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Measurement and assessment of exposure to noise in a working environment - difficulties and responsibilities

PACS:

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ABSTRACT
Decree 2006-892 dated July 19, 2006 transposes European directive 2003/10/EC concerning the exposure of the workers to noise onto the French statute book.
The daily exposure (Lex8h) of workers has to be measured in accordance with French standard NFS 31084 of 2002.
By basing our work on concrete examples encountered in French industry, we have been able to highlight difficulties which may arise when measuring the Lex8h (such as long production cycles in the aeronautical industry, impact of intense acoustic events, and so on) and the solutions can be proposed to overcome them.
The attenuation of personal noise protection has to be determined according to standard NF EN ISO 4869-2 by the application of several methods (SNR, HML, by frequency bands). In addition to the difficulties of applying these methods, we have to be aware that the actual effectiveness of hearing protectors can deviate considerably from their theoretical effectiveness and that ultimately it is the effective duration of wearing the protection that determines the actual protection of workers. Thus, the question then arises as to the guarantee which the responsible entity or person bears for compliance with the Exposure Limit Value of 87 dB (A) when wearing the protection.

FRENCH REGULATIONS

The new obligations applicable to employers are set out in decree 2006-892 of 19 July 2006. They are based on the exposure of workers to noise at various thresholds:
– lower exposure action value : Lex8h of 80 dB(A) or Lpc of 135 dB(C),
– upper exposure action value : Lex8h of 85 dB(A) or Lpc of 137 dB(C),
– exposure limit value : Lex8h of 87 dB(A) or Lpc of 140 dB(C).

The first two values have decreased by 5 dB(A) relative to the previous statutory requirements. Although this is a progressive measure for the protection of workers, it raises an additional difficulty for employers.

Above each of these thresholds, employers are required to implement a certain number of actions. These differ very little from those required by the French text that transposed the 1986 European directive.
However, the exposure of a worker to noise should in no circumstances exceed the exposure limit value. When this occurs, the employer is required to take immediate steps to ensure that it ceases.

The daily exposure level (Lex8h) of workers has to be measured according to the stipulations of standard NFS 31084.
Standard NF EN ISO 4869-2 has to be applied in order to assess the protection provided by personal hearing protectors and thereby compare the level of exposure when wearing the protectors, with the limit exposure value.

MEASURING STANDARD
The method applied to measuring operators' daily exposure is described in standard NFS 31084 of 2002.

The standard describes two procedures:
– "blind" measurements: the readings are taken for all persons working throughout the full shift. This method is only used in exceptional cases;
– after the analysis of the work and grouping of the results into Uniform Exposure Groups, sampling in each group.

Lastly, in the latter case, the standard allows the application of two different approaches:
– breakdown of the activity into tasks (task level measurement), with short duration measurement of each task using a sonometer and reconstitution of all the readings by calculation,
– an approach per post (job level measurement) and long duration measurement using a portable sound exposure meter.

The job level measurement approach requires an analysis of the actual work and not the theoretical work. This analysis proves to be very difficult to implement if it is required to limit the assumptions and the deviations.
However, in certain very special cases, this method can prove to be very useful. For example we have used it in the automobile industry on assembly lines where working times and gestures are highly reproducible. Over a range of several tens of workstations and in particularly carefully controlled experimental conditions, the task approach can be less expensive than the job approach.

However, the job approach has proved to be more suitable in many cases when, taking into account the variability of the work, it is unrealistic to seek to quantify work durations and noise levels which cannot be isolated accurately.

TAKING INTO ACCOUNT INDIVIDUAL NOISE PROTECTION
As mentioned above, a worker's exposure to sound may in no circumstances exceed the statutory exposure value. This has to be calculated with hearing protectors worn.

Three standard methods
Standard NF EN ISO 4869-2 describes the three methods used to calculate the theoretical efficiency of hearing protectors. These are the "octave bands" method, the "HML" method and "SNR" method.
All three are based on the manufacturer's declaration of assumed protection, APVfx.

There are grounds for discussion on the assistance brought by this standard, but this is not the subject of our discussion here.

On the other hand, there are two parameters which are much more determinant than the choice of one of the other of the three methods:
–the actual in situ protection provided by the protectors worn by the operator,
–the actual noise exposure time during which the hearing protectors are worn.

Actual and theoretical protection of hearing protectors
J.G. Casali and M.Y. Park [1] have published a paper on the significant differences that can be noted between the theoretical protection indicated in the manufacturer's notice and the actual protection provided in working conditions. This variation is all the greater when subjects did not follow an appropriate demonstration of their use.
The differences seem to be such that it is illusory to guarantee that the limit exposure values will never be exceeded, except in order to be sure of the quality of installation, the good condition of the protectors, etc..

No particular provision has been included in French law, nor recommendation officially formulated in this respect.

Hearing protectors are only effective when worn

It is worth remembering the difference that the length of time during which the protector is not worn (non wearing duration) makes, assuming of course that the noise received is identical throughout this period.

Table 2 below reminds us that the maximum attenuation of a protector is closely related to the duration of wearing (or not), even before this attenuation can be determined by the type of protector itself.

