person in overall control of the work.) This person should make sure that the responsibilities for controlling risks are clearly defined. Where contractors and subcontractors are involved it is usually best for responsibilities to be set out in the contractual arrangements (see Appendix 3).

74 Where there is an established safety committee they should be consulted on how best to develop the management and monitoring of noise exposure. Employers may wish to consider other methods that have been adopted such as noise committees. Specific input might come from people such as responsible managers, players, conductors, safety and occupational health and safety advisers, and representatives from frequently visited venues. Where amplified sound is used, people such as sound designers, sound engineers, sound contractors and production managers should also be involved.

75 Any group, or its members, should have enough authority to implement the necessary controls or protective measures, including long-range planning and venue alterations etc. A group will probably operate in different formations for different purposes – for example, the grouping needed to consider the noise implications of long-range planning decisions may differ from that finishing the arrangements for that night's concert.

Policy statements

76 A written statement of venue policy is a good way of communicating controls to those working in or using the venue. The policy may include:

- Communication of the risk to hearing from the noise.
- The mechanism for the noise risk assessment, which may include noise measurements.
- A description of the measures established to control the risk. For example the specification of maximum permissible noise levels through physical regulation of the volume or by means of automatic noise limiters (see 'Noise-control measures and training').
- Hearing protection policy – the specification of suitable hearing protectors and where they are available (see 'Personal hearing protection').
- Procedures for monitoring and review.

Touring

77 Pre-planning is especially important when taking a production or band on tour:

- Carry out a generic assessment of likely noise risks and who will be exposed before the start of the tour and identify controls. Review this assessment at each venue to ensure the controls are still suitable.
- Review these risk assessments when circumstances change. For example, the maximum permitted number of players in each orchestra pit might vary in different theatres and this may affect noise exposure.
- Venue managers, tour managers and others involved should share their risk assessments to identify the most suitable controls for the event or performance.
- Control measures identified before touring should be reviewed on site (at each touring location) to ensure they are adequate.

Working elsewhere in the EU

78 The European Directive on which the Noise Regulations are based (Directive 2003/10/EC) sets down minimum standards for the control of noise at work throughout the European Union. Individual EU countries may have additional requirements.

Working outside the EU

79 Outside the EU, local requirements might not correspond to EU requirements. Those working outside the EU are recommended to clarify the position. Those employed in the UK who are touring are advised, where necessary, to negotiate for the maintenance of health and safety standards equivalent to those of the EU to be included in their contracts of employment. For those employed outside the EU it is advisable to clarify the health and safety standards that will apply and seek to get the safeguards required to protect their hearing.

EXAMPLES

Multiple employers involved in a musical production

More than one employer is usually involved when a musical production is staged in a theatre. The theatre operator and the producer are usually the main employers with their representatives having designated responsibilities under the Noise Regulations. Depending upon the noise risk assessment, those at risk could include the performers (both the musicians in the orchestra pit and the artists on stage) and the production team (employed by, or freelancers working for, the producer), all the backstage workers/on-stage technicians (who might be employed by either the producer or the theatre operator or could be freelancers) as well as the theatre operator's front-of-house staff in the auditorium.

The representatives of the main employers will establish, often by means of contract (see Appendix 3), who will be the co-ordinating employer with first responsibility for initiating the noise risk assessment and implementing the control measures. The producer is responsible for the music and will usually initiate this assessment.

It is important that any control measures and any hearing protection requirement resulting from the noise risk assessment include all those at risk. The sound designer and the musical director (both engaged by the producer) will usually co-ordinate any control measures required by the noise risk assessment in consultation with the theatre operator if necessary. Any necessary hearing protection will generally be provided by the respective employers.

Multiple employers involved in planning a pub event

The manager of a public house has engaged a five-piece group, using the services of the fixer, to play in his bar. The responsibility for the Noise Regulations involves both the pub manager and the manager or leader of the group; it may also involve the fixer. The prime responsibility rests with the pub manager who should liaise with the band to ensure that risks to people at work are controlled; no one – bar staff, musicians or security staff – should be exposed to excessive noise. The pub manager should undertake an assessment of the noise risk and may need to ensure that action is taken to reduce the hazard.

CASE STUDY Pre-event noise risk assessment

Name of event: **The Big Festival**
Date of assessment: **11 July 2008**
Assessment completed by: **Anne Onymouse**

What are the noise sources?

- Stage PA systems.
- Instruments and backline.
- Traders' sound systems.

Are there sources of noise which are likely to result in personal exposures above the lower exposure action value?

Yes No

What area(s) may be affected at this level?

- The stage platform (including side wings).
- The stage pit area.
- Concession and other stands within the main arena.
- Medical and welfare tent by side of stage.
- Backstage bar/hospitality facilities.

Action to be taken to protect staff in these noisy areas

1 The stage platform (including side wings):

- Area to be clearly signed as a hearing protection zone (sometimes referred to as HPZ)* where hearing protection is mandatory.
- Operating times of the PA system to be closely managed by Stage Manager and PA contractor.
- Advance discussions to be conducted with bands to minimise backline noise/promote use of in-ear monitoring.
- Disposable hearing protection to be available at entry points to stage.
- Stage Manager to monitor and enforce use of hearing protection onstage.

2 The stage pit area:

- Stage pit to be signed as a mandatory hearing protection zone.
- All pit staff to be advised in advance of show of the need to wear appropriate hearing protection during their shift.
- Disposable hearing protectors to be available on both sides of entry to pit.
- Pit security team to be briefed to refuse entry to anyone not wearing hearing protection (photographers, guests etc).
- Security contractor to ensure staff are rotated to quiet areas during their shift period.
- Security supervisor to monitor and enforce wearing of hearing protection.

3 Concession and other stands within the main arena:

- Site to be set out to avoid stalls and other infrastructure in direct line of speakers.
- Where possible elevate speakers using flown systems.

* Only strictly required at or above the upper exposure action value.

- Inform all stall/concession holders of the likely exposure to loud noise and the need to ensure their staff are briefed and have access to appropriate hearing protection.

4 Medical and welfare tent by side of stage:

- Position medical and welfare facilities as far as reasonably practicable from speakers.
- Make hearing protection available to all medical and welfare staff.
- Request medical and welfare providers to make arrangements to rotate staff to quiet duties during their shift.

5 Backstage bar/hospitality facilities:

- Locate the bar as far as practicable from the stage.
- Limit the hours of operation of the bar PA system.
- Reduce the level of PA systems in the bar and hospitality areas.
- Contact the bar manager to ensure bar staff are briefed on the risks of working in a noisy area.
- Ensure the bar contractor makes appropriate hearing protection available to their own staff.

Noise monitoring plan

- Integrating sound-level meter to be rented and a range of 15-minute L_{Aeq} samples to be taken by the Event Safety Officer during the weekend to establish the geographic limits of noisy areas.
- Dosemeter to be worn by Stage Manager to get sample on-stage exposure levels.
- Local authority will be on site to conduct front-of-house noise sampling to assess compliance with Licence conditions.

Additional considerations

- Review of noisy areas and the type of hearing protection provided to be conducted once measurements are taken during the event. These measurements will also inform those involved about possible measures for future events.
- Continue advance discussions with PA supplier to identify means of reducing on-stage noise and spill into backstage/medical/welfare areas.

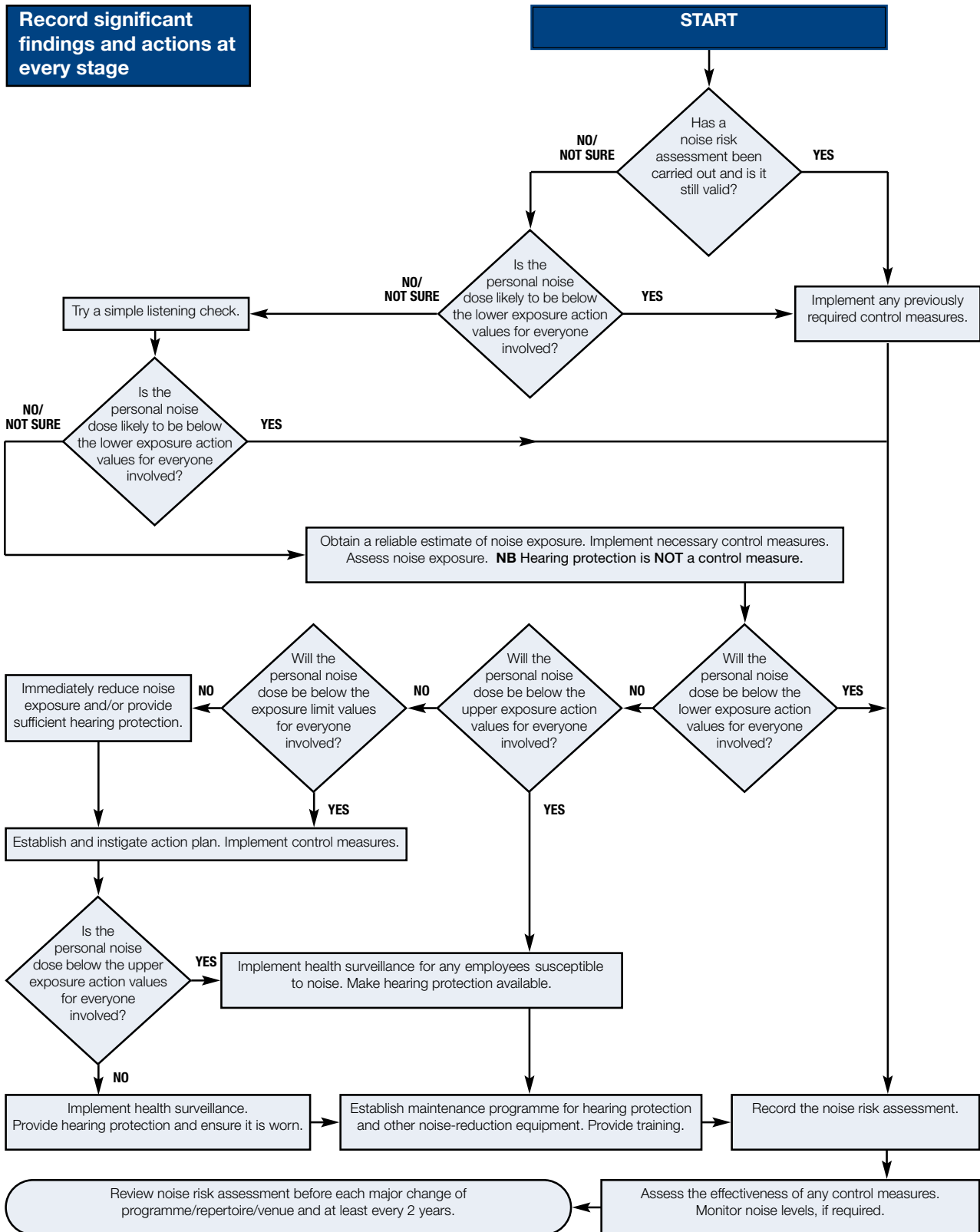


Figure 3 The generic process of noise risk assessment

Noise-control measures and training

Overview

Controlling noise risk and noise exposure
Control measures
Provide information, instruction and training on noise

Controlling noise risk and noise exposure

80 Wherever there is noise exposure at work employers should be looking for ways of working that would reduce the noise or mean that people are exposed for shorter times. Employers should also be keeping up with what is good practice for noise control within their sector.

81 Where there are things that can be done to reduce risks from noise, which are reasonably practicable, they should be done. Where the risk assessment shows that employees or subcontractors are likely to be exposed at or above the upper exposure action values, the employer must put in place a planned programme of noise control. The risk assessment should have produced information on the risks and an action plan for controlling noise.

82 There are many ways of reducing noise and noise exposure, however, it is important to tackle the dominant or loudest noise sources first. Pick the most appropriate solutions to resolve the particular problems of the specific event.

83 Collective protective measures should always be used in preference to individual protective measures. The approach for the control of noise should be, in order of preference, to:

- eliminate the hazard or risk altogether (if it is reasonably practicable to do this, it should be done);
- control the risk at source (for example reduce the volume, substitute quieter sources);
- reduce the noise as it travels to the people exposed (for example physical barriers, distance, absorptive materials);
- reduce exposure (for example by organising the work to reduce the duration of exposure or the number of people exposed to noise).

84 If these measures are not adequate to reduce the exposure enough, then hearing protection must be provided (see 'Personal hearing protection').

85 Control measures should be accompanied by:

- provision of information, instruction and training;
- proper and regular maintenance of equipment.

86 Noise measurements may be necessary to establish the effectiveness of any control measures.

Control measures

87 Any immediate risks should be tackled immediately – this will include providing hearing protection as an interim measure while more permanent noise-control solutions are put in place. This includes any noise hazards that are liable to cause immediate and lasting damage rather than accumulating over time, for example pyrotechnics, fireworks and even loud sound systems. For these types of potential hazards it is crucial to ensure that a thorough noise-control strategy is in place before there is any further exposure.

88 When examining possible measures, consider, for example, the types of instruments being played, the number and positions of performers, whether amplification is being used, the acoustic of the venue and the noise associated with stunts and effects. There may also be other workplace noise such as construction noise, power tools, PA noise and noise created by the public.

89 Some measures may not be feasible. Others may prove ineffective in reducing noise exposure levels on their own. Often a combination of measures may have to be tried, as each measure may itself have implications for others in a variety of ways. A range of appropriate solutions for a particular type of performance or source of sound within the specific venue should be identified. Those involved should be encouraged to suggest ideas for noise control and noise reduction, which can be tried out and adopted when appropriate.

90 Some noise-reduction measures take some time to get used to, for example brass in an orchestra raised on to rostra/risers may not have to play so loudly (see Appendix 6 'Risers').

91 When selecting noise-control measures, always consider whether the measure concerned might create other health and safety issues or unwanted side effects. Two examples from live music are the use of high risers, which may have fall implications (see the Work at Height Regulations 2005⁵), and incorrectly positioned personal acoustic screens, which can cause problems for the player and other players.

92 The noise-control measures should be reviewed to ensure they are properly applied and effective. Any difficulties should be investigated and the findings fed back into the risk-assessment process.

93 The following paragraphs provide general advice on noise-control measures. For more specific advice see the more detailed recommendations for each sector.

Eliminate the hazard

94 Wherever practicable do not generate hazardous levels of sound in the first place. Think of ways of eliminating unnecessary exposure such as avoiding noisy activities, for example, sound system checking while riggers and others are working adjacent to loudspeakers. Also tailor the programme to the venue and avoid reverberant or unsuitable spaces.

Control the risk at source

95 Consider how the noise level can be reduced, for example by reducing the sound output from individual instruments such as damping drums or closing piano lids, leading to an overall reduction in volume. Fold-back levels on the stage should be reduced to the minimum level at which it is possible to work. Noise can also be controlled by the careful design of the premises, for example by using acoustic absorption panels. Adding an acoustic ceiling, acoustic wall linings or carpeting may increase acoustic absorption.

96 Sound-level adjustments can be more readily carried out where amplification is used and it is simple and highly effective to turn amplified sound down. However, it is essential to monitor sound levels to ensure they are not increased again above acceptable levels. A control mechanism within the sound system may help, by providing a warning (or limiting) when a preset sound level is reached.

Separate people from the hazard

97 It is sometimes possible to separate people from the hazard by physically isolating the noise source, for example by using booths for noisy instruments in recording studios or increasing the distance between front-of-house workers not on stage and the stage area and loudspeakers.

Reduce exposure time and the number of people exposed

98 If people, such as pit crews and monitor engineers, have to work in very noisy environments, take measures to reduce the duration of exposure. This could include shortening sound and system checks and rotating staff between noisy and quieter duties. For an individual concert this may not be practical for a specialist such as a monitor engineer, but in the context of reducing an overall weekly exposure level, task variation may be useful. Show days might be balanced with office/warehouse work to achieve a minimised weekly exposure level.

Provide information, instruction and training on noise

99 Awareness of noise risks and controls is very important, as people will then take notice of the risks and use any risk-reduction measures properly. People in the industry have to be made aware of the potential for permanent hearing damage associated with working in a very noisy environment. This may require a considerable shift in personal attitude and collective culture.

100 Understanding the risks from high sound levels should form part of the basic education of performers and technicians, so people coming into the industry know how to protect themselves and become part of the solution rather than the problem. Information and instruction should also include posting warning notices around designated hearing protection zones and briefings to performers and other workers about the noise-reduction strategies adopted for an event.

101 Employers should try to ensure that employees understand the need to follow the employer's or venue operator's instructions on control measures including, for example, abiding by any agreed arrangements for job rotation or restriction of access to noisy areas or following any instructions relating to achieving agreed noise levels, as well as wearing hearing protection when required. Employees should be encouraged to report to their employer any new hazardous noise situations or hearing loss or tinnitus.

102 It is also worth educating employees on the general risks of noise from other non-work activities which still contribute to exposure. For example, the noise level within the in-ear headphones of music players such as MP3 players can be 94 dB at around half volume (with peaks of 110–130 depending on headphones) and 105 dB at full volume (peaks 110–142).

Role of management

103 The role of middle management and supervisors in developing and applying a successful noise policy is important. Their training and instruction is a high priority and should include:

- training to the level required for their responsibilities;
- having those responsibilities clearly set out and knowing the responsibilities of other managers/supervisors;
- understanding the health and safety policy of their employer;
- understanding the importance of providing a safe environment for workers.

104 Employers should also convey their findings to their employees, for example by displaying the outcomes of risk assessments by programme, session or day on a prominent notice board, or by making this information available when confirming rehearsal and performance schedules with players. Findings should also be provided to safety representatives and other employee representatives.

105 Employers should ensure their employees and other workers or self-employed people affected by the work activity understand the noise risks to which they may be exposed. Employers should at least tell them:

- the likely noise exposures and the risk to hearing this creates;
- what is being done to control risks and exposures;
- where and how people can obtain hearing protection if this is needed;
- how to report defects in hearing protection and noise-control equipment;
- what their duties are under the Noise Regulations;
- what they should be doing to minimise the risk, such as the proper way to use hearing protection and other noise-control equipment, how to look after it and store it and where to use it;
- what health surveillance is provided if this is appropriate.

106 Make sure information is provided in a way that can be understood and, if necessary, make special arrangements for workers who do not understand English or cannot read.

Freelancers and self-employed people

107 Where a management or orchestra regularly engages the same freelancers, they should be considered as being employed and provided with training on control measures (including the use of screens and personal hearing protection) as well as regular health surveillance.

Training courses

108 Trade Unions, trade associations and other professional bodies may be able to advise or help identify suitable training courses where these are needed.

Personal hearing protection

Overview

Requirements for hearing protection
When should hearing protection be used?
Making hearing protection effective
How much protection?
Managing hearing protection
Selecting hearing protection
Earplugs
Earmuffs
Training and effective use

Requirements for hearing protection

109 For a device to be categorised as personal hearing protection it must be CE-marked showing it meets the relevant parts of European Standard BS EN 352.⁶ These set criteria for a range of quality and safety aspects, such as comfort, ergonomics, provision of information, factors related to ageing, quality of production, as well as the level of sound reduction. Employers should satisfy themselves that any devices supplied to workers as personal hearing protection are CE-marked and meet the requirements of the relevant part of BS EN 352.

Note about IEMs and headphone monitors

In-ear monitors and headphone monitors do not generally meet the necessary criteria to be categorised as personal hearing protection devices, although some workers in the music and entertainment sector may wrongly consider them to be. However, IEMs and headphone monitors have a valuable role in reducing the risk of hearing damage as they allow a reduced level of reproduced sound on stages and in other work areas. The use of IEMs and headphone monitors is covered in Appendix 8 and Appendix 9 of this book.

When should hearing protection be used?

110 Personal hearing protection should be used where extra protection is needed above what can be achieved using noise control, and as a short-term measure while other, more permanent solutions, technical, engineering or organisational, are being sought. Personal hearing protection should not be used as an alternative to controlling noise by technical and organisational means.

111 The Noise Regulations make the use of personal hearing protection compulsory for employees whose exposure to noise is likely to reach either of the upper exposure action values and for any employees working within designated areas (hearing protection zones). Where the exposure to noise is likely to reach either of the lower exposure action values but be below the upper exposure action values, the employer must provide personal hearing protection to any worker who requests it.

112 The use of hearing protection should not be made compulsory where the law doesn't require it. It is bad practice to have a 'blanket' approach to hearing protection; it is better to target its use and encourage people to wear it only when they need to.

Making hearing protection effective

113 To be of value, hearing protection needs to:

- control the risk. Choose protectors which will result in an effective personal noise exposure below 85 dB, and reduce peak noise to below 137 dB. The more protection the better, but beware of over-protection;
- not over-protect. Cutting out too much noise can cause isolation, or lead to an unwillingness to wear the protectors. Musicians may compensate by actually playing more loudly and increase their risk of playing injuries;
- reduce the noise level to no less than about 70 dB;
- be comfortable and suitable for the working environment. Consider how comfortable and hygienic the protectors are, whether they will be worn with any other protective equipment, and how the activity of the user can be accommodated;
- be properly used;
- be worn at the right time – whenever there is a noise hazard present. Workers need to be told when and where to wear hearing protection;
- be readily available to all who need it and actively supplied by the employer;
- be properly maintained, in good, clean and undamaged condition.

114 People using personal hearing protection should at all times be able to hear any safety alarms and warning signals such as fire alarms, evacuation alerts, reversing vehicles, stage announcements concerning strobe effects etc. Where any doubt exists about the ability of a worker to hear such warnings, alternative means of communication must be provided, for example visible lights or other methods such as vibrating pads.

How much protection?

115 Employers should provide protection that at least reduces the noise exposure to below 85 dB. Avoid protectors that reduce the level at the ear to below 70 dB. Employers must provide protection against impulsive noise, such as gunfire or pyrotechnic effects, sufficient to reduce the C-weighted peak sound pressure level at the ear to below the upper exposure action value of 137 dB.

116 For workers with variable exposures, employers should ensure that their employees have protectors adequate for the worst situation likely to be encountered, and that they know when and where to use them. It might be that using more than one type of hearing protector is an appropriate solution for people whose work varies significantly during the day or from day to day.

117 Table 2 gives an indication of the degree of protection that is likely to be suitable for different levels of noise. It is based on the single number rating (SNR) value provided with a hearing protector. This information is intended as a guide, and will not be appropriate if there is significant low-frequency noise.

Table 2 Selecting hearing protection

Noise level in dB	Select a protector with an SNR of:
85–90	20 or less
90–95	20–30
95–100	25–35
100–105	30 or more

118 Other methods of estimating the performance of hearing protection, for use where more detailed information on the character of the noise is available, are described in Part 5 of L108. A hearing protection spreadsheet is available on the HSE noise web pages (www.hse.gov.uk/noise).

119 It is important to use the right type of hearing protector and to use it whenever hearing protection is required. It is also important to realise how rapidly the upper action value can be exceeded and how hearing can be damaged in a noisy environment.

Managing hearing protection

120 Training should promote the use of hearing protection if it is required and management should ensure it is properly used. Hearing protectors will only provide good protection when used properly – simply handing them out is not acceptable. Consider implementing a systematic programme to:

- include the need to wear hearing protection in the safety policy;
- ensure there are adequate facilities for maintenance and storage of hearing protectors;
- put someone in authority in overall charge of issuing hearing protectors and making sure replacements are readily available;
- carry out spot checks to see that the rules are being followed and that hearing protection is being used properly;
- ensure everyone, including managers and supervisors, sets a good example and wears hearing protection at all times when in hearing protection zones;
- distribute HSE's card *Protect your hearing or lose it!*⁷ to remind people to wear their hearing protection.

Selecting hearing protection

121 Hearing protection falls into two broad categories: earplugs and earmuffs. With regard to the particular needs of workers in music and entertainment, there is a greater variety of products within the earplugs category.

122 Many workers in music and entertainment, such as musicians, performers and sound engineers, need to hear sounds with as little distortion or colouration as possible, especially in the higher frequencies. This can cause problems when using personal hearing protection, as conventional hearing protectors tend to reduce higher frequencies more than lower frequencies. For example, a compressible foam plug that reduces sounds in the 125 Hz range by 25 dB may reduce sounds in the 4000 Hz range by almost 40 dB.

123 Fortunately, hearing protection technology has developed to the point where specialised products can reduce sound levels almost equally across a broad range of frequencies. This means that the user perceives the sound as being far more natural and positive than with ordinary earplugs. These products are usually called 'flat' or 'uniform' attenuation hearing protectors. They come in both earplug and earmuff types. These protectors have been found helpful where there is a particular need for verbal communication, such as for bar staff.

124 When there is no concern about sound quality, hearing protection can generally be both simple and inexpensive, and where the appearance of hearing protection is less important, there is a wider choice.

Acclimatising

All hearing protection alters the listening experience, and it can take a long time to get used to it. The acclimatisation process should be managed – if not, people will give up and their hearing will become increasingly damaged. Avoid wearing hearing protection for the first time in a performance.

A typical sequence for a musician acclimatising to earplugs might be:

- Wear them at home and get used to speaking while wearing them.
- Wear them around and about and get used to conversation.
- Wear them while practising.
- Wear them at rehearsal.
- Wear them in performance.

With enough time to acclimatise to using the right hearing protection, communication with other people should not be a major problem.

Consultation

125 The selection process should take account of consultation with employees or their representatives.

Medical disorders

126 Before selecting hearing protection, find out whether the user has any medical disorder such as earache and irritation of the ear canal that could influence the selection. Where employees have any such disorders, employers should seek medical advice as to the suitability of hearing protection.

Wind and brass players

127 When blowing their instruments, wind and brass players experience their own sound aurally, but also via the skull-bones conducting the vibrations from the instrument to the ears, as they play. Using earplugs can affect this balance as the musician's ear hears less treble sound while experiencing more bass sound via bone conduction. The bass-treble distortion can be extreme. This will be strange for the player, can take some time to get used to and will vary from one individual to another.

128 Ordinary compressible earplugs are generally unsuitable for players of reeded woodwind and brass instruments because of the occlusion effect (singers also find compressible earplugs make the voice sound strange). There are two ways of dealing with the occlusion effect:

- use deep-fitting custom-moulded earplugs which reach into the inner bony portion of the ear canal and so reduce potential vibration and jaw resonance; or
- use earplugs with vents that allow the trapped low-frequency sound to escape.

129 There is a misconception among some woodwind and brass players that it is not possible to wear earplugs due to the build-up of pressure in the ear and the risk of further damage to the ear canal. This has no basis in fact. With the correct earplugs, with patience and sufficient acclimatisation, brass and woodwind players will find they are able to wear appropriate earplugs and have no need to worry that they will suffer further damage to their ears.

Large dynamic range and impulsive sounds

130 Some sources of noise in the music and entertainment sector have a large dynamic range (such as brass, percussion and much woodwind) or can be highly impulsive (such as firearms or pyrotechnics). In these situations 'amplitude-sensitive' or 'level-dependent' hearing protection could be suitable. These use mechanical or electronic mechanisms to allow lower-level sounds to pass relatively unhindered, but 'clip' very high-energy noise. The type with mechanical mechanisms often use the acoustic properties of carefully designed air ducts to give different protection at different noise levels. Amplitude-sensitive hearing protectors come in earplug and earmuff types.

131 Tables 3 and 4 provide general guidance on the selection of suitable hearing protection.

Table 3 Typical problems and selecting suitable hearing protection for live performers

Situation	Typical problems	Possible protection
Amplified instruments or sound systems	Often over-loud.	<ul style="list-style-type: none"> ■ Uniform attenuation earplugs. (Note: using in-ear monitors may remove the need for, or allow reduced levels of, reproduced sound in working areas.)
Singers	Own voice may be over-loud. Other instruments make monitoring voice difficult.	Solo: <ul style="list-style-type: none"> ■ Vented/tuned earplugs. Accompanied: <ul style="list-style-type: none"> ■ Uniform attenuation earplugs.
Reeded woodwinds	Proximity to brass or percussion sections. Jaw resonance (occlusion effect) makes it difficult to monitor instrument while using conventional earplugs.	Near trumpet or percussion sections: <ul style="list-style-type: none"> ■ Vented/tuned earplugs. ■ Uniform attenuation or amplitude-sensitive earplugs. Near amplified speakers: <ul style="list-style-type: none"> ■ Uniform attenuation earplugs.
Flutes and piccolos	Loud peak levels, intense high frequencies. Existing right-ear hearing loss results in perceived distortion.	Generally: <ul style="list-style-type: none"> ■ Uniform attenuation or amplitude-sensitive earplugs. Right-ear hearing loss: <ul style="list-style-type: none"> ■ Asymmetrical vented/tuned earplugs.
Brass	Jaw resonance (occlusion effect) makes it difficult to monitor instrument while using earplugs.	Near percussion or other brass instruments: <ul style="list-style-type: none"> ■ Vented/tuned or amplitude-sensitive earplugs. ■ Earmuffs. Near amplified speakers: <ul style="list-style-type: none"> ■ Uniform attenuation earplugs.
Violins and violas	Conventional earplugs remove higher-frequency sounds.	<ul style="list-style-type: none"> ■ Uniform attenuation earplugs. ■ Some prefer amplitude-sensitive – particularly if near loud neighbours.
Basses, cellos, harps	Proximity to brass section.	<ul style="list-style-type: none"> ■ Vented/tuned earplugs.
Pianos and harpsichords	Conventional earplugs remove higher-frequency sounds.	<ul style="list-style-type: none"> ■ Uniform attenuation earplugs.
Drums and percussion	High sound levels, intense higher frequency sounds such as cymbals. Conventional earplugs reduce sound levels too much and may result in over-hitting to compensate.	<ul style="list-style-type: none"> ■ Uniform attenuation or amplitude-sensitive earplugs. ■ Earmuffs.
Pit orchestras	Often over-loud.	<ul style="list-style-type: none"> ■ Uniform attenuation earplugs. ■ Headphone monitors.
Conductors and music teachers	Conventional earplugs remove higher frequency sounds.	<ul style="list-style-type: none"> ■ Uniform attenuation earplugs.
<p>Note that while the problems are common, personal and environmental factors vary widely. Employers should consult performers before selecting particular hearing protection. Professional advice is desirable.</p>		

Table 4 Typical problems and selecting suitable hearing protection for other workers

Situation	Typical problems	Possible protection
Live sound engineers Studio performers and engineers	Just very loud. Competing external sounds.	<ul style="list-style-type: none"> ■ Uniform attenuation earplugs. (Note: using headphone monitors or in-ear monitors may remove the need for, or allow reduced levels of, reproduced sound in working areas.)
Theatre and other live-performance cast and crew	Continuous sounds (generators). Impulse sounds (pyrotechnics, gunshots).	<ul style="list-style-type: none"> ■ Earmuffs. ■ Compressible earplugs. ■ Premoulded earplugs.
Concert venue workers	Need protection against high sound levels while retaining ability to communicate.	Communication not an issue: <ul style="list-style-type: none"> ■ Compressible earplugs. ■ Earmuffs. Need to communicate: <ul style="list-style-type: none"> ■ Uniform attenuation earplugs.
Bars and clubs	Need protection against high sound levels and may need ability to communicate.	Glass collectors: <ul style="list-style-type: none"> ■ Compressible earplugs. ■ Earmuffs. ■ Premoulded earplugs Bar staff: <ul style="list-style-type: none"> ■ Uniform attenuation earplugs. DJs: <ul style="list-style-type: none"> ■ Earmuffs with sound restoration devices (ANC) fitted. Managers, security staff: <ul style="list-style-type: none"> ■ Uniform attenuation earplugs with comms fitted. (Note: using headphone monitors or in-ear monitors may remove the need for, or allow reduced levels of, reproduced sound in working areas.)
Note that while the problems are common, personal and environmental factors vary widely. Employers should consult workers before selecting particular hearing protection. Professional advice may be desirable.		

