NO NEED TO SHOUT!

A GUIDE FOR THE

FOOTWEAR & LEATHER INDUSTRIES

This guide (based on new legislation) will inform you about the dangers from noise and what to do to reduce the risks of hearing damage, deafness and other problems caused by noise.

bfa
british footwear association

Community
THE UNION FOR LIFE

BLC
Leather Technology Centre

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SECTION 1. INTRODUCTION

YOU WHAT?

"It was only after I had been out of the footwear industry for some 15 years that I discovered I had a serious hearing problem. I had to have the TV volume turned up all the time. I could not hear the telephones ringing and, in particular, children's voices. You don't realise your hearing has gone until it is too late".

THE PROBLEM

Noise is probably the most widespread and underestimated of industrial hazards. There is a hundred years' worth of knowledge that workplace noise can cause deafness and associated conditions such as tinnitus (ringing in the ears). Despite this, current Health and Safety Executive figures suggest that at least 1.3 million employees are exposed to noise levels that can cause permanent noise-induced hearing loss.

Furthermore, the HSE recently published survey on self-reported work-related illness suggests that there are currently 170,000 people suffering deafness, tinnitus and other ear conditions, caused or made worse by work.

EFFECTS OF NOISE ON HEARING

High noise levels tire the ears, whereas a quiet spell rests the ears and allows them to return to normal. This time to return to normal however depends on how loud the noise was and how long the exposure lasted. These two aspects are linked and the combination is known as "noise dose". Consequently, damage can occur if too little time elapses between doses.

OCCUPATIONAL DEAFNESS

There is a risk of hearing damage from exposures upwards of 80 dB(A).

As a rule of thumb, if you cannot hear a normal conversation clearly when you are two metres away from the speaker, the noise level is likely to be around

85 dB(A) or higher.

If you cannot hear someone clearly when you are about one metre away, the level is likely to be around 90 dB(A) or higher.

Too much loud noise damages hearing by causing:

- Temporary and permanent hearing loss
- Permanent tinnitus (ringing in the ear)
- Hyperacusis (the person with noise damaged hearing who has to ask people to speak up and when they do, has to tell them not to shout). Hyperacusis also distorts common sounds.

OTHER EFFECTS

Even a slight impairment of hearing may result in a significant and irreversible reduction in the quality of life. Hearing loss cuts its victim off from other people, social interaction becomes more and more of a strain and family life becomes difficult.

It may mean having to turn up the television, or having to drop out of a conversation with friends.

Besides causing temporary or permanent hearing loss, noise can also be a safety hazard. Most obviously, noise interferes with verbal communications leading to errors and failures to respond to warning sounds and shouts.

This is, of course, made worse where individuals have got used to noise as a result of temporary or permanent hearing loss. Such deafness cannot only affect workplace safety, but may affect the safety of the individual outside the workplace.

High noise levels also produce stress, by triggering bodily reactions, designed to prepare the body to deal with crisis situations.

Noise can also affect work performance, in particular delicate tasks requiring concentration. This in turn can further contribute to stress and errors which may have safety implications.

SCALE OF NOISE-INDUCED DEAFNESS

How do you know there is a problem?

The number of people in Great Britain suffering from hearing difficulties, as a result of exposure to noise at work, was estimated at 509,000 by a Medical Research Council (MRC) survey in 1997 – 98.

The estimated number of cases of hearing loss seen for the first time in 2003 by occupational and audiological physicians in the Occupational Surveillance Scheme for Audiologists reporting scheme was 322, increased from 219 in 2002.

Although other industries may have greater noise problems, **there are sectors within the footwear and leather industries where hazardous noise levels could be encountered.**

NOISE - HEALTH WARNING!

Fact: If you are exposed to a loud enough noise, for long enough, you will lose some hearing or even go deaf.

How do we measure noise?

We use a unit called a DECIBEL (dB). In very simple terms this is a measure of the volume of noise but because the human ear 'hears' differently at each pitch we use what is called a weighted measurement (dB(A)) to more closely represent the effect noise has on your ears.

The scale used to measure noise is what is known as a logarithmic scale (see figure 1).

