Summer parties in Algarve – DJs and Audience noise exposure

V. Rosão
SCHIU, Vibration and Noise Engineering, Faro, Portugal

R. Constantino
SWORK, Health and Safety at Work, Faro, Portugal

ABSTRACT: The legislative requirement to limit noise exposure of workers is one important achievements of the humanity progress, reflected by European Directives. It is widely accepted that the most important acoustic parameter of the noise exposure is *Daily Noise Exposure Level* ($L_{EX,8h}$, dB(A)). The initial concern of noise exposure was extended, over time, to less obvious work places, such as Music. Recognizing the potential occupational hazards in this sector, Directive 2003/10/EC establishes the obligation to develop a *Code of Conduct*. The present study was undertaken within Algarve, a very important tourism region, where many summer DJs parties are conducted, aimed to access the noise exposure in both DJs and Audience areas. Based on the results of the present study, we can observe that DJs and Audience are often exposed to extremely high noise level and according to this fact several recommendations are suggested to minimize their consequences.

1 INTRODUCTION

The legislative requirement to limit noise exposure of workers is one of the important achievements of the progress of humanity and has a history of implementation, in Europe, of about 30 years, since the publication of the European Directives 80/1107/EEC (OJEC, 1980) and 86/188/EEC (OJEC, 1986). This legislation was revised by Directive 2003/10/EC (OJEU, 2003a).

Since the beginning the essential acoustic parameter for the quantification of noise exposure is called *Daily Noise Exposure Level* ($L_{EX,8h}$) (dB(A): reference sound pressure of 20 μPa), which corresponds to an energetic average of noise levels over time, penalized (higher value) when the daily exposure of the worker is more than 8 hours and benefited (lower value) when the worker's daily exposure is less than 8 hours. The energetic average of noise levels is usually called *A-weighted Equivalent Continuous Sound Pressure Level* and represented by $L_{Aeq,T}$, so we can write (OJEU, 2003a):

$$L_{EX,8h} = L_{Aeq,T} + 10\log\left(\frac{T}{8h}\right) \quad (1)$$

where T is the time, in hours, of the daily noise exposure of the worker.

In 1986 legislation (OJEC, 1986) the limit of the noise exposure of workers was $L_{EX,8h}$ = 90 dB(A) and in 2003 legislation (OJEU, 2003a), currently in force, the limit is $L_{EX,8h}$ = 87 dB(A).

Over time there has been, naturally, an evolution of the quantitative limits referred, as well as an evolution of sensitivity of the population, in general, and of the specialist in this matter in particular. This development meant that the initial concerns centered on noise exposure of workers in heavy industry it was extending, over time, to another type of activities where common sense did not recognize, usually, the existence of risks associated with noise exposure, e.g., in Schools (EASH, 2013) and Music (Behar, 2006).

One of the major problems concerning music activities is that many musicians and entertainment workers, such as DJs, regard themselves as self-employed people or freelancers, which are not covered by general Health and Safety at Work Directive (OJEU, 1989) as well as noise exposure legal obligations. Recognizing the professional noise exposure of these workers and also the potential occupational hazards, Directive 2003/10/EC (OJEU, 2003a) was established. According to this directive and for the case of the music and entertainment sectors, should be established as an obligation, the development, until 2008, of a *Code of Conduct* for these sectors.

The European Communities developed the *Code of Conduct* referred in the form of a chapter (Chapter 8) in the reference (EC, 2008a), which has a Portuguese version (EC, 2008b). The UK has developed the *Code of Conduct* in the form of a single document more extensive (HSE, 2008).

Other aspect of the development which has take place in this matter relates to the emergence of rules limiting not only the noise exposure of workers but

also the noise exposure of the audience of musical performances. For example, the German Standard DIN 15905-5 (GS, 2007) states that at any point accessible to the audience the *A-weighted Equivalent Continuous Sound Pressure Level*, every half hour ($L_{Aeq,30min}$), cannot exceed 99 dB(A). This limitation is more permissive, and possibly better adjusted, than the limit of a maximum value, with the time weighting *Fast* ($L_{FAeq,Max}$) of 100 dB(A), established in the *Guidelines for Community Noise* (WHO, 1999). Note that, although this kind of limitation may have problems associated with the individual liberties of the people, there are studies (PINCHE, 2005) that show its necessity, because they show that a good portion of adolescents visitors of discotheques consider that music is usually too loud and uncomfortable and prefer to listen the music not so loud.

