

PHYSICAL AGENTS DIRECTIVE: AUDIOMETRY IMPLICATIONS FOR SMALL AND MEDIUM ENTERPRISES

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1 INTRODUCTION

With the impending implementation of the Physical Agents Directive (PAD), with particular attention to the noise requirements, the Small and Medium Enterprise (SME), especially small-scale industrial manufacturing units, the Management may find some of the conditions daunting and difficult to understand.

From the Employer's point of view, a clear route to compliance with the directive needs to be indicated. To the uninitiated, the noise and vibration regulations may appear as a series of common sense rules wrapped up in confusing numerical values.

From reading the PAD, the clause requirements should be able to be split into two categories: suggested guidelines, and mandatory regulations. This would clarify the present position of the SME operational practices, and therefore point the way towards improvement and consequent compliance.

However from reading the draft document, the rules and regulations are not backed up with clearly stated measures and criteria. This leaves the SME Manager with unanswered questions, particularly what is required, and where to get help.

2 SPECIALIST REQUIREMENTS OF AUDIOMETRY

Occupational Audiometry is a technique for the early detection of hearing loss due to excessive noise exposure. This is a process performed as a sequence of actions between the Audiologist and the worker.

Audiometry is only one part of a hearing conservation programme, which for noise exposure, includes:

- Operation or Process Risk Assessment
- Workplace Noise Assessment
- Noise reduction measures at "Source"
- Provision of personal protective equipment (PPE)
- Provision of an appropriate health surveillance service

What constitutes "appropriate" health surveillance certainly includes audiometric testing.⁸

This routine Audiometric testing requires a competent skilled operator and certain specialist equipment to carry out these operations with accuracy in mind.

It is advisable to hold a baseline record of a worker's hearing level before he enters the workplace. This reference audiogram should be used to establish change in hearing over time. It should be taken after the ears have not been subjected to excess noise for 12 hours before testing.

An audiogram taken at the end of a working shift to expose a temporary threshold shift can be used to establish which workers are adequately protected against noise.

A typical sequence during the Audiometry appointment includes the following:

- Timing of the appointment to take account of temporary threshold shift.
- Introductory questionnaire
- Otoscopic examination
- When previously exposed to noise noted.
- Instruction in using apparatus
- Audiometric recording
- Interpretation of results
- Discussion of results
- Discussion of any further action on either part

Behind the scenes, the individual records of the patient history should be kept from the original test at start of work, and including all the subsequent periodic tests (every 2 to 5 years is normal). This provides evidence of long term trends in hearing performance, which is important, as there is a "latency" effect in seeing evidence of damage far later than the start of the damaging exposure.

Furthermore the reporting of personal medical results to the Employer, or Doctor (General Practitioner) causes additional difficulties with permissions and confidentiality. The patient is normally asked to sign a waiver, so that the records can be kept by the OHD, and accessed by the employer and their medical representative(s).

The provision of individual audiology health records should include the following features:

- Up to date patient file
- Contain a summary of results
- Complete set of audiogram printouts
- In a suitable form for consultation, or further action
- Confidential, therefore filed within an OHD restricted system, not accessible without some confidentiality safeguard
- The provision of a report to management that is general rather than specific to individual need.

It can be seen therefore that this process cannot be undertaken without the necessary specialist skills and equipment.

This leaves two possibilities:

2.1 In House Audiometric Testing

In a large company that employs hundreds (or thousands) of personnel, the employees will require some services from either an internal or local "Occupational health Department" (OHD). This OHD will normally be able to supply the Nursing Staff for the Audiometric tests, having access to the necessary apparatus. Historically this has been the cheapest and most convenient option for a large-scale operation to comply with existing regulations.

Alternatively if the number of employees is small, the overhead cost of an OHD becomes prohibitive, and a viable alternative needs to be sought.

Good acoustic testing environments are easier to achieve in larger companies.

2.2 Independent and Mobile Audiometric Services

An opportunity presents itself here as the proactive audiometry service provider can campaign around the local area targeting SMEs, specifically ones that are known to be manufacturing concerns.

It may be difficult for a small company with a large geographical base to provide 'new starter' baseline hearing tests, sufficient annual repeats within a time frame and adequate acoustic conditions to perform the tests.

3 FEEDBACK OF RESULTS

3.1 Positive

The Audiologist will review the results from the audiogram in line with the Health and Safety Executive categories and decide on an action as laid down in that code of practice. If no problem is found, then he/she will advise there and then that no foreseen problems exist and no further action will be taken until the next routine periodic re-examination. Advice will be given on hearing protection but it is not usually in the UK for the audiologist to be the one who gives in-depth training on this issue

If the results are unclear, borderline, the patient is unwell, or the hearing loss is not noise induced, workers are referred to their GP, it may be necessary for the person to see a specialist in ear nose and throat medicine who can give a definitive diagnosis of noise induced hearing loss.