Earplugs

132 Earplugs fit into the ear or cover the ear canal. They are less visually intrusive than external hearing protection but need careful selection as they represent a very personal protection against specific noise sources under specific conditions. All earplugs should come with an indication of the theoretical noise reduction. The description of the reduction may be a single number or it may give an indication of the reduction at different frequencies. It should be remembered that the theoretical attenuation of 'off the shelf' earplugs is based upon a system of averaging and it is often appropriate to take a 'real world' view and assume that the reduction is 4 dB less than stated on the packet.

133 Instructions for all earplugs should give advice on the correct method of use as the seal created between the earplug and the ear is fundamental to its effectiveness. Where earplugs are supplied by an employer there is a duty to ensure that correct training is given. In circumstances where a health surveillance programme is in operation it would be best to incorporate the appropriate selection, fitting and training as part of that programme. The certification of different earplugs to comply with European Standards is progressing as new types of earplugs are developed. Trade literature should clearly identify if the type of earplug on offer has been certified. (Further details may be found in HSE publication L108.²)

Compressible earplugs (disposable)

134 The advantages and disadvantages of compressible earplugs are:

Advantages

- Inexpensive and simple to use.
- Effectively protect against high sound levels.
- Smaller than earmuffs – can be carried in a pocket.
- More comfortable than earmuffs in hot environments.

Disadvantages

- Provide uneven frequency attenuation – remove more high frequencies than low.
- Occlusion effect distorts sound perception for reeded woodwind and brass musicians.
- Interfere with speech communication.
- Require careful insertion to ensure effective protection.
- Risk of infection from dirty hands.

Useful for

- Crew, venue staff, and other workers in situations in which sound quality and speech communication are not issues (especially non-music applications).
- Emergency applications (such as forgetting or losing custom-moulded earplugs).

135 This type of earplug is more suited to job functions where the user does not need to hear the full frequency range of the sounds. Musicians and sound engineers may not find these suitable during a performance but they are useful as a last resort.

Premoulded earplugs (reusable)

136 Premoulded earplugs are generic-fit earplugs shaped for the average user's ear canal. Most have a triple-flanged plug that fits inside the ear canal. These plugs are generally reusable but require regular cleaning. Various types are available including uniform attenuation and amplitude-sensitive.

Most premoulded earplugs have a triple-flanged plug that fits inside the ear canal

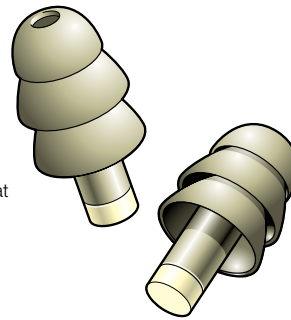


Figure 4 Premoulded earplugs

137 The advantages and disadvantages of premoulded earplugs are:

Advantages

- Less expensive than custom-moulded earplugs.
- Easy to insert properly.
- Last longer than compressible earplugs.
- Do not require custom-fitting – available off-the-shelf.
- Reusable – if kept clean.

Disadvantages

- More expensive than compressible earplugs.
- Uniform attenuation types generally not as ‘flat’ as custom-moulded uniform attenuation earplugs.

Useful for (uniform attenuation types)

- Musicians and vocalists who want a relatively inexpensive earplug with relatively uniform attenuation for practice and rehearsals.
- Bar staff and other workers who want relatively inexpensive earplugs that do not muffle voices and other higher-frequency sounds as much as compressible plugs.

Custom-moulded earplugs

138 The silicone earplug is moulded to the shape of the user’s ear canal and should be fit-tested. They are typically made by a laboratory that supplies local audiologists and hearing clinics. They can come in filtered or vented/tuned varieties. Here each plug is bored out, and then fitted with an adjustable vent or capped with a button-sized filter attached to its outer end.

139 In filter types, the filter, in conjunction with the air inside the bored-out section, offsets the loss of high frequencies that normally occurs when an object is inserted into the ear. Not only can the frequency attenuation of the fitting be specifically tuned to the user’s needs, but also the plugs themselves will be comfortable and highly effective and are readily reusable. Filters are available which, for example, reduce overall noise levels by 9, 15, and 25 dB.

140 The vented/tuned earplug, which does not reduce sound levels up to about 2000 Hz, reduces higher frequencies significantly. Typically, vented/tuned earplugs attenuate higher frequencies by about 20 dB when the adjustable vent is wide open. Closing the vent increases higher-frequency attenuation to as much as 28 dB (performance similar to compressible earplugs). Most ear-mould laboratories can make custom-moulded vented/tuned earplugs.

141 The advantages and disadvantages of custom-moulded earplugs (filter types) are:

Advantages (filter types)

- Can provide even attenuation of frequencies up to about 6000 Hz.
- Can be modified to adjust high-frequency attenuation.
- May be flesh-coloured and unobtrusive.

Disadvantages (filter types)

- Expensive.
- Need custom-fitting by a qualified professional.

Useful for (filter types)

- Musicians playing or seated nearby to instruments that produce higher-frequency sounds (for example, violins, trumpets, piccolos, and pianos).
- Anyone working with or around amplified sound (for example, musicians, vocalists, DJs, sound engineers, conductors, and teachers).
- Anyone who needs sound reduction with minimal distortion or colouration.

142 The advantages and disadvantages of custom-moulded earplugs (vented/tuned types) are:

Advantages (vented/tuned types)

- Allow musicians playing lower-frequency instruments to hear themselves while screening out surrounding higher-frequency sounds.
- Very little occlusion effect.
- Right and left earplugs can be adjusted separately to compensate for right-ear hearing loss in flute and piccolo players.
- Small 500 Hz resonance improves vocalist's ability to monitor voice.

Disadvantages (vented/tuned types)

- Expensive.
- Need custom-fitting by a qualified professional.

Useful for (vented/tuned types)

- Musicians playing bass and lower-frequency instruments (for example, lower strings, reeded woodwinds, and low brasses) who wish to shield themselves against high-frequency sounds from percussion or trumpet sections.
- Those solo vocalists who need protection against their own voice.

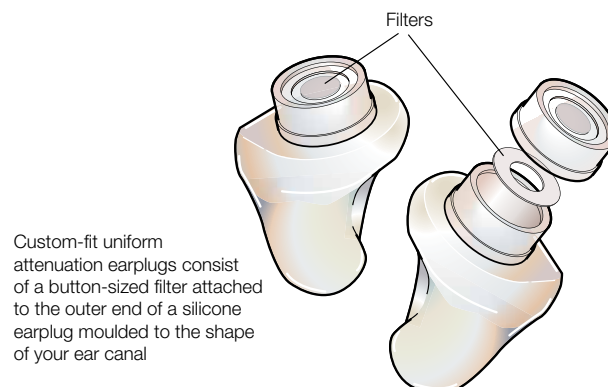


Figure 5 Custom-moulded earplugs

Canal caps/semi-insert earplugs

143 Canal caps and semi-insert earplugs come on a headband. Canal caps (sometimes called semi-aural plugs) generally have rounded tips that cover the entrance to the ear canal, while semi-insert plugs generally have tapered tips that are pushed into the ear canal. Both types are convenient for situations where the hearing protection has to be taken on and off frequently. They are not designed for continuous use.

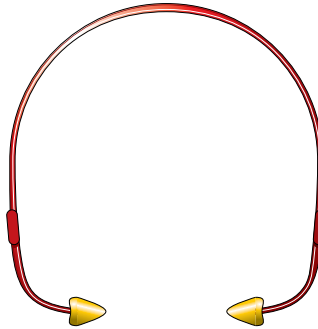


Figure 6 Semi-insert earplugs

144 Where patterns of exposure to excessive noise are likely to be repeated and short-term, earmuffs or canal caps may be preferred because they are quick and easy to fit and remove, and therefore more likely to be fitted when exposure occurs.

Earmuffs

145 Earmuffs (sometimes referred to as 'ear defenders') are hard plastic cups that fit over and surround the ears and are sealed to the head by cushion seals. Tension to help the seal is provided by a headband. They are easy to fit and use, once appropriate training is given, and their use is easily monitored. Helmet-mounted earmuffs may be appropriate for riggers.

146 Some earmuffs provide sound restoration. These have a microphone on the outside and a speaker on the inside, often electronically limited, to enable the wearer to hear external signals. This electronic system can introduce a tiny but sometimes noticeable time delay.

147 Some earmuffs incorporate systems to relay communication or other audio signals (for example, music for DJs). These devices reduce the ambient noise levels and therefore allow the wearer to listen to the music at a reduced level. They can provide an alternative to headphones in noisy environments. Earmuffs should comply with BS EN 352-6⁸ and BS EN 352-8.⁹ Check that limiters are fitted to limit the level of sound reproduced at the wearer's ears.

148 Earmuffs, like all hearing protectors, should be selected on the basis of comfort, practicality and hygiene to help ensure they are worn properly. Any attempt to alter the earmuffs or using damaged earmuffs could make them ineffective. Comfort considerations include:

- Pressure from the seals on the head – resilient seals only need a low headband force.
- A large contact area between the seal and head helps reduce the contact pressure but in hot conditions may cause sweating.
- Weight – the lighter the better but the cups need to be large enough to fit right over the user's ears.

149 The advantages and disadvantages of earmuffs are:

Advantages

- Inexpensive and simple to use.
- Easier to slip on and off than earplugs.
- More comfortable than earplugs in cold environments.
- Less occlusion effect than with compressible earplugs.

Disadvantages

- Heavier and more obtrusive than earplugs.
- Can be uncomfortable in warm or humid conditions – earplugs may be preferred.
- May not be effective for use with spectacles, long hair, beards and jewellery.

Useful for

- Crew members who need protection while working around loud sound and who are not concerned with how the earmuffs look.

Training and effective use

150 Users must be trained how to correctly fit and use hearing protection, including:

- why hearing protectors are provided and where and when they must be used;
- the need to follow the manufacturer's instructions;
- how to avoid items such as spectacles, long hair, earrings and costume accessories, and any other personal protection, interfering with the effectiveness of the hearing protection;
- the need for full acclimatisation;
- the importance of wearing hearing protection at all times in a noisy environment (removing it for only a few minutes will lower the protection to the wearer very considerably);
- cleanliness – all protectors should be thoroughly cleaned before use and stored hygienically. Earplugs should be inserted only after washing hands thoroughly. Disposable earplugs should be discarded if unwrapped and after use and should not have passed their expiry date;
- earplugs, canal caps and in-ear monitors should not be shared;
- how to store, care for and frequently check their hearing protectors to make sure they remain in a good, clean condition;
- where to report damage to their hearing protectors and how to obtain replacements or new protectors. Earmuff seals and caps should not be damaged, with no reduced tension of the headbands.

Hearing health surveillance

Overview

Providing health surveillance

Hearing checks

What is health surveillance?

How is health surveillance arranged?

What does an occupational health service provider do?

What should be done with the results of health surveillance?

Providing health surveillance

151 Employers must provide health surveillance involving hearing checks for all employees who are likely to be frequently exposed at or above either upper exposure action value, or are at risk for any other reason, for example they already suffer from hearing loss or are particularly sensitive to damage. It is not a suitable substitute for controlling risk at source.

152 The purpose of health surveillance is to:

- identify when employees are showing early signs of hearing damage;
- provide an opportunity to do something to prevent the damage getting worse;
- check whether control measures are working.

153 Employees must co-operate with their employer's health surveillance programme. Employers should consult their trade union(s) safety representative(s), or employee representative(s) and the employees concerned before introducing health surveillance. It is important that everyone understands that the aim of health surveillance is to protect their hearing. Understanding and co-operation are essential if health surveillance is to be effective.

154 There is no requirement for self-employed people to have health surveillance, however they are strongly advised to arrange it if they think their exposure frequently exceeds the upper exposure action value, they regularly have to wear hearing protection, or have other concerns about their hearing. If you are a freelancer, see Sound Advice 1 'Freelancers'.

Hearing checks

155 Hearing checks can be a matter of concern for those whose employment depends on their ability to hear. Musicians and sound engineers rely on good hearing and they may worry that any deterioration will affect their ability to carry out their work activities. Employees and freelancers should be encouraged to view health surveillance programmes (hearing checks) as a positive contribution to preserving their hearing.

156 For some, the check will show that there is no problem, while others may find that their hearing is in the early stages of damage. Some may already suspect that their hearing is deteriorating and check results may confirm these fears. These individuals may be worried that they will lose their jobs if their employer is informed that they are 'losing their hearing'. However disciplinary action cannot be based on the results of the hearing check.

157 Whatever the outcome, the check should be viewed as an opportunity to identify any deterioration at an early stage and to ensure that appropriate measures are taken to prevent any further harm.

What is health surveillance?

158 Health surveillance for hearing damage usually means:

- regular hearing checks in controlled conditions which includes measuring hearing sensitivity over a range of sound frequencies;
- telling employees about the results of their hearing checks;
- keeping health records;
- ensuring employees are examined by a doctor where hearing damage is identified.

159 Ideally health surveillance starts before people are exposed to noise (for new starters or those changing jobs) to give a baseline. Ensure this covers all those people who are employed on a regular basis.

160 Health surveillance can, however, be introduced at any time after exposure to noise. This would be followed by a regular series of checks, usually annually for the first two years and then at three-yearly intervals (although this may need to be more frequent if any problem with hearing is detected or where the risk of hearing damage is high).

161 Hearing checks should be carried out by someone who has the appropriate training. The whole health surveillance programme needs to be under the control of an occupational health professional (for example a doctor or a nurse with appropriate training and experience). Employers must make sure that any hearing health surveillance is carried out properly.

How is health surveillance arranged?

162 Larger companies or organisations may have access to in-house occupational health services which may be able to carry out the programme. An external contractor is necessary where there are no facilities in-house. Details of occupational health services may be found through trade associations or local business support organisations. The Musicians' Union provides advice for freelancers.

What does an occupational health service provider do?

163 Suitable occupational health service providers will be able to demonstrate they have the training and experience needed. They should be able to:

- advise on a suitable programme;
- set up the programme;
- provide suitably qualified and experienced staff to carry out the work;
- provide the employer with reports on employees' fitness to continue work with noise exposure;
- provide employees with feedback on the state of their hearing including their results and general advice on how to look after their hearing.

What should be done with the results of health surveillance?

164 Analysing the results of health surveillance for groups of workers can give an insight into how well the programme to control noise risks is working. The results should be used to target noise reduction, education and compliance practices more accurately. This information should be made available to employees or safety representatives.

165 The employer needs to:

- keep health records of the health surveillance and fitness-for-work advice provided for each employee (but not the confidential medical records which are kept by the doctor). A health and safety inspector can ask to see health records as part of their checks that you are complying with the Regulations;
- make employees' records available to them;
- act upon any recommendations made by the occupational health service provider about employees' continued exposure to noise;
- ensure that any employee with suspected hearing damage is referred to a doctor, to ensure that the employee receives advice from an occupational health professional;
- use the results to review and, if necessary, revise the risk assessment and plans to control risks.

CASE STUDY Health surveillance (audiometry)

A major multi-media company engaged an occupational health provider to cover their requirement for health surveillance.

The company implemented the following:

- Occupational Health would be consulted for any staff who may be exposed to high noise levels with regard to the need for health surveillance. Job roles, identified as putting individuals at risk to high noise exposure, would have a baseline audiometric test on employment and subsequent hearing checks as part of the health surveillance programme.
- All musicians and singers on employment and routinely throughout their work would be put into a health surveillance programme.
- Other staff who may be regularly exposed to noise levels above 85 dB in the normal course of their work would also be included.
- Hearing checks would be free of charge for staff.
- Records would be held on behalf of the employer by the occupational health provider and would be held as 'Medical in Confidence'.
- Results would be communicated to the individual and, if there were any anomalies or some hearing loss, appropriate medical advice and counselling (in confidence) would be provided.
- Fitness for work would not be determined from the results but would continue to be determined by the individual's ability to do their job.
- Managers would not have access to individual medical records, except where the individual consented directly to the disclosure, but would have a written statistical report of results to enable the manager to target noise reduction, education and compliance practices more accurately.
- Several levels of health surveillance were also agreed with the occupational health provider:

Level 1: Noise exposure between 80 dB and 85 dB (the lower and upper action values)

Example: Wearing limited headphones/listening to noise level from a controlled output on a regular basis.

CASE STUDY Health surveillance (audiometry) cont

Require:

- A baseline audiometry test when starting, or within 3 months of starting work.
- Further audiometry tests depending on the result of the baseline test, or in the event of an adverse exposure to noise, eg a loud peak of sound through unlimited headphones.

Level 2: Noise exposure approaching, but not exceeding 85 dB (the upper action value)

Example: Working in areas with unlimited output and/or unlimited headphones.

Require:

- A baseline audiometry test when starting, or within 3 months of starting work.
- A re-test in 1 year to check that they are not 'hypersensitive' to noise damage.
- Further tests depending on the audiometry results. Also in the event of an adverse exposure (as described above). If a significant deterioration in hearing has occurred then removal from that work, and/or more regular audiometry may be necessary.
- The maximum interval between audiometry tests should not exceed 3 years in this situation.

Level 3: Noise exposure above 85 dB (exceeding the upper action value)

Example: Very noisy areas (festivals, live events etc); musicians, depending on risk assessment or noise measurement.

Require:

- A baseline audiometry test when starting, or within 3 months of starting work.
- A re-test in 1 year to check that they are not 'hypersensitive' to noise damage.
- Further tests depending on the audiometry results. Also in the event of an adverse exposure (as described above). If a significant deterioration in hearing has occurred then removal from that work, and/or more regular audiometry may be necessary.
- The maximum interval between audiometry tests should not exceed 2 years in this situation.

Note: In the case of Level 3 employees, the occupational health provider decided to increase the degree of health surveillance beyond HSE's guidance in view of the nature of their exposure.

Part 2

Sound advice for specific sections of the music and entertainment industry

Sound Advice 1	Freelancers 50 <i>Freelancers and other self-employed people</i>
Sound Advice 2	Venues 56 <i>Design, layout and management for pubs, clubs, studios and indoor live music events</i>
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1 Freelancers

Freelancers and other self-employed people

Overview

Background
Responsibilities under the Noise Regulations
Exposure management
Estimate exposure
Hearing protection
Other ways to reduce exposure
Health surveillance
Information, instruction and training
Musicians Hearing Passport

Background

1 This section will help those working in music and entertainment who regard themselves as freelancers or self-employed, for example session musicians, freelance orchestra musicians, jazz musicians, teachers, DJs, lighting/sound engineers, video designers, technicians, cameramen, stage production managers, crew members etc. Freelancers and self-employed workers are also advised to read all the venue-specific guidance that applies to their work. Self-employed musicians are often referred to as freelancers.

Responsibilities under the Noise Regulations

2 The Noise Regulations require each self-employed person to manage the risk to themselves and, so far as reasonably practicable, any other people at work, including other freelancers and other self-employed workers. This will include reducing the risk from noise exposure through organisational and technical solutions. If the risk cannot be eliminated in this way then the engager/contractor may need to provide hearing protection and, if necessary, ensure it is worn.

3 Engagers/contractors and freelancers/self-employed people must work together to provide a safe working environment and protect the hearing of individuals. Engagers/contractors should take reasonable steps to ascertain the exposure of performers during other engagements in the day and manage the risk to their hearing (also see paragraph 14).

4 Collective measures such as organisational controls or changes to layout etc are generally best done by the person in overall control of the venue or production, for example the producer, the publican, the venue operator, promoter or other event organiser. Also, where required, the person in charge should provide hearing protection to workers who need it.

5 Freelancers and self-employed subcontractors are advised whenever undertaking work to clarify any responsibilities under the Noise Regulations and to ensure that any risks are controlled – this is best established by the contract of engagement.

6 Freelancers and self-employed people should understand the practical approach to noise control as it relates to their own speciality. They should use their knowledge

to help reduce their own risk and influence others, for example by engaging proactively with other freelancers and self-employed people in the industry or by checking to ensure that venues have all the necessary procedures in place to help keep exposure levels down. They should not rely solely upon personal hearing protection.

EXAMPLE

Self-employed technician

A self-employed backline technician is engaged to work on an event.

The main contractor should be responsible for implementing noise controls, such as equipment specification, speaker positions, schedules, the provision of acoustic screens etc as these are often beyond the technician's control.

The main contractor should also ensure suitable hearing protection is provided where required, although individuals may wish to use their own hearing protection if they have special requirements such as custom-moulded earplugs.

The technician should confirm that the main contractor will be responsible for implementing the necessary noise controls. This could be done by means of a simple clause in the contract of engagement.

Exposure management

7 Many musicians and other workers in music and entertainment are self-employed and may work for a number of different clients. They may carry out a number of engagements in a day for different engagers/contractors. Freelance musicians, for example, may well be involved in one or two or even all of the following activities in any one day:

- rehearsal(s);
- performance(s);
- teaching;
- practising;
- recording.

8 If a musician were to be exposed for 3 hours at 88 dB, the daily exposure would be 84 dB. However, if this happened three times in the day, the total daily exposure would be 88 dB. In this situation the musician's hearing will be at risk.

9 Freelancers and self-employed people should be aware of their exposure to noise over the day. If they undertake more than one session or activity (such as practising or a sound check) during a day they ought to assess and keep track of their exposure. This could be done using HSE's on-line calculator (www.hse.gov.uk/noise/calculator.htm) or the ready-reckoner (also see Appendix 4 'Estimating noise exposure'). Where they identify a risk they should discuss with their engagers/contractors what controls could be used to reduce exposure.

In general, freelancers and self-employed people are advised to try to adopt any relevant recommendation on controlling noise contained in this book, regardless of the duration of an engagement.

Estimate exposure

10 It is good practice for freelancers/self-employed people to estimate the likely noise levels produced by their instrument or specialist occupation (for example typical levels

during practice by a brass player or during a show for a stage manager). This will enable them to estimate their daily exposure and, if necessary, take steps to reduce the risk. They should also ask engagers/contractors to provide advance information of their likely exposure before work begins. Representative noise levels of instruments and of workplaces such as pubs and clubs are given in other parts of this book.

11 Measuring sound levels with a noise meter can be helpful in tracking exposure during practice, rehearsals or where no data on noise levels is available. However, noise measurements can misinterpret personal exposure if they are not carried out properly (see Appendix 5 'Measuring noise').

12 Freelancers and other self-employed people are strongly recommended to keep a record of their noise exposure and when they have had to use hearing protection. This will help them to understand the extent of their exposure over a typical period and the noise risks they might face. The Musicians' Union can provide its freelance members with a Hearing Passport to help with this process.

Hearing protection

13 If the exposure is likely to be over 80 dB the engager/contractor should have suitable hearing protection available and freelancers/self-employed subcontractors may choose to wear it. If the exposure is likely to be at or above 85 dB, hearing protection must be worn. Personal hearing protection should be used while decisions are being made on how best to reduce noise exposure by technical or organisational means, and should continue to be used if there is still a risk to hearing after all other reasonably practicable measures have been put in place.

EXAMPLE

Freelance folk musician

A folk musician (flute player) has the following activities on a particular day:

Practice at home (2 hours)	86 dB
Teaching in a local school (3 hours)	89 dB
Gig in a venue (2 hours)	93 dB

Using the points system (see Appendix 4 'Estimating noise exposure using the points system') the daily exposure from these activities will be:

Practice	2 hours	86 dB	32 points
Teaching	3 hours	89 dB	97 points
Gig	2 hours	93 dB	160 points
Total 289 points = 89 dB			

At this level of exposure the musician would be at risk of hearing loss and should do what they can to reduce the exposure levels and if necessary wear suitable hearing protection and have a regular hearing check (health surveillance).

Possible methods for reducing exposure levels include:

- controlling amplification levels during the gig;
- arranging to conduct lessons in a suitable classroom;
- practising at lower levels and encouraging students to do the same by stressing the importance of dynamic control and choice of repertoire.

14 While it is the responsibility of the engager/contractor to provide a healthy and safe working environment (including hearing protection where it is necessary), freelancers/self-employed workers are advised to provide their own personal hearing protection where they have specific requirements, such as custom-moulded earplugs – see ‘Personal hearing protection’ in Part 1.

Other ways to reduce exposure

Practice/rehearsals

15 It is recommended that, whenever possible, freelance musicians practise at quieter levels in appropriate practice room(s) to reduce their overall exposure to noise.

Setting up

16 Freelance musicians should think carefully about how they set up their equipment when carrying out a gig. Strategic positioning and direction of speakers and amplifier-combos are recommended.

Noise limiters

17 Freelancers and sound technicians, including those providing their own amplification equipment, may find that some venues will have a noise limiter that has been set to cut the power supply to the amplification equipment when a specific noise level is reached. Ensure that you ask the venue if a limiter has been set, what type it is, and how that may affect your performance. See Sound Advice 5 ‘Pubs and clubs’ for further details of types of limiters. The limiter may have been set to reduce noise breakout from the premises or to protect the venue staff from hearing damage.

Leisure time

18 Freelancers and self-employed people should remember that exposure to loud noise during leisure time will contribute to the overall exposure and could contribute to hearing damage.

Health surveillance

19 Where there are many short-term engagements, it may be difficult to ensure the provision of adequate health surveillance. While the Noise Regulations do not require freelancers or self-employed people to provide themselves with health surveillance, it is strongly recommended that they have regular hearing checks.

20 Hearing checks will not prevent damage to hearing but regular checks will identify any early signs of hearing loss and highlight the need for action to be taken to reduce the risk of any further damage.

21 Freelancers and self-employed people need to take action to protect their hearing from noise risk. The Musicians’ Union, the RNID, NHS+ and other bodies such as the British Society of Audiology can provide guidance and access to health surveillance. Freelancers can use the Musicians’ Hearing Services, which provides a hearing protection scheme, offers regular audiometry, and advice on hearing protection and hearing conservation.

22 Freelancers and self-employed people who regularly work with the same orchestra or management should ask to be included in the provision of regular health surveillance (see also ‘Hearing health surveillance’ in Part 1).

Information, instruction and training

23 Engagers/contractors should consult with freelancers and self-employed people when conducting noise risk assessments and ensure they are provided with any significant findings of their risk assessments.

24 Engagers/contractors should provide freelancers and self-employed people with health and safety instructions including, for example, on how to use acoustic screens and personal hearing protection. All freelancers should follow the health and safety instructions provided by their engager/contractor and discuss the instructions if they appear unreasonable. Acoustic screens should only be used in accordance with the instructions of the engager/contractor (see Appendix 7 'Acoustic screens').

25 Freelancers and self-employed people who regularly work for the same management, orchestra or client should receive training in the use of all equipment provided to manage the risk to hearing (including screens and personal hearing protection) unless they already have such training.

26 Freelance musicians or self-employed workers engaging 'deps' or substitutes should ensure that the risks and control measures in place are communicated to them.

27 Freelancers and self-employed people are advised also to look at 'Noise-control measures and training' in Part 1.

28 Each engager/contractor has a duty to manage noise exposure. However, full co-operation between engagers/contractors and freelance musicians or other self-employed people is necessary to meet the requirements of the Noise Regulations. It is recognised by industry groups that a scheme to help freelancers manage their exposures and exchange information would be beneficial. To be successful this requires input from both engagers/contractors and the freelancers or other self-employed people involved. One way of helping freelancers to manage their noise exposure is to use a 'Hearing Passport' scheme.

The Musicians Hearing Passport

The purpose of the Musicians Hearing Passport is to:

- increase awareness of the risk of hearing damage;
- promote the provision of health surveillance among freelancers;
- reduce the risk of hearing damage;
- promote the use of hearing protection when necessary; and
- ensure that hearing protection is used properly.

The Musicians Hearing Passport includes details of certified training and health surveillance undertaken by the freelancer.