2 CHARACTERIZATION CARRIED

2.1 *Summer DJs Parties in Algarve*

The Algarve (south of Portugal) is a region very popular, especially in summer, for national and international tourists, largely due to having a great number of high quality beaches along its 150 km of coastline. Fun offers, in this region, are many and varied, and lately (some years ago) begun to be fashionable the Summer DJs Parties, where the noise levels are usually high.

As explained in the INTRODUCTION, the music and entertainment sectors have a special consideration of the legislation currently in force in Europe (OJEU, 2003a). For this reason and because there are no known studies about noise exposure in Summer DJs Parties, in Algarve, it was considered appropriate to access the typical noise exposure associated. Have been considered two areas of characterization: one area next to DJs and other area in the Audience (in the middle of the dance floor).

Once the DJs are usually Freelancers, the legal limits (OJEU, 2003a) are not directly applicable, as they applies to Workers, and the definition of Worker in accordance with the Framework Directive 89/391/EEC (OJEC, 1989) is: *any person employed by an employer, including trainees and apprentices but excluding domestic servants*.

Thus, in the absence of legal enforcement for DJs, should be their own the first interested in knowing the noise exposure that they are usually subject and find the best ways to minimize it, since any affectation of they hearing mean, sure, an affectation of they career. Be noted, in this regard, what is established in Council Recommendation 2003/134/EC (OJEU, 2003b).

2.2 *Objective*

The aim of this work is to obtain quantitative data about noise exposures, in DJs area and in Audience, in typical Summer DJs Parties, in Algarve, and analyze and discuss the results and the main problems associated.

2.3 *Equipment and measurements*

Measurements were made near the DJs in 16 Parties (P1-P16) and in the Audience (in the middle of the dance floor) in 9 Parties (P1-P9). The equipment used was a Class 1 Integrator Sound Level Meter. In each Party, measurements were made every half hour, between 00:00 and 06:00 am. Measurement dates were as follows (month-day), all in 2013:

- DJs: P1: 07-28; P2: 07-31; P3: 08-01; P4: 08-02; P5: 08-03; P6: 08-04; P7: 08-06; P8: 08-07; P9: 08-08; P10: 08-09; P11: 08-10; P12: 08-11; P13: 08-12; P14: 08-15; P15: 08-16; P16: 08-17.
- Audience: P1: 08-15; P2: 08-16; P3: 08-18; P4: 08-19; P5: 08-21; P6: 08-22; P7: 08-23; P8: 08-24.

All parties were featured outdoors, so the values obtained are not representatives of Parties in closed spaces. Equipment has been fixed, near the DJ, to the support structure of the mixer (1 meter high and 1 meter away from the DJ's ear), and in the middle of the dance floor fixed to structure (3 meters high).

2.4 *Results*

In Table 1 and Table 2 are shown the results obtained, for *A-weighted Equivalent Continuous Sound Pressure Level*, every half hour ($L_{Aeq,30min}$), and total (6h) energetic average, in the area of DJs. In Table 3 are shown the results obtained in the Audience (in the middle of the dance floor).

The results higher than 99 dB(A), that exceed what is established in German Standard DIN 15905-5 (GS, 2007), are identified in bold.

Table 1. A-weighted Continuous Equivalent Level near DJ (Part 1).

