Occupational Noise Exposure and Regulatory Adherence in Music Venues in the UK

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Abstract

Noise in most working environments is an unwanted by-product of the work process, and in the majority of countries, most industries have had regulatory controls on noise exposure for several years. In the music industry the noise is the desired product rather than a by-product, and for a long time the entertainment industry in the UK was exempt from these regulations. From April 2008 however, the music industry in the UK became regulated under the Noise at Work Regulations 2005, meaning that employers in the entertainment industry from orchestras to nightclubs are legally required to adhere to the same requirements for controlling noise exposure for their staff that have been applied to other industries for many years, and which are based on ISO 9612:2009.

It is now over two years since implementation of the regulations, and the key question is to what degree are employers in these sectors undertaking their responsibilities to staff in terms of noise assessment, reduction of exposure, provision of adequate protection and provision of training on noise risk? This study assessed four public music venues where live or/and recorded music is played. A total of 30 staff in different positions across the venues were monitored using noise dosimetry across a complete shift to determine noise exposure. A questionnaire was used to determine patterns of noise exposure, attitudes to noise levels and hearing loss and levels of training about noise risk.

Results showed that the majority of staff (80%) in all venues exceeded the daily noise exposure limit value in their working shift. Furthermore, use of hearing protection was rare (<30%) and not enforced by most venues. The understanding of the hazard posed by noise was generally low, and the implementation of the noise regulations was at best haphazard, with staff regularly exceeding regulatory limits, and the implication is that the industry is still failing to meet its regulatory requirements.

Introduction

The relationship between noise and hearing loss is well known and documented (Peters *et al*, 2005, RNID, 2009), and legislation has been in place in most countries for many years to control the exposure of workers to noise in the workplace. Regular personal noise exposure that gives an equivalent noise dose in excess of 80 dBA for an 8-hr period is likely to cause some hearing loss in a small proportion of listeners, (NIOSH, 1998) while daily noise exposure above 85 dBA ($L_{EX\ 8H}$) is likely to cause some hearing loss in a large proportion of people (SCENHIR, 2008; ASHA, 2010).

In the UK, the current regulations are the Control of Noise at Work Regulations 2005 (NaWR), which are aligned with Directive 2003/10/EC of the European Parliament (European Commission, 2003) and based on the recommendations of ISO 9612:2009.

In the music industry, noise is the desired product rather than a by-product, and for a long time, the entertainment industry in Europe was exempt from the regulations, meaning that staff working in entertainment venues (such as music venues, cinemas and outdoor festivals) were unprotected by legislation.

When NaWR was put in place the music industry was included in the provision. They were given a 2 year window to respond to the requirements of the legislation, and from April 2008 the music and entertainment industries became regulated under the Control of Noise at Work regulations 2005 (Health and Safety Executive, 2008). The regulations require employers in all area of the entertainment industry to adhere to the same action levels for controlling noise exposure that previously were applied to other industries such as construction. This includes a wide variety of staff and employment situations, from concert promoters, bar and security staff and maintenance staff in the venue, to those involved in creating the music such as musicians and sound engineers. Freelance workers are also generally covered under the terms of the regulations (ibid).

High levels of sound have traditionally been an integral part of both the live music industry (Butterfield, 2006) and the nightclub industry (Smeatham, 2002), as this is considered an integral part of the experience. Press publications regularly give positive publicity to particularly high sound levels – for example a review of a live festival in a music trade magazine includes comments such as *'...elevated the show to the next level and secured it as one of the UK's loudest outdoor dance festivals'* (Low, 2009: 21). Noise levels in live popular music and rock concerts have been shown by a number of authors to be around 105-110dBA LA_{EQ} over the duration of a concert (Barlow, 2010), with some large events and festivals reaching average levels of over 115dBA. As many of the musicians, and more importantly the paying customers view high levels of sound in a positive manner, there is a low incentive to engage with the regulations. The key issue is whether over two years after the application of the noise regulations to the industry, the regulations are being applied, and if so to what degree.