Freelancers agree to:

- enrol for health surveillance;
- undertake training in the proper use of hearing protection and understanding the risk of hearing damage;
- keep their own records of their estimated daily/weekly exposure;
- make their own calculations to assess their likely personal overall exposure using the data supplied by either the engager/contractor, other collated data sources and/or their own personal records (using the HSE points calculator system available on www.hse.gov.uk/noise/calculator.htm).

Engagers/contractors agree to:

- supply data on typical exposure levels based on previous experience and assessments;
- provide information on the expected noise dose from the event, especially when the freelancer has been engaged to perform a specific repertoire. It is suggested that venue owners and engagers/contractors consider installing recording noise meters in their venues to help generate a databank of typical noise levels to enable information to be provided to freelancers;
- ensure that freelancers have access to any noise policies affecting their engagement.

Visit www.musicianshearingservices.co.uk or telephone 020 7323 2076 for more information.

2 Venues

Design, layout and management for pubs, clubs, studios and indoor live music events

Overview

Background
Design
Control measures
Noise exposure policy
Cost-effective solutions for smaller venues

Background

1 Room size, design and building materials can all have a significant effect on the sound levels within a space. Other factors include the range and style of music (particularly rock and pop) and the number of performers, and any other performance noise sources (for example, pyrotechnics or cannons).

Design

2 Architects/designers and builders should incorporate design features that help to promote the performance of music under the best possible conditions and in compliance with the Noise Regulations.

3 Installing in-built monitors and other equipment can help venue owners/operators to monitor and maintain reduced noise-exposure levels.

4 Architects/designers and owners/operators proposing new buildings or major refurbishments are strongly recommended to consult a competent acoustician before undertaking any major work. Do not redecorate existing acoustic treatments as this may reduce their effectiveness considerably.

5 Set designers should consider noise levels alongside other health and safety issues. They should carefully consider the effect the materials they use will have on the noise levels experienced by performers on stage. For example, hard, reflective surfaces might unnecessarily increase sound levels experienced on stage. Conversely, soft, damping or absorptive materials might reduce sound levels.

Control measures

6 Where problems are known to exist, the venue owner/operator should consider making arrangements for changes to the layout or improvements to the building to help reduce noise exposure levels. This might be as simple as separating the bar from the performance area by a door or introducing carpeting and absorbent materials such as drapes at the back of the stage.

Noise exposure policy

7 In many premises the venue operator may have the responsibility of ensuring compliance with the Noise Regulations and if so will need to exercise control over the noise levels from, for example, both the resident DJs and the visiting DJs and bands who may be under the control of an external promoter. Venue operators are advised to develop a written noise exposure policy. This should include as appropriate:

- a description of the control measures designed to protect workers, including casual workers and musicians. Venue operators should ensure that any actions taken to comply with duties they may have under environmental noise legislation do not have an adverse effect upon controls to manage workplace exposure or vice versa;
- provision and use of hearing protection, whether it is compulsory, and where it is available from;
- the recommended and maximum permitted noise levels (amplifier volume settings) and whether noise limiters are installed;
- any special advice or requirements, for example for DJs;
- the positions of any agreed noise measurement reference positions. See 'Noise risk assessment and planning' in Part 1, Sound Advice 4 'Rock and pop', Sound Advice 5 'Pubs and clubs' and Sound Advice 6 'Orchestras';
- use of house equipment, such as amplifiers and speakers, whether it is provided and whether using the house system is compulsory;
- communication of the risk to hearing from noise.

8 Venue operators should ensure that duty managers have effective control over all sound levels within the building, however they are made. This may be as simple as setting a comfortable playing level or could include the use of noise meters and/or noise limiters if levels are consistently breached.

9 Venue operators, when hiring out the premises ('a four walls deal') to others to present an event, should:

- ensure the venue is suitable for the particular requirements of the event to be performed in terms of the scale of both the stage and auditorium and, where appropriate, the orchestra pit;
- ask to see the noise risk assessment (along with the risk assessment for the event);
- provide the hirer with the details of the venue's noise exposure policy;
- provide the hirer with any relevant information on noise control, for example any previous risk assessments.

10 Venue operators who are engaging people to present an event in their premises should also do the following to minimise the exposure of performers and other workers to high noise levels:

- ensure the stage setting(s) of the event are appropriate;
- ensure the positioning of performers is appropriate in relation to other artists and workers in the same area;
- if amplified sound is used, ensure appropriate control measures are implemented.

CASE STUDY

A small nightclub (250 occupancy) playing mainly rock music all night most nights faced the need to improve so that it could continue to operate as a live music venue. However, after taking advice the owner was reassured to find that there were simple and reasonably practicable solutions which could be made to reduce risks from noise including:

- The small triangular stage was moved from a corner and rebuilt as a slightly larger rectangle against a side wall.
- Sound-absorbent panels were fixed to the walls and ceiling around the stage and others were mounted elsewhere in the room.
- The monitor speakers on stage were lifted off the floor and directed towards the musicians.
- A new loudspeaker system was installed with four speakers mounted over the audience, which distributed the sound more evenly.
- Acoustic screens were provided around the drums.
- The house technician was trained in sound-level-measuring techniques.
- The bar was moved from the music area into a different room.

Noise measurements showed a significant reduction. Musicians, staff and audience were asked for their reactions to the changes and these were all very positive.

Source: *Prevention of risks from occupational noise in practice* European Agency for Safety and Health at Work.¹⁰

Cost-effective solutions for smaller venues

11 Venue operators should not be deterred from carrying out simple noise controls as simple solutions can often be very effective:

- Ensure the band is in a suitable location facing the majority of the audience and preferably not the bar or other work areas.
- Locate the band behind the main loudspeakers.
- Make sure the loudspeakers are facing the right way, especially instruments such as guitar combos (loudspeaker/amplifiers), to ensure other workers are not unnecessarily exposed to loud music. Angling a guitar or bass combo or elevating it on a flight case means each player can hear what is necessary without putting extra sound energy into the room. Helping the band hear what they are doing often means they can play at reduced volume.
- Consider whether the loudspeakers can be located to avoid excessive volume for the staff (and for the public close by). Mount the speakers up high. Can the loudspeakers be wall-mounted? Can stands be used to elevate them?
- What can be done to eliminate reverberation and reflected sound? Hard and flat surfaces reflect sound and make for a loud and confusing listening environment, so look for ways to cover walls and break up surfaces. For example can drapes be put across the wall behind the band when they are playing or a carpet placed on the stage floor? And don't forget the roof – ceiling tiles can be highly effective. Make sure, however, that the materials used do not create a fire hazard.
- Soundproofing should be considered for doors, windows and other 'leaky' areas – especially if it prevents spill into otherwise quiet areas. Beware, however, the use of improvised materials, which can be ineffective and could present other risks.
- When setting up for a rehearsal or performance in a venue that does not have a specific fixed stage or performance area, try to reduce sound exposure levels for performers by considering the size of venue and the positioning of:

- the performers;
- the monitors;
- the PA speakers;
- other workers and the audience.

12 While it certainly isn't up to a venue operator to determine how the musicians play, it is worth ensuring that things like drapes, blankets and gaffer tape are on hand to dampen sound, for example from drum kits.

CASE STUDY

A company with several venues across the country recently reviewed the noise content of its occupational health policy and produced a comprehensive package pulling together aspects of company documentation, a standardised noise assessment procedure and appropriate training.

Company documentation includes a reassessment of safe working practices and procedures. Section 1 covers the basic legal requirements and types of different activities carried out which could produce loud noise. Section 2 details how the noise assessments are carried out by measuring noise levels in identified areas and indicating exposure values for people working in those areas, including the time taken to reach the lower and upper exposure action values. This is used specifically for front-of-house employees where exposure is fairly uniform in defined areas, and not for exposure from specific pieces of equipment used in close proximity to an individual. The existing precautions are then itemised and an action plan drawn up, with immediate, medium- and long-term actions for each venue.

Immediate actions include the rotation of staff, preventing unnecessary entry to areas and use of personal hearing protection. The medium-term action in one venue includes the use of shielding screens, while a longer-term proposal is to install acoustic panelling and other means to reduce reflected sound pressure levels. The company has several venues so it can make direct comparisons between the physical structure of their venues as well as the different type of acts. Good practice in one venue can be used elsewhere.

When considering personal hearing protection, the appropriate frequency analysis (see paragraph 13 in Part 1 of this book) and the need for communication are assessed as part of the selection process. All employees are being given an information pack which explains the different types of hearing damage that can occur, different types of hearing protection, the importance of wearing hearing protection and how to look after it.

CASE STUDY

A venue owner engages live bands on five nights a week. After consultation with health and safety representatives, he arranged for some noise measurements to be made. With a reference position 5 m away from the loudspeakers, a level of 103 dB was measured. It was clear that the staff were being exposed to excessive noise.

A number of minor architectural changes were made:

- Changed location of the stage.
- Provided loudspeakers directly above the dance floor.
- Put acoustic absorption material on the ceiling and upper part of the walls opposite the stage and on the wall behind the bar.
- Fitted an acoustic screen to the end of the bar nearest the stage.
- Replaced doors to kitchen, office and foyer with acoustic doors.

Some management changes were made:

- Bands were limited to a maximum of 103 dB.
- Job rotation for glass collectors.

Figures 7 and 8 show the changes made.

The venue owner is providing hearing protection for all staff and requires bar staff and glass collectors to use it. He is developing plans for further noise reduction including a review of the policy on music levels.

The levels of exposure are shown below:

	Before $L_{EP,d}$ dB	After $L_{EP,d}$ dB
Bar staff	92	86
Glass collector	94	88
Door staff	91	84
Reference point	103	100

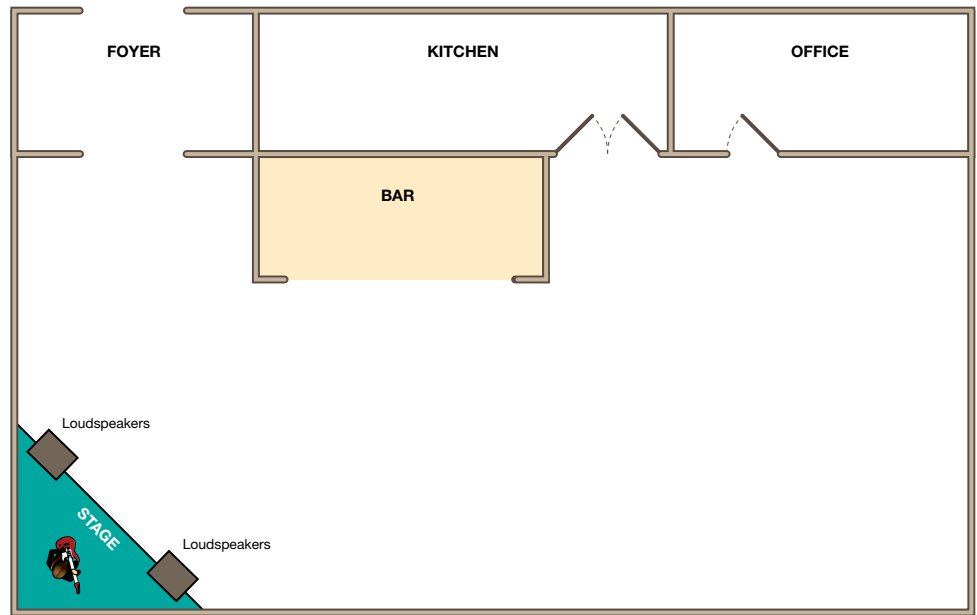


Figure 7 Before changes were made

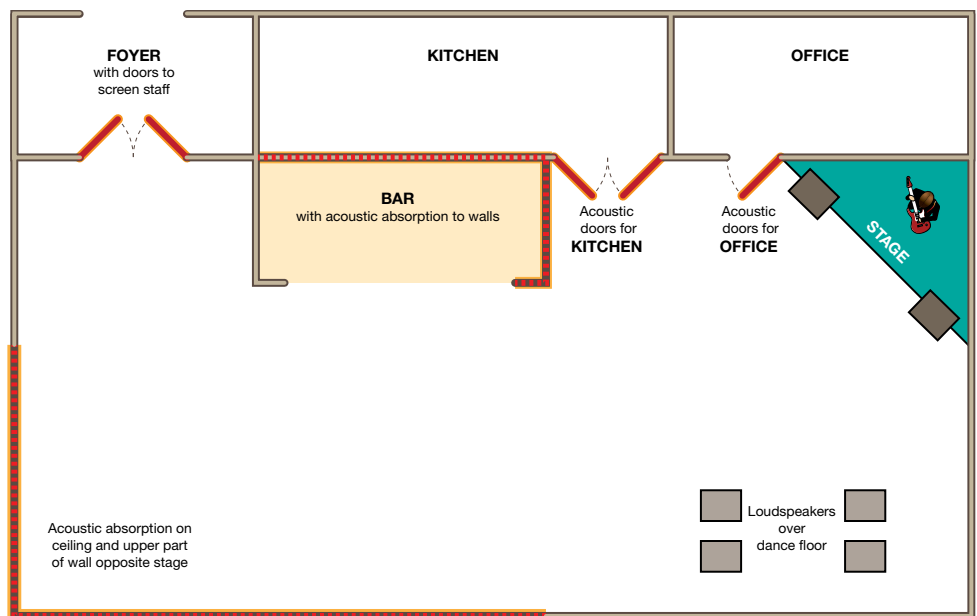


Figure 8 After changes were made

3 Rehearsals

Rehearsals and warm-ups

Overview

Background
Use a suitable venue
Mixture of repertoire and quieter rehearsals
Time-out
Hearing protection
Screens
Consistency
Assess and review

Background

1 Carry out a noise risk assessment and take steps to ensure that exposure to sound is reduced as much as possible during warm-ups and rehearsals. It is important that the musicians and the conductor/musical director can hear each other well without excessive loudness. There is a general duty to reduce the risk, so that if something can be done and it is reasonably practicable to do so it must be done. There are various ways to achieve this.

Use a suitable venue

2 Make sure the venue is suitable for rehearsal. Wherever possible use a purpose-built/acoustically treated rehearsal room/hall but, if not, using a larger space might mean that noise exposure is reduced.

3 The most common fault with rehearsal rooms is that they lack physical volume and have low ceilings. Rooms with low ceilings and reflective parallel walls result in excessive noise and reverberation. Where possible, use a space with more height and increase the separation between players more than there will eventually be in the performance space. Aim for at least 17 m³ per person with a ceiling height of at least 7 m. This will generally provide sufficient volume for noise to be maintained at acceptable levels.

Mixture of repertoire and quieter rehearsals

4 Schedule a variety of loud and quiet music during a rehearsal to reduce the overall exposure. Try and allocate noisy instruments/passages into separate rehearsals.

5 Aim to rehearse at a quieter overall level unless the group is trying to achieve a 'balance' in the actual performance space. Limit the time spent when trying to get a balance before returning to the quieter rehearsal level. When repeating sections to iron out problems, musicians should try to play quietly, except for those who need to be heard at full volume. Try to avoid rehearsing when extraneous noise is increasing the overall exposure to noise.

Time-out

6 Exposure to noise can induce high stress levels in individuals. Stress should be assessed as part of the overall risk assessment. Consider allowing time-out for individual musicians and crew to manage their own stress levels by permitting them to leave the rehearsal for a short time if they are feeling extremely stressed by the noise. The conductor/musical director needs to be informed if this policy is in place. It might also mean that the seating position of one or more performers needs to be reassessed.

7 Ensure that non-essential people, such as riggers or cleaners, and musicians who are not actually rehearsing, are excluded from the rehearsal.

Hearing protection

8 Some players who might find it difficult to perform using hearing protection are quite comfortable using it during rehearsals. Using hearing protection during rehearsals could be particularly useful if loud passages are being repeatedly rehearsed (see 'Personal hearing protection' in Part 1).

Screens

9 Screens should only be used as determined by the noise risk assessment (see Appendix 7 'Acoustic screens'). The positions of any screens should be noted if the stage or performance space is to be re-set between the warm-up/final rehearsal and the performance.

Consistency

10 When rehearsing in the performance space directly before a performance, try to ensure that players are seated where they will be seated during the performance. This is so players can acclimatise themselves to the sounds they are likely to experience during the performance.

Assess and review

11 A rehearsal is a working environment and is part of the assessment process. Act upon feedback to try and ensure that noise-exposure problems are properly managed.

12 Encourage the conductor/musical director to go out front to assess volume levels as heard by the audience.

4 Rock and pop

Amplified music performed before a live audience

Overview

Background
Noise risk assessments
Control measures
On-stage control measures
The off-stage environment
Pre-show sound checks and schedules

Background

- 1 This section deals with events where live amplified music is performed to an audience, referred to here as 'rock and pop'. However it covers a huge variety of music genres and instrument types, including set-ups that may normally be thought of as classical or orchestral. The prime consideration is the use of amplification and sound-reinforcement equipment in live performance.
- 2 The number of people in this sector who are already suffering from noise-induced problems such as hearing loss, tinnitus and other permanent medical complaints is proof that this is a hazardous environment and personal hearing damage does occur.
- 3 This section outlines practical approaches to noise control and noise exposure reduction that can be considered good practice. It does not consider in detail using personal hearing protection. However, it is highly likely that hearing protection will need to be used as well as the noise-control measures outlined (see 'Personal hearing protection' in Part 1).
- 4 There is a common misunderstanding in the rock and pop world that Regulations concerning noise levels solely refer to issues of noise pollution and neighbourhood disturbance caused by spill from concert and event venues. However, as explained in Part 1, where people are at work (including the self-employed) then there is a legal obligation for employers, event organisers and the self-employed to control noise levels to protect the health and safety of workers – even if that noise is something deliberately generated and people are willing to expose themselves to potentially damaging levels of noise.

Noise risk assessments

- 5 A noise risk assessment flowchart for planning a rock/pop event is shown at the end of this section.
- 6 Tables 5 and 6 give typical noise levels and noise exposures for a range of people working with amplified live music.
- 7 Virtually any live event using amplified instruments and sound-reinforcement equipment will exceed the upper exposure action value. Therefore, some kind of control measures will almost certainly be required.

8 To determine what control measures are necessary, establish:

- What is the source of the noise?
- What specific areas are affected?
- Which workers have to operate in these areas, for example musicians, technical crew, stewards, welfare and medical teams, bars and concessions?

9 Carrying out such an assessment for specific locations, instruments, repertoire and venue layout will allow the employer/organiser to prioritise actions and target the areas and employees at highest risk. Where this involves measurement, see also the advice on measuring noise in Appendix 5.

10 Considering noise exposure should form a key part of the planning process, in particular sound system design, speaker location, equipment selection, the acoustic of the venue, the acts/groups, the number and positions of performers, the differences between the different instruments and so on. Planning is particularly important for concert tours and should involve both venue and acts. Taking account of noise issues at an early stage is likely to be both more effective and more economic than simply handing out earplugs to crew once the tour is underway, especially as the performers will probably also need hearing protection.

Table 5 Representative noise levels

Noise source	dB	Peak
Percussion	90–105	125–146
Amplified guitar (on stage using in-ear monitors)	100–106*	118
Amplified guitar (on stage with wedge monitors)	105–112*	124
Drummer at indoor music festival	105	144
Guitarist at indoor music festival	103	146
Bass guitarist at indoor music festival	101	133
Several musicians		
Amplified rock music	102–108*	140 and above

* at 3 m.

Table 6 Representative exposure levels

Occupation	dB	Peak
<i>Indoor/stadium music festivals</i>		
Monitor engineer	96–104	147
Production manager	101	146
Keyboard technician	101	145
FOH sound engineer	99–100	139/145
Promoter's representative	96–100	146
Pit supervisor	102	140
Stage manager	96–98	137
Lighting chief	94	146
Security staff (depending on location)	89–94	137/146
Security – Pit	100	146
Catering staff	91	134
Fire officer	101	144
Cashier	89	131
Events manager	85–87	137
Film crew	98–100	139/143
Merchandise staff	100	134
Bar staff	96–97	131/136
House managers	80–91	131/137
Cloakroom staff	90	145
<i>Outdoor music festivals ('Pop concerts')</i>		
Stage manager	98	134
Technicians	91–93	133/138
Catering	87	135
Merchandising	85–101	127/146
Security – Pit	91–101	136/144
Security staff (depending on location)	85–100	122/146
Ambulances	88–94	124/133
Bar staff	86	128
Site manager	87	129
Camera operator	100	137
Delay tower engineer	93	125

11 A 'pre-event noise risk assessment' may help plan the event. This might include:

- selecting a suitable location for the event;
- selecting a balanced line-up;
- selecting an appropriate design for staging;
- selecting suitable materials to reduce vibration and sound levels on stage;
- design and use of PA systems and amplification;
- starter level of sound in a performance;
- sound checks and rehearsals.

12 The design and layout of venues can have a significant effect on noise levels and the noise exposure of individuals (see Sound Advice 2 'Venues'). Size and staging, design and building materials, public address systems and the weather can all affect the sound levels being produced in outdoor venues.

13 Venues should have already carried out noise risk assessments for their own staff, and visiting or touring productions should request these to assess where people may be at risk and where special attention needs to be given to noise control.

14 Any noise risk assessment should be updated if there are any changes (for example to the set design, venue, seating or line-up/set).

15 Where temporary concert stages are established, such as at outdoor festivals or concerts in marquees, assume risk-control measures will be needed. Generic risk-control measures should be put in place as a matter of course and they can then be adapted or modified during the event as necessary. The organisers should assume that the entire stage area, the pit area, the front-of-house control position and any locations adjacent to delay and in-fill speakers are hearing protection zones, even after the control measures have been put in place. See also 'Personal hearing protection' in Part 1.

16 For outdoor events and festival sites, the organiser has to consider not only the exposure to people working backstage and on stage, but should also bear in mind the way site layout may bring other workers, contractors and concessionaires into noisy areas. Taking account of such issues during the site planning stage is crucial, since it is extremely difficult to solve once structures, staff and equipment are in place. Also think about the management of the noise generated by the concessions themselves – many of whom bring their own PA systems and generators. For further information see *The event safety guide*.³

17 Also remember that other periods of exposure from non-work activities increase the overall dosage, for example a loud show followed by listening to a personal stereo at reasonable volume. While outlawing personal headsets on the tour bus is clearly drastic, awareness of how and when people are exposed to noise hazard is a fundamental first step to reducing the risk of damage.

Control measures

18 The first, simplest and most effective measure is to turn down the volume wherever practicable. Unfortunately this is often overlooked and flies in the face of the 'Rock and Roll' attitude. However, the simple step of keeping levels under control at every stage of the instrument/signal/amplification/reinforcement chain is fundamental.

19 Loud stage noise levels can compromise the quality of the performance and the sound that is delivered to the audience. It has been known for stage monitoring levels to be so loud that the front-of-house engineer in an arena has been unable to hear his own mix. This seriously compromises the possibility of creating a suitable mix for the audience. The use of in-ear monitoring can significantly improve the overall sound quality.

On-stage control measures

20 On-stage control measures include the following:

- Turning it down does not necessarily mean reducing the overall output of the main PA, but requires an analysis of why things are so noisy and targeting measures to control the main 'offenders'. This is particularly true on stage where amplification of individual instruments (backline) often competes with on-stage monitoring (fold-back, side-fills) and the PA itself.
- Consider substituting quieter instruments and amps in the first place. High-quality amplifiers and speakers that operate without distortion are far preferable to driving inferior systems at higher rates. Introducing distortion makes the output less intelligible and leads to increases in sound level in attempting to achieve clarity. The result is often a spiral of increasing volume without ever achieving clear monitoring.
- Consider increasing distance, isolation or shielding of noisier instruments where possible. Drum kits can be positioned and shielded/enclosed to minimise noise levels for performers and workers situated close by. Ideally shielding should be acoustically absorbent rather than reflective material.
- Position and angle guitar amplifier/speakers (guitar combos) for maximum ease of listening for the player. Additionally simply raising a guitar combo on a flight-case could significantly reduce exposure for other players, have a marked reduction in overall stage noise and improve clarity for the player. Guitar combos could be positioned and mic'd in a separate area from the performance area.
- Consider using technology that eliminates the need for loud backline amplifiers on stage. This could range from simply plugging instruments into a mixing desk by means of Direct Injection (DI) boxes rather than mic'ing up an amplifier, through to using amplifier modelling software, foot pedals or other hardware. Whatever system is used, sound engineers can achieve greater control of on-stage levels through careful management of monitor levels rather than expecting musicians to fight it out in a battle of escalating stage volume.
- Use risers to separate sections of the band, and to elevate particularly noisy instruments above the heads of other performers – or move to the front of the stage, particularly where very loud instruments may be used – brass, amplified guitar and snare drums can produce extremely high sound levels. See Appendix 6 'Risers'.
- A 'shaker' or 'thumper' is especially useful for reducing drum monitor levels. Shakers will allow performers to use hearing protection and monitor their performance while still maintaining contact with their instruments.
- Consider altering the drum kit set-up to ensure cymbals etc are not at ear-height. Experiment with raising or lowering the cymbals as necessary to protect the hearing of everyone who is close by. Try hanging small strips of cloth from each cymbal's centre nut.
- Some drum players are quite happy with headphones/in-ear monitors and a shaker rather than a traditional drum fill. The headphones should be selected to provide hearing protection; the devices that reproduce sound inside the headphones should be limited. This alone may save several dB of overall stage level.
- Damping drum kits can reduce overall noise levels, especially in rehearsals. Methods include:

- taping small pieces of cloth or other sound-absorbent materials inside the drumheads;
 - placing rubber rings on top of the drumheads;
 - taping small pieces of cloth to the rims so that the cloth lies loosely over the skins;
 - stuffing foam rubber inside the drums or hanging it from the inside of the drumheads;
 - stuffing the bass drum with a pillow, towel or shredded newspaper.
- Use screens where appropriate, particularly where there is orchestral music support to the main rock performance. Care should be taken with acoustic screens, since they can make noise levels higher if positioned incorrectly (see Appendix 7 'Acoustic screens')

On-stage monitoring

21 The need for musicians to hear their own performance and that of other performers is fundamental, but this can lead to an excessively loud and confusing stage environment if not planned and managed correctly. Monitor systems are often used as a means of overcoming high stage noise, but effort is better put into reducing those levels to achieve clarity rather than boosting other signals.

22 On a noisy stage it is very seldom the answer to turn something up to make it clearer. Always start by turning down the overall level and making adjustments in the balance; the human ear just doesn't work well at high noise levels. So, for example, someone asking to hear more vocal in a mix may well just need to hear less of everything else, especially if that noise is spill from other monitor mixes.

23 A well-balanced monitor system should allow all the players to hear what they need at a comfortable level while maintaining a reasonable work environment for everyone else on the stage. This needs time and planning, as well as a skilful monitor engineer who understands the needs of musicians. Consider the following:

- Position speakers to provide effective listening levels to the performer(s) concerned without causing excessive spill, which makes it harder for everyone else to hear what they need.
- The layout of performers on the stage can radically affect the levels of exposure from spill that musicians experience. Therefore careful planning of the stage layout may avoid the need for noise competition between monitor mixes and other noise sources. The advice of monitor engineers at this stage is valuable.
- Monitor engineers should use their equipment properly and safely. This means:
 - resisting the temptation to allow stage levels to creep upwards;
 - 'prepping' the system to put the right equipment in the right place;
 - 'ringing out' or tuning the system to identify problem frequencies which may cause rapid and unexpected feedback.
- All sound checks should be carried out with the minimum number of people present.

24 Perhaps the most effective means of avoiding monitor spill is to use monitor headphones or in-ear monitors (IEMs) (see Appendix 8). IEMs and monitor headphones allow a very quiet stage environment with benefits for all workers. IEMs have many benefits including clarity, controllability and comfort. It should be noted that generally IEMs and monitor headphones are not classified as personal hearing protection, and although they may provide some protection against external noise, their performance in this respect cannot be guaranteed. The use of limiters with IEMs and with monitor headphones is strongly recommended.

CASE STUDY

Staff at a major music festival were exposed to very high noise levels without adequate care for their safety. There were more than 50 000 people present and two major outdoor stages. The following problems were found:

- Security staff were less than 1 m from the front of the bass speakers for the main stage.
- Food vans for the main stage were facing the stage and positioned close to the PA delays.
- There was no refuge from the noise. Sound levels in staff rest areas reached or exceeded 79 dB, and there were no quiet areas or refuges where staff were working.
- There was little or no evidence of control of the noise levels that the staff were exposed to, or limiting of the time spent in the noisy locations, or warning of the risks due to the noise.
- Hearing protection had been provided without training in how to use it. In some cases security staff receiving the highest exposures were choosing not to use any hearing protection.
- Hearing protection had not been considered for staff at the food outlets.

Commentary

- The use of noise control and hearing protection was inadequate.
- Neither the event organiser nor the individual employers had carried out their responsibilities under the Noise Regulations.
- Under the Noise Regulations employers have a duty to protect their own employees from the risks associated with high noise exposures. There is also a duty to protect other workers who are put at risk by their noisy activities.
- Exposure needs to be reduced by means other than hearing protection as outlined in this book. Where a risk still remains, the correct fitting and use of hearing protection needs to be enforced.
- Employees have a duty to use hearing protection provided for them if their exposure is likely to exceed 85 dB.

Table 7 Daily noise exposure for workers at the festival.