Half-Hours	$L_{Aeq,30min}$ [dB(A)]							
Parties	P1	P2	P3	P4	P5	P6	P7	P8
00:00	75	88	81	75	73	84	**100**	92
00:30	86	91	84	76	84	85	**100**	94
01:00	91	95	90	81	88	87	**101**	97
01:30	94	96	92	85	92	93	**106**	**107**
02:00	95	**101**	93	89	93	96	**104**	**108**
02:30	96	99	93	92	96	97	**105**	**107**
03:00	**101**	**101**	**101**	97	99	97	**103**	**103**
03:30	**101**	99	**104**	**100**	**106**	97	**105**	**106**
04:00	**102**	99	**103**	**100**	**107**	97	**105**	**103**
04:30	**103**	99	**104**	**102**	**106**	98	**104**	**104**
05:00	**101**	97	**103**	**102**	**104**	97	**105**	**103**
05:30	**102**	97	**105**	99	**102**	**100**	**100**	**100**
6h average	99	98	**101**	98	**102**	96	**104**	**104**

Table 2. A-weighted Continuous Equivalent Level near DJ (Part2).

Half-Hours	$L_{Aeq,30min}$ [dB(A)]							
Parties	P9	P10	P11	P12	P13	P14	P15	P16
00:00	84	85	85	87	86	95	91	77
00:30	95	89	89	93	91	**100**	94	88
01:00	**102**	89	96	94	91	**100**	99	95
01:30	**106**	90	97	95	93	**103**	**101**	**101**
02:00	**101**	90	99	98	94	**104**	**100**	**104**
02:30	**103**	90	97	97	97	**108**	**111**	**101**
03:00	**102**	92	98	98	97	**111**	**115**	**108**
03:30	**108**	93	98	**100**	94	**113**	**116**	**109**
04:00	**105**	95	97	99	97	**110**	**116**	**110**
04:30	**104**	93	96	98	93	**109**	**116**	**111**
05:00	**104**	94	97	99	57	**110**	**116**	**112**
05:30	**103**	92	96	100	44	**112**	**110**	**112**
6h average	**104**	92	97	98	94	**109**	**113**	**108**

Table 3. A-weighted Continuous Equivalent Level in the middle of the dance floor.

Half-Hours	$L_{Aeq,30min}$ [dB(A)]								
Parties	P1	P2	P3	P4	P5	P6	P7	P8	P9
00:00	71	84	80	86	96	78	85	81	91
00:30	83	90	89	93	96	83	87	88	94
01:00	88	90	93	93	97	87	90	90	99
01:30	89	90	95	94	96	89	92	91	**101**
02:00	92	89	95	96	98	92	92	92	**100**
02:30	89	88	96	95	97	92	91	93	**111**
03:00	91	91	96	95	**105**	96	95	99	**115**
03:30	92	92	96	94	**103**	92	94	98	**116**
04:00	92	90	97	92	**103**	92	91	98	**116**
04:30	90	90	96	94	**100**	93	92	98	**116**
05:00	89	89	95	93	95	91	92	98	**116**
05:30	93	89	97	93	93	92	91	99	**110**

2.5 *Daily Noise Exposure for DJs*

To determine the *Daily Noise Exposure Level* ($L_{EX,8h}$), with special interest for workers (DJs included, despite the particularities associated with freelancers), given the legal limits applicable, it is also necessary to know the typical daily exposure time.

Once the legislation is historically based on the application to industrial activities, where the noise is typically stable and regular, every working day, it makes more sense to talk about a single value of daily noise exposure. In the case of activities where noise can change from day to day and from season to season (summer, winter), such as DJs, it makes less sense to talk about a single value of daily noise exposure.

Since, even in industries, there may be activities with noise change from day to day, the law (OJEU, 2003a) allows, in these cases, the determination of a weekly average value ($L_{EX,w}$), using the following expression (IOS, 1990):

$$L_{EX,w} = 10\log\left[\frac{1}{5}\sum_{i=1}^{m} 10^{\frac{L_{EX,8h,i}}{10}}\right] \quad (2)$$

where m is the number of working days in the week and $L_{EX,8h,i}$ is de *Daily Noise Exposure Level* in each of these days. This expression is equivalent to:

$$L_{EX,w} = L_{Aeq,T} + 10\log\left(\frac{T}{8h\times 5}\right) \quad (3)$$

where T is the total of working hours during the week.