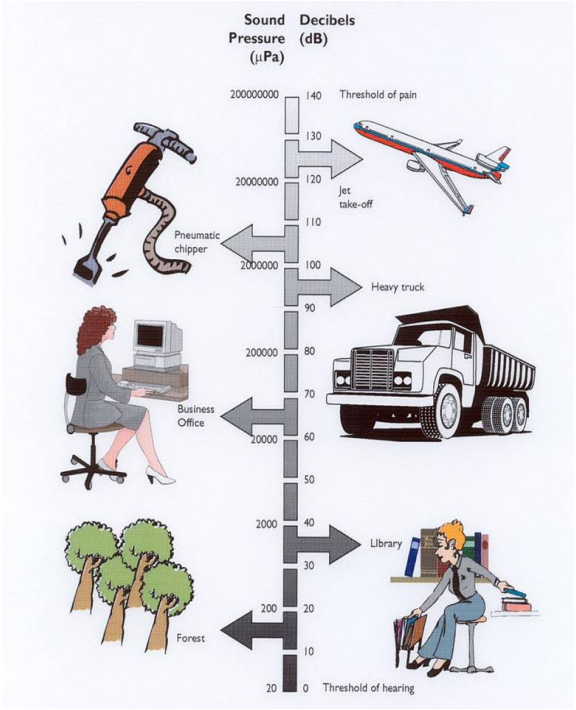
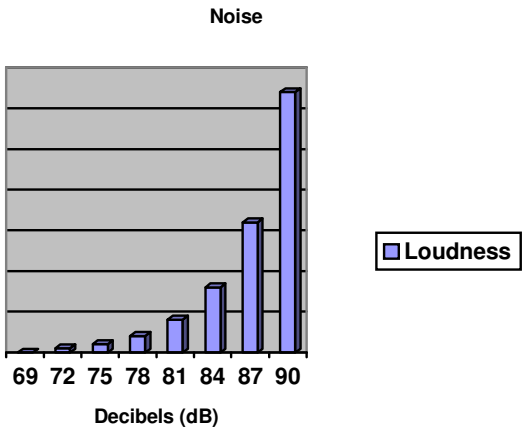


Figure 1. The Decibel scale for noise measurement

An increase of 3 dB(A) would cause the noise level to double.

The new legislation requires a reduction in levels by 5dB(A) which is quite significant – in fact it is something like 3 times quieter.



You will hear all sorts of terms – Leq, Max A-weighted etc. but what you really need to know is that the quieter a noise is the longer you can safely be exposed to it without causing permanent harm.

GLOSSARY OF KEY TERMS/DEFINITIONS

Term	Definition
L_{eq}	The steady equivalent continuous sound level which contains the same sound energy as the continuously varying sound level over the same sample period.
$L_{EX,8}$	Daily or weekly noise exposure level taken over an 8-hour reference period or a nominal week of five eight-hour working days respectively. Refer to international standard ISO 1999:1990.
Octave bands	Define frequency of sound in terms of a bandwidth.
Octave band analysis	Equivalent continuous sound level (L_{eq}) measured within a particular frequency band
"A" weighting	Sound pressure level curve that follows the hearing characteristic of the human ear.
Pa	Pascal unit of sound pressure.
PPE	Personal protective equipment for hearing protection.

TYPICAL NOISE LEVELS IN SHOE & LEATHER PRODUCTION

Operation	dB (A) Leq
Clicking	77 to 83
Closing	77 to 87
Eyeletting	89 to 93
Upper roughing	84 to 94
Welt sewing	90 to 100
Rough rounding	90 to 95
Sole stitching	88 to 91
Fleshing machine	82 to 88
Effluent treatment plant (centrifuges, blowers)	88 to 93
Fork lift truck	87 to 91
Mobile pressure washer	83 to 94
Compressors	86 to 91
Setting machine	88 to 91
Staking machine	83 to 90
Carlessi drier	82 to 88

These values are taken from historical surveys in the industries. In individual factories, the noise levels will be dependant on a variety of environmental factors.

SECTION 2.

CHANGES TO THE LAW AND COMPANY DUTIES

New European Directive on Noise

A European Directive has been adopted which means that we must introduce new UK noise regulations by April 2006.

Directive 2003/10/EC on the minimum health and safety requirements regarding exposure of workers to the risks arising from physical agents (noise), was adopted on 9 December 2002 and came into force on 15 February 2003. The Directive tightens the legal requirements in relation to noise by lowering the exposure action values to 80 and 85 dB(A).

The New Control of Noise at Work Regulations 2005 were agreed by the Minister, and were made on 18 June 2005 and laid in Parliament on 28 June 2005, The Regulations are now expected to come into force on 6 April 2006."

This directive introduces a number of additional requirements on employers compared to the original legislation and these are summarised in Appendix 1. However there are three noise values that need to be understood in implementing the new directive.

Exposure limit value 87 dB(A)
Absolute maximum at ear including hearing protection (No requirement for this in 1986 directive)

Upper exposure action value 85 dB(A) $L_{ep,d}$*
Mandatory wearing of hearing protection (1986 Second action level – 90 dB(A) $L_{ep,d}$)*

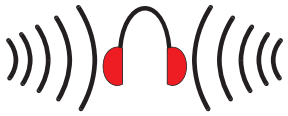
Lower exposure action value 80 dB(A) $L_{ep,d}$*
Advisory wearing of hearing protection (1986 First action level – 85dB(A)
*$L_{ep,d}$ $L_{ex,8}$stand for "the daily personal noise exposure"

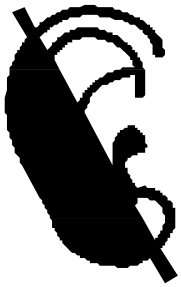
NOW HEAR THIS! NOISE, THE LAW AND YOU

- Assess and keep a record of noise exposure – have you made a recent survey of noise levels in your factory – does it reflect the current conditions?
- Do you have a programme for noise reduction? See "SOUND SOLUTIONS", Section 4.
- When you buy new machinery, suppliers **must** provide information on noise emissions. Make sure you receive this.
- Identify hearing protection zones – have you marked all areas where ear protectors **must** be provided and worn?
- Provide suitable hearing protection – have you checked that they are suitable for the range of noise and are acceptable to the wearers?
- Maintain equipment – are machines and ancillary equipment maintained and serviced to keep noise levels at a minimum?
- Do you have a maintenance programme – does it include the acoustic equipment? Is acoustic equipment (eg noise hoods and ear protectors) properly looked after?
- Inform, instruct and train employees about risks to hearing – have you made sure that employees understand and appreciate the hazards of exposure to high levels of noise?