Job	Location	Hearing protection	L _{EP,d} dB
Paramedic	Side of main stage	Muffs	100
First-aider	Tent at side of main stage	Muffs when outside tent	97
Food service	Close by PA delays of main stage	None	100
Gate security	Side of main stage	None	101
Gate security	Wheelchair area for main stage	None	95
Door security	Secondary venue tent – 1	None	99
Stage security	Secondary venue tent – 1	Earplugs	108
Door security	Secondary venue tent – 2	None	103
Drummer	On stage	None	104
Bass guitarist	On stage	None	101
FOH sound engineer	Tower approximately 30 m from stage	Earplugs	99
Monitor engineer	Side of stage, behind PA	None	96

25 Good working practice for monitor headphone and IEM users includes:

- Do not share headphones. Where this cannot be avoided, give users their own ear pads and voice tubes.
- Headphones should be fully adjustable and well-maintained.
- Headphones or associated equipment should incorporate an adjustable volume control that enables the user to listen to incoming signals at a comfortable level.
- Clean headphones regularly. Foam pads can be washed, wiping cables prevents them from becoming brittle, and cleaning voice tubes (which can become blocked with food, dust or make-up) ensures the level of transmitted signals remains audible.
- Allow time for users to make adjustments to their equipment, and to clean and maintain it.
- Users need regular training including how to use the headphones and associated equipment, any volume-control features and why adjustment of the listening level through the headphones is important, as well as the importance of regular cleaning and maintenance.
- Reducing ambient noise levels will enable headphone users to keep listening levels as low as possible.

26 Similar benefits may be obtained from using small personal monitor speakers that can be placed near a performer rather than relying on a traditional wedge or side-fill at a distance. These are particularly effective for relatively static performers such as keyboards and DJs.

The off-stage environment

27 High sound levels can be produced throughout a venue, and the noise risk assessment for an event should identify all the people who are at risk, not just the musicians or stage crew. See *The event safety guide* for guidance on audience protection. Consider the following:

- The choice and location of speakers can significantly affect sound levels. Technical staff and working crew etc should be protected from unnecessary exposure to high sound levels, for example by ensuring lighting desks are not placed near loudspeakers.
- Re-orientate the stage and/or loudspeakers to direct less sound towards staff locations. Where there are multiple speakers, such as in discos, clubs, concert halls or theatre auditoria, try reducing the sound levels of those speakers nearest staff locations.
- The dispersion pattern of modern speakers enables the 'targeting' of sections of the venue or audience, which in turn means the level at the front of the crowd can be reduced. The total power output from the sound system (for a given audience sound level) can be reduced by using a line array. These loudspeaker systems effectively direct sound in a narrow beam to audience locations, providing a higher quality sound, with less 'spill'. The key is to ensure that speakers (whether or not technically line array) are positioned and aligned to efficiently get sound to the audience and avoid either an excessively high sound level at the front of the audience or needless spill into sensitive areas.
- Where possible, arrange stages and loudspeaker positions to avoid excessive sound levels for bar staff, stewards and other workers. Where a venue has a number of speaker positions around the building, consider the direction and volume from each group of speakers. Those that are close to noise-sensitive locations such as the bar should be individually controllable. For outdoor events and festivals, consider the noise impact on, for example, stewards, security, first-aiders, concessions (not just stage production staff/performers).
- PA systems can be flown or stacked in such a way as to introduce a natural

separation between speaker enclosures and staff, making it impossible to get too close to the sound source – this is particularly important for workers in the stage pit and other locations close to speaker stacks. Spill from side-fills and other on-stage sources can also be a problem for pit teams.

- A similar effect can be achieved by means of barriers around speaker positions. This approach is of particular value when considering protection of the public and front-of-house staff.
- 'Satellite' or 'delay' stacks are speaker clusters placed at some distance into the audience from the main speaker positions and to which the signal is delayed to make it coincide with the sound travelling from the main speakers. Therefore the sound is reinforced and intelligible a long way back from the stage and the level at the front can be reduced because the noise from those speakers no longer has to reach all the way to the back. This is an example of how good planning can both tackle a noise hazard and enhance the public enjoyment of a show.
- Noise limiters can be used to set a maximum permissible output level for the sound system. While normally used to manage noise pollution from a venue, the same set-up could be employed to limit the maximum front-of-house or stage sound output.
- At festival sites concessions and other commercial operations often have their own PA systems. The event organiser should ensure that the output of such systems is managed along agreed guidelines taking account of the potential combined effect of several systems, to minimise the noise exposure of employees on site, including those working on concessions' stalls.
- If radio headsets are in use, they should provide hearing protection and be limited (see Sound Advice 9 'Studios').

Stage pits

28 On large pop concert stages and outdoor events it is common to find a fence line restraining the crowd a few metres in front of the stage itself. This is the 'pit barrier' and creates an area called the 'stage pit' in which stewards, security and welfare staff can help the crowd – and which commonly hosts photographers and media crew. The noise levels found in even small stage pits are so high that staff are liable to exposure well above either upper exposure action value – even if they are only present for a brief period (speaker and audience noise together can easily exceed 120 dB).

29 Stage pits should be hearing protection zones with access only granted to authorised personnel equipped with appropriate hearing protection.

Pre-show sound checks and schedules

30 Careful planning may mean some tasks can be completed when there is no noise hazard, for example ensuring that lighting focusing and sound checking are carried out at different times.

31 Sound checks are a vital part of the event set-up process, but they are also a mechanism by which technicians and players receive additional exposure to high noise, particularly if the sound check is not properly managed. Ideally instruments will be individually checked at a realistic volume and then an ensemble piece played at full concert level which can usually be set at a lower on-stage volume. A sound check at full concert levels should only be necessary for balancing sound levels, as distinct from rehearsals or last minute run-throughs of sets.

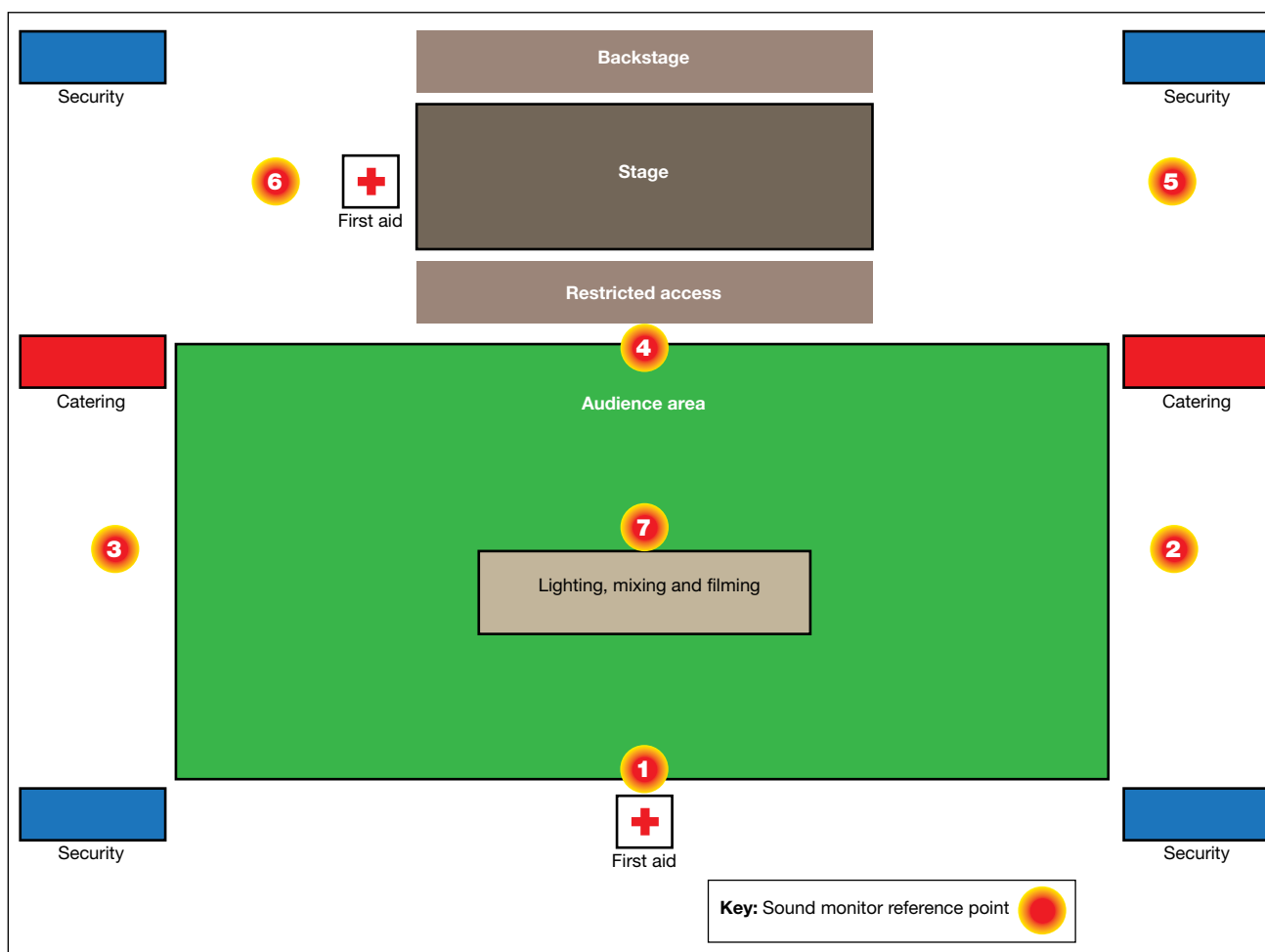


Figure 9 Example of an outdoor music event showing reference positions for noise measurement

32 From a noise exposure perspective it is essential to limit both the duration and volume of sound checks. Similarly, limiting the number of non-essential personnel on stage and in the auditorium during a sound check will have time-management as well as noise-exposure benefits. Every venue or event should have somewhere quiet for musicians and crew to take breaks or rest periods.

33 The sound check is a good opportunity to identify any unexpected or particularly troublesome noise elements. This could be achieved by monitoring sound levels at specific representative reference positions (see Figure 9).

34 Remember that the sound check is not solely for the purpose of musicians – it is often the only opportunity for front-of-house and monitor engineers to set their systems to achieve an optimum mix and safe playback levels.

35 Awareness of loud noise as dangerous means that crew should only be in the immediate vicinity of the stage during noisy periods if their job specifically requires it. The stage should not be used as a viewing platform or rest area for off-duty crew. It is a high-risk environment to which access must be strictly controlled.

36 The way in which work tasks are scheduled can have a significant impact on personal noise exposure over time. When planning the individual work, a load-in and show, or even an entire tour, consider when, where and to whom noise exposures will occur. Organise the work to ensure that personal noise doses are kept as low as reasonably practicable. This might be achieved by:

- balancing loud and quiet activities for example, show and offsite duties;
- ensuring that staff take breaks and rest periods away from loud noise areas;
- rotating staff to limit exposure time (particularly useful for stewards and security staff);
- limiting any recorded music to predetermined levels, and monitoring and controlling it. Keep recorded music as low as practicable, especially between acts, to reduce overall exposure;
- venue managers scheduling shows to ensure that staff have a balance between loud and more moderate events.

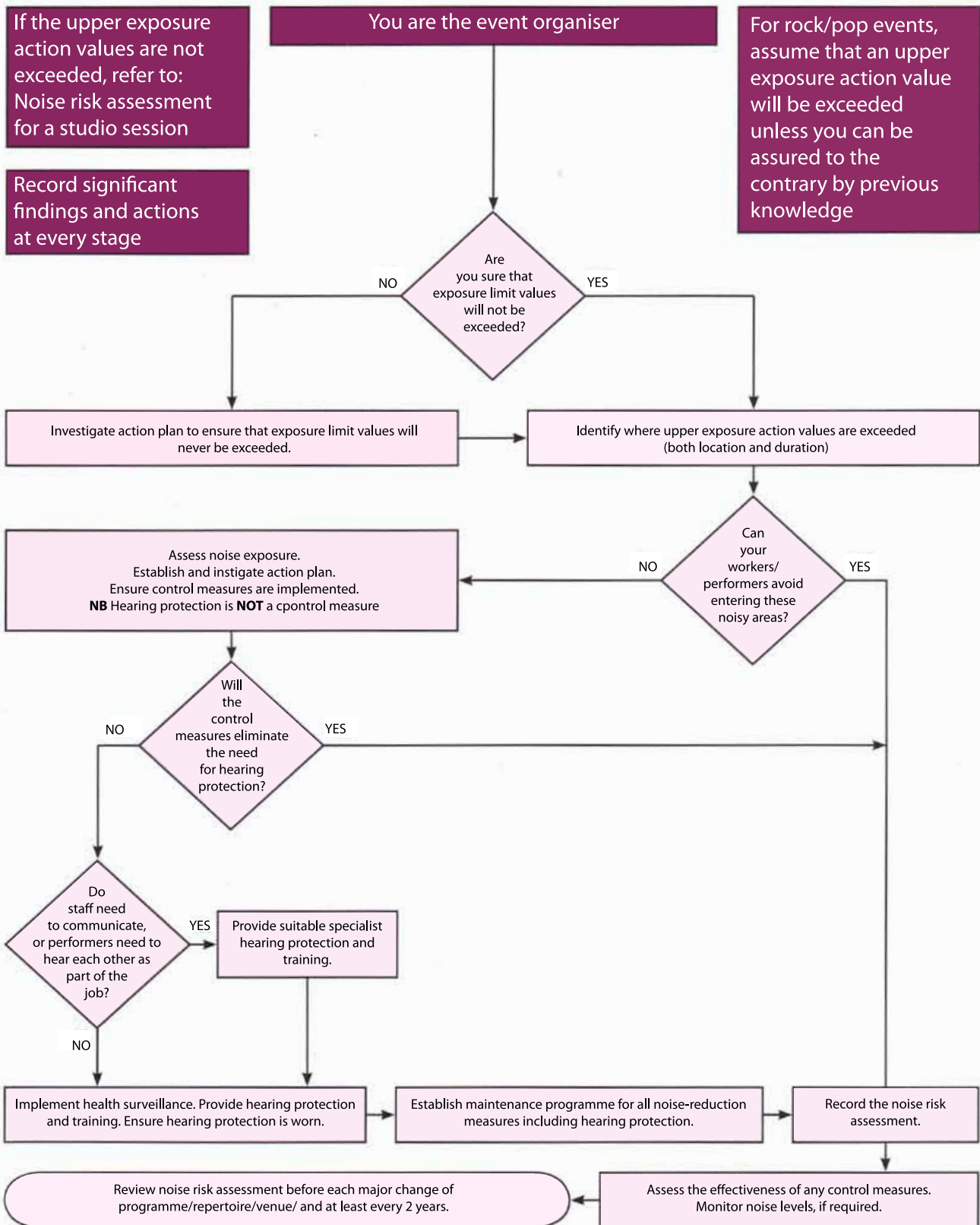


Figure 10 A noise risk assessment method for planning a rock/pop event

5 Pubs and clubs

Amplified music played in nightclubs, bars, pubs and restaurants

Overview

Exposure to noise
Design
Management
Live performers

Exposure to noise

1 This section provides advice on methods of controlling the risk of hearing loss in venues where amplified music is played, including nightclubs, bars, pubs and restaurants. In most industries noise is an unwanted by-product. However, high sound levels often provide the principal stimulus for customers to attend a pub or club. It is important to remember that all employees, including any guest performers, are covered by the Noise Regulations and employers have responsibilities to protect their employees' hearing. Self-employed people should also read Sound Advice 1 'Freelancers'. A noise risk assessment flowchart for pubs and clubs is shown at the end of the section.

2 There is a strong likelihood that workers in venues playing amplified music will be exposed to noise levels at or above the upper exposure action value of the Noise Regulations. For representative exposure levels see Table 8. Remember that no single measure will be appropriate for every situation and it is important to identify the actions that will best control the risk.

Design

3 Methods of reducing noise in work areas can be split into two categories – physical separation and focusing the music in the desired locations. Architects/designers and owners/operators proposing new buildings or refurbishments should consult competent acousticians and/or sound engineers before undertaking any major work. See also Sound Advice 2 'Venues'.

4 The noise in a venue is made up of three components: the direct path is the uninterrupted path between the loudspeakers and the ear, the reverberant path is the sound reflected off one or more surfaces, and the structural path is through the fixings and mountings. The careful positioning of loudspeakers may reduce direct exposure and isolation mountings may be needed to reduce structurally transmitted noise. However, many noise-control measures aim to reduce reflected sound. This may be achieved by acoustic absorption to control the reverberant paths. Note the absorption can also improve the quality of the reproduction of the music.

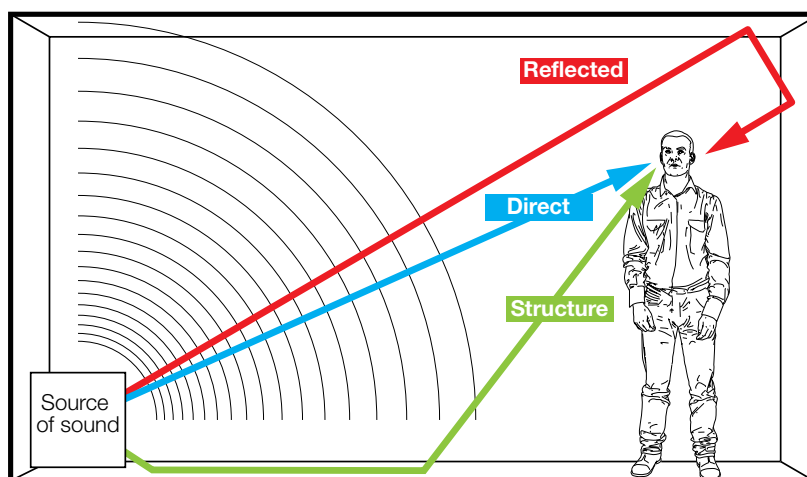


Figure 11 The three components of noise

Table 8 Representative exposure levels in clubs

Occupation	dB
Bar staff	89–99
Glass collectors	90–100
Waiters	102
DJs	93–99
Lighting technician	104
Security	97
Door	84
Dance floor	94–104

In this example the employer must:

- Assess the risks to every employee from noise.
- Take action to reduce the noise exposure that produces the risk.
- Make sure the legal limits on noise exposure are not exceeded.
- Provide hearing protection and ensure it is worn.
- Provide information, instruction and training.
- Carry out health surveillance.

For more information see Part 1.

5 It is important that the materials used meet the required standards of flame retardancy and flame propagation.

Physical separation

6 These techniques help separate staff from the music:

- Position bars away from the dance floor and performance areas.
- Provide staff off-duty areas with noise levels below 80 dB.
- Locate bars in quiet areas or 'chill-out' rooms where the noise levels are preferably below 80 dB.

- Acoustic screening can be helpful to protect specific workers and locations from direct noise sources, for example, technicians, bar staff, front of house. The effectiveness of screens depends on their design and location(s) which need to be carefully considered.

Focusing the music

7 Successful noise control requires the music to be focused where it is wanted (such as the dance floor or the performance area). The following techniques can help to focus the music and therefore reduce the noise levels away from the dance floor or performance area:

- Use equipment which avoids distortion and allows volume levels to be set lower while achieving the desired effect.
- Directional speakers can be helpful to focus sound away from sensitive areas to where it is wanted, for example over the dance floor using loudspeakers mounted in the ceiling and facing downwards.
- Increase the number of directional loudspeakers to avoid 'hot-spots'.
- Install vibration isolation mounts to loudspeakers to prevent noise entering the building structure.
- Avoid peripheral loudspeakers or reduce their volume if they cannot be avoided.
- Do not have loudspeakers pointing toward the bar or other fixed work locations.

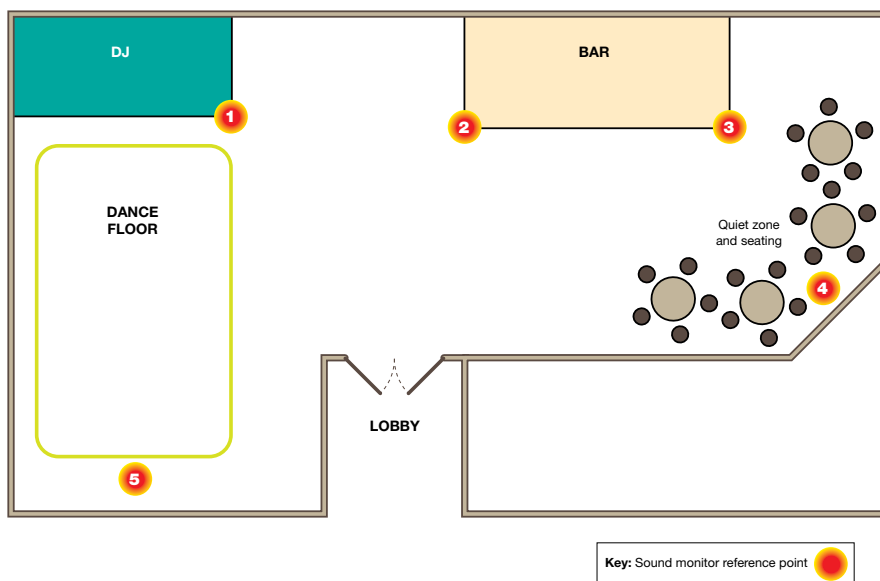


Figure 12 Example of a pub/club layout showing reference positions for noise measurement

Management

8 Venue operators are encouraged to develop a written noise-exposure policy. This document should aim to provide clear messages regarding the control of noise in the venue to all staff and subcontractors (see also Sound Advice 2 'Venues'). It should also include policies on the following:

- level setting and monitoring;
- exposure management;
- maintenance;
- information, instruction and training;
- hearing protection;
- health surveillance.

Level setting

9 The exposure of employees to noise levels will depend on the volume of music played as well as the duration and proximity of the noise source. There will be instances where the volume needs to be controlled by setting maximum levels. This is usually done by the use of limiters, and many clubs and pubs will already be aware of their use for reducing noise breakout as part of the licensing procedure and local nuisance control.

10 Where noise-volume-limiting devices are used for reducing exposure to employees, the responsibility and ability to alter the maximum level should be clearly identified in the noise-exposure policy. The policy should also be clearly communicated to all people who have the means to adjust levels up to the maximum during events (for example duty managers, DJs, musicians and technicians).

CASE STUDY Nightclub refurbishment

Refurbishment of two nightclubs in one building provided an opportunity to re-design them with the aim of reducing the employees' exposure to noise. Before the refurbishment the clubs had very little acoustic absorption in them and the lack of space made it difficult to introduce a quiet zone.

The following design changes were introduced as part of the refurbishment:

- A bar was moved to increase the distance between it and the dance floor.
- All loudspeakers were oriented so they faced away from the bars.
- Acoustic absorbent tiles were placed on the ceiling.
- Acoustic absorbent material was placed on as much wall area of the club as possible (durable coatings near the floor, spray coatings nearer the ceilings).
- Areas were finished with mineral wool absorbers behind galvanised perforated sheet steel.
- A large toughened glass screen was positioned at one end of a bar to shield it from the dance floor.
- Vibration isolation was used to isolate the bass bins (loudspeakers).
- Narrow directivity loudspeakers were mounted in the ceiling above the dance floor and positioned pointing down.
- A DJ console was created which also acted as a screen for a bar behind.
- The sound system was used to carefully equalise the music and set at a level of 103 dB on the dance floor.

The measured daily noise exposure before and after the refurbishment was:

	Before refurbishment $L_{EP,d}$ dB	After refurbishment $L_{EP,d}$ dB
Bar staff	90.3–95.9	86.6–89.1
Glass collectors	95.2–98.1	94.5–97.0
DJ	98.6–99.8	97.3–98.2

A significant reduction in the exposures of bar staff was achieved, however, hearing protection was still required. Glass collectors were required to wear hearing protection and DJs were encouraged to avoid using monitor loudspeakers and to use earmuffs with sound restoration or in-ear monitors.

11 Karaoke systems should have in-built noise limiters as they are used by members of the public who are not covered by management noise policies.

12 Where required, the choice of noise limiter will depend on the type of equipment to be controlled:

- Where the venue has a purpose-built amplification and speaker system the noise level can be controlled by measuring average output against a set threshold. This level cannot be exceeded and, as the quality of sound output can be maintained, there is less likelihood of public awareness of control.
- Where control of the level is not directly under the control of the management, via a purpose-built system, then the limiter will rely on a microphone picking up noise levels and if a preset level is exceeded, the power supply to the noise-generating source is cut off. This is usually done through a series of warning lights. This system requires strict management control to avoid any possible consequences of an abrupt termination. These types of limiters are often used by people in charge of venues where performers, for example guest DJs, supply their own equipment.
- All noise limiters should be tamper-proof or located in secure areas.

Monitoring

13 Where spot checks of the noise levels are being used as part of an assessment they should be at predetermined reference positions to allow direct comparisons between different situations. This will also allow for other representative exposure calculations to be carried out if necessary.

Exposure management

14 Managing exposure to noise could include:

- Limiting the time staff spend in noisy areas.
- Rotating staff between noisy and quiet areas and rotation between quiet and noisy shifts. Task rotation can provide some reduction in exposure where there are workstations in quiet areas. Management should have enough control and administration to demonstrate how the system safeguards staff and should explain the purpose of any rotation system to staff.
- Providing regular 'quiet breaks' and periods working in quiet areas.

15 The Noise Regulations allow the noise exposure to be assessed over a week rather than a day in certain circumstances (see Appendix 4).

Maintenance

16 Sound equipment does deteriorate and should be properly checked and maintained. Note in particular there is a tendency to increase the volume if the music system is distorting.

17 Equipment such as noise limiters, acoustic screens, sound absorbers and vibration isolation mounts should also be kept in good working order.

Information, instruction and training

18 Employees need to understand the risk of hearing loss and how it is being controlled, including the proper use of hearing protection. Individuals who have influence over the noise levels (duty managers, DJs, musicians and technicians) need to understand their responsibilities.

Hearing protection

19 See 'Personal hearing protection' in Part 1.

Health surveillance

20 See 'Hearing health surveillance' in Part 1.

Live performers

21 Any venue that engages performers, such as musicians or DJs, should have a formal contractual relationship with the performer(s) and anyone else involved such as an agent or a fixer. The contract should, among other matters, identify the responsibilities of all parties under the Noise Regulations. See also Appendix 2 'Contracts'.

22 Many venues, in particular small pubs, do not issue written contracts when engaging performers. However all venues should consider this procedure to ensure that the engager/contractor and the performers are fully aware of the responsibilities of both the venue operator and the performer(s).

EXAMPLE DJ harmed

A 24-year-old DJ related that one night, after working in a club where the sound system was particularly loud, he went home with a ringing sensation that was so bad it took several days for his ears to recover. The ringing in one ear (tinnitus) has never completely stopped. He has become very sensitive to loud music, particularly high frequencies, and his tinnitus increases dramatically if exposed to loud noise. He is now careful always to wear earplugs when DJ-ing.

23 Visiting performers should be encouraged to use the in-house PA system rather than setting up their own temporary arrangements, which may make it more difficult for management to control noise exposure.

24 Between 'sets' performers should be encouraged to move to a quiet area. When arranging for live 'gigs', ensure that support acts, such as DJs, disco or karaoke, are arranged so that they will not contribute to excessive noise exposure.

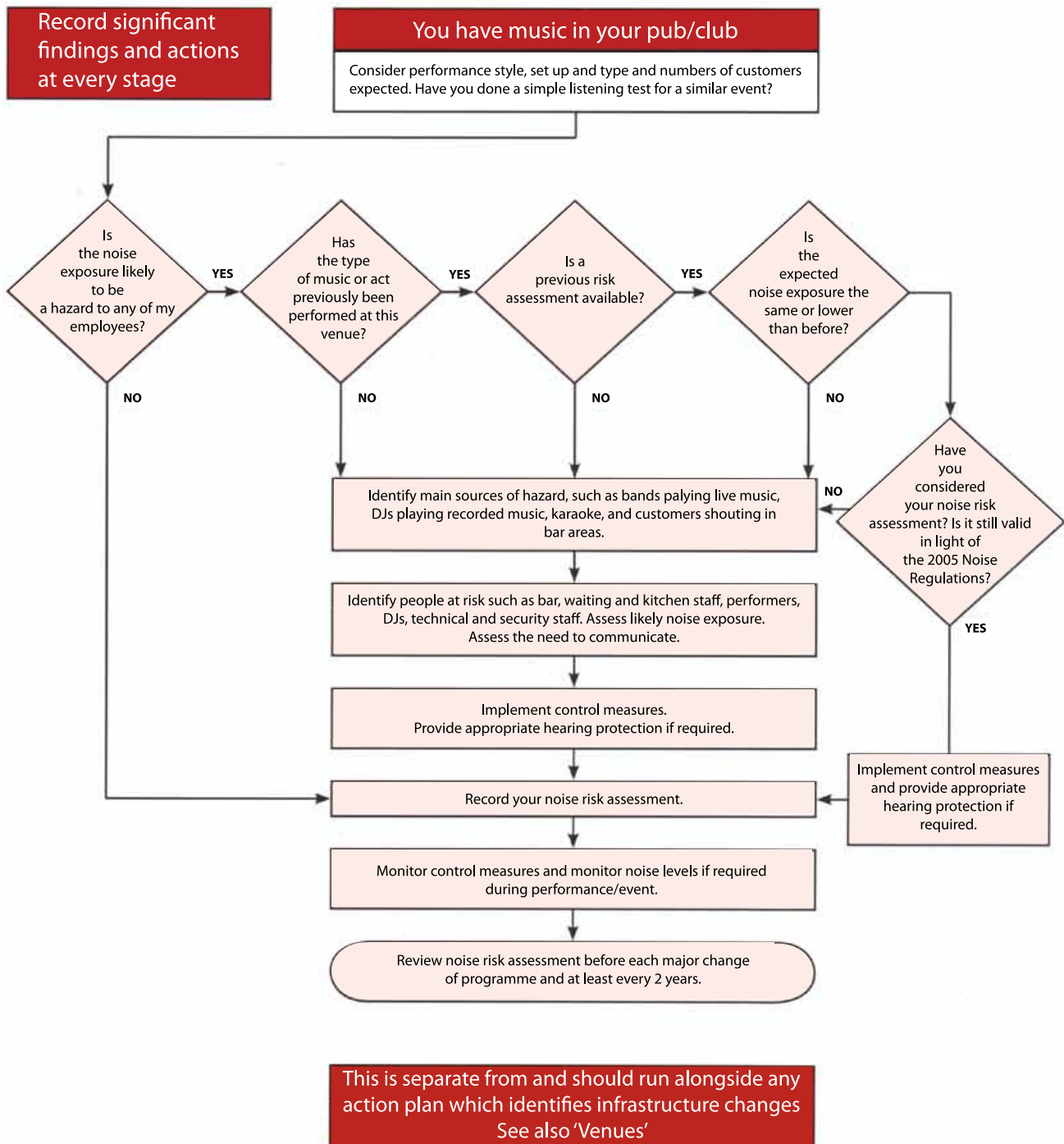


Figure 13 A noise risk assessment method for a pub/club event

6 Orchestras

Symphony orchestras, chamber orchestras, bands and other ensembles

Overview

Background
Noise risk assessments for orchestras
Scheduling
Venue
Layout
Screens
Personal hearing protection
Reference positions

Background

- 1 Most orchestras will require control measures as most musical instruments have the potential to produce hazardous noise levels. Representative noise levels can be found in Table 9. A noise risk assessment flowchart for a typical orchestra is shown at the end of the section. Additional guidance can be found in Sound Advice 7 'Orchestra pits' and Sound Advice 8 'Stage bands'.
- 2 By carrying out a noise risk assessment based on noise measurements or other available information, the extent of the problem can be established and will allow the development of a plan for controlling the noise exposure.
- 3 Excitement in musical performance is not achieved by volume alone. Constant loud volume may become monotonous and is potentially damaging to both performer and listener. Drama is created by dynamic contrast, which can be achieved with a reduction in general volume levels that would not be noticed by the audience. This represents a culture change and may require greater effort to achieve the softer levels needed to maintain the range of dynamic contrast.
- 4 Table 10 aims to demonstrate how long it would take for a symphony orchestra player or singer to be exposed to the upper exposure action value of 85 dB if playing a typical repertoire, for example by composers such as Haydn, Schubert or Vaughan Williams.
- 5 Studies indicate that orchestral musicians can reach the upper exposure action value by playing for as little as 10–25 hours per week.