Background

In the EU noise exposure for any given time uses the long-term average measure LA_{EQ} (sometimes expressed as dBA Leq), which is used to calculate a "personal daily noise exposure" or $L_{EX\ 8H}$. which normalises the exposure to an 8-hour working day. (Health and Safety Executive, 2005). Under the 3-dB "exchange rule" defined by the ISO, with each doubling of sound energy (an increase of 3 dB), the time taken to reach the maximum daily dose reduces by half (ISO, 2009). Where noise exposure is highly variable, the measure may be normalised over a working week (five 8-hour days).

If an employee works in an environment in which he or she is exposed to an $L_{EX\ 8H}$ exceeding the "lower exposure action level" of 80 dBA the employer is obliged to provide a number of regulatory requirements (Health and Safety Executive, 2005). These include the provision of optional noise protection, a range of monitoring programmes including audiometry, and training in noise risk for employees. If the average sound level exceeds the "upper exposure action level" of 85 dBA, it is mandatory for the employer to both provide protection and to ensure that protection is worn, (ibid) as well as to use other controls to minimise exposure – for instance using engineering solutions and administrative options such as variation in working patterns. The mandatory upper limit for noise exposure of an employee (the Exposure Limit Value or ELV) is 87 dBA $L_{EX\ 8H}$. This must take into account the effects of any controls such as use of hearing protection. Monitoring must be undertaken if the workplace is likely to exceed the lower action level. In the EU, there are also controls on the levels of exposure to impulsive "peak" noise, with the lower exposure action level being 135 dBC, the upper exposure action level being 137 dBC, and the ELV being 140 dBC.

These regulations are common across many countries as the majority of noise regulations are based on ISO 9612:2009. However, these regulations are different from those in the USA, where both the measures and action levels vary, though the employer requirements are largely similar. The USA calculates a time weighted average (TWA) (OSHA, 2011) rather than $L_{EX\ 8H}$. Use of TWA in itself has a minimal effect on average exposure values, however the exchange rule used under US legislation is 5 dB rather than 3 dB; this will give a lower value for an 8 hour TWA compared to $L_{EX\ 8H}$ for identical durations of exposure in excess of 85 dBA. In addition, the first action level is set at 85 dBA (8-hr TWA) (ibid) rather than 80 dBA.

The permitted exposure level in the USA is the equivalent to the upper exposure action level in the EU. This is currently set at 90 dBA (8-hr TWA) (OSHA, 2011). As the exchange rules also differ, durations of exposure considered hazardous by the regulatory bodies of the EU countries and the US are considerably different, particularly as sound levels increase. For example, in an environment where noise levels reach 115 dBA, in the EU an unprotected employee would be considered to have reached maximum noise dose in 30 seconds, whereas the maximum duration of exposure at this level would be 15 minutes in the USA. Canadian legislation varies between jurisdictions, but the majority of jurisdictions use the 85 dBA TWA and the 3-dB exchange rule (with the exception of Quebec, which uses the 90 dBA TWA and 5-dB exchange rule) (CCOHS, 2009).

In the USA, the National Institute for Occupational Safety and Health (NIOSH) uses the 3-dB energy exchange rule and 8-hr 85dBA permitted exposure level recommendation – though this is based on a TWA, it is essentially the same as the ISO standards applied in Europe (NIOSH, 1998). Their calculations of acceptable limits are therefore very close to the UK/EU regulations. It recommends that "*levels at or above this level* (85 dBA) *are considered hazardous."* (NIOSH, 1998: 1).