3.2 Negative

The worker will be informed by the Doctor, or the suitably qualified representative, of the situation, perhaps after further consultation. If a permanent threshold shift is noted (correctly known as "Noise Induced Permanent Threshold Shift" or NIPTS), then the source of the risk will be investigated in the light of eliminating or reducing the risk at source. However equipment redesign, operational changes or alterations of production methods, and additional PPE, may reduce the risk within specified limits. Otherwise the assignment to other work may be the only way that future exposure can be reduced. Unfortunately due to latency, the worker is now more sensitive to damage due to the "Damaged Ear Theory"³ (Where the already damaged ear is more susceptible to further damage than an undamaged ear, subjected to the same exposure.)

There are occasions where that none of the above solutions are possible or may be prohibitive due to expense.

The negative results should now be compared to the results from the other workers in the same area, or workers that complete similar tasks or share some of the same job functions. This would possibly indicate an early warning for these workers to provide an opportunity to reduce the risk before permanent damage occurs.

Records of an employee's individual exposure to noise in the workplace are rare and currently are not accessible with the audiometric record. It is often not possible to relate the noise level over time to the hearing loss to be able to assess attributable hearing deficit, though the calculations are available to do this.⁷

4 SHORTFALLS AND DIFFICULTIES

4.1 Implementation

When changing the rules in regard to whether Audiometric testing is required, or in this case effectively lowering the old "action levels", the impact of the implementation causes unforeseen problems, as side effects. These difficulties need to be addressed by evaluating their impact on reasonable implementation, without burdening the SME with increased operational costs.

4.2 Levels and durations

Disregarding for the moment the peak sound pressure limits, the PAD quotes limit examples of daily averages of sound exposure over a fixed duration of 8 hours, (i.e. $L_{(A)EX,8h}$). Even the experienced Practitioner (and Acoustician alike), would appreciate the provision of a table or chart showing the variation in $L_{(A)EX,8h}$ level, in respect to variations of exposure time, specifically various work shift times around the 8 hour mark.

It can be seen in real data that the simple application of the "equal energy principle", as the time of noise exposure increases, the acceptable level falls, as these two variables are inversely proportional. To show this, a chart, or graph will show these relative metrics in the easiest to understand way.

4.3 Impact Noise

There are ongoing issues surrounding exposure to impact noise. There is no doubt that these short duration high intensity sounds cause enormous damage to the auditory system and once the aging process takes effect retirement years are cursed with severe deafness and communication difficulty.

Impact noise has always been a difficult source to pin down. The nature of the noise has variables that are not always captured with the typical sound level meter (SLM), or dosimeter. Some specialised impact noise meters are available but still can underestimate the harm that the noise is causing.

According to Dancer et al ² the degree of auditory damage is proportional to many contributing factors namely:

- Peak pressure
- Pulse duration
- Waveform
- Number of impulses
- Repetition rate

In addition these parameters interact with each other, so the determination of likely hearing damage is difficult even with specific data on particular machines or processes.

Furthermore from Dancer et al ² "There appears to be a good general agreement that NIPTS is more common following exposure to impulsive noise, than following exposure to continuous noise"

No such mention is made within the draft copy of the directive, but the quoted p_{peak} values are a starting point, for noise sources that are short term repetitive.

4.4 Weighting

The use of "A" weighting to give a single figure representative value to noise levels that cause damage to human hearing is flawed in that all the lower frequencies are removed by the "A" weighted filter. The use of "C" weighting (better for measurement of lower frequency noise as in Aircraft noise) can give a better picture of the damaging factor, present in noise at work.

The ear itself is a non-linear device, and its sensitivity to noise is frequency dependant (hence "A" weighting). However human hearing can be damaged by low frequency noise that exists between 100 Hz. and 10 Hz. where these frequencies are filtered out by the measuring device, if using weighting filters.

A provision should be made in the directive to measure noise in broad-band terms, using a "linear" frequency response, the single figure overall acoustic sound pressure level (OASPL) or, $L_{p,8h}$ should be used to indicate damaging noise exposure in contrast with the accepted annoying sound exposure.

4.5 Where to go for assistance

The internet and yellow pages are not set up for employers to browse for audiometry services. Looking under Occupational health, one may find one or two hits, but they may not be local enough to be viable. The regulatory committee should produce a central database of accredited clinics, centres, and mobile facilities that can adopt the Audiometric workload. Links to this database should be available from internet sites of local councils, hospitals, HSE, and under titles such as occupational health, to ensure that the Employers can find a "choice" of providers to suit convenience and budget.

Audiometric service providers need to push for the generation of this database.

4.6 Use of Personal Protective Equipment (PPE)

Only the correct use of PPE can yield the claimed improvements to the worker. Some of the claimed noise attenuation factors are on the generous side, and are not always achievable. These claims are always in ideal conditions, using perfect equipment set up as an experiment, not as in an everyday workshop environment.