Equation (1) and equation (3) assume a logarithmic (base 10) variation of noise exposure as a function of the ratio (T/T_0) between the effective duration of exposure (T, in hours) and the reference duration of exposure (T_0, in hours; for daily average T_0 = 8h and for weekly average $T_0 = 8\times5 = 40$h).

The possibility of using an annual average is not provided in the legislation (OJEU, 2003a), although we believe to be appropriate to write the following expression for the calculation of the annual average ($L_{EX,a}$), with greater potential of applicability to cases of greater annual variability of noise exposure, as is the case for DJs:

$$L_{EX,a} = L_{Aeq,T} + 10\log\left(\frac{T}{8h\times 22\times 11}\right) \quad (4)$$

In the above equation are assumed as reference 22 days of work per month and 11 months of work per year, which means T_0 = 1936h.

Table 4 shows the values of $L_{EX,a}$ calculated for the different Parties characterized (see Table 1 & Table 2), and the overall energetic average of all Parties, order by increasing L_{Aeq}, for different annual percentages (T/T_0) of noise exposure (it was assumed no exposure to noise in time supplementary to the percentage indicated and a common working week with 5 days):

- 100%: about 48 weeks per year of exposure.
- 90%: about 43 weeks per year of exposure.
- 80%: about 39 weeks per year of exposure.
- 70%: about 34 weeks per year of exposure.
- 60%: about 29 weeks per year of exposure.
- 50%: about 24 weeks per year of exposure.
- 40%: about 19 weeks per year of exposure.
- 30%: about 14 weeks per year of exposure.
- 20%: about 9 weeks per year of exposure.
- 10%: about 5 weeks per year of exposure.

In bold and on dark gray background are values higher than 99 dB(A) (values extremely high), in bold and on light gray background are values greater than 87 dB(A) (*Exposure Limit Value* of legislation

(OJEU, 2003a)), in no bold and on dark gray background are values greater than 85 dB(A) (*Upper Exposure Action Value* of legislation (OJEU, 2003a)) and in bold and no background are values greater than 80 dB(A) (*Lower Exposure Action Value* of legislation (OJEU, 2003a)).

Note that the analysis of the values of Table 4 should be done with some care, since it is using an annual average not provided in legislation. For example, the International Standard ISO 9612 (IOS, 2009) indicates that the calculations should be made using the so-called *Nominal Day*, or *Nominal Week* (there are no references to a *Nominal Year*), of noise exposure, and this day/week should correspond to a typical day/week (which in some way, in terms of annual average, may be deducted from the values of Table 4) or for security, the highest day/week of noise exposure. The values in Table 4 must be understood as being indicative (and somehow lower bounds), for cases of non-occurrence of a total noise exposure in a year (1936 hours of noise exposure per year). For security, should be used the values associated with the day/week of greater noise exposure, regardless of higher or lesser percentage of annual exposure. Very probably the most suitable exposure value to consider, in each case (for each DJ), should be between the values of Table 4 and the values of the day/week with maximum exposure, but only audiometric tests, prolonged and directed to DJs, can provide evidence about the most appropriate exchange rate to consider for DJs (see, e.g, the chapter 3.3 of reference (USDHHS, 1998) for a more detailed discussion about the best exchange rate). Note also that in some cases and in some instances the DJs use headphones with very high sound intensity, which can significantly increase the noise exposure.

Table 4. Daily Noise Exposure Level calculated for DJs.