SUMMARY

1. Carry out noise assessments
2. Record assessments
3. Reduce noise to lowest reasonable practicable level
4. Mark ear protection zones
5. Provide and maintain suitable hearing protection
6. Maintain equipment





7. Inform and train employees
8. Enforce use of hearing protection in ear protection zones

SECTION 3.

DEVELOPING BEST PRACTICE

A best practice standard would require employees working in hearing protection zones where the noise level is greater than 85 dB(A), to undergo audiometric testing (pre placement and routinely) by or under the responsibility of a doctor. To be available at 80 dB(A) and 112 Pa where risk indicated.

A best practice standard would require that any new plant and equipment purchased must specify that the noise level should be as low as is reasonably practicable.

GENERAL NOISE CONTROL MEASURES

- Assessments of exposure to be made and records kept
- Control measures to reduce noise at source to start at action level where daily personal exposure is 85 dB(A)
- Noise to be reduced at source to lowest possible level if above 85 dB(A)
- Employees exposed to 80 dB(A) and above to be given sufficient information and training to take appropriate action to protect themselves
- If daily exposure is above 85 dB(A), then employees **must** be provided with **and wear** suitable and sufficient hearing protection
- Switch noisy machinery off when not in use
- Limit the number of people working in noisy areas
- Reduce the length of time people are exposed

- Provide noise havens, quiet areas
- Note that, from a distance, noise has less force

NOISE ASSESSMENTS

Employers are required to make adequate arrangements for the assessment of exposure where this is likely to be at or above either the first or peak action levels.

Noise assessments must be reviewed when there have either been a significant change in the work to which the assessment relates, or moreover there is a reason to suspect that the assessment is no longer valid.

The noise assessment will help the employer to:

- Identify the daily noise exposure of all employees who might be at risk of hearing damage
- Obtain information necessary to control the noise exposure
- Draw up an informed action plan to reduce the risk of hearing damage

Five Steps to Noise Assessment:

1. Look to see whether there is likely to be a hazard
2. Identify all workers likely to be exposed to the hazard
3. Evaluate the risks arising from the hazard
4. Record the findings
5. Review the assessment and revise it if necessary

REDUCE/CONTROL NOISE AT SOURCE

Noise may be reduced by:-

a. Eliminating the need for the process concerned, all of the time or part of the time, by substituting a quieter machine or process

b. By changing the way an operation is carried out, or a machine works

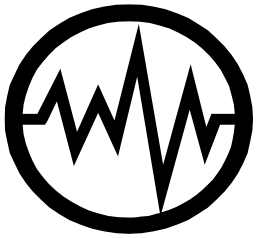
c. By maintaining machinery

d. By enclosing the machine or process in enclosures, or in separate areas/rooms

f. By using noise absorbent material near noisy operations

TOP 10 NOISE CONTROL TECHNIQUES

The following are 10 simple noise control techniques that have wide application across a range of industries. In many cases, they will produce substantial noise reductions quickly and cheaply, with little or no effect on normal operation or use. *See Appendix 2.*



Damping

Fan Installation

Ductwork

Fan Speed

Pneumatic Exhausts

Pneumatic Nozzles

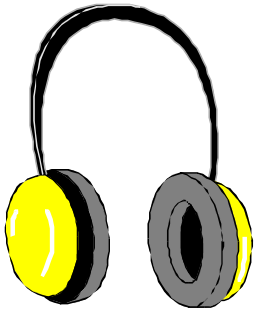
Vibration Isolation Pads

Existing Machine Guards

Chain and Timing Belt Drives

Electric Motors

See also Appendix 3



SECTION 4.

CASE STUDIES

SOUND SOLUTIONS FROM THE FOOTWEAR & LEATHER INDUSTRIES

The first thing you should do is try to reduce the noise at source. Some footwear and leather manufacturers have been able to reduce noise levels successfully by making relatively inexpensive changes or additions to their machines, or by changing the methods used. Some are described below:

- Sound absorbent hoods for rough rounding, stitching and other machines
- Lining machinery casings or extraction enclosures with sound absorbent materials
- Putting machinery on anti-vibration mountings
- Putting silencers on machines using compressed air and also fitting silencers to the outlets of free standing extractors have been found to be effective in reducing the noise level.

In addition minor changes to work handling methods can also reduce noise levels e.g.