Noise risk assessments for orchestras

- 6 Assessment should begin when planning a season or concert, and continue right up to the moment when the music starts – when it switches to monitoring the effectiveness of the control measures. Some orchestras, where repertoire and venue(s) are consistent for a period, are able to base their noise risk assessments on previous noise measurements. Others may be able to use existing noise measurements as a point of reference, and may find it useful to take noise measurements as part of their monitoring. Additional material on noise measurement can be obtained from *A sound ear II* through the ABO¹¹ and Appendix 5 'Measuring noise'.

Table 9 Representative noise levels

Noise source	dB	Peak
Single musicians		
Violin/viola (near left ear)	85–105	116
Violin/viola	80–90*	104
Cello	80–104*	112
Acoustic bass	70–94*	98
Clarinet	68–82*	112
Oboe	74–102*	116
Saxophone	75–110*	113
Flute	92–105*	109
Flute (near right ear)	98–114	118
Piccolo	96–112*	120
Piccolo (near right ear)	102–118*	126
French horn	92–104*	107
Trombone	90–106*	109
Trumpet	88–108*	113
Harp	90	111
Timpani and bass drum	74–94*	106
Percussion (high-hat near left ear)	68–94	125
Percussion	90–105	123–134
Singer	70–85*	94
Soprano	105–110	118
Choir	86	No data
Normal piano practice	60–90*	105
Loud piano	70–105*	110
Keyboards (electric)	60–110*	118
Several musicians		
Chamber music (classical)	70–92*	99
Symphonic music	86–102*	120–137
* at 3 m		

Note: These representative noise levels are collated from a range of sources. They give an indication of the variety of noise levels and noise peaks that musicians and other workers can receive from the instruments concerned. This information may be helpful with estimating noise exposure and in identifying potential noise 'hot spots'. However, as shown, many of the instruments can exhibit a range of noise levels depending on how loudly they are played, for how long and under what circumstances (eg repertoire, venue, number of instruments concerned). Do not only use this information for a risk assessment but look at 'Risk assessment and planning' in Part 1 and any other relevant sector guide(s).

Table 10 Examples of how long it might take for a player to be exposed to the upper exposure action value of 85 dB if playing at the level of a typical symphony performance

dB		
82	16 hours	eg violin
85	8 hours	eg harp
88	4 hours	eg trumpet
91	2 hours	eg trombone/French horn
94	1 hour	eg loud piano
97	30 minutes	eg loud soprano
100	15 minutes	
103	7.5 minutes	
137 dB (peak)	Maximum instantaneous peak noise when wearing hearing protection	Note that the peak noise from percussion, eg snare drum or cymbal clash, may exceed the 137 dB upper exposure action value.

7 The starting point for a noise risk assessment may be based on the following:

- Knowledge of the venue – its acoustic, space, restrictions and resources.
- Knowledge of the various works to be played – peak volume, length and analysis of the scores for extreme changes in dynamics (change in volume, timbre, tempo), instrumentation (numbers of each instrument required) and concentrations of energy.
- Layout of players – the number and configuration of musicians, for example how many brass or placement of percussion?
- Knowledge of the individuals involved – conductors (Do they like music loud? Do they rehearse a lot?), soloists (Are they noisy? Do they play loud instruments?) and composers (if available).
- The noise effects of specific instruments.
- Is amplification involved?
- Are there any special effects or pyrotechnics – is the *1812 Overture* to be performed?

8 Noise risk assessments help establish who is at risk and identify ways to prevent and protect people from hearing damage. Communication of the findings from noise risk assessments increases awareness among players, conductors and composers about possible noise-induced hearing damage and encourages everyone to moderate demands for ever-louder playing. Ensure that stage managers and orchestra porters are included in awareness training. Noise risk assessments will identify areas of greatest risk, which should be the priority for control.

Scheduling

9 Scheduling can help reduce noise exposure:

- Programme a quieter repertoire.
- Match the venue(s) with the programme.
- Programme concerts with a balanced quiet/loud repertoire.
- Schedule rehearsals with a balanced quiet/loud repertoire.

- Allocate noisy instruments/passages into separate parts of rehearsals.
- Allow time for adjustments.
- Allow time for players' ears to recover from noise exposure.
- Match the programme with the venue.

Venue

10 Modifications to the venue can help reduce noise exposure:

- Install specially-designed acoustic panelling and floor covering in frequently-used rehearsal and performance spaces; low and medium frequency acoustic absorption in pits or rehearsal rooms improves clarity and reduces exposures.
- Install adjustable acoustic panels, curtains and drapes in venues and use these to achieve lower noise levels.
- Make use of existing installed acoustic panels such as roof panels which may not be apparent.
- Consider extending the stage (use an apron) to increase the space available for performers.
- Try to keep a clear gap at the front of the platform – the floor surface may help reflect the higher frequencies towards the audience. This may allow players, particularly the strings, to play at a slightly lower level.
- Ensure that risers with more varied heights and widths are available.
- Improve projection – if you can reduce the amount of energy loss between the instrument and the audience/conductor, then you can reduce the power that a player needs to generate.
- Don't overdo special effects in performance. Select the quietest possible pyrotechnics to achieve the desired effect.
- Use earplugs as a last resort – see 'Personal hearing protection' in Part 1.
- Remember, the solution in one venue may not work in another. Try to have a variety of noise-control measures available, as a collection of small adjustments may add up to a significant reduction in noise exposure. Each 3 dB of reduction in the noise level means half the noise exposure.
- Reduce volume/power output.
- Ensure conductors are aware of the house policy on noise control.

How a conductor can help

The conductor can play a vital part in helping to lower musicians' noise exposure in line with the Noise Regulations. It can be beneficial to understand the common rehearsal and performance practices that can greatly impact on a musician's noise exposure. Some of these control measures could include:

- Rather than rehearsing the full orchestra, a conductor may choose to undertake sectional rehearsals when they have detailed work with one or more sections of the orchestra.
- Exploring a greater range of dynamics within the orchestra to create excitement in the variance between a piano and forte marking rather than going for fortissimo could be of benefit.
- Performing with the orchestra in a number of varying layouts which will give sections occasional respite from traditional 'noisy' areas of the orchestra helps share the load.
- During rehearsals, once the desired effect has been achieved, allowing the orchestra to play under the marked dynamic.
- Avoiding unnecessarily rehearsing very loud sections of the score repeatedly.
- In a full orchestral rehearsal, while making corrections, only working with those particular players or sections who need to be playing at the time and avoid asking other instruments to play.

When programming a concert or a series, a conductor can also be aware that musicians' exposure is measured over a weekly average, so if they were able to programme larger, noisier works balanced out with smaller or quieter pieces, this could reduce noise exposure for their performers. It is also beneficial for an opera and ballet orchestra to rehearse in a space outside the orchestra pit, giving more ambient space to allow sound to escape. Generally the conductor has considerable control over the whole noise output of the orchestra and is able to improve conditions for musicians by being aware of what they are asking of their orchestra.

Layout

11 Plan the seating layout to minimise problems with noise exposure:

- If there is room, separate performers from one another. An average space of 1.7 m² per person is adequate but 2 m² space is better. Try to build upwards rather than out, as this helps to maintain contact between players and keeps the sides and back of the orchestra in closer contact with the conductor.
- Avoid putting players under an overhang as this is likely to increase noise exposure.
- Place brass and woodwind on risers to help them project their sound. They will not need to work so hard to produce their sound.
- Do not put one row of noisy instruments in front of another noisy row, unless the back row is high enough to play over the heads of the players in front.
- On flat stages try staggering seating so that a musician is not playing directly into the back of the player in front.
- It may be possible to rotate the seating positions within some sections of the orchestra and share the exposure of sitting near noisy neighbours.
- If there is room, leave a couple of metres between the percussion section and other performers. Avoid having side-drum heads and suspended cymbals level with the ear of the players seated in front.
- Use fold-back speakers with caution.
- Meet with the conductor to explain the noise-control strategies.
- For some programmes it may be possible to have the noisiest instruments in one area of the stage. The rest of the performers can be remote from that group or be protected by the careful use of screens, minimising their exposure. However, noise measurements may be necessary to ensure that you are not placing the musicians in the noisy area at extreme risk.

Woodwind

12 Allow a clear path between the audience and the woodwind – this involves placing the woodwind players on risers and may require an even greater elevation for the brass.

Horns

13 Use adjustable baffles behind the horns – this improves the forward projection of their sound, so they don't have to play as loudly.

Brass

14 The use of risers to elevate brass sections may help to project their sound, which is highly directional, over the heads of the performers in front of them (see Appendix 6 'Risers').

Screens

15 If the above measures are insufficient, consider using screens (see Appendix 7 'Acoustic screens').

Personal hearing protection

16 If, after putting in place all the appropriate control measures, the exposure is likely to be at or greater than the upper exposure action value, personal hearing protection must be used. In other situations its use may be recommended. See Part 1 'Personal hearing protection'.

17 Some woodwind players may think they have natural protection by using the Valsalva manoeuvre (the creation of a slight positive middle-ear pressure when blowing a woodwind or brass instrument), however, this cannot be considered as an alternative to using hearing protection.

Reference positions

18 Reference positions for taking noise measurements can be useful for orchestras, especially when touring, to help assess whether sound levels are under control (see Figure 14).

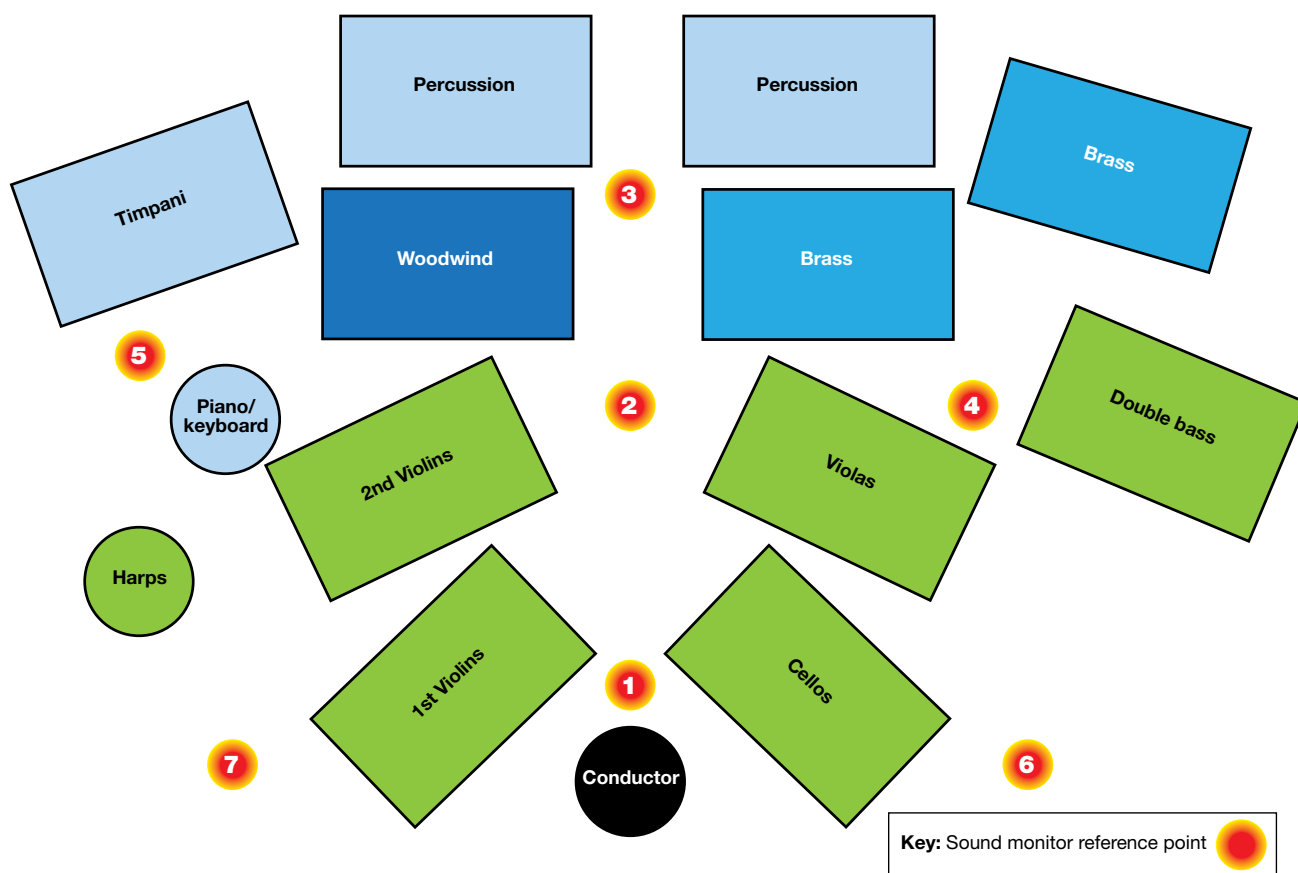


Figure 14 Example of an orchestral layout showing reference positions for noise measurement

CASE STUDY Symphony orchestra noise measurements

The orchestra management arranged for a noise assessment of individual members of the orchestra. Measurements were made during rehearsals. The musical repertoire being rehearsed at the time of this noise assessment was:

Vaughan Williams *A London Symphony*

Haydn Symphony No. 104 in D Major, 'London'

Schumann *A Song of Orpheus*

These were considered by members of the orchestra to be relatively quiet works.

80% of the musicians wore individual dosimeters mounted on clothing as close to the ear as practical.

Other measurements were made by sound level meters (SLMs) positioned in strategic locations. These were:

- just behind and to the left of the conductor;
- at the centre front of the auditorium (balcony);
- where the double basses would normally sit (for this rehearsal they were in the centre of the rostra at the rear of the orchestra).

Each SLM was mounted on a tripod, with the microphone positioned at about head height (when seated) and pointing towards the middle of the orchestra.

The key findings were:

Dosemeters results

Total number of musicians with valid results	66
Number for whom $L_{EP,d}$ exceeded upper exposure action value (85 dB)	26
Highest recorded $L_{EP,d}$	93 dB
Highest recorded L_{Aeq}	98 dB

The highest recorded sound levels tended to centre on the brass and woodwind sections, followed by percussion and timpani.

SLMs results over 6h 47m	$L_{EP,d}$ dB	L_{Aeq} dB
Auditorium	76	76
Conductor	79	80
Bass section	80	81

Conclusions

- A significant proportion (over 30%) of the musicians received a noise exposure in excess of the upper exposure action value of 85 dB during rehearsals of what were considered to be relatively 'quiet' works.
- Control measures should be implemented and hearing protection worn until the control measures are shown to be effective.

EXAMPLE

Planning concert layouts

The variation of layouts is one of the more effective control measures available, by providing the appropriate distance and height between players at different times. The input and co-operation of the conductor is essential as this enables the orchestra to address the issues as they develop and, with monitoring, vary the layouts of the orchestra. This has the added bonus of providing opportunities for artistic experimentation.

It would be relatively straightforward to vary layouts between concerts were the orchestra to perform only in its home venue. However it is important to consider the idiosyncrasies and unsuitability of some of the stages where the orchestra is repeating all or part of a programme. These engagements are crucial and repeating programmes happen frequently. It would be unfair on conductors and the musicians to change the layout after significant preparation at the home venue and, for this reason, the knowledge and experience of the players of these smaller venues is crucial. Reaching a balance, therefore, usually requires compromise on all fronts.

Two examples are shown in Figures 15 and 16. Note risers are provided with their heights marked.

Another layout for an orchestra/pop group during a recording session is in Sound Advice 9 'Studios'.

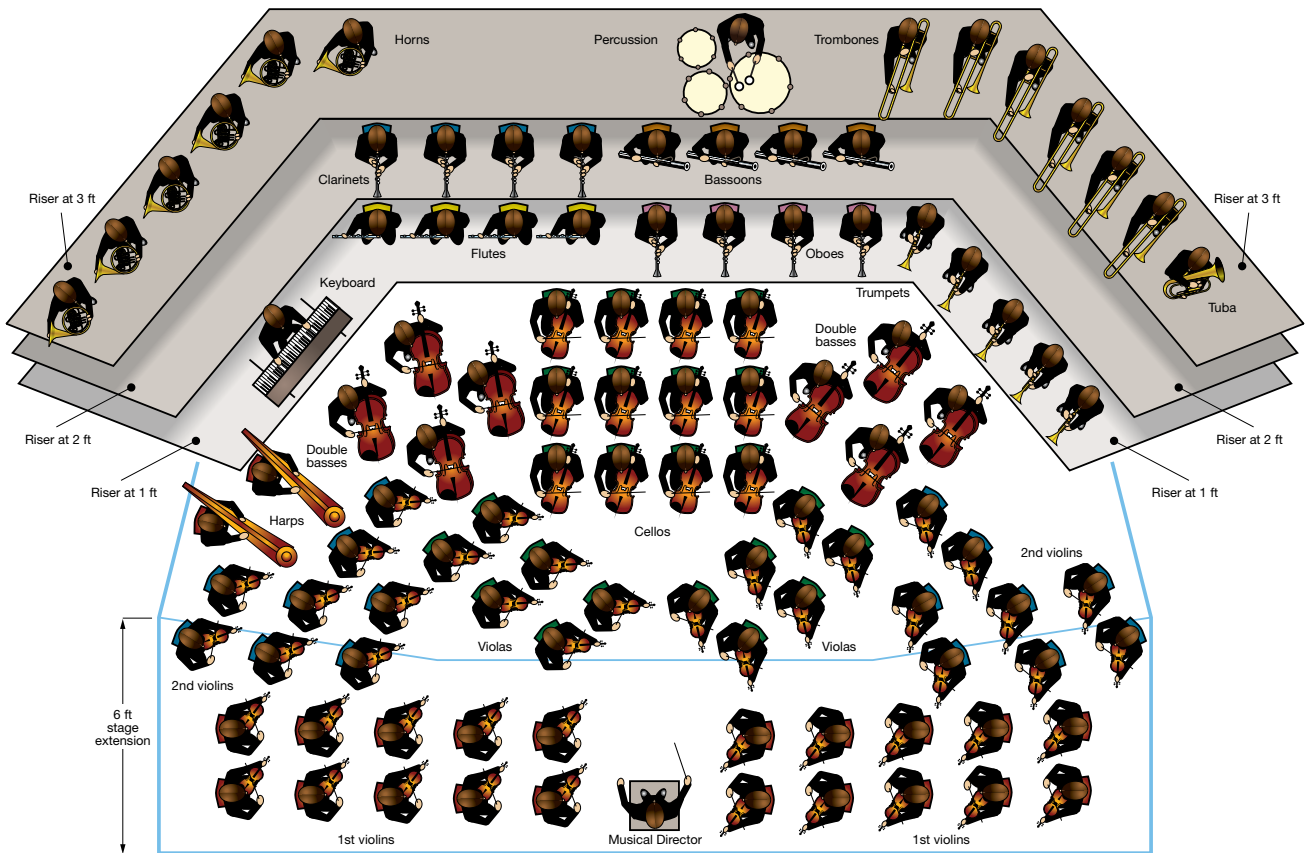


Figure 15 Example orchestra layout from Royal Festival Hall, pre-2007

Note: to be more effective the riser heights for the trumpets should be at least 2 ft

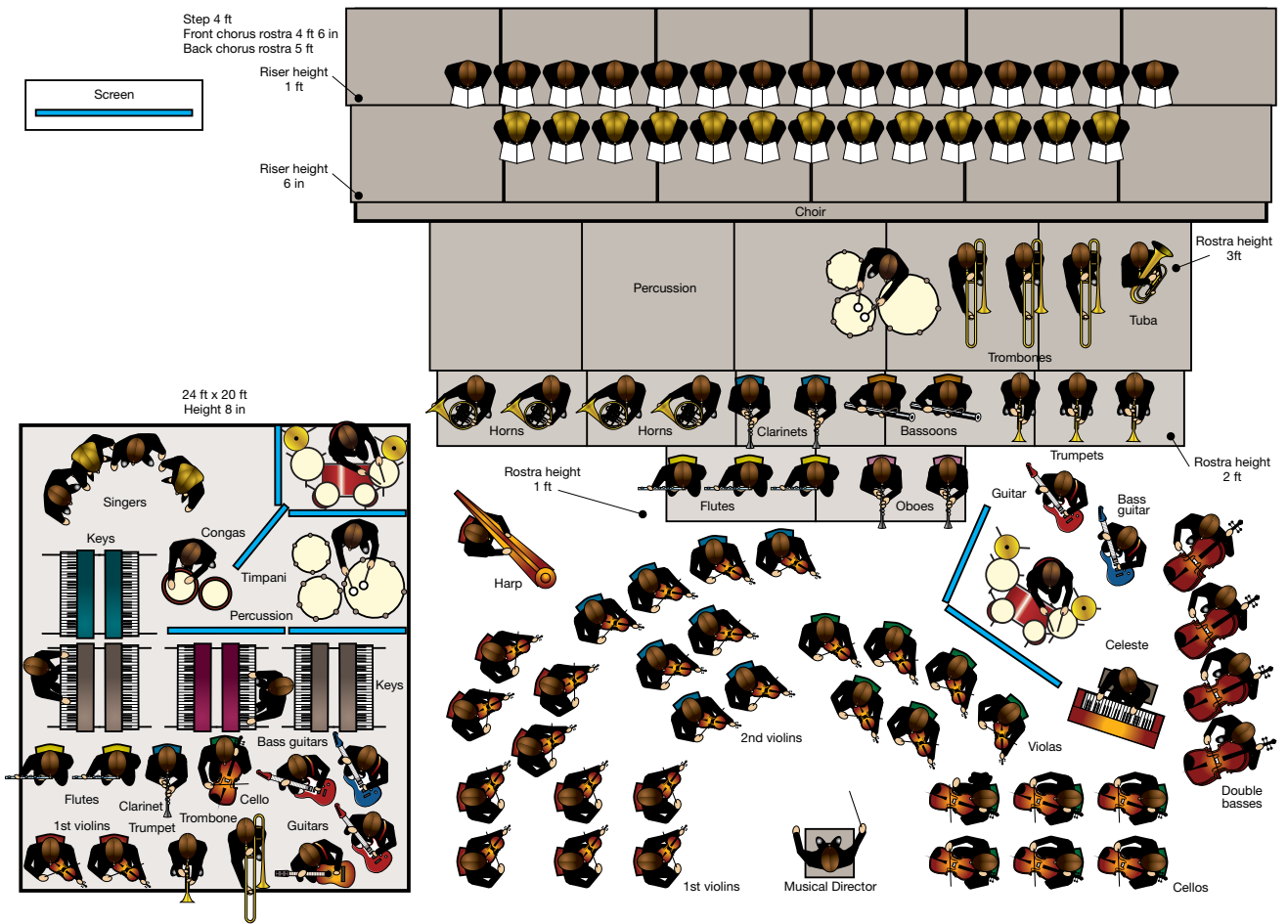


Figure 16 Example layout from 'MusicLab', an educational programme involving professional and amateur musicians

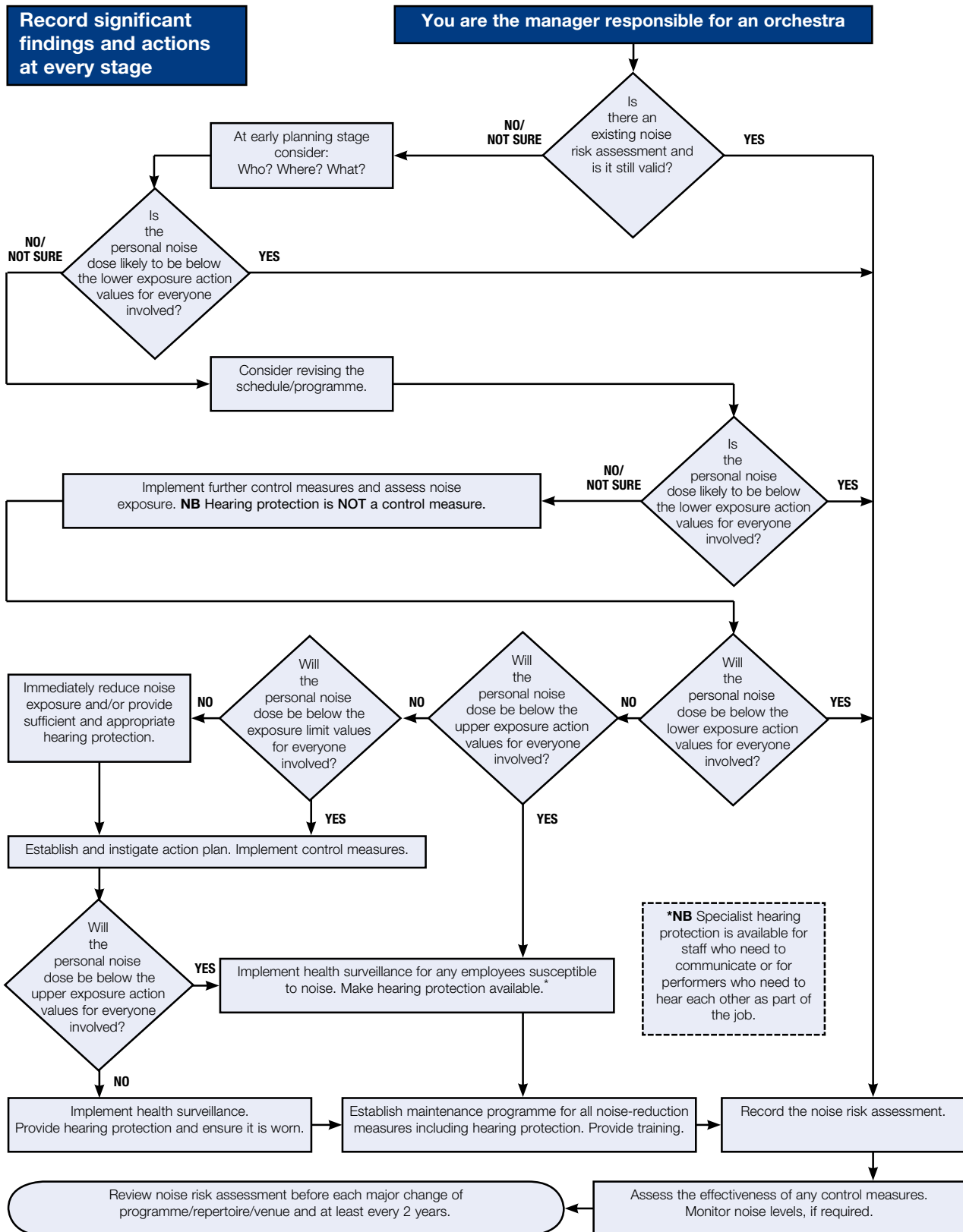


Figure 17 A noise risk assessment method for orchestras

7 Orchestra pits

Orchestra pits in theatres and opera houses

Overview

Background

Control measures

- Use sound-absorbent materials
- Position performers strategically
- Amplification
- Use shakers
- Use acoustic screens
- Use risers

Background

- 1 This section covers indoor orchestra pits. See also Sound Advice 6 'Orchestras' and Sound Advice 8 'Stage bands'.
- 2 Musicians may experience two main problems when playing in orchestra pits:
 - Orchestra pits are often cramped and can be almost totally enclosed spaces. A space of 1.7 m² per musician in an orchestra pit is regarded as good; if this is reduced to 1.2 m² per musician the conditions are confined and the musicians can feel claustrophobic and hemmed in, with difficult resonances. Height also has an effect. Wherever possible there should be between 2.5 m and 3.5 m between the floor of the orchestra pit and the underside of any overhang.
 - Pit-orchestra musicians and conductors may have to play the same show several times a week, often for months on end. In this case scheduling would not be an effective control measure.
- 3 These two factors make it all the more critical that noise-control measures are effective and observed. For representative noise levels in orchestra pits see Table 11.
- 4 Touring companies should carry out a separate noise risk assessment for each pit-venue on the tour. Different sizes and shapes of pits may require alternative control measures. Ensure that any changes do not cause additional/secondary safety problems.