Parties	$L_{Aeq,6h}$	$L_{EX,8h}$	$L_{EX,a}$ [dB(A)]									
	ap	100	90	80	70	60	50	40	30	20	10
P10	**92**	**91**	**89**	87	**84**	**81**	77	72	66	58	47
P13	**94**	**93**	**91**	**89**	86	**83**	79	74	68	60	49
P6	**96**	**95**	**93**	**91**	**88**	**85**	**81**	76	70	62	51
P11	**97**	**96**	**94**	**92**	**89**	86	**82**	77	71	63	52
P2,4,12	**98**	**97**	**95**	**93**	**90**	87	83	78	72	64	53
P1	**99**	**98**	**96**	**94**	**91**	**88**	**84**	79	73	65	54
P3	**101**	**100**	98	96	93	90	86	**81**	75	67	56
P5	**102**	**101**	**99**	**97**	**94**	**91**	87	**82**	76	68	57
P7,8,9	**104**	**103**	**101**	**99**	**96**	**93**	**89**	**84**	78	70	59
Av.	**105**	**104**	**102**	**100**	**97**	**94**	**90**	**85**	79	71	60
P16	**108**	**107**	**105**	**103**	**100**	**97**	**93**	**88**	**82**	74	63
P14	**109**	**108**	**106**	**104**	**101**	**98**	**94**	**89**	**83**	75	64
P15	**113**	**112**	**110**	**108**	**105**	**102**	**98**	**93**	87	79	68

ap: Annual percentages of noise exposure. Av.: Average. P2,4,12: P2, P4 and P12; P7,8,9: P7, P8 and P9.

3 CONCLUSIONS AND RECOMMENDATIONS

The noise exposure is one of the most important risks related to the music and entertainment activities, affecting not only professionals but also the audience itself. In an occupational perspective hazards should not be ignored because they can inflect a variety of health and safety risks to workers, such as, hearing loss and other physiological disorders (increasing blood pressure) (HSE, 2008). It is crucial to develop studies quantifying noise exposure of their activities, providing important information for regulations purposes and reviews.

The results in Table 3 show that, in the Audience, only in 2 Parties (P5, P9) was exceeded the limit value of $L_{Aeq,30min}$ = 99 dB(A) (GS, 2007). Note that, for the Audience, the measurements were made in the middle of the dance floor. For Audience zones closer to the DJs, or closer to main loudspeakers, the values should tend to the values presented in Table 1 and Table 2.

The results in Table 1 and Table 2 show that, in the Audience closer to DJ, only in 3 Parties (P10, P11, P13) values were not higher than 99 dB(A).

The results in Table 4 show that, in the DJs area, on all Parties characterized was exceeded the *Exposure Limit Value* ($L_{EX,8h}$ = 87 dB(A)) applicable to workers and established by legislation (OJEU, 2003a), and in 8 Parties (P3, P5, P7, P8, P9, P16, P14 and P15) was exceeded the value of 99 dB (A), which is considered very high. Table 4 shows too that, for the average value of all Parties, is required annual percentage of noise exposure less than or equal to 40% (less than or equal to about 19 weeks per year) for $L_{EX,a}$ to be less than 87 dB(A) (*Exposure Limit Value* of legislation).

Taking into account the values obtained and the explained above, it is confirmed that the noise levels occurring in Summer DJs Parties, in Algarve, are indeed very high. This underscores the need to do something, for the protection of users and for the protection of workers, in particular DJs.

We hope that, having regard to the quantification performed by this work, the people involved become more awake to the effective need of some type of intervention, because the values obtained show a high probability of hearing loss for workers exposed. Note that, in conversations with some people involved in this kind of Parties, is a common observation that, most DJs, have already significant hearing loss.

Note also that one of the measures recommended in the *Code of Conduct* ((EC, 2008a & EC, 2008b) is the existence, in performances with amplified music, of a greater number of loudspeakers, distributed around the enclosure, each of them emitting lower

noise levels, instead of few loudspeakers, located near the stage, emitting higher noise levels to cover the whole area of the enclosure. In all Parties characterized in this work, the loudspeakers stand on the stage, emitting from there to the whole area. Another common type of measure for these cases, is the possibility, for workers and users, to visualize in real-time and on a screen, or similar, the values of noise levels during the Parties, which also was not observed in any of the Parties characterized. Only was observed characterization of noise levels in order to check compliance with the legal noise limits (environmental law) in the Houses in the neighborhood of the Parties.

In order to promote more safety and healthy workplaces, a number of recommendations should be taken in to account, considering not only the freelancer/self-employed workers, but also the employer or contractor, acoustic and health and safety at work professionals.