- Replacing the metal wheels on racks with rubber or nylon wheels
- Using nylon bushes instead of ball-bearings
- Using rubber buffers where there is metal to metal impact

INDUSTRY EXAMPLES OF ENGINEERING CONTROL

In many circumstances engineering control may be the most cost effective way of reducing noise. Expert analysis of noise sources and identification of the right control measures are necessary. Engineering control has been effective in many ways, for example:

Fork lift truck (cabbed) – Potential Noise Reduction 22dB(A) Leq

Method – Absorptive lining in cab
Noise reducing floor mat
Improved acoustic sealing (eg bonnet, doors)
Noise insulating material applied to bonnet
Modified cooling air passages
Improved engine door seals

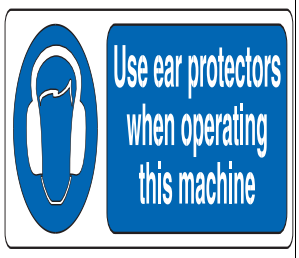
New stacker truck

Hydraulic power packs – Potential Noise Reduction 17dB(A) Leq

Method - Mounting the motor pump unit on a rigid frame, isolating it and the valve bank from the machine body

Venting of tanks during filling - Potential Noise Reduction 17 dB(A) Leq

Method - Re-routing vented gas via a hose to outside of building



Staking Machine – Potential Noise Level above 90 dB(A)

Method - enclosure using a steel channel with Absorbent material with a mesh front. Opening reduced to a minimum

Staking machine

Buffing Machine – Potential Noise Level above 85 dB(A) (dust extraction unit) when motor and fans running

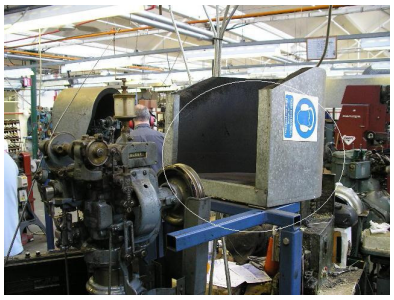
Method - Ducting, motors, fans and dust collection unit relocated outside the building. Also enclosure of fan

Fork Lift Truck – Potential Noise Level consistently above 85dB(A) in older trucks

Method - Programme to replace older FLT's with new ones

The following pictures show relatively inexpensive noise control enclosures:

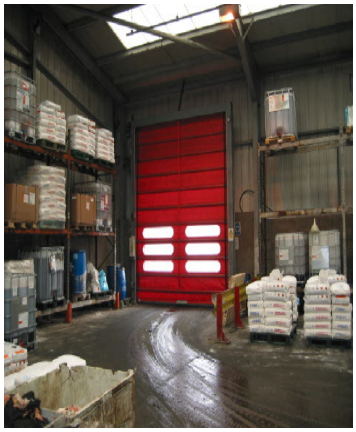
Fig.1 is fitted to a Rounding Machine. As you can see, the enclosure does little to protect the user from noise.



Issues of maintenance and service are answered by a simple hinge arrangement (Fig.2).

There is always a compromise between accessibility and effectiveness. What the enclosures do is protect surrounding work-stations from the noise – typically 3-5 dB front to back

Effluent plant blowers enclosed to reduce noise



Roller shutter door into factory to segregate noisy from quiet areas.

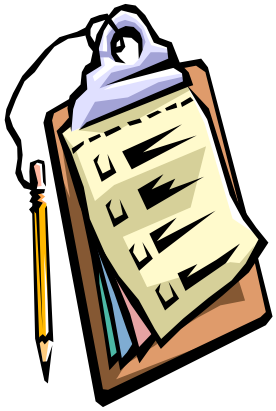
Photos courtesy of: Loake Bros Ltd and Scottish Leather Group Ltd

See Appendix 4.

COST .v. RISK

The standard of duty for Noise at Work Regulations is that of "reasonable practicability". This means that the cost of complying with the regulations must be compared with the risk incurred by not complying. It is sometimes a difficult concept to equate cost against risk, but easier to compare the cost of doing something against the alternative of being fined by the HSE for non-compliance, or the potential expense of a claim for industrial deafness.

For example, when considering the measures needed to quieten machinery, the employer must take into account the financial consequences that may occur from not taking the appropriate measures. Economies may be possible by looking at alternative ways of reducing noise at source, but the final judgement and decision rests with the employer.



SECTION 5.

PERSONAL PROTECTIVE EQUIPMENT

Personal Protective Equipment should be a last resort.

The trade union, the TUC and employers' associations support the use of PPE where necessary.

The main aim of any noise control programme must be the control of workplace noise.

If hearing protection is used as a temporary measure then steps must be taken to identify and clearly indicate the danger areas where they should be worn.

It is important that the right type of PPE is used and this will be determined by risk assessment.

Hearing protection should be constantly monitored for condition and any defects reported immediately, with a view to replacement.