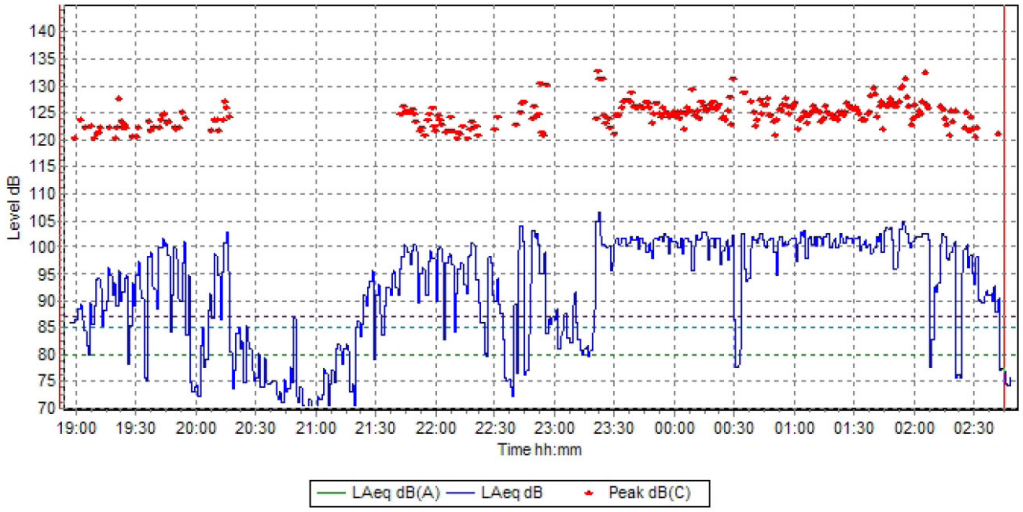
Criteria

This study measured noise exposure levels across a number of small to medium size (capacity ~300-500) music venues where live and recorded music is played, to analyse the current occupational noise exposure on different employee roles in typical venues. In conjunction with the noise exposure measurements, the study used questionnaires also investigated levels of understanding and compliance by staff and employers with the Noise at Work Regulations in Music Venues and particularly focused on the following research questions;

- The actual level of noise exposure of employees in the venues under investigation.
- The level of understanding of the noise regulations amongst staff and management.
- The degree to which employers and employees in these venues adhered to the regulations.

Noise dosimetry was used to measure personal noise exposure of a number of 30 different staff in separate roles working at eight events over a 6 month period. Each member of staff was fitted with a Cirrus Research ® Dosebadge™ model CR:110A for the duration of their shift. This was placed on the shoulder approximately 10cm from the ear. Each meter had up to date manufacturer calibration, and was also calibrated immediately before use using the supplied calibration system built into the RC:110A reader unit (which complies with IEC 60942:2003 Class 2). Results were analysed using the Cirrus Research dBLink3 software which provides time history reporting (Figure 1) and statistical analysis of results.

Figure 1 – A Typical Time History plot of noise levels from dBlink3 software



The understanding of the regulations by staff and the application of the regulatory requirements in the venues were assessed using an 11 point structured questionnaire, and also by semi-structured interviews with staff.

Analysis

For the purpose of analysis, staff were subdivided by job role. These were broken down into the categories of Group 1: Bar and Catering staff, Group 2: Technical staff and Group 3: Promotional/Security staff. As shift lengths varied, for each member of staff the noise exposure was normalised to an 8 hour personal noise dose ($L_{EX\ 8H}$),in line with ISO 9612:2009. In addition, exposure to peak impulse noise in dBC was also recorded.

Questionnaire responses were broken down by job category and venue. Responses were entered into a spreadsheet for statistical analysis. The sample of subjects consisted of 42% bar and catering staff, 38% technical staff, and the remaining 20% Door and Promotional staff. The general demographic was young, with 70% of the questionnaire respondents under the age of 24, and only one respondent over the age of 50. 73% of respondents were Male and 27% Female.

Results

Personal Noise doses ($L_{EX\ 8H}$)from a single work shift are presented for all employees in table 1. Subjects are subdivided by venue and job category. Colour coding is used to indicate the venue and the level of average and peak exposure in relation to the UK regulatory levels.