The major recommendation relies on the fact that contractor and freelancers must work together to achieve the reduction of noise risks. The contractor has the obligation to promote a safety environment for their workers, through risk assessment and implementation of collective or individual measures. When the risks are high, the contractor should manage a prioritized action plan.

Whenever it is possible, the collective measures, as noise control, equipment specification and position should be the first to implement since they protect a high number of people (workers and audience). On the other way freelancers should be aware of the regulations of level noise exposure and also their health consequences. The hearing protection should be implemented when collective measures are not sufficient to reduce or eliminate the noise risk. Point out that some of the DJs observed used hearing protectors, typically with a noise attenuation of approximately 6 dB, which, according to the values obtained is clearly insufficient, if not implemented further action.

It is strongly recommended that freelancer DJs required Health Surveillance for themselves and regularly hearing checks, that prevents hearing damages identifies early signs of hearing loss. Additionally, noise level exposure assessments are also strongly recommended to these professionals, providing the key information to implement preventing measures.

In all of these matters the acoustic and health and safety professionals should play one of the most important role, making not only the required measuring studies, but also advising about the technical problems.

In addition some information sessions must conducted, for both contractors and workers, explaining the main issues concerning this subject.

ACKNOWLEDGMENTS

The authors thank all the people who contributed to the realization of the measurements, especially to Nuno Lourenço, Rui Lopes and Zélia Ramos.

REFERENCES

Behar, A. & Wong, W, & Kunov, H. 2006. Risk of Heraing Loss in Orchestra Musicians: Review of Literature. Medical Problems of Pergorming Atists, 21: 164-168.

Brockt, G. 2010. Control of noise exposure for employees in the music sector. Proceedings of 20th International Congress on Acoustics (ICA 2010). Sydney, Australia.

European Agency for Safety and Health (EASH) 2013. Occupational safety and health and education: a whole-school approach.

European Communities (EC), 2008a. Non-binding guide to good practice for the application of Directive 2003/10/EC "Noise at work".

European Communities (EC), 2008b. Guia indicativo de boas práticas para a aplicação da directiva 2003/10/CE "ruído no trabalho".

German Standard (GS) 2007. DIN 15905-5. Event-Technology - Sound Engineering - Part 5: Measures To Prevent the Risk of Hearing Loss of the Audience by High Sound Exposure of Electroacoustic Sound Systems.

Healthy and Safety Executive (HSE), 2008. Sound Advice: Control of noise at work in music and entertainment.

International Organization for Standardization (IOS) 1990. ISO 1999. Acoustics: Determination of occupational noise exposure and estimation of noise-induced hearing impairment.

International Organization for Standardization (IOS) 2009. ISO 9612. Acoustics: Determination of occupational noise exposure: Engineering method.

Official Journal of the European Communities (OJEC). 1980. L327. Council Directive 80/1107/EEC, of 27 November, on the protection of workers from the risk related to exposure to chemical, physical and biological agents at work.

Official Journal of the European Communities (OJEC). 1986. L137. Council Directive 86/188/EEC, of 12 May, on the protection of workers from the risk related to exposure to noise at work.

Official Journal of the European Communities (OJEC). 1989. L391. Council Directive 89/391/EEC, of 12 June, on the introduction of measures to encourage improvements in the safety and health of workers at work.

Official Journal of the European Union (OJEU), 2003a. L42. Directive 2003/10/EC, of the European Parliament and of the Council, of 6 February, on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise).

Official Journal of the European Union (OJEU), 2003b. L53. Council recommendation 2003/134/EC, of 18 February, concerning the improvement of the protection of the health and safety at work of self-employed workers.

Policy Interpretation Network on Children's Health and Environment (PINCHE), 2005. Final Report Exposure Workpackage 1. European Work Group.

United States Department of Health and Human Services (USDHHS) 1998. Criteria for a recommended standard.: occupational noise exposure: revised criteria 1998.

World Health Organization (WHO) 1999. Guidelines for Community Noise.