Other factors govern the correct use of PPE, and are commonly found in all industrial units where working conditions are sometimes far from ideal namely:

- Use of Hearing Defenders (Muffs), alongside other PPE i.e. goggles, or helmet
- Use of Hearing Defenders (Muffs), alongside personal items i.e. spectacles, or turban
- Use of Hearing Defenders while trying to communicate with fellow workers
- Use of Hearing Defenders that isolate the worker effecting efficiency, concentration, safety or other psychological effects
- Use of Hearing Defenders that isolate the worker causing shock and surprise due to other workshop operations, coming into field of vision
- Use of both Muffs and Plugs and the claimed "A" weighted attenuation factors are directly Summed. (This rarely works as each hearing defender has frequency dependant characteristics that are not compatible.)

The Occupational Safety and Health Administration (OSHA) in the USA suggest a 50% safety factor when calculating the effectiveness of PPE's because the manufacturers NRR's (noise reduction

ratings) are obtained in ideal conditions, in a laboratory setting and in the real world are unrealistic. There is now established evidence that this type of approach is a valid one.⁶

The worker whose noise exposure is measured using 'C' weighting has his hearing protection needs measured thus:

In the case of the NRR being 26dB and the Lex being 100dB using a 'C' weighting
Half NRR = 13
 $100 - 13 = 87\text{dB}$

In the case of the NRR being 26dB and the Lex being 100dB using an 'A' weighting
NRR -7=19
Half NRR=9.5
 $100 - 9.5 = 90.5\text{dB}$

Occasionally, high noise environments may necessitate using earmuffs and earplugs in combination. OSHA allows 5dB to be added to the greater NRR so in the 'A' example above the 90.5dB exposure would be reduced to 85.5dB

Consideration needs to be given to producing a guide to hearing protectors & how to calculate their appropriate use. The OSHA 50% approach to NRR's needs further investigation as this is a new concept in the UK. There also needs to be evaluation programmes in place to monitor the effectiveness of hearing protection using this technique.

Training and motivation go hand in hand. Workers need to be aware of issues like the effect on daily noise doses when PPE is removed for short periods.

4.7 Audiometry Asset Management

The cost of ownership of the Audiometry apparatus will be directly affected by the increased utilisation. This equipment is expensive, and if it is to be used effectively and efficiently, more than one audiologist may be using a single audiometer. If so the general wear and tear will increase the scheduled maintenance charges, and potentially increased breakdowns.

The increased workload for an audiometry provider will perhaps point to a requirement for a mobile van or an installation of a booth. The purchase and maintenance of major elements such as these burden the small scale independent Audiologist who arrived with a suitcase instrument in the past. Small scale industry may not have a quiet little room without external noises and distractions, as isolation and patient concentration produces the best Audiometric data.

Calibration of the instrumentation will normally be annually though may be six monthly. However increased workload may require component changes in the measurement chain that requires realignment or system calibration. This causes addition costs to the service provider, which must be reflected in the charge to the SME customer.

A large company with an internal OHD will more likely have the room, booth, multi machines and various staff suitably trained to give flexibility with no, or little increase in cost.

4.8 Better Noise Reduction

There are some hidden problems behind the implementation of this directive, which is basically designed to improve the situation in regard to "minimising" noise exposure of personnel, which is not under dispute here. However the machines or plant that produces the "noise" may be already comprehensively guarded and the operators have correct and properly used PPE. If this is so, the lowering of the action values, requires better guarding (noise reduction at source), better PPE, or both. This may or may not be available, but at what price? Improved PPE may be available at a relatively low cost compared to the audiometric service, but enclosing plant and machinery, or worse, replacing tooling, can cost disproportionate amounts.

4.9 More Civil Claims

The increasing of the number of people that require audiometry by lowering the action levels will also increase the number of civil claims for the permanent loss of hearing. This could cause an increase in national production costs as another overhead charge. (i.e. who is to pay for the increased claims, legal fees, and referrals to Specialists and Consultants etc?)

There is no legislation in place for the worker who has been successful with a civil-claim then chooses to continue working in a noisy environment. All audiometry can do in this instance is to follow the progress of an increasing deafness. The only legislation in place is for the employer to provide PPE's

5 INCREASED EXTENT OF AUDIOMETRY REQUIREMENT

It is difficult to pin point the number of people exposed to excessive noise as the working conditions and engineering processes are so variable. According to the Health and Safety Executive¹ the figures published by the "Association of British Insurers" provides one measure of the national problem: the number of workers exposed to noise above the upper exposure action value of $L_{(A)EX,8h} = 85$ dB (A) or $P_{peak} = 200$ Pa, not including any attenuation provided by PPE, is 1.1 million.

Furthermore an estimated 170,000 people in the UK suffer deafness, Tinnitus, or other ear condition as a result from noise at work.¹

From a study of the US population (US-Environmental Protection Agency)⁴ exposed to daily average noise levels of 85 dB(A) and above, the following areas at risk of "noise at work" were indicated, and these could still pin point the general percentages across employment areas for present day US and possibly the UK population pro rata. The original data is summarised in the following table:

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