EAR PLUGS AND EAR DEFENDERS

There are many types and they all suffer from the same problem:

- Only effective if worn correctly
- Have to fit
- Have to be a correct type for noise
- Have to be clean and undamaged

A hearing protection programme which places overall emphasis on disciplining the workforce to wear hearing protectors, rather than eliminating or controlling noise at source, may be badly planned and inefficient.

It is better to reduce noise at source.

Where employees are likely to be exposed to the second action level of 85 dB(A) $L_{ep,d}$ or to the peak action level of 140 Pa, the employer should designate an ear protection zone.

This should be demarcated and identified by means of a sign indicating that this is an ear protection zone and that employees must wear personal ear protectors whilst in the zone.

SECTION 6.

The following is an extract from the HSE Noise at Work Advice for Employers booklet INDG 362

INFORMATION, INSTRUCTION & TRAINING

Where employees are likely to be exposed at or above any of the action levels, companies are required to provide information, instruction and training including:

- The likely noise exposure and the risk to hearing this noise creates
- Where and how people can obtain hearing Protectors
- How to report defects in hearing protectors and noise control equipment
- The employee's duties under the Noise Regulations
- What the employee should do to minimise the risk, such as the proper way to use hearing protectors and other noise control equipment, how to look after them and store them, and where to use hearing protectors

Information should be given in a way the employee can be expected to understand (for example it might be necessary to make special arrangements if the employee does not understand English or cannot read).

Employees and Safety Reps

Consulting with trade union-appointed safety representatives or other employee representatives is a

legal requirement. Working with safety representatives and employees' representatives is a very useful means of communicating on health and safety matters in the workplace. For example, discuss with them any plans you may have for a new type of hearing protector, or for identifying an ear protection zone, or for introducing a health surveillance programme.

Remember: involving employees in decisions can help to foster closer working relationships and make employees more receptive to new ideas.
See below an example of a test paper on noise and hearing conservation awareness:

Test Paper

This is a multiple choice paper. Tick one answer only.

Q1. What is the noise level at which the law says I must wear hearing protection?
a) 9 decibels c) 90 decibels
b) 85 decibels d) 100 decibels

Q2. What colour signs are used to mark ear protection zones (i.e. hearing conservation area)?
a) blue & white c) blue & yellow
b) yellow & white d) red & green

Q3. What medical problems can exposure to high noise levels cause?
a) deafness c) sickness
b) dizziness d) skin rash

Q4. Is there a cure for noise induced hearing loss?
a) Yes b) No

Q5. If I work in a noisy area for 8 hours how long must I wear my hearing protection for?
a) 2 hours c) 4 hours
b) 10 minutes d) 8 hours

Q6. How often should I wash my reusable ear muffs/plugs?
a) weekly c) daily b) monthly d) annually

Q7. If a noise level increases by 3 decibels does it?

a) half?
b) double?
c) treble?
d) increase 10 minutes?

See page 21 for answers.

SECTION 7.

USEFUL CONTACTS AND INFORMATION

Health & Safety Executive Noise Toolbox
www.hse.gov.uk

Institute of Acoustics. Tel: 01727 848 195
education@ioa.org.uk

Reducing Noise at Work. Guidance on the Noise at Work Regulations 1989 L108 HSE Books 1998 ISBN 0 7176 1511 1

Sound Solutions: Techniques to reduce noise at work HSG138 HSE Books 1995 ISBN 0 7176 0791 7

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

Protect your hearing or lose it! Pocket card INDG363 HSE Books 2002 (single copy free or priced packs of 25 I 0 7176 2540 0 or priced packs of 25 pocket cards and five posters ISBN 0 7176 1559 6)

Buying new machinery: a short guide to the law and some information on what to do for anyone buying new machinery for use at work. Leaflet INDG271 HSE Books 1998 (single copy free or priced packs of 15 ISBN 0 7176 1559 6)

A guide to audiometric testing programmes; Medical Guidance Note MS26 HSE Books 1995 ISBN 0 7176 0942 1

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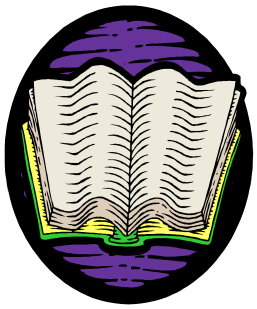

Answers to Section 6

Q1 b. Q2 a. Q3 a. Q4 b. Q5 d.

Q6 c. Q7 b.

Summary of Changes to Noise at Work Regulations

APPENDIX 1.