Control measures

- 5 Possible control measures include:
 - using sound-absorbent materials;
 - position of performers;
 - amplification;
 - using shakers, acoustic screens or risers.

Table 11 Representative noise levels in orchestra pits

Noise source	dB
Opera orchestra pit	
Violin	84–90
Viola	87
Cello	86
Double bass	86
Trumpet	93
Trombone	90
Horn	91
Piccolo/flute	90
Clarinet/bass clarinet	88
Oboe/bassoon	87
Percussion	85
Conductor	82
All instruments	88

Use sound-absorbent materials

6 Reduce sound hazards by installing acoustic panelling and other sound-absorbent materials. This treatment can be highly cost effective.

Position performers strategically

7 Positioning is especially crucial in orchestra pits because they are often very confined spaces with low ceilings. The musicians are often playing directly into each other's and the conductor's ears. The low, overhanging ceilings prevent sufficient sound escaping to the audience, resulting in louder playing levels, or even amplification. Consider the following:

- Maximise the space between the performers (in particular between the loudest instruments, for example percussion) and other performers where the size of the pit and the relationship between the performers (as required for artistic purposes) permit. This will help lessen the effect on other performers of sound levels produced by the noisiest sections.
- Position loud instruments or sections in open ceiling areas of the pit so their sound can escape out of the pit.
- Consider seating brass players near the front of the pit around the conductor/musical director so the other musicians will not be exposed to loud, highly directional sound coming from the brass.
- Stand the conductor/musical director on a riser above the brass section to limit the exposure of the conductor/musical director to excessive noise.
- Encourage conductors/musical directors to work with players to reduce sound levels. They play an essential role in co-operating to reduce noise exposure including looking at repertoire and performance noise levels.
- Consider seating rotation and/or adjusting the schedules of the performers to reduce their individual exposure levels. The ears should be allowed time to recover from noise exposure (see paragraph 72 in Part 1).

- Where the performance is to be amplified, consider the orchestra layout with a view to minimising the effects on performers of sound levels produced by other performers. One possible measure might be to place the percussion section in a segregated area. This would enable the sound levels produced by the percussion section to be controlled through the amplification system.
- 8 Allow time within the scheduling for any necessary adjustments, such as moving seats, musician stands and acoustic screens, or minor variations in layout.

Amplification

9 Sound equipment should be selected by a sound designer or other suitably qualified person who should ensure that it meets the requirements of the production in the venue concerned and is used within the manufacturer's specification while bearing in mind the need to manage sound levels. Consider the following:

- Position loudspeakers strategically. The volume of amplifiers, on-stage monitors and front-end speakers can be turned down while still achieving the same acoustic effect if careful thought is given to positioning.
- Raise monitor speakers and fold-back speakers off the floor. This puts them closer to ear level, which means the overall output level can be reduced with the benefits of minimised spill, less reverberant noise and increased clarity. Advice on good working practice for monitor headphones and in-ear monitors is provided in Appendix 8 and Appendix 9.

CASE STUDY

Musical theatre pit orchestra

The following case study highlights the problems facing musicians when working in the confined space of a theatre orchestra pit.

The musicians performed six evening shows each week with two matinee performances, each lasting about three hours. The assessments were all made under the Noise at Work Regulations 1989.

Initial noise assessment July 2002

Noise measurements were taken with four sets of static noise-monitoring equipment to establish the range of noise levels in the pit.

Measurement position	Show L_{Aeq} dB	Daily noise exposure with one show per day $L_{EP,d}$ dB	Weekly average of daily noise exposures $L_{EP,w}$ dB
Drum booth	92	88	89
Timpani	87	83	85
Conductor	87	83	84
Flautist	92	88	89

Conclusions

- Replace the previously installed perspex screens with absorbent screens between sections (particularly between brass and woodwind).

- Place absorbent material on the net at the stage edge to reduce spill from the stage-edge fill speakers into the pit and to make the edge of the pit by the flautist absorbent.
- Investigate the contribution to the noise exposure of the musicians from the front-of-house stage-edge show sound system.
- Provide hearing protection.
- Carry out a further noise assessment to quantify improvement.
- There would be little benefit in introducing more absorption within the drum booth as this was already 'dead'. The drummer was provided with closed-back headphones with a small mixer and a direct feed from the sound desk which enabled him to control the mix he heard and so reduce the intrusive airborne noise from the drums.
- Initial assessment should have been carried out on all the musicians to obtain a clearer picture of individual noise exposure. This would have saved costs and time and would have resulted in achieving the reduction in exposure levels sooner.
- Other recognised noise sources: the sound of a musician's own instrument; the sound of other instruments, especially nearby; the sound of a house sound system, particularly from speakers set into the stage edge over the pit; noise from the auditorium (such as applause).

Second noise assessment August 2002

Noise measurements were taken on the right side of the flautist and the left side of the flautist – to establish any variation from side to side; between the horns and the bass trombone (level with the horn players' left ears); and above the head of the trumpet player.

Measurement position	Show L_{Aeq} dB	Daily noise exposure with one show per day $L_{EP,d}$ dB	Weekly average of daily noise exposures $L_{EP,w}$ dB
Flautist right	89	85	86
Flautist left	89	85	86
Horn player/ bass trombone	94	90	92
Trumpet	96	92	93

Conclusions

- Improvements resulting from remedial works in the pit caused a reduction in the $L_{EP,w}$ at the flautist's position of 3 dB. As this position was still above the first action level, hearing protection needed to be made available.
- After the first assessment it was recommended that the entire perspex screen between the brass and woodwind should have absorbent material fixed to both sides. The first trial would be to have 30 mm dense mineral fibre applied on each side and black wood serge used as a decorative cover stretched over the fibre. The perspex should be left alone for the top section of the screen to allow the brass section to see through it. The mineral fibre should have a minimum density of 60 kg/m³. If, after these controls have been carried out and reduction is still insufficient, hearing protection should be provided and used.

Third noise assessment September 2002

Noise measurements were taken between violas; between saxophone/clarinet and cello; between French horn and trombone (by horn players' left ears); by trumpeter's left ear; by flautist's left ear.

Measurement position	Show L_{Aeq} dB	Daily noise exposure with one show per day $L_{EP,d}$ dB	Weekly average of daily noise exposures $L_{EP,w}$ dB
Violas	85	81	82
Sax/cello	85	82	83
French horn (left ear)	91	87	88
Trumpet (left ear)	94	89	91
Flute (left ear)	89	85	86

Conclusions

- Flautist: further remedial works resulted in a negligible reduction, so hearing protection should be made available.
- Brass: the additional absorptive material on the perspex screen in front of the brass position resulted in a significant reduction in exposure levels. Hearing protection should be made available for the French horn but provided to and used by the trumpet.

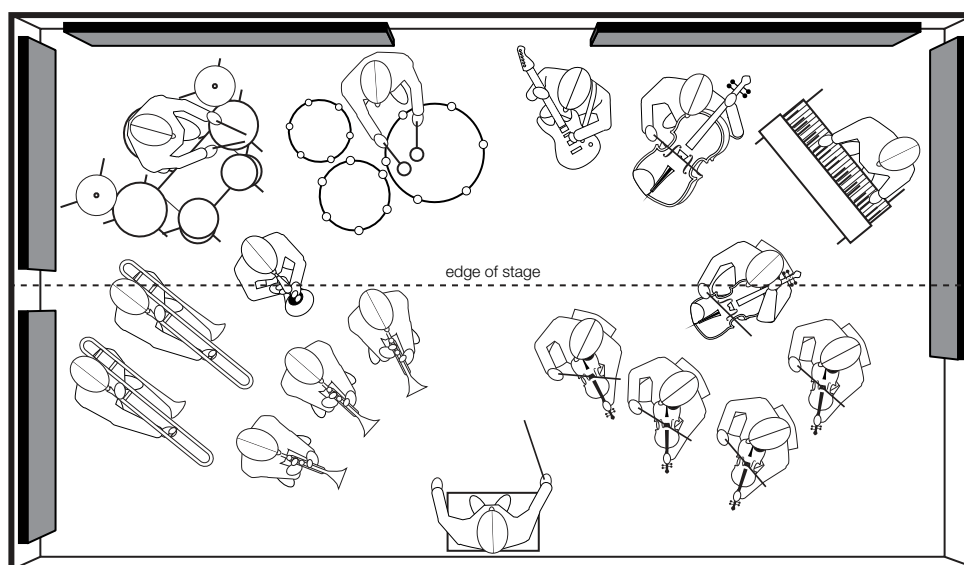


Figure 18 Use of sound-absorbent panels in a small music theatre pit

Use shakers

10 Shakers can allow performers to monitor and maintain contact with their instruments. They can easily be attached underneath drummers' seats or to small plywood boards placed on the floor.

Use acoustic screens

11 Moveable screens may be needed as well as sound-absorbent panels (also see Appendix 7 'Acoustic screens').

Use risers

12 If the pit overhang allows it, using risers to elevate brass sections may help to project their sound, which is highly directional, over the heads of the performers in front of them (see Appendix 6 'Risers').

8 Stage bands

On-stage and off-stage bands and choruses in theatrical performances

Overview

Background

Control measures

On-stage bands

Off-stage bands and off-stage musical instruments

On- and off-stage choruses

Fold-back monitors

Persistent sources of noise

Background

1 In this section the term 'artists' refers to performers (and, where relevant, to other workers such as stage-management staff) on stage other than bands. The term 'bands' includes orchestras, ensembles and groups. See also Sound Advice 6 'Orchestras'. Orchestra pits are covered in Sound Advice 7 'Orchestra pits'. Sound Advice 9 'Studios' may also be helpful.

2 Siting the band on stage can contribute to the noise exposure of the artists and is best avoided unless their location is regarded as essential to the artistic requirements of the production. Always carefully consider the positioning of the on-stage band in relation to other artists. Other possible locations for the band, for example galleries or in the auditorium, may be appropriate.

Control measures

On-stage bands

3 Possible control measures include:

- minimising the volume levels produced by the band/orchestra. This could mean producing less volume and/or using physical elements such as absorbent material and screens;
- maximising the distances between the band/orchestra and artists;
- positioning the band and/or artists at different heights;
- where an artist is positioned close to a high level of noise, consider rotating positions.

4 Differences between on-stage bands in a musical and on-stage orchestras in an opera should also be taken into account, for example, a West End musical will be performed eight times a week, but the band will usually be amplified so sound levels can be managed through the amplification process. On-stage orchestras in an opera will not usually be amplified, but the opera may not be performed every night.

Off-stage bands and off-stage musical instruments

5 The same considerations and possible control measures apply to off-stage bands as to on-stage bands. Also consider the location of the bands/instruments to minimise the impact on artists. For example where the music is amplified, the off-stage bands/instruments could be remote from the stage.

On- and off-stage choruses

6 Consider the effect of chorus noise levels on other artists on stage. The same considerations and possible measures apply as those to orchestras/bands on stage.

7 Choral volume should be regularly monitored to minimise the effects of noise levels produced by individual singers on each other without compromising the overall balance of sound.

Fold-back monitors

8 Take steps to ensure that the noise levels of fold-back monitors are as low as possible. Volume levels may need to be adjusted to suit the specific requirements of the artists at different times in the course of the performance and should not be set at a fixed level for the duration of the performance.

Persistent sources of noise

9 Consider rotating or varying the positions of artists close to sources of persistently loud noise such as other artists, musical instruments or special effects.

9 Studios

Facilities for recording and/or broadcasting live music

Overview

Background

Control measures

Planning

Positioning performers

Reducing exposure

Performers' monitor speakers

Control room monitor speakers

Background

1 This section deals with recording live music, primarily in purpose-built facilities: studios. It may also be relevant to broadcasting music. It should be read in conjunction with Sound Advice 4 'Rock and pop' and Sound Advice 6 'Orchestras'.

2 What makes this advice different is that typically there is no paying audience involved. This to some extent reduces the usual burden which typically gives priority to appearance over audibility. Layout can therefore be optimised for sound without such severe space restrictions. Microphones and their leads and stands need not be obscured, distant parts of the studio and other remote areas are equally useable and when recordings are being made there is usually the ability to 'retake' when desired. Where multi-mic methods are used, it may also be possible to keep performance noise down irrespective of whatever balance is achieved at the mixing desk. These features can provide the opportunity for a degree of experimentation, which will help comply with the Noise Regulations.

3 A noise risk assessment flow chart for studios is at the end of the section.

Control measures

4 Where a noise risk assessment has indicated there is a risk, possible control measures may include the following:

- planning;
- positioning performers;
- reducing exposure for everyone;
- adjustment to speakers.

Planning

5 The room size, shape, design and acoustic all have a direct bearing on the sounds being generated. At the event-planning stage, consider noise-exposure levels for performers, engineers, crew, and ancillary activities such as hospitality. Allow enough time to comfortably complete the project – an extra day or half day could reduce the overall intensity for everyone.

6 When new-build or structural modifications are planned, try to envisage how all those involved with the end product are likely to interact with the environment created. Consider how noise risks can be eliminated or reduced by thoughtful

design, for example, will the Green Room enable its occupants to be part of an event without the risk of noise hazard?

7 Try to reduce noise 'hot spots' in performance areas by installing sound-absorbent materials, screened areas and acoustic refuges.

Positioning performers

8 The positioning of performers is important:

- When calculating how many musicians/performers can be accommodated in a studio, aim for 2.0 m² of floor space per person together with a surrounding perimeter area.
- Separate the performers from each other as far as practicable which may help to reduce exposure levels. Provide risers – see Appendix 6 'Risers'.
- Take into account the sources of sound and visualise the noise footprint that each will have. It may be helpful to carry out noise measurements before and after layout adjustments to help gauge the effect.

Reducing exposure

9 Minimise the duration of noise exposure for everyone:

- Make sure staff who are not needed for a particular piece leave the studio or use 'acoustic refuges' where provided.
- Control rooms should only contain essential staff, and not be treated as Green Rooms.
- Make good use of acoustic screens to isolate loud instruments or shield individuals/groups from prevailing sounds.
- Drum kits can be positioned and shielded to minimise noise spill.
- Particularly noisy instruments could be positioned and mic'd in a separate area from the main performance.
- Any shielding materials should be acoustically absorbent rather than reflective.
- Play more quietly, especially if instruments are individually mic'd.

10 Disposable hearing protection, for example earmuffs or disposable earplugs, should be kept available in case they are needed.

Performers' monitor speakers

11 Remember that any reduction in sound levels from the loudest instruments will result in less need for high fold-back levels.

- Try replacing floor wedges with smaller stand-mounted speakers at ear level.
- Use headphones or in-ear monitors rather than fold-back speakers, so reducing unwanted sound in the performance area. All headphones and in-ear monitors should be fitted with noise limiters – see Appendix 9 'Click tracks and headphones' and Sound Advice 4 'Rock and pop'.
- Try using single-earpiece headphones and swapping ears between takes to reduce overall exposure.
- Consider using click tracks in place of monitors – see Appendix 9 'Click tracks and headphones' and Appendix 6 'Risers'.

Control room monitor speakers

12 Reduce monitor levels in the control rooms to the lowest feasible listening levels when recording, overdubbing and mixing. There are often other workers, for example producers, performers and engineers, who need to be present, and who may be there for many hours.

13 It is often necessary for the sound engineer to raise the volume of quiet pieces of music for analytical purposes. If these listening levels were to be

maintained during loud passages, even the peak action level would probably be exceeded. It can therefore be appreciated why control room speaker levels need to be frequently adjusted, but there should be some safeguard to avoid inadvertently leaving speaker volumes at high levels. The use of electronic limiting in loudspeaker feeds is not favoured by sound engineers.

14 An alternative approach is to lock off the system to achieve a maximum level (say 80 dB for an 8-hour session or 87 dB for a 3-hour session) but then provide a method of fleeting gain increase. This could be achieved with a simple push button on the mixing desk that provides full gain while pressed. A more sophisticated electronic version might calculate the duration of the full-volume mode, so that a cap could be applied to its use.

CASE STUDY Recordings of an orchestra

There were two performances before an invited audience. Both performances had the same orchestra and pop group. At the first concert light music was played and the performance was arranged in a traditional 'classical' layout. At the second concert pop music was played and a 'novel' layout was tried.

Noise levels within the brass and percussion sections of an orchestra can exceed 95 dB. In the traditional layout of the orchestra, players of quieter instruments seated in front of these sections can receive a significant noise exposure from these louder instruments. During the pop concert recording the orchestra experimented with placing the brass and percussion sections to the front of the orchestra. The woodwind and strings were on raised staging behind. Individual microphones were used for each player and the sound heard by the audience was amplified and balanced electronically. Players used headsets to hear backing tracks and clicks.

Clear, head-height screens, separating the pop musicians from the orchestra, provided some additional protection where pop and orchestra musicians were in close proximity.

To maintain the benefit of the physical noise controls the pop musicians and sound technicians were reminded of the need to moderate amplified sound levels on the stage. As a consequence the monitor speakers for the pop musicians gave a lower level than the pop musicians were accustomed to.

Table 12 compares the daily noise exposure of the orchestra during the 'classical' concert recording with a traditional layout of the players, and the noise exposure during the pop concert with the novel arrangement. Both events were at the same venue. The exposure in both cases arises from a full-length rehearsal and performance within the same day.

Commentary

The orchestra musicians had said that previous recordings of pop concerts had given much higher sound levels than classical recordings. Compared to a classical recording this experimental arrangement of the orchestra gave a reduced exposure for most string and woodwind players, and no increase in exposure for the brass players.

Table 12 Comparison of daily noise exposure

Player	Traditional layout for 'classical' concert $L_{EP,d}$ dB	Novel layout for pop concert $L_{EP,d}$ dB
Trumpet	92	93
Clarinet	91	80 (on back row of orchestra)
Violin	88	87
Viola	87	84
Cello	83 (at far edge of orchestra)	86 (in front of woodwind)

The rearrangement of the orchestra was viable because musicians were playing with backing tracks and clicks heard through headsets with electronic balancing of the sound from each instrument for the recording and audience. The additional microphones and sound equipment significantly increased production costs. The orchestra layout described here is unsuitable for a classical concert where players need to hear other orchestra sections or where the audience need to hear the quieter instruments acoustically (not amplified).

Illustrations of the two layouts are in Figures 19 and 20. Figure 19 shows a traditional orchestra layout, which places the quieter section, the strings and woodwind, between the pop group and the orchestra's brass and percussion sections. Transparent acoustic screens were placed between the strings and the pop group's equipment but these did not provide enough protection from their loud amplifiers and monitors.

Figure 20 shows how the layout was changed to provide more noise protection for the orchestra. The strings and woodwind sections were tiered which moved them away from the noisiest area of the stage. The brass and percussion sections were situated down-stage and separated from the pop group's band by acoustic screens. These screens were placed far enough away from the brass so as not to cause any noise reflection but also to protect them from the loudness of the group's amplifiers.

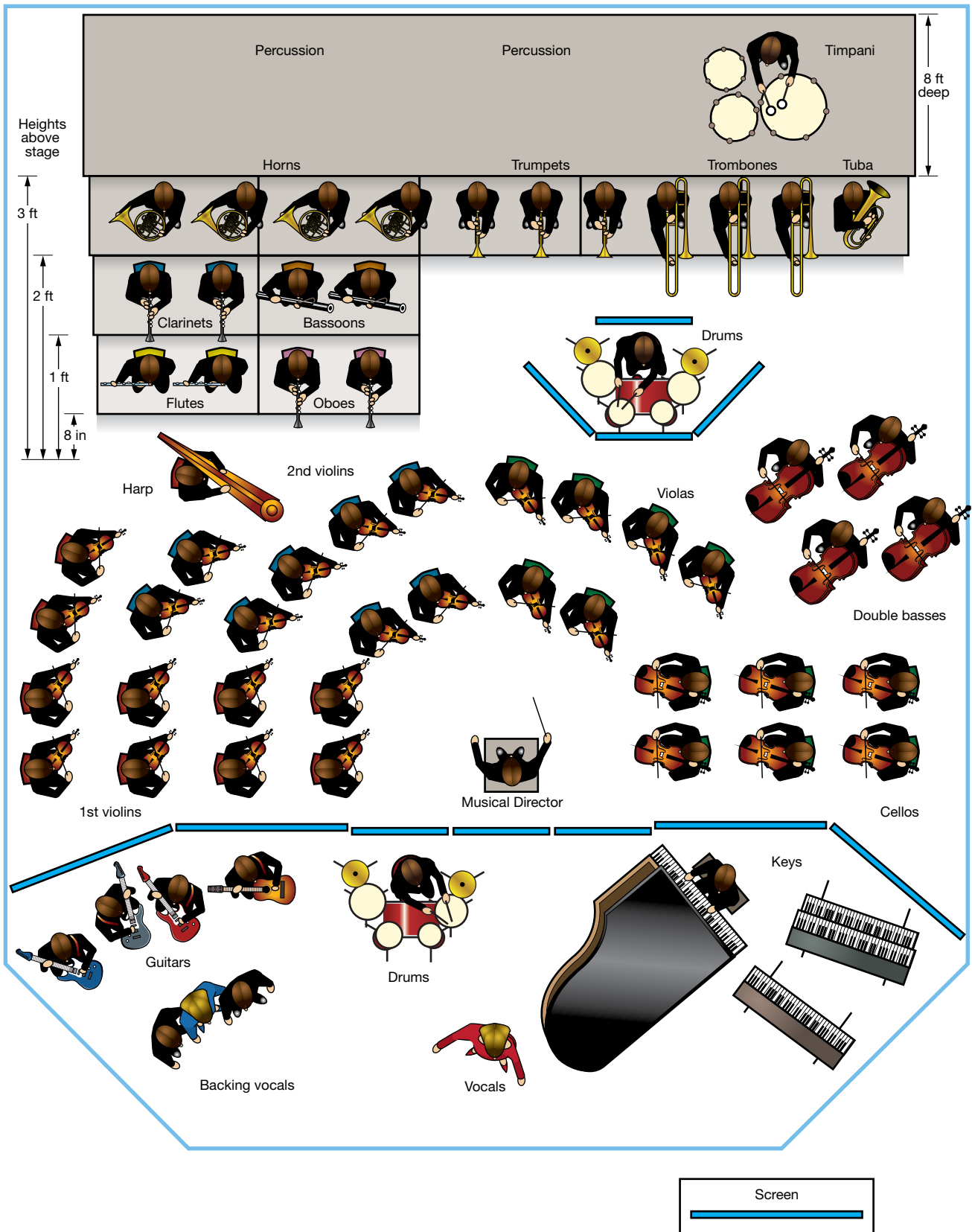


Figure 19 'Classical' concert recording

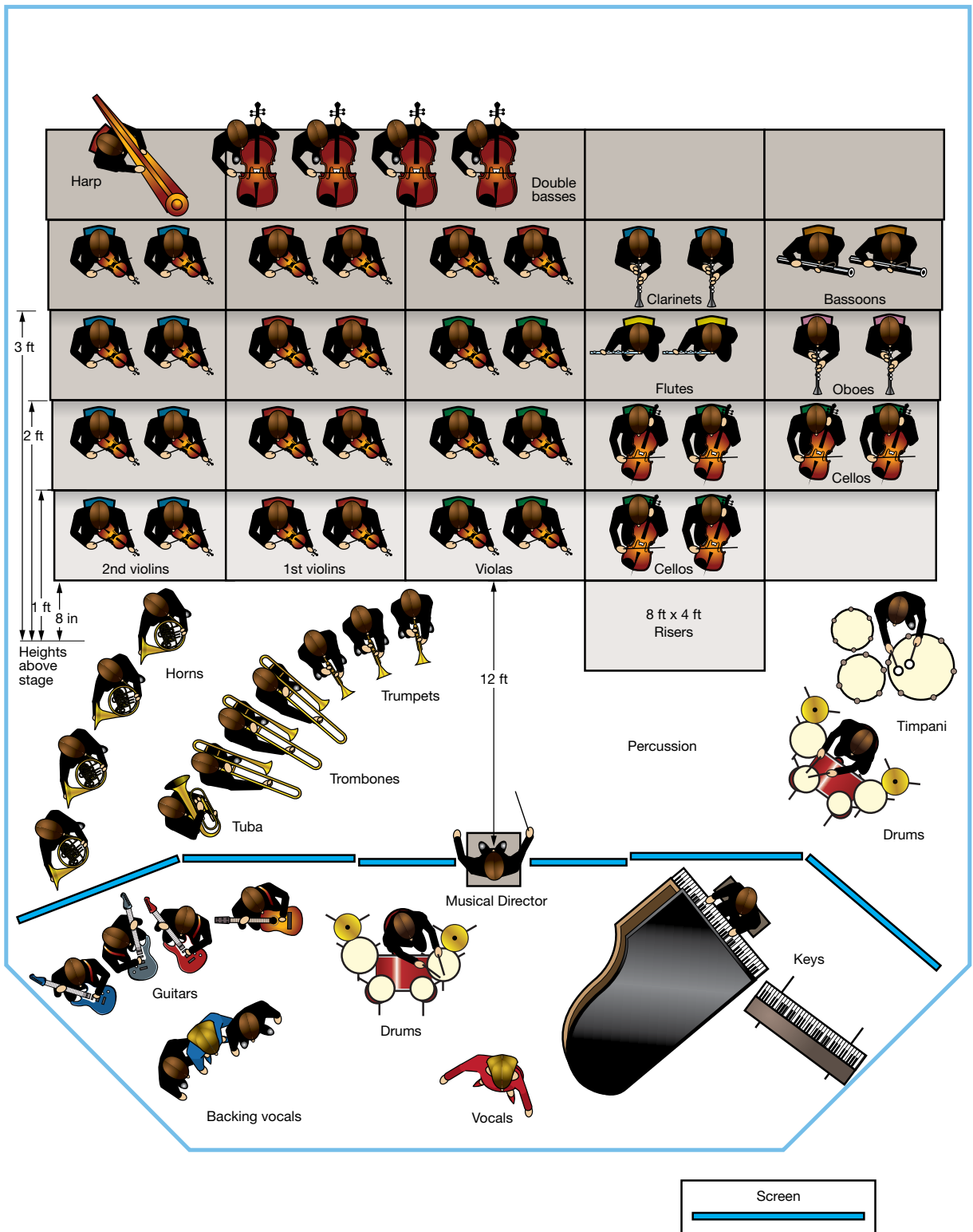


Figure 20 Novel layout for pop concert recording

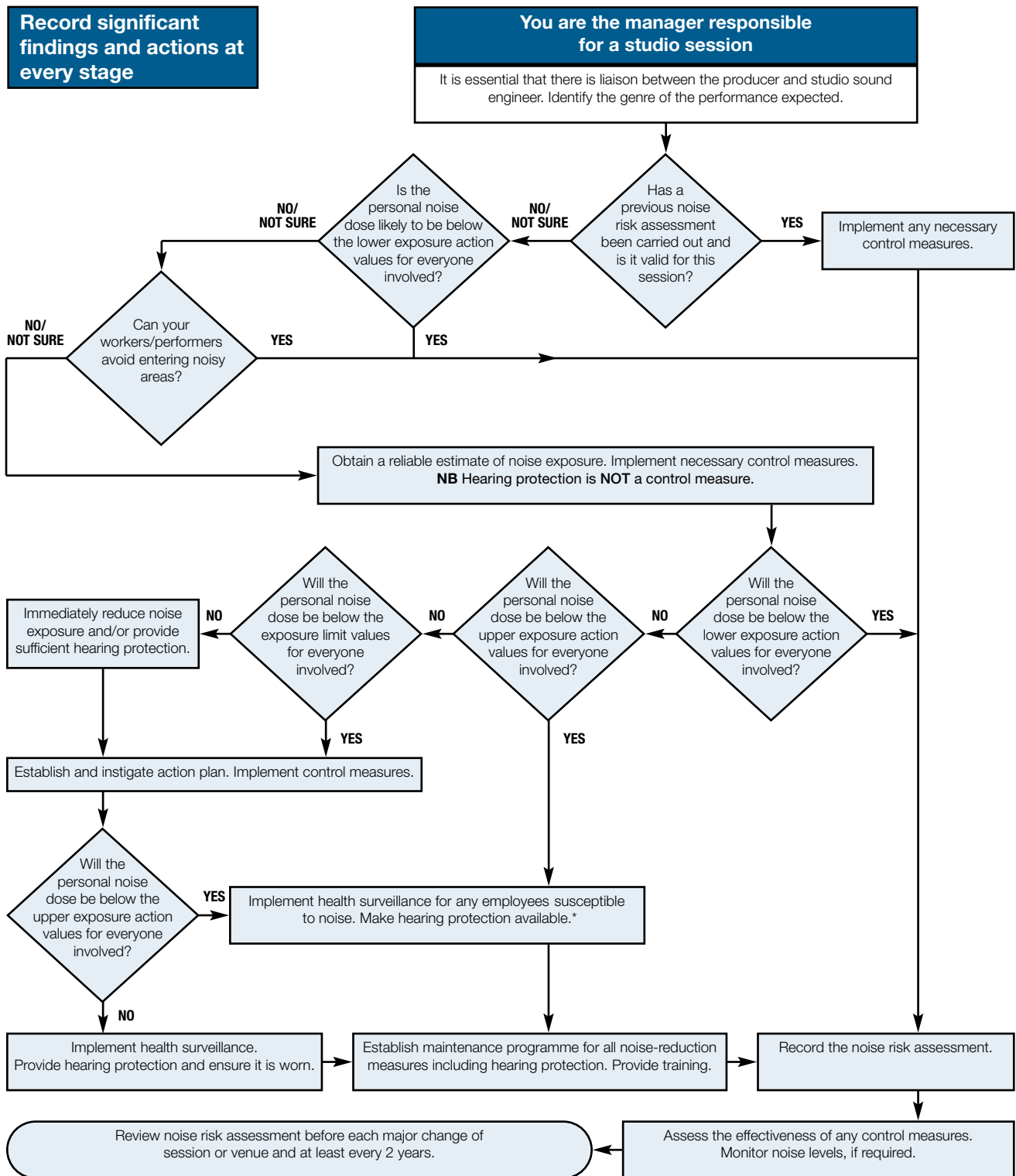


Figure 21 A noise risk assessment method for a studio session

10 Music education

Teachers, conductors of student groups, education officers and directors in schools and music colleges

Overview

Who is this guidance for?