Table 1 – Noise Exposure for staff shifts sorted by occupation and venue

CATEGORY	OCCUPATION	LAeq dB(A)	DURATION (Hours)	$L_{EX\ 8hr}$	Peak level dB(C)
Bar and Catering	Bar Staff	85.2dB	3:02	81.0dB	132.2dB
Bar and Catering	Bar Staff	87.8dB	3:38	84.4dB	126.8dB
Bar and Catering	Bar Staff	91.1dB	4:49	88.9dB	125.8dB
Bar and Catering	Bar Staff	92.0dB	4:05	89.1dB	129.8dB
Bar and Catering	Bar Staff	92.1dB	3:06	88.0dB	133.7dB
Bar and Catering	Bar Staff	86.4dB	3:41	83.0dB	128.6dB
Bar and Catering	Bar Staff	74.9dB	4:16	72.2dB	124.5dB
Bar and Catering	Bar Staff	81.1dB	4:18	78.5dB	127.7dB
Bar and Catering	Bar Staff	99.0dB	5:52	97.7dB	131.7dB
Bar and Catering	Bar Staff	94.0dB	5:25	92.3dB	128.6dB
Bar and Catering	Bar Staff	91.5dB	4:32	89.0dB	127.4dB
Technical Staff	Sound Engineer	93.0dB	6:18	91.9dB	128.9dB
Technical Staff	Sound Engineer	93.8dB	5:02	91.8dB	131.9dB
Technical Staff	Sound Engineer	95.3dB	6:58	94.7dB	130.1dB
Technical Staff	Sound Engineer	93.6dB	6:57	93.0dB	130.0dB
Technical Staff	Sound Engineer	100.4dB	3:29	96.8dB	132.2dB
Technical Staff	Sound Engineer	99.8dB	6:28	98.9dB	141.9dB
Technical Staff	Sound Engineer	89.8dB	7:33	89.6dB	131.0dB
Technical Staff	Sound Engineer	97.8dB	7:51	97.7dB	132.2dB
Technical Staff	Sound Engineer-Artist	93.5dB	4:45	91.2dB	131.8dB
Technical Staff	Stage Engineer	100.6dB	6:59	100.0dB	134.5dB
Technical Staff	Lighting Engineer	86.3dB	4:04	83.4dB	121.4dB
Technical Staff	Dj	91.2dB	2:43	86.5dB	132.1dB
Security and Promotion	Door Staff -Promoter	94.6dB	3:25	90.9dB	133.3dB
Security and Promotion	Door Staff -Promoter	96.4dB	6:59	95.8dB	134.3dB
Security and Promotion	Door Staff -Promoter	93.7dB	4:41	91.3dB	131.4dB
Security and Promotion	Door Staff	85.2dB	3:38	81.8dB	128.8dB
Security and Promotion	Door Staff	74.4dB	3:55	71.3dB	117.6dB
Security and Promotion	Venue Manager	98.7dB	7:44	98.5dB	135.5dB
Security and Promotion	Bar Manager	90.9dB	4:33	88.4dB	133.7dB

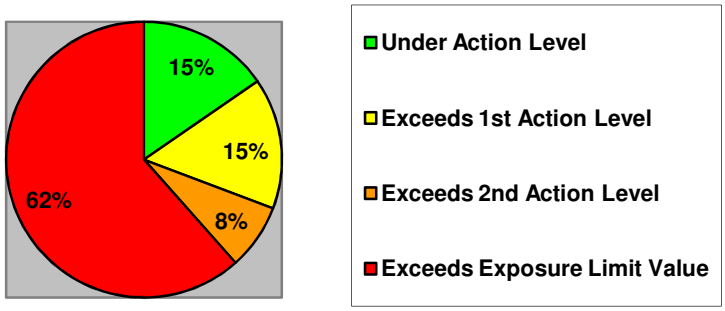
Legend

Exposure Level	Under Action level	Exceeds 1st Action Level	Exceeds 2nd Action Level	Exceeds ELV
Venue	VENUE 1	VENUE 2	VENUE 3	VENUE 4