Provision	***Noise at Work Regulations 1989***	***Regulations from February 2006***
Reduce risk	To lowest level reasonably practicable	Eliminated at source or reduced to a minimum
Assess and where necessary measure exposure	Where noise experienced	Where are, or are likely to be exposed to risk
Assessment period	8 Hours	8 Hours or 1 Week
Provide information and training to workers and reps	85 dB(A) and 200 Pa	80 dB(A) and 112 Pa
Workers' right to hearing checks/audiometric testing	85 dB(A) by or under the responsibility of a doctor.	85 dB(A) by or under the responsibility of a doctor. To be available at 80 dB(A) and 112 Pa where risk indicated
Health surveillance	-----	Provisions to ensure appropriate health surveillance where risk indicated
Make hearing protection available	85 dB(A) and 200 Pa	80 dB(A) and 112 Pa
Hearing protection to be worn	90 dB(A) and 200 Pa	85 dB(A) and 140 Pa selected to eliminate risk or reduce to a minimum
Limit on exposure	-----	87 dB(A) and 200 Pa at the ear
Programme of control measures	90 dB(A) and 200 Pa	85 dB(A) and 140 Pa
Delimit areas, put up signs and Controls access	Where reasonably practicable 90 dB(A) and 200 Pa	85 dB(A) and 140 Pa where technically feasible and the risk of exposure so justifies
Workers reps to receive information	85 dB(A) and 200 Pa (assessments) 90 dB(A) and 200 Pa (programmes of measure)	Refers back to Directive 89/391/ EEC
Derogations	Weekly exposure averaging from hearing protection where health and safety risk	From hearing protection where health and safety risk
Transitional periods	-----	5 years from exposure limitation for shipping 2 years from implementation for music and entertainment sectors
Non-application	Sea and air transport	Conflict with public service activities

APPENDIX 2.

EMPLOYERS' CHECKLIST

Have you made a survey of noise levels in your factory recently? Does it reflect the up to date conditions in your factory?	**YES** ☐ **NO** ☐
Is new equipment checked for noise emission?	**YES** ☐ **NO** ☐
Are all machines level and securely anchored and where practicable, fitted with anti-vibration mountings?	**YES** ☐ **NO** ☐
Are all machines and ancillary equipment as well maintained and services as they should be?	**YES** ☐ **NO** ☐
Are machines correctly adjusted?	**YES** ☐ **NO** ☐
Is it possible to segregate noisy machines?	**YES** ☐ **NO** ☐
Have you marked all areas where ear protectors must be provided?	**YES** ☐ **NO** ☐
Do employees understand and appreciate the hazards of exposure to high levels of noise?	**YES** ☐ **NO** ☐
Has your workplace been assessed?	**YES** ☐ **NO** ☐
Have you kept a record of results?	**YES** ☐ **NO** ☐
If the answer to any of the above is "no" you could be in breach of the law and should take appropriate action.	

APPENDIX 3.
TOP 10 NOISE CONTROL TECHNIQUES

The following are 10 simple noise control techniques that have wide application across the whole of industry. In many cases, they will produce substantial noise reductions quickly and cheaply - with little or no effect on normal operation or use.

1 DAMPING

Typical applications

Chutes, hoppers, machine guards, panels, conveyors, tanks . . . . .

Technique

There are 2 basic techniques:-
— unconstrained layer damping where a layer of bitumastic (or similar) high damping material is stuck to the surface

— constrained layer damping where a laminate is constructed.
Constrained layer damping is more rugged and generally more effective. Either re-manufacture steel (or aluminium) guards, panels or other components from commercially available sound deadened steel or buy self adhesive steel sheet. The latter can simply be stuck on to existing components (inside or outside) covering about 80% of the flat surface area to give a 5 - 25 dB reduction in the noise radiated (use a thickness that is 40% to 100% of the thickness of the panel to be treated).

Limitations:
The efficiency falls off for thicker sheets. Above about 3mm sheet thickness it becomes increasingly difficult to achieve a substantial noise reduction.

2 FAN INSTALLATIONS

Typical applications

Axial flow or centrifugal fans.

Technique

Maximum fan efficiency coincides precisely with minimum noise. Any fan installation feature that tends to reduce fan efficiency is therefore likely to increase noise. Two of the most common examples are bends close to the fan (intake side in particular) and dampers (close to the fan intake or exhaust). Ideally, for maximum fan efficiency and minimum noise, make sure there is at least 2 - 3 duct

diameters of straight duct between any feature that may disturb the flow and the fan itself. Noise reductions of 3 - 12 dB are often possible.

3 DUCTWORK

Typical applications

Extraction, ventilation, cooling, openings in walls and enclosures.

Technique

Instead of fitting silencers, it is often possible to achieve a 10 - 20 dB reduction in airborne noise from a duct or opening by lining the last bend in the ductwork with acoustic absorbent (foam or rockwool / fibreglass). Alternatively, construct a simple absorbent lined right-angled bend to fit on the opening. Ideally, either side of the bend should be lined along a length equivalent to twice the duct diameter. Where flow velocities are high (> 3m/s), consider using cloth faced absorbent. Duct vibration can usually be treated by damping.

4 FAN SPEED

Typical applications

Axial or centrifugal flow fans.

Technique

Fan noise is roughly proportional to the 5th power of fan speed. So in many cases it is possible to achieve a large reduction from a small drop in fan speed by changing control systems or pulley sizes and re-setting dampers. The following table provides a guide to the trade-off that can be expected.