Noise levels produced by individual instruments

Plan to avoid over exposure

Exposure-reduction measures for employed and private instrumental teachers

Hearing preservation – education and training of students

Orchestras, brass bands, wind bands and other ensembles/vocal groups

Classroom teaching

Who is this guidance for?

1 This section is for:

- directors of teaching establishments;
- instrumental teachers – including private/peripatetic at any level;
- classroom teachers;
- conductors of student instrumental/vocal groups;
- Education officers/learning managers.

2 Teachers should use this advice to prevent damage to their own hearing. They are also encouraged to pass on this information to their students as part of their complete musical education.

3 Each establishment should identify the responsibilities for risk control.

Noise levels produced by individual instruments

4 For representative noise levels see Table 13.

5 The exposure measurements in Table 14 were taken over approximately a one-hour period of adult tuition in a purpose-built teaching room. If a teacher's exposure were to continue at that level for eight hours then the representative noise level would be the actual daily exposure level. Note the peak exposure of the cornet player would be of concern.

Plan to avoid overexposure

6 Employers of teachers and self-employed teachers need to plan their working week to avoid overexposure. Any noise exposure, not just to music, over the week is cumulative. The Noise Regulations allow exposure to be assessed across the working week – see Appendix 4.

- Revise the structure of lessons so that only certain groups in the class are actually using instruments at any one time while other groups are planning and 'composing' their works.
- Try and alternate sessions so that exposure to loud noise is limited.

7 Private instrumental teachers should maintain a record of exposure levels and adjust their teaching schedules if necessary to prevent overexposure.

Table 13 Representative noise levels

Noise source	dB
Music teaching: group practice	
Saxophone: Tutor	93–95
Saxophone: Students	94–96
Music teaching: individual lessons: tutor exposure	
Violin with piano accompaniment (small practice room)	82
Violin with piano accompaniment (large practice room)	76
Violin	84
Flute	89
Electric guitar	88
Saxophone	95
Trombone	90
Piano	82
Singing (piano accompaniment)	85
School orchestra practice	
Tutor conducting	94
Student trombones (back row)	94
Student percussion	92
Student trumpet soloist with orchestra	96
Student saxophone (back row)	91
Student clarinet (front row)	95
Student flute (front row)	98
Staff tuba	92

Table 14 Representative exposure levels measured at a college

Instrument	dB	Peak
College tuition		
Flute	93	116
Oboe	84	132
Clarinet	90	132
Alto saxophone	93	132
Tenor saxophone	95	134
Bassoon	83	120
French horn	85	129
Cornet	89	140
Trombone	91	132
Euphonium	96	131
Violin	88	120
Violin	86	126
Piano	80	126
Bass guitar	80	121

Exposure-reduction measures for employed and private instrumental teachers

- 8 Ways of reducing noise exposure include the following:
- Teaching rooms should be assessed as suitable for the purpose. The size of teaching rooms is important – it is likely that teaching in a small room will result in higher exposure levels than those in a larger auditorium where the teacher can get further away from the sound being produced. Avoid highly reverberant rooms – select an appropriate acoustic. Select rooms not by size of instrument but by how noisy they are – the players of the loudest instruments need the largest rooms. See also Sound Advice 2 ‘Venues’.
 - Acoustic treatment – use a teaching room that has been fitted with sound-absorbent materials, such as carpeting, acoustic panelling or drapes. See also Sound Advice 2.
 - Positioning when teaching – some instruments are highly directional. Teachers should avoid standing directly in the ‘line of fire’ during lessons. When possible make use of acoustic screens between the pupil and the teacher – see Appendix 7 ‘Acoustic screens’.
 - Scheduling of lessons – avoid back-to-back scheduling of lessons without ‘respite’ periods.
 - Content of lessons – it might be possible to include some instruction which does not require the student to play.
 - Teaching levels – ask the student to play at a reduced level during lessons whenever possible.
 - Avoid ‘playing along’ with student(s) to reduce overall noise levels.
 - When teaching in groups, avoid constant ‘group’ practice.
 - Wear hearing protection when necessary.

The Building Regulations

The Building Regulations set out some guidelines relating to the design of school buildings:

- Under Building Bulletin 93¹² (Requirement E4 from Part E of Schedule 1 to The Building Regulations 2000 (as amended)) ‘Each room or other space in a school building shall be designed and constructed in such a way that it has the acoustic conditions and the insulation against disturbance by noise appropriate to its intended use.’
- The Education (School Premises) Regulations 1999,¹³ which applies to both new and existing school buildings, contains a similar statement: ‘Each room or other space in a school building shall have the acoustic conditions and the insulation against disturbance by noise appropriate to its normal use.’
- Although Building Regulations do not apply to all alteration and refurbishment work, it is desirable that such work should consider acoustics and incorporate upgrading of the acoustics as appropriate.
- Section 4 of Building Bulletin 93: ‘The design of rooms for speech’ and Section 5: ‘The design of rooms for music’ give guidance on various aspects of acoustic design relevant to schools.

Look at Building Bulletin 93 on the DFES website: www.teachernet.gov.uk/acoustics.

Hearing preservation – education and training of students

- 9 As part of teaching, consider discussing the following with students:
- Type of practice rooms – encourage students to practise in rooms that have been fitted with sound-absorbent materials: carpeting, acoustic panelling, drapes etc.

- Size of practice room – encourage students to practise in larger rooms if possible. Greater space than 1.7 m² per person is desirable. Good results have been achieved by moving the loudest instruments into the largest spaces.
- Encourage students to play more quietly.
- Where sound reinforcement is used, select high-quality amplifiers used quietly.
- Take account of exposure during private practice time and also during rehearsals and performances. Encourage students to use typical dB readings to calculate their typical noise exposures to help identify the control measures needed, for example shortening the time spent on loud practising. Many conservatoire students are expected to do at least four hours of private practice over a day. In the case of brass players this would automatically push them over the upper exposure action value – either the length of the practice period should be reduced or other control measures taken. Wearing hearing protection is the last resort.
- Use technique to reduce exposure, for example, violin/viola players can reduce sound levels to their left ear by keeping their heads more upright while playing. This also encourages a good playing posture.
- Use practice mutes. There is a large amount of information on the internet about the various practice mutes available – search under ‘practice mutes’:
 - rubber practice mutes are available for stringed instruments;
 - various practice mutes are available for brass instruments. Make sure the mutes are designed to reduce output volume rather than redirect the output straight into the ear via a stethoscope simply to avoid disturbing the neighbours;
 - practice pads are available for drummers. In addition, most percussion instruments can be successfully dampened for practice purposes with pieces of cloth or foam.
- Pianists should keep tops/lids lowered during practice.
- Practise amplified instruments at the lowest possible levels. Use electronically limited headphones.
- Practise guitars acoustically rather than amplified.
- Consider ‘off-hours’ sound exposure, for example personal/car stereos, cinemas, sporting events etc.

Orchestras, brass bands, wind bands and other ensembles/vocal groups

10 Teaching duties often include conducting ensembles both in rehearsal and in performance. Refer to other parts of this book for general information about sound-reduction techniques for use in these situations. These cover:

- reduced volume during rehearsal;
- orchestral/ensemble layout;
- mixing loud and quiet repertoire;
- suitable rehearsal and performance venues;
- encouraging trumpets/trombones to raise their bells during loud passages to project their sound over the top of other performers. This should enable them to play at a lower level to produce the same effect.

11 Sound levels produced by groups of student instrumentalists are likely to be higher than those produced by a professional group of players because of less-developed technical abilities and natural exuberance. Damaging sound levels have been measured at the conductor’s position in school bands.

CASE STUDY School music department

Despite the excellent acoustics of purpose-built practice and performance facilities, music teachers at a school could be at risk of receiving excessive noise exposures.

Table 15 gives the noise levels teachers were exposed to during lessons for individual pupils and group practice at a school with excellent teaching facilities. The L_{Aeq} is the measured level when pupils were actually playing rather than the average level over the lesson. Daily exposure increases with both the level and duration of the sound. The exposure time to 80 dB $L_{EP,d}$ is the total time in the day that a teacher is hearing pupils play at the measured sound level before that teacher reaches their 80 dB daily exposure. Some teachers could reach a hazardous exposure within a single lesson.

Daily exposure will increase with listening and playing times.

The following recommendations were made:

- Lower noise levels are possible in the larger practice rooms. These should be the preferred choice for lessons on louder instruments.
- Avoid playing loudly all the time. Reduce the exposure time at hazardous levels by having a repertoire of loud and quiet pieces.
- Limit the amplification of electronic instruments.
- Use hearing protection designed for musicians in conjunction with noise controls where a risk remains.

Table 15 Noise levels to which teachers were exposed during lessons

Activity	L_{Aeq} dB	Exposure time to 80 dB $L_{EP,d}$
Leading and playing with eight-member saxophone group	93 to 95	15 to 24 minutes
Conducting brass, woodwind and percussion orchestra	94	19 minutes
Saxophone lesson	95	15 minutes
Trombone lesson	90	48 minutes
Flute lesson	89	60 minutes
Electric guitar lesson	88	75 minutes
Singing lesson	85	2.5 hours
Piano	82	5 hours
Violin lesson tutor providing piano accompaniment	Small practice room 82 Large practice room 76	5 hours Not exceeded

Classroom teaching

12 There are various methods of reducing noise levels during classroom teaching:

- When using keyboards during general class music teaching, instruct the students to maintain the lowest possible volume unless demonstrating/performing to the class. Headphones can also be used to reduce class exposure, but these should be fitted with noise limiters.
- When using percussion instruments in classroom situations, consider using softer beaters as a way of reducing noise levels, particularly in practice or rehearsal situations.
- Consider the use of hearing protection for both teachers and students to protect hearing during 'loud' lessons.
- Listen to recorded music at moderate volume.

CASE STUDY An audiologist with a role in a college of music

While my daughter was attending a music college on a singing/vocals course, I became aware that the college syllabus had no content on the safety aspects of exposure to high sound levels in the context of music tuition, and performance. The college management and tutors were very open to my offer to help them in this respect. I have a long-standing background in NHS and private audiology, with an MSc in Environmental Acoustics, a special interest in musicians' hearing protection, and past publications on noise control and hearing conservation.

Sound-level measurements in the keyboard, guitar, bass guitar and drum/percussion practice rooms at the college, confirmed routine exposures to sound levels between 93 dB and 103 dB, with the percussion peak level at over 120 dB.

It was arranged that I would meet the students and give them a presentation to cover:

- the basic anatomy and functioning of the ear and hearing system;
- an introduction to the science behind hearing and noise measurement;
- an awareness of UK and European health and safety legislation on hearing conservation matters;
- practical guidance on managing their own noise exposure from music and other sources.

The students and college staff have all proved to be very receptive to this information, effectively empowered to adopt an educated attitude to the routine use of hearing protection, and the routine scrutiny of sound levels during practice and performance. Around 75% of them report previous episodes of 'temporary threshold shift', (dull hearing), and/or tinnitus (head noises), following exposure to common levels of sound experienced when playing or listening to music.

Since 2000 this 'Hearing Awareness' lecture has been given to every new entrant in their early weeks at the college, and the staff have set an excellent example by using hearing protection themselves, reinforcing the information the students have been given, and reviewing working practices with regard to sound levels.

11 Marching bands

Civilian and military marching bands

Overview

Performance types
Position of musicians and other performers
Ceremonial parades
Band display

- 1 While this section is based on experience with military bands, it is equally applicable to all marching bands.
- 2 The singular term 'band' in this context should be understood to refer to a single body of musicians, whether from a unitary ensemble or two or more ensembles combined for a particular event (for example, massed bands performing at a major parade such as the Queen's Birthday Parade).
- 3 Table 16 represents typical noise levels to which members of marching bands are exposed.

Performance types

4 There are two types of marching band engagement, each of which places different requirements on the band in terms of volume and so requiring a different approach to control measures. The first is a ceremonial parade, in which the band is providing musical support to marching troops; the second is a band display in which the band performs as a discrete 'act' for the entertainment of an audience, either in an arena or street procession.

Position of musicians and other performers

5 Certain instruments (for example, trombones, cornets and percussion) present a greater hazard than others, both to the players and those close to them, and these instruments should be carefully positioned within the marching band. The directional brass instruments should be at the front of the band, reducing the muffling effect of other performers and so requiring less volume from the players concerned to project their sound. Trombones should be in the front rank, placing no other performer directly in line with the bell of the instrument. The maximum possible free space should be left around the bass drum and cymbals to allow for natural dissipation of the sound of these instruments. See Figure 22 for a plan of a marching band.

Table 16 Representative noise levels

Instrument	dB	Peak
Marching bands		
Piccolo	112	130
Clarinet	119	140
Alto saxophone	113	140
Tenor saxophone	115	142
French horn	111	140
Cornet	120	142
Trombone	113	145
Euphonium	113	138
Tuba	117	146
Snare drum	113	144
Cymbals (large)	121	146
Cymbals (small)	118	146
Bass drum	122	145
Drum Major	96	132
<p>Commentary</p> <p>Worst-case figures from a series of measurements taken with two professional bands at the Royal Military School of Music during September 2006.</p> <p>Taking the average exposure over a day all of the above would have been above the action values.</p>		

Ceremonial parades

6 In a ceremonial parade there needs to be enough volume from the band for all marching troops taking part to be able to hear clearly, to enable them to march in time with the music. Possible control measures include a combination of parade format and personal hearing protection.

Parade format

7 Measures that will reduce the necessary volume from an individual musician within the band include:

- placing the band at the centre of a marching column rather than at its head, reducing the distance for sound to travel to the furthest participant from the source;
- employing more than one band if the marching column is particularly long and placing them at intervals within the column;
- adjusting the format of a formal parade to reduce the distance between the band and marching troops.

Personal hearing protection

8 Where adjustments to the parade format cannot eliminate risk, personal hearing protection should be provided and used.

Band display

9 When a band is performing solely for the entertainment of an audience, either in an arena display or procession, excessive volume is not a necessity. The dynamic range employed within the performance should be maintained at a level to minimise the risk. It will be necessary to educate both performers and audiences, among whom there is often an expectation of excessive volume during marching displays.

10 The person in charge of the band(s) should assess any risk associated with the performance, including additional elements such as cannons and pyrotechnics, and employ appropriate control measures. Where the risk is beyond the immediate control of the band (for example pyrotechnics), personal hearing protection should be provided for all performers.

11 Personal hearing protection should be routinely available for both performers of the naturally louder instruments and those positioned close to them.



Figure 22 Plan of a marching band

Appendix 1

Examples of workers covered by this guidance

This list is not definitive but indicates the jobs of people working in the music and entertainment sectors that might be affected by loud noise from live or amplified music or special effects.

Acrobats and gymnasts	Actors
Aerobic instructors	Architects
Artistic directors	Audio engineers and assistants
Backline technicians	Bar staff
Child performers	Choirs
Choreographers	Classical music ensembles
Composers	Conductors
Crew	Crowd managers
Dance instructors	Dancers
Designers	Disc jockeys
Door supervisors	Engagers
Entertainers	Event organisers
Fixers	Front-of-house staff
Groups such as pop, rock, jazz, folk and country	Instrument technicians
Jazz musicians	Lighting designers
Lighting crew/engineers/technicians	Managers
Marshals	Monitor engineers
Musical directors	Musicians
Music instructors	PA providers
Pit orchestras	Opera singers
Orchestra porters	Piano technicians
Producers	Production companies
Promoters	Projectionists
Recording engineers	Refreshment staff
Riggers	Security personnel
Set designers	Singers
Sound designers	Sound engineers
Sound equipment operators/suppliers	Special effects designers/personnel
Staff (including managers, bouncers and servers)	Stage bands
Stage crew/technicians	Stage management
Stage workers (such as carpenters, props builders, electricians and welders)	Stewards
Studio owners/operators	Technical directors
Those engaged in musical education	Ushers
Venue managers/owners	Video technicians
Vocalists	Waiting staff

Appendix 2

A table of the actions required based on exposure action values compared with exposure limit values

Exposure action values and exposure limit values			
	Daily or weekly personal average noise exposure	Peak sound level	Actions
Below lower exposure action values	Less than 80 dB (A-weighted)	Less than 135 dB (C-weighted)	<ul style="list-style-type: none"> Reduce noise levels as far as reasonably practicable.
Lower exposure action values	80 dB (A-weighted) or above Cannot take the effect of hearing protection into account	135 dB (C-weighted) or above Cannot take the effect of hearing protection into account	<ul style="list-style-type: none"> Undertake risk assessment. If any employees are identified as being particularly susceptible to noise, health surveillance should be implemented. Make suitable hearing protection available. Establish a maintenance programme for equipment supplied to reduce noise risk such as noise limiters and hearing protection. Provide training.
Upper exposure action values	85 dB (A-weighted) or above Cannot take the effect of hearing protection into account	137 dB (C-weighted) or above Cannot take the effect of hearing protection into account	<ul style="list-style-type: none"> Implement the actions required by lower exposure action values (above). Establish and implement a programme of control measures. If these measures are not sufficient to reduce exposure below 85 dB then: <ul style="list-style-type: none"> suitable hearing protection must be worn; and a health surveillance programme implemented.
Exposure limit values	87 dB (A-weighted) Allowed to take hearing protection into account	140 dB (C-weighted) Allowed to take hearing protection into account	<ul style="list-style-type: none"> Must reduce to below limit values.

Appendix 3

Contracts

Using contracts to help with noise control

- 1 Contracts can help the planning process by setting out the arrangements for noise control. They have been found particularly helpful where there are several contractors working together with a producer/venue provider(s). Contracts can be useful when dealing with the specific requirements of the Noise Regulations and can form part of the overall health and safety considerations for the event/production.
- 2 A contractual approach is often more readily understood by the parties concerned as so many matters are already covered in this way – from performers' riders to equipment specifications. The contractual approach can also act as an aide-memoire. Experience shows joint meetings can often slip by because of time constraints, whereas specified contractual obligations for consultation are usually taken on board.
- 3 Including things in a contract can help principal contractors/producers to pass on relevant information to subcontractors. For example, a contract stipulating a hearing protection zone could insist that subcontractors' crews wear earmuffs.
- 4 The roles of different professionals in achieving effective noise-control measures should be clearly set out. This may be most successfully accomplished by inclusion in a contract, either within the main document or as appendices. Central to this process are professionals such as sound engineers, DJs, conductors and musical directors. The extent of their responsibilities should be clearly specified. Designated responsibilities should be appropriate to their training and experience.
- 5 For smaller-scale events, contracts may be the most direct way of ensuring noise-control issues are considered. Key points can easily form part of standard contracts for musicians. These may be of most help to those with individual contractual arrangements, particularly for short hire periods. Similarly, venue operators can include some standard points relating to their requirements from performers – for example which instruments and equipment will be brought to the performance by the performers and what, if any, control measures will be carried out by them.
- 6 In small venues a contract should help remove grey areas about who would do what and identifying what needs to be done by laying down responsibilities early on (apart from the non-transferable legal responsibilities).
- 7 Work undertaken for a client by a contractor is usually covered by a civil contract. It is good practice for health and safety requirements to be written in to such a contract. However, health and safety responsibilities are defined by criminal law and cannot be passed on from one party to another by a contract. In any client/contractor relationship, both parties will have duties under health and safety law. Similarly, if the contractor employs subcontractors to carry out some or all of the work, all parties will have some health and safety responsibilities. The extent of the responsibilities of each party will depend on the circumstances. (Extract from: *Use of contractors: A joint responsibility* INDG368.¹⁴)

CASE STUDY

One fixer expressed this view:

'When going to work in premises new to me, it would be helpful to make it part of the contract that the venue owner ensures there is a briefing re exits, hazards, fire arrangements, equipment location and to include noise issues.

'I'd like to see set out what noise-reduction features and equipment are available within the venue. They should make available noise assessments carried out by other users of the venue when performing, including what measures they took and the effectiveness of those measures. I don't want to have to chase it up but to have it as a clear part of the contract. No arguments.'

8 This appendix lists some of the considerations that could form part of an agreement. However blanket get-out clauses such as 'you must wear hearing protection at all times' should be avoided. Contracts should be tailored to the particular situation. This advice does not cover the area of contracts of employment nor is it exhaustive:

- Clarify the responsibilities, requirements and the different health and safety needs and commitments of the parties.
- Establish who will be the key person to make final decisions; this is essential where many contractors/subcontractors will be working. Ensure this information is provided to everyone who needs to know.
- Establish whether noise level measurements are to be carried out – both initial and ongoing monitoring.
- Specify who is responsible for the control of amplified sound levels.
- Establish whether limiters are set on any amplified music.
- Establish which, if any, parties would suffer financial loss if it became necessary to terminate a performance because of noise issues.
- Take account of any pyrotechnics or similar effects at an early stage and specify the requirements to meet noise risk assessment outcomes in the contracts with suppliers of the effects.
- Establish time parameters.
- Provide a summary of key tasks to be carried out.
- Establish who is responsible for ensuring that a sufficient noise risk assessment be carried out and at what time and who will implement any necessary control measures.
- Specify site meeting(s) with the relevant person(s) from the venue(s) and the producer(s) to discuss noise-control strategies.
- Specify an early meeting between relevant people from each group where several groups are due to work together. This will enable the bringing together of different assessment information and resolution of possibly conflicting needs.
- Consult with the enforcing authorities where required/appropriate.

9 Provide information such as:

- what noise-control equipment, both fixed and mobile, will be provided in the venue;
- details of measurements of sound levels in the venue taken by the venue owner;
- access to accumulated records relating to noise from other venue users including, where available, assessments of the repertoire suitable for the venue and noise-control strategies adopted;
- audience seating plans for the production;
- any known requirements/concerns/recommendations/comments made by enforcement authorities about noise issues specific to the event or the venue;

- regarding equipment: technical specifications including noise-output parameters, integration with other equipment and best positioning for performance and noise-control requirements;
- where hearing protection is identified as necessary, a specification of the type and use of hearing protection for all contractors to meet;
- anything relevant arising out of the event to the venue operator to add to databases of user assessments in the venue.

10 The implications for noise-reduction control measures could form part of all relevant contractual relationships covering such matters as:

- refurbishment/decoration contracts;
- effects of using or siting other equipment/materials;
- set designs for productions;
- putting down floor or stage coverings;
- changing furniture;
- fitting double-glazing.

11 Any such issues should be considered in conjunction with other health and safety concerns such as fire.

Appendix 4

Estimating noise exposure using the points system



Noise exposure ready-reckoner (Daily exposure)

Sound pressure level, L_{Aeq} (dB)	Duration of exposure (hours)								Total exposure points	Noise exposure $L_{EP,d}$ (dB)
	¼	½	1	2	4	8	10	12		
105	320	625	1250							
104	250	500	1000							
103	200	400	800							
102	160	320	630	1250						
101	125	250	500	1000						
100	100	200	400	800						
99	80	160	320	630	1250					3200
98	65	125	250	500	1000					2500
97	50	100	200	400	800					2000
96	40	80	160	320	630	1250				1600
95	32	65	125	250	500	1000				1250
94	25	50	100	200	400	800				1000
93	20	40	80	160	320	630				800
92	16	32	65	125	250	500	625			630
91	12	25	50	100	200	400	500	600		500
90	10	20	40	80	160	320	400	470		400
89	8	16	32	65	130	250	310	380		320
88	6	12	25	50	100	200	250	300		250
87	5	10	20	40	80	160	200	240		200
86	4	8	16	32	65	130	160	190		160
85		6	12	25	50	100	125	150		130
84		5	10	20	40	80	100	120		100
83		4	8	16	32	65	80	95		80
82			6	12	25	50	65	75		65
81			5	10	20	40	50	60		50
80			4	8	16	32	40	48		40
79				6	13	25	32	38		32
78				5	10	20	25	30		25
77					8	16	20	24		20
76					6	13	16	20		16
75					5	10	13	15		15

Instructions:

- For each task or period of noise exposure in the working day look up in the table on the left the exposure points corresponding to the sound pressure level and duration (e.g. exposure to 93 dB for 1 hour gives 80 exposure points);
- Add up the points for each task or period to give total exposure points for the day;
- Look up in the table on the right the total exposure points to find the corresponding daily noise exposure (e.g. a total exposure points for the day of 280 points gives a daily noise exposure of between 89 and 90 dB).

Figure 23 HSE's ready-reckoner for daily noise exposure



Noise exposure ready-reckoner (Weekly exposure)

Daily noise exposure, $L_{EP,d}$ (dB)	Points							Total exposure points	Weekly noise exposure $L_{EP,w}$ (dB)
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7		
95	1000	1000	1000	1000	1000	1000	1000	5000	95
94	800	800	800	800	800	800	800	4000	94
93	630	630	630	630	630	630	630	3200	93
92	500	500	500	500	500	500	500	2500	92
91	400	400	400	400	400	400	400	2000	91
90	320	320	320	320	320	320	320	1600	90
89	250	250	250	250	250	250	250	1300	89
88	200	200	200	200	200	200	200	1000	88
87	160	160	160	160	160	160	160	800	87
86	130	130	130	130	130	130	130	630	86
85	100	100	100	100	100	100	100	500	85
84	80	80	80	80	80	80	80	400	84
83	65	65	65	65	65	65	65	320	83
82	50	50	50	50	50	50	50	250	82
81	40	40	40	40	40	40	40	200	81
80	32	32	32	32	32	32	32	160	80
79	25	25	25	25	25	25	25	130	79
78	20	20	20	20	20	20	20	100	78

Instructions:

- For each working day in the week look up in the table on the left the exposure points corresponding to that day's noise exposure (e.g. a noise exposure on Day 1 of 90 dB gives 320 points);
- Add up the points for each day worked to give total exposure points for the week;
- Look up in the table on the right the total exposure points to find the corresponding weekly noise exposure (e.g. a total exposure points for the week of 2000 points gives a weekly noise exposure of 91 dB).

Figure 24 HSE's ready-reckoner for weekly noise exposure

Example one: Bar staff

1 Employees in a nightclub have a typical work pattern. They work for a total of 6 hours in the nightclub from 20:00 to 02:00 the following morning. During this shift they work:

- behind a bar for 2 hours where the noise level is 90 dB;
- collecting glasses for 2 hours where the noise level is 94 dB;
- working in the cloakroom for 90 minutes where the noise level, determined using a simple listening test, suggests a level of approximately 80 dB;
- in the staff room for 30 minutes where the noise level, determined using a simple listening test, suggests a level of approximately 80 dB.

2 The calculation of the noise exposure is shown below, based on the noise exposure ready-reckoner at www.hse.gov.uk/noise/calculator.htm:

Noise level	Duration	Notes	Exposure points
90 dB	2 hours	2 hour column and 90 dB row	80
94 dB	2 hours	2 hour column and 94 dB row	200
80 dB	2 hours	The exposure in the cloakroom and staff room are added to give a total of 2 hours	8
Total noise exposure points			288
$L_{EP,d}$			89 to 90 dB

3 This work pattern of noise exposure gives a daily exposure ($L_{EP,d}$) of between 89 and 90 dB. The priority for noise control or risk reduction is the noise exposure while working behind the bar and while collecting glasses, as these give the highest individual noise exposure points.

Example two: Weekly averaging using the HSE on-line calculator

4 Steve is a sound engineer who does an average of two shows a week. The remainder of his time is spent preparing and servicing equipment, paperwork and travel. Assessing his overall noise exposure on the basis of a single day's measurement would not be representative – it would either be too high on a show day, or too low on a warehouse day. The HSE website has both daily and weekly noise exposure calculators that allow input of sample measurements to give an average overall weekly exposure.

5 An average show day would include:

Activity	Duration	Noise level (L_{Aeq})
Travel to show	45 minutes	75 dB
Load-in and installation	2.5 hours	72 dB
System check	15 minutes	89 dB
Sound check	30 minutes	92 dB
Show	2.5 hours (inc. support act)	96 dB
Load-out and travel	1.5 hours	73 dB

6 Inputting these values into the daily exposure noise calculator (see Figure 25) gives an average personal exposure of 91 dB and an exposure point value of 436. Note the insignificance of the set-up and travel periods compared to overall exposure.

Exposure calculator				
	Noise level (L_{Aeq} dB)	Exposure duration (hours)	Exposure points (job/task)	Exposure points per hour
Job / task 1	75	0.75	1	1
Job / task 2	72	2.5	2	1
Job / task 3	89	0.25	8	31
Job / task 4	92	0.5	31	63
Job / task 5	96	2.5	393	157
Job / task 6	73	1.5	1	1
Job / task 7				
Job / task 8				
Total duration		8		
Daily noise exposure (LEP,d)		91 dB	436 points	

Figure 25 Results from daily noise exposure calculator for an average show day

7 For Steve, non-show days are usually of two types; office or warehouse. Office days present negligible noise exposure and the daily exposure is below 70 dB.