Discussion

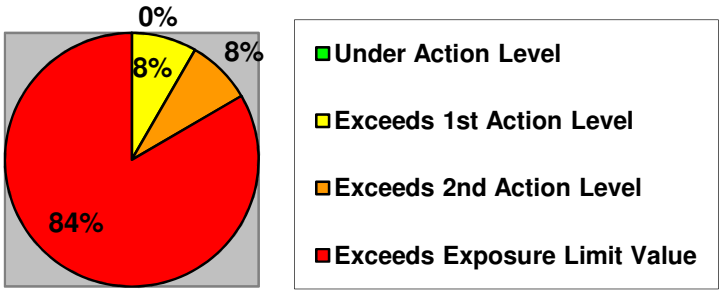
Results showed that in total, 80% of staff in all venues exceeded the daily noise exposure limit value in their working shift. More than half of the catering and bar employees exceeded the exposure limit value and only 15% were under the first action level (figure 2). None of the staff at any venue wore any form of hearing protection during the events being monitored. Despite the high levels of exposure, when questioned in semi-structured interviews on site no member of bar or catering staff in any of the venues could recall ever having used hearing protection at work.

Figure 2 – Proportion of bar/catering staff within exposure levels



Of the technical staff, all of those listed as sound engineers (84% of the group) were exposed to sounds in excess of the ELV during their working shift (figure 3). Despite this only one sound engineer was observed used hearing protection, although the lighting engineer and stage engineer both used in-ear Hearing Protection.

Figure 3 – Proportion of technical staff within exposure levels



There were fewer door and promotional staff in the sample, however, of these, 3 out of 5 were in a position exposed to noise above the upper action level, of which only one was wearing hearing protection.

Results from the questionnaires indicated that 75% of the staff had worked in the venue for more than a year, with the same proportion working part time (3 or fewer days per week). Mean part time hours were 16 hours per week, with a standard deviation of 7.4 hours. Full time staff worked between 30 and 49 hours per week.

Over 85% of subjects had experienced tinnitus and 50% had experienced threshold shift at some point, with more than 75% of these reporting that this had occurred during or after a work shift.

A total of 61.5% of staff reported having been taught about the effects and levels of noise exposure at work. Despite this, 55% of staff (82% of bar and catering staff, 60% of door and promotional staff and 20% of technical staff) did not think that hearing protection was available in the venue, while 70% of staff reported never using hearing protection, with 15% using it occasionally and 15% regularly.

When the results are considered by venue, of the 4 venues, 3 had the majority of their staff exposed to levels over the ELV. In one venue, the all bar and door staff were all under the second action level, although the technical staff exceeded ELV. Of the other three venues, in two venues, *all* staff exceeded the upper action level – with most also exceeding ELV, while in the third only one member of staff was below the upper action level.

Conclusion

It is understandable that music venues feel the need to create high sound levels to satisfy audience requirements. However, employees working in these venues should not be put at a health risk. The Noise at Work regulations had been in force for the music industry for two years at the point of this study, yet these results show that in most cases the daily personal noise exposure level of these employees are well over the regulatory limits.

Potentially more importantly, the understanding of the regulations by staff and employers appears to be poor. Despite 61% of staff reporting having had training, few employees were aware of the provision of hearing protection in their workplace, and there was no apparent attempt by employers or managers in the events monitored in this study encourage or enforce the use of hearing protection in noisy areas. Despite the very high proportion of staff reporting tinnitus and threshold shift after work shifts, only one venue appeared to be protecting non-technical staff, and this was primarily due to the construction of the venue in which the bar was segregated from the live show. Technical staff in this venue were still exceeding regulatory limits without hearing protection. In the other three venues virtually all the staff exceeded ELV during their shift.

There was also an apparent resistance to the wearing of hearing protection. When interviewed, some bar staff and sound engineers reported inability of carrying out the job as long as they wear hearing protection, due to communication difficulties and difficulty hearing or balancing the mix. Very few of the staff had been introduced to 'musician's ear plugs' which reduce levels while keeping the tonal balance intact (Patel, 2008).