FAN SPEED REUCTION	NOISE REDUCTION
10%	2 dB
20%	5 dB
30%	8 dB
40%	11 dB
50%	15 dB

5 PNEUMATIC EXHAUSTS

Note : a well designed silencer will not increase system back pressure. Almost invariably it is possible to reduce pneumatic exhaust noise permanently by 10 - 30 dB by fitting effective silencers. The following are the practical points that can make the difference between success and failure:-

— *back pressure* : fit a larger coupling and silencer
— *clogging* : fit a straight-through silencer that cannot clog (and has no back pressure)
— *multiple exhausts* : manifold them into a single, larger diameter pipe fitted with the rear silencer from virtually any make of car (from your local tyre and exhaust fitter). Typically 25 dB reduction.

6 PNEUMATIC NOZZLES

Typical applications

Cooling, drying, blowing . . . . .

Technique

In most cases, it is possible to replace existing nozzles (usually simple copper pipe outlets) for quiet, high efficiency units. These not only reduce noise levels by up to 10 dB, but also use less compressed air. The types of nozzle to look out for are entraining units from various manufacturers and in a variety of sizes.

7 VIBRATION ISOLATION PADS

Typical applications

Machine feet, pumps, mezzanine installations . . . . .

Technique

Mounting motors, pumps, gearboxes and other items of plant on rubber bonded cork (or similar) pads can be a very effective way of reducing transmission of vibration and therefore noise radiated by the rest of the structure. This is particularly the case where vibrating units are bolted to steel supports or floors. However, a common error with the use of these pads is for the bolt to ”short-circuit” the pad, resulting in no isolation. Additional pads must be fitted under the bolt heads.

There are many types of off-the-shelf anti-vibration mounts available, for instance rubber/neoprene or spring types. The type of isolator that is most appropriate will depend on, among other factors, the mass of the plant and the frequency of vibration to be isolated. Any supplier of anti-vibration mounts will be able to advise you on this.

8 EXISTING MACHINE GUARDS

Technique

The existing guards on many machines can often be improved to provide a significant noise reduction. The two principles involved, which must be used in combination, are:-

(i) *Minimise gaps*

Reducing by half the "gap" open area in a set of guards can reduce the noise by 3 dB. If you can reduce the openings (flexible seals, additional close fitting panels etc) by 90%, then a 10 dB noise reduction is possible.

(ii)*Acoustic absorbent*

Lining a significant proportion of the inside of the guards with acoustic absorbent (foam, rockwool/fibreglass) will reduce the noise "trapped" by the guards. Consequently, less noise will escape through any gaps. Failure to line the inside of the guards could result in an increase in noise at the operator's position if the gaps have been minimised as in (i) above. In most cases, both sets of modifications can be tested in mock-up form using cardboard (and wide tape) to extend the guarding and temporarily fitting areas of acoustic foam inside. Not only does this process help with the practical aspects (access, visibility etc), but it usually also provides a very good indication of the noise reduction that can be expected. Very "Blue Peter" but very effective. Guard vibration radiated as noise can also be treated via damping.

9 CHAIN AND TIMING BELT DRIVES

Technique

Noisy chain drives can often be replaced directly with quieter timing belts. Within the range of timing belts available, there are also quiet designs that use different tooth profiles to minimise noise. There is also a very new design of belt for applications where noise is critical which uses a chevron tooth pattern to provide very quiet running. Noise reductions in the range of 6 - 20 dB are often possible using this approach.

10 ELECTRIC MOTORS

Technique

Most companies have large numbers of electric motors used on anything from fans to pumps to machine tools. However, it is not very common knowledge that general duty motors are available (at little or no cost premium) that are up to 10 dB(A) or more quieter than typical units as direct replacements. The best approach is to feed these motors into the system over a period of time so that all replacement motors are quiet motors.

This sheet was produced by the Engineering Industry Noise Task Group (see http://www.hse.gov.uk/noise/who.htm) with the grateful assistance of Peter Wilson of the Industrial Noise and Vibration Centre (INVC).

The HSE website is a valuable information resource www.hse.gov.uk

APPENDIX 4.

NOISE CONTROL : DETERMINING THE BEST OPTION

1 THE APPROACH

Enclosures … and silencers … and possibly barriers, or even lining the roof with acoustic absorbent. In most cases, these techniques represent the limit of the noise control technology that is considered. Whilst in some cases one or more of them may be the solution, how do you find out whether there are alternative options that are more practical and lower cost?

The problem is that unless a high degree of specialised engineering expertise is available, it is difficult to make a judgement of what constitutes the best solution in each case. However, there is a simple approach that non-experts can use to determine - at least in outline - the best solution to any noise problem. If you want or need to reduce the noise from a machine or process, then following this systematic approach to noise control can remove the guesswork from determining the most practical and cost effective solutions to particular problems.

The underlying message from this approach could be summarised as: Noise is a health and safety issue, but noise control is an engineering problem.

2 THE PROCEDURE

Machines and processes should not be regarded as monolithic "noisy units", but as collections of noise sources, each of which generates noise in a particular manner.

The procedure that must be followed to determine the best solution involves the following steps.

(i) List all potential noise sources (within each machine or process).

(ii) Rank the sources.