In fact, if the declaration "always worn" means 95% of the time for a person who ignores this non-linear spread, the attenuation will only be 13 dB and not the expected attenuation. And it will be no more than 10 dB for 90% of the time.

Duration of wearing		Duration of non wearing in % of 8h		Maximum attenuation
4h00	50%	4h00	50%	-3 dB
6h00	75%	2h00	25%	-6 dB
7h12	90%	48mn	10%	-10 dB
7h36	95%	24mn	5%	-13 dB
7h55	99%	5mn	1%	-20 dB

Table 1: predicted maximum attenuation of a hearing protector based on the non-wearing duration

Experience feedback

During a wide-ranging measurement campaign for a large industrialist (involving approximately 1000 subjects), we noted the following information every time we installed the measuring equipment on a person:

– the type of protectors worn (moulded plugs, foam muffs, helmet, no protector),
– durations of wearing declared verbally and anonymously by the instrumented workers.

Lastly, after determining the noise exposure of the workers by application of standard NFS 31084, we examined the declared duration of wearing based on the measured sound exposure levels.

This data does not claim to represent anything other than the workshops in which we carried out our survey. Similarly, it is only an image delivered in situ at a particular time and, does not constitute a true survey. Nonetheless, the results obtained are worth examining. The workers questioned account for approximately 25% of the total population concerned. They cover four industrial sites.

Table 2 indicates the type of hearing protection chosen by the workers. This is relatively varied, which can be explained in particular by the fact that the operations carried out, sometimes guiding the choice of the protector (attenuation range, ease of wearing and removing, discomfort in hot environment, etc.) are not always the same on the four sites.

In passing it is noted that the proportion of workers on 3 of the 4 sites stating that they do not wear the protectors is 50% or more, a figure which is much higher than the proportion of workers with little exposure to noise.

	No protector	Ordinary ear plugs	Moulded ear plugs	Helmets
Site 1	50 %	27 %	15 %	8 %
Site 2	67 %	11 %	15 %	7 %
Site 3	28 %	25 %	41 %	6 %
Site 4	58 %	21 %	0 %	21 %

Table 2: type of hearing protectors worn on the 4 sites of the same company

Among those stating that they wear their protectors (Cf. table 3), are a relatively small number who state that they wear them less than 90% of the time (ie. less than 10 dB attenuation). However, it is possible that this does not take into account those who, among the ones stating that they "always" wear them, in fact actually wear them less than 100% of the time, but are not conscious of the impact of their approximation.

	Always	Less than 90% of the time
Site 1	24 %	25 %
Site 2	31 %	19 %
Site 3	68 %	16 %
Site 4	25 %	25 %

Table 3: declared durations of protector wearing on 4 sites of the same company

Finally (Table 4), we note a certain consistency between the declared durations of wearing and the measured level of sound exposure (the higher the noise levels, the greater the number of workers having to wear protection).
Even so, it is noted that 47% of workers exposed to more than 85 dB(A) still state that they never wear protectors.
If we consider that out of the workers exposed to more than 97 dB(A) daily, 5% state that they use no protection and 19% wear protectors less than 90% of the time, almost one quarter of the workers are theoretically exposed to more than the exposure limit value of 87 dB(A).

	Never	Always	Less than 90% of the time
Lex8h < 80 dB(A)	100 %	0 %	0 %
80 < Lex8h < 85	66 %	12 %	22 %
85 < Lex8h < 97	42 %	31 %	27 %
Lex8h > 97 dB(A)	5 %	76 %	19 %

Table 4: distribution of the declared durations of wearing according to the level of daily exposure of polled workers

CONCLUSION

Lowering the thresholds at which interventions are required to 80 and 85 instead 85 and 90 dB(A) respectively is supposed to benefit workers exposed to noise. The European directive and its transposition into French law stipulates that collective protection actions have to be sought in priority over individual protection. However, faced with these stricter requirements, there is occasionally a temptation on employers to simplify by stipulating that wearing personal hearing protectors is the only answer to the problem.

The actual performances of personnel hearing protectors in working environments are of doubtful validity (not because the protectors may be poor, but rather because they are not always worn in optimum conditions).
We know that the period during which they are worn is absolutely determinant, much more so than the method of calculating their efficiency. Are workers fully aware of this slightly mysterious aspect? We can imagine they are.
Lastly, we have provided modest evidence, more than a survey in the strictest sense of the term, of the conditions in which the protectors are worn (or not) at a large French industrial company, according to the oral and anonymous declarations made to us by the workers.
The results have shown that the wearing of hearing protectors is far from being routine, even when the noise levels are high. An even more pertinent question is possibly the position of the workers most exposed to noise when they do not wear their protectors constantly ?
The results we have obtained, backed by considerations as to the actual efficiency of protectors in work environments seem to justify the fears as to the efficiency of individual hearing protectors providing the only response to the noise exposure of workers.
Note (10) in the introduction to European directive 2003/10/CE should be recalled frequently.

References: [1] J.G. Casali et M.Y. Park: Laboratory versus field attenuation of selected hearing protectors. Sound and Vibration, 1991, 25, 10, pp.28-38