8 Warehouse days are a bit more variable and may include running sound systems to check components, using a compressor for spray painting and so on. If the same daily exposure process is adopted for a representative warehouse day, this gives the following figures:

Activity	Duration	Noise level (L_{Aeq})
Stock check and equipment preparation	3.5 hours	68 dB
Loading/unloading vehicles	1.5 hours	78 dB
System operation check	15 minutes	92 dB
General admin and office	2.75 hours	65 dB
Use of spray booth	30 minutes	83 dB

9 Inputting these values into the daily exposure noise calculator gives an average personal exposure of 79 dB and an exposure point value of 25 (see Figure 26).

Exposure calculator				
	Noise level (L_{Aeq} dB)	Exposure duration (hours)	Exposure points (job/task)	Exposure points per hour
Job / task 1	68	3.5	1	0
Job / task 2	78	1.5	4	2
Job / task 3	92	0.25	16	63
Job / task 4	65	2.75	0	0
Job / task 5	83	0.5	4	8
Job / task 6				
Job / task 7				
Job / task 8				
Total duration		8.5		
Daily noise exposure ($L_{EP,d}$)		79 dB	25 points	

Figure 26 Results from daily noise exposure calculator for warehouse day

10 To establish a representative weekly exposure, take these three exposure patterns and add them into the weekly exposure calculator. Steve does two shows and two warehouse days a week, and one office-only day.

11 Inputting these values into the weekly exposure noise calculator gives an average personal exposure of 87 dB (see Figure 27).

12 The results show that even with two relatively quiet warehouse days and one 'very quiet' office-only day, Steve's exposure is 87 dB; this is above the upper exposure action value. The dose he receives on show days is the most significant.

13 For a freelance musician example see Sound Advice 1 'Freelancers'.

Weekly noise exposure calculator	
	Daily exposure ($L_{EP,d}$ dB)
Day 1	91
Day 2	91
Day 3	79
Day 4	79
Day 5	70
Day 6	
Day 7	
Day 8	
$L_{EP,w}$	87 dB

Figure 27 Results from weekly noise exposure calculator

Appendix 5

Measuring noise

1 This Appendix gives a brief overview of the techniques used to measure noise. It is aimed at providing supporting information rather than as a guide to competency. Fuller information can be found in L108. Noise measurements should be carried out by someone who is 'competent', with the relevant skills, knowledge and experience to undertake measurements in the particular working environment. Noise-measuring equipment generally involves the use of a meter incorporating a microphone and a method of recording the noise levels. The exact type and how it is used will depend on what is being measured and why.

Establishing personal noise exposure

2 Determining personal noise exposure depends on knowing the noise levels that a person is exposed to, and how long they are exposed to these levels. When making noise measurements the aim is to establish the noise at the position occupied by the head of the person whose exposure is being evaluated.

Hand-held sound-level meters

3 One method is the use of a hand-held sound-level meter. This is most suited to making sample noise measurements at the position of a person's head. Where noise sources are distinct and close to the subject, such as playing of musical instruments, it is particularly important to choose an appropriate measurement position. Where the measurement is made at the side of a person's head, it should be made on the side where noise levels are higher. Where a person is working in an area with a broader diffuse noise source then the measuring position is not so critical, as it is the noise level in the area into which the person is entering that is being measured, such as an area in front of a stage at an outdoor event. In this case taking an average noise measurement over the area may be appropriate.

Personal dosimeters

4 Another method is the use of dosimeters. These have the advantage of being able to measure noise over prolonged periods of time, even the full working day. Various types are in use but all of them will have a microphone that can be mounted on the shoulder, to make a representative measurement of noise at the head position. The microphone should be placed on the side of the head most exposed to noise. Elevated noise levels will be recorded where dosimeters are mistreated. They can be prone to errors by accidentally knocking, rubbing or covering the microphone, so employers need to be sure that the levels recorded reflect the working conditions. They often allow a visual record of noise levels over time to be produced, so can help to understand the dominant sources of noise exposure for people who are exposed to various noise sources during the day.

Fixed monitoring

5 This is often used by employers to monitor noise levels in a specific area where previous investigations have established a level that should not be exceeded. A microphone will be installed at a point that has been identified as being important for monitoring and the information relayed to a metering point that can be seen by a duty manager. This is useful in clubs and pubs where bands bring in their own equipment. Noise limiters with feedback systems (see Sound Advice 5 'Pubs and clubs') are a variation on this theme.

Appendix 6

Risers

1 Risers are platforms, sometimes called rostrums or rostra, used to raise musicians so that the sound from their instruments is not aimed directly into the ears of musicians in front (or behind in the case of French horns). Typically risers are used to elevate the brass section and woodwind sections but they may be useful for other musicians such as percussion and choirs. Wind instrument players will generally not have to work so hard to produce their sound if risers are used.

2 The height of risers should be adjusted to suit particular performers. If, for example, a trumpet player habitually performs with bell down, putting the trumpeter on a riser could make matters worse by causing the noise to be aimed directly at the ears of the musician in front. (In this case staggering the layout so that the sound of the trumpet is directed between the torsos of the musicians in front may help.) Experimenting is usually necessary to decide the most suitable heights of risers in the particular circumstances.

3 A height of 50 cm is often regarded as a good starting level. When using risers, make sure that there is still good headroom and that the performers are not too close to the ceiling. Wherever possible there should be between 2.5 m and 3.5 m between the riser and any overhanging ceiling.

4 The edges of risers should be marked. Access to risers must be safe and suitable. Guardrails or other protection is needed at the rear of risers to stop people, instruments and equipment falling off the edge.

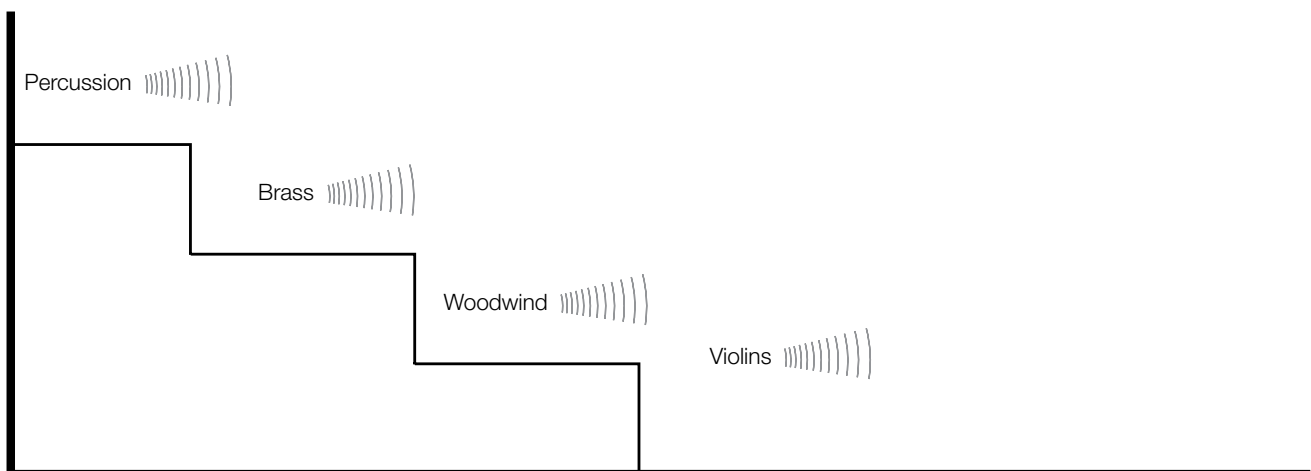


Figure 28 The effect of risers

Appendix 7

Acoustic screens

Use of screens

1 Acoustic screens should only be used in accordance with the risk assessment and on a collective basis as determined by a person who is competent. It is essential that screens are carefully sited to ensure that they do not create a secondary problem of reflected sound for players close by. Screens should be as large as possible, and extend vertically as far as possible. The application of absorption to them helps control sound levels.

2 Proper training is essential on the choice and use of acoustic screens. Extreme care is needed in positioning screens. Experimenting is usually necessary to achieve the best result.

3 Large screens may help to isolate percussion sections, other noisy instruments and loudspeakers from other performers. However they need enough room to be effective and can reflect sound back at performers seated behind them unless arranged so as not to increase the sound levels for these performers. Large screens may produce distortion and make it difficult for the performer to hear other instruments. In most environments, it may be necessary to include vision panels in screens unless the screens themselves are transparent.

4 Screens should not be regarded as personal protective equipment as they can double the noise exposure of the player to the rear, as well as increasing the risk of an over-playing injury. The protection afforded to the player in front may prove to be more psychological than acoustic although this may be worthwhile where the risks of hyperacusis or stress are significant.

5 Acoustic screens can provide some protection to individual players from noisy sections in orchestral layouts. However screens are not useful to all sections of an orchestra, for example horns, and can sometimes cause sound to reflect back to the performer.

6 In amplified music environments, the strategic positioning of appropriate absorbent screens can provide significant protection. Where the sound is amplified and performers are using monitors, drum kits should be mic'd and located in booths where possible. Alternatively place a large screen in front or behind the drum kit (where vision is required, this could be transparent) to help isolate the drummer's sound from the rest of the performers.

7 In film-set environments, the use of appropriate absorbent screens positioned out of shot can be used as protection during loud activities.

Personal screens

8 Individual acoustic screens can be located around players to help protect them from high sound levels produced nearby. Individual acoustic screens are most effective if placed near to a performer's head and used in accordance with the manufacturer's instructions. The indiscriminate use of personal screens can actually increase the noise exposure for others so screens should be introduced in a considered manner. It is not acceptable to slightly reduce a medium risk (for example, to the performer in front of a screen) by doubling a high risk to the musician playing into the screen (which reflects sound back at the musician).

Potential problems

9 Employers need to take into account potential problems if they are considering installing screens, for example:

- Lack of room.
- Screens can reflect sound back at the performers seated behind nearby.
- Screens may produce distortion.
- Screens may make it difficult for performers to hear other instruments.

Types

10 There are two main screen constructions: these are hard (acoustically reflective) and soft (acoustically absorbent). There is a hybrid third type that combines the hard and soft types.

11 Hard screens are commonly made from plastic or similar transparent material to maintain visual contact.

12 Soft screens comprise an acoustically absorbent material (mineral fibre, foam, foils etc) mounted on a panel and covered in a decorative finish.

13 Screens can be relatively small and discretely placed to deal with localised specific issues. Studio screens are usually 2 m or so high, and can be used to form enclosures.



Figure 29 Local reflective screen

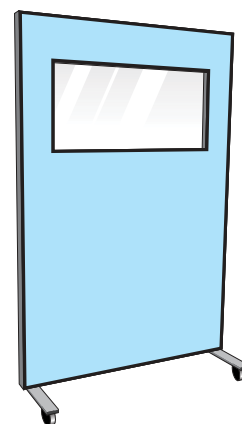


Figure 30 Absorbent 2 m high screen



Figure 31 Perspex drum screens



Figure 32 Small stand screen

Appendix 8

In-ear monitors

1 Additional information to that referred to in Sound Advice 4 'Rock and pop' paragraphs 24 and 25 on in-ear monitors (IEMs) is provided below:

Advantages

- Help towards a very quiet stage environment with benefits of clarity, controllability and comfort.
- Custom-moulded earplug protects against undesired background sound.
- Belt-clip transmitter-receiver feeds direct signal into ears, eliminating need for on-stage monitors and reducing on-stage sound levels.
- Wireless transmitter-receiver provides freedom of movement.
- Smaller and lighter than headphone monitors.

Disadvantages

- More expensive than headphones.
- Training essential.
- Dangerous unless limited.
- May not be suitable with some medical conditions.

Useful for

- Reduction of noise exposure during live music performances.
- Personalised monitoring.

2 IEMs are essentially earplugs with built-in miniature monitor speakers. IEMs receive an audio signal from a wireless transmitter-receiver system to earplugs moulded to the shape of the user's ear canals. Less expensive IEMs may use 'ear buds' rather than custom-moulded plugs but these should never be used for hearing protection because the earpieces do not fit snugly and so will let in more outside sound, which leads in turn to higher, rather than lower, monitor levels.

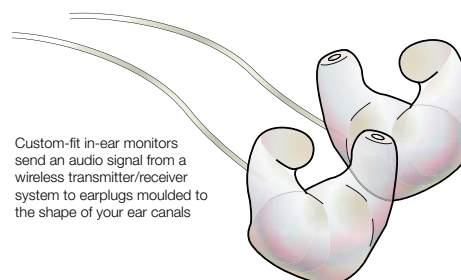


Figure 33 Custom-fit in-ear monitors

3 In-ear monitors intended to provide hearing protection must comply with BS EN 352-2¹⁵ and any other appropriate parts. This will ensure that IEMs provide hearing protection from ambient sources and provide noise limitation of the signal received from the communication system. Custom-moulded earplugs need to fit tightly beyond the second bend in the ear canal or they will not keep out all background sound. An improper fit could cause the user to turn the IEMs up to overcome the undesired background sound unless a noise limiter is fitted. It is essential that IEMs are fitted with noise limiters to reduce the risk of damaging sound levels being delivered to the wearer.

4 Training in how to use IEMs is essential to avoid turning a potential benefit into a hazard. It is essential that users keep the volume down to a reasonable level rather than turning it up because they like it loud. The systems require planning, set-up and a moderate initial investment, but if used effectively the benefits outweigh the costs.

Appendix 9

Click tracks and headphones

Click tracks

1 Avoid overusing click tracks. They should be electronically limited. Keep the number of users to a minimum as not everyone in a section may need to hear the track. When using single monaural headphones, consider alternating the earpiece from one ear to the other occasionally, dividing exposure between both ears. Individual user-volume controls for each set of headphones should be provided.

2 It may be possible to avoid the use of click tracks, for example by providing pulse mats. Experimentation with pulsed cue lights proved unsuccessful and this system is not advised.

Headphones

3 This advice mainly relates to the general use of headphones. For the use of headphones as hearing protection see paragraphs 7-9 below.

4 If headphones are used, the tendency is to generate in-ear noise levels louder than those in the venue. To counteract this it is sensible only to use headphones provided with limiters. In particular in-ear headphones (buds) such as provided with MP3 players should be used with extreme care and only if equipped with limiters. Most commercially available headphones with limiters are currently set at 93 dB. Other limits are possible. Advice should be sought on how long they can be used for. It is good practice to check all types of limited headphones annually to make sure the limiter is working properly.

5 The advantages and disadvantages of headphones are:

Advantages

- Allow a very quiet stage environment.
- Easier to slip on and off than in-ear monitors.
- Do not require custom-fitting.
- Noise-cancellation models help block out background sound.

Disadvantages

- Heavier and more obtrusive than in-ear monitors.
- Many noise-cancellation models create a feeling of 'fullness' in the ears.
- Expensive.
- Dangerous unless limited.

Useful for

- Studio applications (musicians, vocalists, and sound engineers).
- Live applications (DJs and sound engineers).
- Live-performance communication purposes.
- Low-ambient-noise environments (areas where the daily noise exposure is below 85 dB).

6 Most headphones offer no or little protection from ambient noise.

7 The only type of headphone that can be defined as a hearing protector is one incorporated into an earmuff.

8 Headphones that comply with BS EN 352-1¹⁶ provide hearing protection from ambient sources but do not provide limitation of the signal received from the communication system unless noise limiters are fitted. Headphones that also comply with BS EN 352-6⁸ provide noise limitation of the signal received from the communication system. It is strongly recommended that headphones be fitted with noise limiters to reduce the risk of damaging sound levels being delivered direct to the wearer's ears.

9 Headphones can incorporate a combination of active and passive protection as well as signal-limiting capabilities (sound conveyed electronically) to afford optimum protection with ease of operation. Both active and passive protection is highly desirable as otherwise there is a risk that the in-ear noise levels may be louder than those in the venue because the wearer will receive both the ambient noise and the electronically communicated noise.

Good working practice

10 A list of suggestions for good working practice for headphone users in the music and entertainment industry is given below:

- Headphones should not be shared. Where this cannot be avoided, users should be given their own ear pads and voice tubes.
- Headphones should be fully adjustable and well-maintained.
- Headphones or associated equipment should incorporate an adjustable volume control that enables the user to listen to incoming signals at a comfortable level.
- Headphones should be cleaned regularly. Foam pads can be washed, wiping cables prevents them from becoming brittle, and cleaning voice tubes (which can become blocked with food, dust and make-up) ensures the level of transmitted signals remains audible.
- Users should be allowed time to make adjustments to their equipment, and to clean and maintain it.
- Users should receive regular training that includes how to use the headphones and associated equipment, any volume-control features and why adjustment of the listening level through the headphones is important, and the importance of regular cleaning and maintenance.
- Reducing ambient noise levels will enable headphone users to keep listening levels as low as possible.

References

- 1 *The Control of Noise at Work Regulations 2005* SI 2005 No 1643 The Stationery Office 2005 ISBN 978 0 11 072984 8 (also available from www.opsi.gov.uk)
- 2 *Controlling noise at work. The Control of Noise at Work Regulations 2005. Guidance on Regulations L108* (Second edition) HSE Books 2005 ISBN 978 0 7176 6164 0
- 3 *The event safety guide: A guide to health, safety and welfare at music and similar events* HSG195 (Second edition) HSE Books 1999 ISBN 978 0 7176 2453 9
- 4 *Management of health and safety at work. Management of Health and Safety at Work Regulations 1999. Approved Code of Practice and guidance L21* (Second edition) HSE Books 2000 ISBN 978 0 7176 2488 1
- 5 *The Work at Height Regulations 2005 (as amended): A brief guide* Leaflet INDG401(rev1) HSE Books 2007 (single copy free or priced packs of 10 ISBN 978 0 7176 6231 9) www.hse.gov.uk/pubns/indg401.pdf
- 6 BS EN 352 Parts 1-8 *Hearing protectors. Safety requirements and testing* British Standards Institution (see other references and 'Further reading' for full details)
- 7 *Protect your hearing or lose it!* Pocket card INDG363(rev1) HSE Books 2005 (single copy free or priced packs of 25 ISBN 978 0 7176 6166 4) www.hse.gov.uk/pubns/indg363.pdf
- 8 BS EN 352-6: 2002 *Hearing protectors. Safety requirements and testing. Ear-muffs with electrical audio input* British Standards Institution
- 9 BS EN 352-8:2008 *Hearing protectors. Safety requirements and testing. Entertainment audio ear-muffs* British Standards Institution
- 10 *Prevention of risks from occupational noise in practice* European Agency for Safety and Health at Work 2005 ISBN 978 92 9191 153 0. Download from <http://osha.europa.eu/publications/reports/6905812>
- 11 *A sound ear II: The Control of Noise at Work Regulations 2005 and their impact on orchestras* Association of British Orchestras 2008. Download from www.abo.org.uk
- 12 *The Building Regulations 2000 (as amended) Building Bulletin 93 Acoustic design of schools*. View at www.teachernet.gov.uk/acoustics
- 13 *The Education (School Premises) Regulations 1999* SI 1999 No 2 The Stationery Office 1999 ISBN 978 0 11 080331 9 (also available from www.opsi.gov.uk)
- 14 *Use of contractors: A joint responsibility* Leaflet INDG368 HSE Books 2002 (single copy free or priced packs of 10 ISBN 978 0 7176 2566 6) www.hse.gov.uk/pubns/indg368.pdf
- 15 BS EN 352-2:2002 *Hearing protectors. Safety requirements and testing. Ear-plugs* British Standards Institution

16 BS EN 352-1:2002 *Hearing protectors. Safety requirements and testing. Ear-muffs* British Standards Institution

Further reading

BS EN 352-3:2002 *Hearing protectors. Safety requirements and testing. Ear-muffs attached to an industrial safety helmet* British Standards Institution

BS EN 352-4:2001 *Hearing protectors. Safety requirements and testing. Level-dependent ear-muffs* British Standards Institution

BS EN 352-5:2002 *Hearing protectors. Safety requirements and testing. Active noise reduction ear-muffs* British Standards Institution

BS EN 352-7:2002 *Hearing protectors. Safety requirements and testing. Level-dependent ear-plugs* British Standards Institution

BS EN 458:2004 *Hearing protectors. Recommendations for selection, use, care and maintenance. Guidance document* British Standards Institution

Control of noise in the music entertainment industry. Code of practice Worksafe Western Australia Commission 2003 www.docep.wa.gov.au/worksafe

Health surveillance at work HSG61 (Second edition)
HSE Books 1999 ISBN 978 0 7176 1705 0

Hear the music: Hearing loss prevention for musicians
Dr Marshall Chasin 2006. Available from www.westone.com

Listen while you work: Hearing conservation for the arts for performers and other workers in art and entertainment Safety & Health in Arts Production & Entertainment (SHAPE), Canada 2001 ISBN 978 0 7726 4643 9
www.shape.bc.ca/resources/pdf/listen.pdf

Noise at work: Guidance for employers on the Control of Noise at Work Regulations 2005 Leaflet INDG362(rev1) HSE Books 2005 (single copy free or priced packs of 10 ISBN 978 0 7176 6165 7) www.hse.gov.uk/pubns/indg362.pdf

Noise levels and noise exposure of workers in pubs and clubs: A review of the literature RR026 HSE Books 2002 ISBN 978 0 7176 2571 0

Personal protective equipment at work (Second edition). Personal Protective Equipment at Work Regulations 1992 (as amended). Guidance on Regulations L25 (Second edition) HSE Books 2005 ISBN 978 0 7176 6139 8

Sound Advice website – <http://soundadvice.info>

Glossary and useful information

ABO Association of British Orchestras.

Action values see 'Exposure action values'.

Backline Collection of musical instruments and their direct amplification on stage.

Bone conduction Transmission of sound signals through the bones of the skull. The signal is directed straight into the inner part of the ear, bypassing the middle and outer parts of the ear.

BS British Standard.

BS EN European Standard adopted as a British Standard.

Click track Backing or metronome track that is played back to musicians (normally through headphones) to enable them to keep accurate time. It is common for situations where drummers have to keep time with a pre-recorded or sequenced track.

Competent People having such practical and theoretical knowledge and such experience as is necessary to carry out the work. Need to be aware of the limits of their expertise and knowledge and sufficiently independent and impartial to allow them to make objective decisions. Do not necessarily need to be employed by an independent company, but in-house personnel must have enough authority and independence to be able to make necessary decisions and recommendations.

Cue lights A means of indicating to performers when to start and stop, using a (typically green) lamp.

Diplacusic Condition where the two ears hear a given pitch as two distinct tones.

Distributed sound system Technical term for a sound reproduction/reinforcement system that uses a number of smaller loudspeaker enclosures placed around the venue rather than one or two large stacks at the side of the stage. This reduces the sound level from individual speakers while achieving an even overall spread of sound at an acceptable level for listeners.

Engager/Contractor In the entertainment industry employers are often known as engagers or contractors. Other terms used, which may or may not imply employment, include producers, promoters, managers and fixers.

Exposure action values (EAV) Levels of exposure to noise at which certain actions need to be taken. The values are:

- lower exposure action values (LEAV):
 - daily or weekly exposure of 80 dB;
 - peak sound pressure of 135 dB;
- upper exposure action values (UEAV):
 - daily or weekly exposure of 85 dB;
 - peak sound pressure of 137 dB.

Exposure limit values (ELV) These relate to personal exposure to noise and must not be exceeded:

- daily or weekly exposure of 87 dB;
- peak sound pressure of 140 dB.

Fold-back monitors Loudspeakers sited near performers to allow them to hear specific sounds which would otherwise be too quiet, for example for a singer on stage to hear a pit orchestra. Includes on-stage monitors and side fills.

Freelancer Someone who is not permanently employed full-time by any one employer. A freelancer may go through periods of self-employment or be employed by more than one employer.

Frequency analysis The breakdown of sound into discrete component frequencies, measured in Hertz and usually grouped in bands or octaves. Appropriate for selecting suitable hearing protection and designing acoustic control measures.

Health record Record of the person's details, work assignments and exposures, dates of any health surveillance procedures and information on the person's fitness to work in noisy environments. The record does not contain clinical details and must be kept by the employer. It is not a confidential document.

Health surveillance For the purposes of this document, ongoing assessment of the state of aural health of an employee as related to exposure to noise.

Hearing Passport Includes details of training and health surveillance undertaken (for more information see Musicians' Hearing Services).

Hearing protection zones (sometimes referred to as HPZ) Areas where the wearing of hearing protection is compulsory. Wherever practicable all such zones should be signed using the sign shown. Signs introduced under the Noise at Work Regulations 1989 which refer to ear protection zones are also acceptable.

Hyperacusis Increased sensitivity to sound which may cause discomfort or physical pain.

Hz Hertz, SI unit of frequency. The human ear can detect frequencies between 10 and 20 000 Hz.

In-ear monitors Essentially earplugs with built-in miniature monitors (loudspeakers). It is essential that they are fitted with noise limiters.

L_{Aeq} The 'equivalent' continuous noise level that would deliver the same noise dose as a varying level over a given period, and is a good way of describing the average level of noise.

$L_{EP,d}$ Daily personal noise exposure level. It is averaged over an 8-hour period rather than the actual time in the work environment.

$L_{EP,w}$ Weekly personal noise exposure level. It is averaged over a period of 5 days (40 hours) by measuring the noise exposure on each of 7 days, then dividing the result by 5.

Limit values See 'Exposure limit values'.

Line array systems Sometimes known as phase array design. A vertical hang of loudspeakers which generates a cylindrical wave front with a better throw and accurate control of off-axis sound. This can mean that levels at the front of a venue do not need to be so loud to reach the back.

Medical record Account of a person's examination and treatment including their medical history, any medication, therapies and referrals. An individual may have more than one medical record. The medical record for hearing health surveillance will contain the hearing health questionnaire, the ear examination, the audiogram and any referral correspondence. It is kept by the doctor or occupational health professional in charge of the health surveillance programme. Medical records are confidential and may not be shown to the employer without the written consent of the individual.

Monitors See 'Fold-back monitors'.

Musicians' Union 60-62 Clapham Road, London
SW9 0JJ. Tel: 020 7582 5566 www.musiciansunion.org.uk.

Musicians' Hearing Services (MHS) An organisation set up to look after musicians' hearing. They will assess hearing, give advice on hearing conservation and supply custom-moulded musicians' hearing protection. They have a long-standing relationship with the music industry and offer a service not only to musicians but to all performers. Tel: 020 7323 2076 or www.musicianshearingservices.co.uk.

Noise dose See 'Noise exposure'.

Noise exposure 'The noise dose', which can be calculated, takes account of the actual volume of sound and how long it continues. Noise exposure is not the same as sound level, which is the level of noise measured at a particular moment.

Noise limiters Sometimes known as volume regulatory device (VRD), controls noise exposure from amplified music. Modern noise limiters can be fitted with anti-tamper relays connected to external switches to improve system security.

Noise measurements Decibels (dB) are used for measuring noise. A-weighting is used to approximate to the frequency responses of the human ear. C-weighting is used to measure peak, impact or explosive noise.

Occlusion effect Occurs when an object (like an unvented earplug) completely fills the outer portion of the ear canal. This changes the way sounds are produced in the ear canal, especially noises produced by the body (for example breathing, swallowing and noise travelling through bone and tissue). The result is these noises appear louder.

Orchestra pit In a theatre, an area in which the orchestra performs at a lower level in front of, and usually partially under, the stage.

PA Public address system. Sometimes called a 'tannoy'. Often used to refer to any loudspeaker transmitting messages rather than music.

Peak values See 'Exposure action values' and 'Exposure limit values'.

Pulse mat An electro-mechanical mat that pulses in time with an applied signal, typically a click track.

Reference position Standard location, usually static, selected to enable monitoring of noise levels to be conducted by measurements.

Risers Rostra or platforms.

RNID Royal National Institute for Deaf and Hard of Hearing People, 19-23 Featherstone Street, London EC1 8SL Tel: 0808 808 0123 Information: 0870 6050 123 www.breakingthesoundbarrier.org.uk/home. They also offer a telephone hearing test on 0845 600 5555.

Seating rotation The amount of exposure to noise depends on where the musician sits and plays within the orchestra/band. The noise exposure of musicians may be varied by moving them.

Shakers (or thumpers) An attachment that fits directly to the drum stool and transmits low-frequency vibration – giving the player the right ‘feel’ without the need for high-volume bass speakers, effectively a loudspeaker without a cone. They allow performers to use hearing protection and monitor their performance while still maintaining contact with their instruments.

Simple listening checks An easy way of establishing whether there might be a noise problem. Where it is difficult to hold a normal conversation without shouting or where there is live amplified music (as in a pub, club or pop concert) it is probable that the noise is above the lower exposure action value.

Single number rating (SNR) value Method of indicating the degree of protection offered by a hearing protector.

Sound restoration Device in earmuffs that reduces ambient noise levels to allow relayed communication or other signals at a reduced level.

Stage pit In large pop concert stages and outdoor events, an area in front of the stage formed by the edge of the stage and a barrier a few metres away, which restrains the crowd.

Three-decibel rule The sound intensity doubles with every three dB increase. Thus sounds at 88 dB are actually twice as intense as they are at 85 dB and 115 dB is 1000 times as intense as 85 dB.

Tinnitus Buzzing, ringing or tone in the ear. Temporary tinnitus is a warning; a sign that ‘you got away with it that time’.

VRD Volume regulatory device (see noise limiter).

Further information

For information about health and safety ring HSE's Infoline Tel: 0845 345 0055
Fax: 0845 408 9566 Textphone: 0845 408 9577 e-mail: hse.infoline@natbrit.com or
write to HSE Information Services, Caerphilly Business Park, Caerphilly CF83 3GG.

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