(iii) Develop noise control measures for the major sources. These steps are considered in more detail below.

2.1 List Noise Sources

The first step is to list all the potential noise generating sources and then to break down the list into two broad categories as shown:-

SOURCES OF AERODYNAMIC NOISE cause noise by direct disturbance of the air		SOURCES OF MECHANICAL NOISE cause mechanical vibration which is transmitted through the machine structure to the external surfaces which vibrate and radiate noise.	
1	FANS	1	IMPACTS (a) presses (b) mechanical handling
2	COMPRESSED AIR (a) air jets (b) pneumatic exhausts (c) air motor exhausts	2	ROTATING MACHINES (a) gears (b) pumps (c) bearings (d) electrical machines
3	COMBUSTION	3	FRICTION FORCES AND OTHERS (a) cutting tools (b) brakes

Example: electrical hand-drill source list and categorisation.

Aerodynamic	Mechanical
Fan	gears
Windage	out-of-balance
	electrical forces
	bearings commutator

Once this listing and categorisation is complete, your next step is to rank the contributions from each source.

2.2 Rank Sources

Ranking the sources involves establishing the relative contributions from each source to the total noise produce by the machine or process. Unless this has been done the choice of noise control measures is based on guesswork. To achieve effective noise control you must tackle the dominant sources first. If the dominant sources are not treated first, the effect of any noise control measures will be disappointing as they are likely to be limited to a maximum reduction of less than 3 dB. Taking a case where there are 3 sources on a machine:-

1 pump generating 93 dB(A)
2 fan generating 90 dB(A)
3 motor producing 88 dB(A)

Total noise is therefore 95.6 dB(A)

If it is assumed that the fan is the noisiest source (due to the subjective impression caused by tonal content) without carrying out the ranking process, and a silencer is fitted, then the result is as shown above. A 15 dB reduction in the fan component only produces a 1 dB overall noise reduction as it is not the dominant source. Used properly, the ranking process allows the overall noise reduction to be estimated in advance before spending money on modifications.

The main ranking techniques are:-

(i) Listen : associate the characteristics of the noise with an understanding of the machine operation.
(ii) Alter operating characteristics: change speeds, feeds, load etc and note effect on noise.
(iii) Timing : associate noise with parts of machine cycle.
(iv) Isolate : run each source separately or temporarily cover all sources (barrier mat or even cardboard) and uncover each in turn. Make sure you can do this safely.
(v) Frequency: features of the frequency spectrum can be a powerful diagnostic tool.

This simple process (listing and ranking) ensures that the correct sources will be treated in the correct order.

Example: An automatic circular saw used to cut long lengths of aluminium extrusion generated 105 dB(A). An expensive enclosure was fitted over the saw – with no effect on overall noise level as the dominant noise radiator was the component length outside the enclosure. The simple diagnostic test of cutting a very short length of extrusion would have demonstrated that the noise level dropped substantially, proving that the saw was only a minor source and that the enclosure would provide no benefit.

3 OPTIONS AND COSTS

Once categorisation, listing and ranking of the noise sources has been carried out, you can consider noise control techniques in detail. There are only a limited number of plant noise control techniques available:-

Noise control at source: engineering modifications that alter the process of noise generation. Limited only by the experience and imagination of the engineer.

Silencing: for aerodynamic sources there are a range of conventional and unconventional "silencers" available.

Vibration isolation: introduce a vibration "break" to prevent the transmission of mechanical energy.

Vibration damping: extract and dissipate the energy in vibrating surfaces.

Enclosure: prevent the transmission of sound by introducing a barrier.

Barriers: place a partial barrier between source and receiver.

At this stage noise control engineering expertise may be required in order to cost the options for each of the ranked sources and to predict the likely noise reduction for each option. The most important factor is that you consider all the options for the dominant noise sources.

Once the above steps are complete, it is then possible to define with some accuracy the costs involved in achieving decreases in noise levels.

Note that whilst the direct costs of developing and putting in place modifications are quite easy to assess, there are also likely to be indirect costs that should be taken into account. These include the effects on production and ease of maintenance both of the machine itself and of the noise control measures.
Example : Hammer mills. Enclosures costing £40,000 were proposed for 4 hammer mills used in the manufacture of nappies. However, there was concern not only at the cost, but also the space and access limitations. Diagnosis proved that the dominant source of the noise was actually vibration from the hammers radiated by the web infeed. A vibration damper was designed for the web that reduced the noise from98 dB(A) down to 82 dB(A) at a cost of around £4,000. Normal operation and access were unaffected.

4 CONCLUSIONS

It is possible to define with some accuracy the best noise control options for any project by following a simple procedure to determine the dominant source within the noisy plant. If the range of options is limited only to high cost conventional techniques (enclosure etc), the risk is that either nothing will be done (risking hearing damage for employees) or that industry will spend substantially more than necessary. The key to cost effectiveness is to approach noise control as an engineering problem and to follow a simple diagnostic and ranking procedure to target modifications precisely where they will do most good - wielding a noise control scalpel rather than a chainsaw.

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