In summary, from the events and venues monitored, the music industry currently appears to be largely ignoring their legal responsibility to protect staff from high noise levels, despite high profile campaigns to inform and educate the industry (Health and Safety Executive, 2008). In particular, the fact that the industry press gives positive publicity to particularly loud levels indicates a lack of concern for the potential health effects.

Given the large and expanding size of the live music industry, and the young average age of people working in this sector, this suggests a very high number of staff across this industry who are at risk of noise induced hearing loss in later life. These results indicate that a much more strenuous effort needs to be made to both educate workers and employers, and also to enforce the regulations where they are applicable, as implementation of the current regulation does not appear to be generally occurring.

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The authors report no declarations of interest.

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References

ASHA, (2010) *Noise and hearing loss prevention* [website]. American Speech-Language-Hearing Association: Rockville, MD. Available at: http://www.asha.org/public/hearing/disorders/noise.htm. Accessed 17 Nov 2010.

Barlow C (2010) Potential Hazard of Hearing Damage to Students in Undergraduate Popular Music Courses. *Medical Problems of Performing Artists.* V25, (4) pp 175-183

Butterfield D. (2006) *Measurement of noise levels that staff are exposed to at live music events.* Norwich, UK: Health and Safety Executive/HMSO publications

CCOHS (2009). *Occupational Exposure Limits in Canada.* Hamilton, ON: Canadian Centre for Occupational Health and Safety. Noise: Available at: http://www.ccohs.ca/oshanswers/phys_agents/exposure_can.html. Accessed 16 Nov 2010.

European Commission. Directive 2003/10/EC of the European Parliament and of the Council of 6 February 2003 on the minimum health and safety requirements regarding exposure of workers to the risks arising from physical agents (noise). *Official Journal of the European Union, 15 Feb 2003.* Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri= OJ:L:2003:042:0038:0044:EN:PDF. Accessed 18 Nov 2010.

Health and Safety Executive (2005). *The Control of Noise at Work Regulations 2005: Guidance on Regulations*. Norwich UK: HMSO publications

Health and Safety Executive (2008). *Sound advice—Control of noise at work in music and entertainment.* Norwich, UK: HMSO publications.

ISO (2009) International Organisation for Standardization. *Acoustics: Determination of occupational noise exposure—engineering method (ISO 9612:2009)*. Geneva: ISO Technical Committee

Low, A (2009) A phat dance party with a heart. *Audio Pro International,* September 2009: p21-22

NIOSH, (1998). *Criteria for a recommended standard: occupational noise exposure, revised criteria 1998.* Atlanta: National Institute for Occupational Safety and Health., Centers for Disease Control and Prevention; 1998. Available at http://www.cdc.gov/niosh/docs/98-126/. Accessed 16 Nov 2010.

OSHA (2011) *Occupational Safety and Health Standards: 29 CFR 1910.95 Occupational Noise Exposure.* Washington, DC: Department of Labor, Occupational Safety and Health Administration; Available at http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=9735. Accessed 08 April 2011

Patel J (2008) *Musician's Hearing Protection—A Review.* Norwich, UK: The Health and Safety Executive/HMSO

Peters C, Thom J, Mcintyre E, et al. (2005). *Noise and hearing loss in musicians.* Vancouver, Canada: Safety and Health in Arts Production and Entertainment (SHAPE).

RNID (2009): *Noise Exposure–The Facts.* London, UK: Royal National Institute for Deaf People. Available at: http://www.rnid.org.uk/VirtualContent/101700/Noise_exposure_August_2009.pdf.

SCENHIR, (2008) *Potential health risks of exposure to noise from personal music players and mobile phones including a music playing function.* Brussels: Scientific Committee on Emerging and Newly Identified Health Risks. European Commission Directorate General for Health and Consumers; 23 Sep 2008. Available at: http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scenihr_o_018.pdf.

Smeatham D. (2002) *Noise levels and noise exposure of workers in pubs and clubs—a review of the literature*. Norwich, UK: Health and Safety Executive/HMSO publications.