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NOISE EXPOSURE ASSESSMENT: SOME ARGUMENTS REGARDING THE SIMPLIFICATION OF ISO 9612 METHODS

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Abstract
The drafting of standard ISO9612 was the result of efforts by the acoustical community, health and safety actors, and industrial end users alike, who were looking forward to enjoy a way of being able to compare results performed in different countries using the same method. However, the local measuring habits and culture eventually resulted in 3 methods being included in the standard. Over the years, it has been felt by some industrial actors that the requirements regarding measurement time were too stringent for these methods to be always practically applicable and financially acceptable, especially when it comes to the basic assessment of whether a worker is overexposed or not. Is a simplification of the standard feasible and reasonable? Using a few examples, the present paper discusses the matter.

Keywords: Occupational noise exposure, measurement.

1 Introduction

For many years, assessing the noise exposure level of workers often was a painful adventure! Such an assessment was usually required by law, but the way of performing this assessment was left to the discretion of the measurer. This could easily lead to some strong discrepancies between the various measurements so eventually national standards were drafted. Meanwhile, most European regulations defined a warning level of 85 dB(A) over 8 hours and a danger level of 90 dB(A) over 8 hours; whether this included the uncertainty or not depended on the regulation, e.g. in France the sum of the measured exposure noise level plus the associated uncertainty had to be compared to these values [1].
In France national standard Afnor S31.084 [2] was introduced in 1984. While it did point out the difficulties in the assessment and it described the measurement procedure, there was no

procedure for the assessment of the uncertainty. More to the point, there was quite a stir when two consultants for a large company performed measurements according to the standard in two similar industrial plants: the former concluded that 25% of the workers had a noise exposure level greater than 85 dB(A) while the later found that 80% of the workers actually had a noise exposure level greater than 85 dB(A). During the careful investigation that followed, it actually turned out that due to the absence of work analysis one consultant had underestimated the amount of time spent in noisy conditions while the later had overestimated it.
The next draft of standard S31.084 [3] managed to take into account the lessons painfully learned in this matter. It introduced the idea of performing a work analysis in order to detect possible noisy phases in the work pattern that should be carefully investigated. More to the point, it also gave directions regarding the description of the workday using such descriptors as quantity of material or product in and out of the workstation.
In 2003 the European Union decided that it would lower the warning level and the danger level to respectively 80 and 85 dB(A) over 8 hours [4]. This prompted a need to know precisely which workers were in which range of noise exposure. Meanwhile, there was quite a strong need felt by safety managers and measurers of large companies to be able to compare noise exposure data from various plants all over the world. This eventually resulted in a standardization effort by ISO to draft a noise exposure assessment standard that would be applicable worldwide. Standard ISO9612 [5] was born of those efforts. Due to its international origins, it did feature all the usual measurement methods as used by the various parties involved: full day measurement (as practised by North American measurers), job based measurement (as practised in France), and task based measurement (as favoured, e.g., in Scandinavia and Germany). More to the point, being an ISO product, it also featured a method for the evaluation of the uncertainty of measurement according to GUM [6]. This standard was eventually published in 2006 and entered official service with the countries of the European Union within the next three years.
Long gone had been the days where one would pretend assessing the noise exposure level of workers through a mere couple of measurements. One now had to fulfil specific requirements, and that does take time. Complaints regarding the amount of time needed to fulfil the requirements were not long to come back, especially when measurers found themselves confronted to much cheaper competition due to the fact that they did not bother to apply the standard to the full extent.
This does prompt a question: is it possible to simplify the use of the standard, and in the affirmative how and when?

2 ISO 9612 standard

The aim of standard EN/ISO 9612 is to help the user perform the assessment of the noise exposure of workers. The knowledge of this quantity is required by most occupational noise regulations (e.g. references [8,9]). More to the point, in the European Union Countries, regulations usually refer to European Standards in order to avoid the costly process of changing the regulations whenever new trends or techniques were introduced. Thus it was of importance to participants that they could recognize their own measurement culture in the standard. ISO9612 eventually provided for three methods: full day measurement, task based method and job based method. Whatever the choice, a full work analysis is required.

2.1 Measurement methods

The full day measurement method is basically simple: the worker under study is fitted with a dosimeter for his whole working day. If he is the only one to be measured this measurement will have to performed again on two other days in order to get the three samples that constitute a minimum for the assessment of the uncertainty of the measurement; alternatively two other workers performing the same job may be measured on. The full day measurement method was designed as a favorite by the North American members of the workgroup.

The task based measurement method requires the measurer to split the work of each kind of worker into tasks. While this is very useful for the later purpose of noise reduction analysis (and designed as a favorite by the Scandinavian members of the workgroup), experience shows that it very often is difficult to find out how long the duration of a task is. More to the point, during the work analysis, when interrogated about their work the workers easily forget about short duration yet intensely noisy events. For example during a measurement campaign in a cable factory it was later found out that an old ultrasonic cleaner that was daily used for a couple of minutes would generate 105 dB(A) at 2 m but nobody had pointed it out to the measurer! According to standard ISO9612 a minimum of 3 measurements are required for each task (though a higher number may eventually be required according to the standard deviation of the measurements).

The job based measurement method is meant to avoid the complication of assessing the duration of the tasks. A job performed by an individual is made of several tasks; one of the safeties inherent to this method is that should small noisy events be forgotten by the measurer or the worker they yet are taken into account provided that the measurement time is long enough. This was the favorite method of the French members of the workgroup. Experience may have some surprises with this method too: for example looking at the noise exposure of operators working at a same position it was quickly found out that they actually split into two groups, which was due to the fact that the younger ones went out of their control cabin for specific operations while the old hands could perform them from within! According to standard ISO9612 a minimum of 5 measurements are required for each job (though a higher number may eventually be required according to the standard deviation of the measurements). Of course it may be tempting to use a sampling method to perform the measurements but while such a sampling must be randomly made one must make sure to include whatever noisy events likely to occur in this job.

2.2 Homogeneous exposure groups

A Homogeneous Exposure Group (HEG) is a group of workers who are similarly exposed. This notion is not exclusive to acoustics; it has been used for a long time in Chemistry. Those groups are typically made of persons performing the same job or the same task at the same location. Defining such groups on the basis of the work analysis enables the measurer to speed up the measurement effort by actually performing the measurements on a limited number of individuals. For example, for a 25 strong HEG, a 12.5 hours minimum measurement effort is required. The number of individuals to be measured is of course defined according to the actual size of the HEG, and the required measurement time varies accordingly. Depending on the standard deviation of the results among the HEG, it may sometimes be found out necessary to split it into smaller groups. This often results from either deviation in the prescribed work pattern or previously unspotted activity.

One should note that all the workers are to be accounted for. This means that the sum of the HEG people must equal the total workforce under study.

2.3 Defining a nominal day

Whenever the job may be quite hectic, with lots of tasks randomly happening, it may be necessary to try and define a “nominal day”. Such a move allows the measurer to define, on the basis of his work analysis, a day featuring either the average durations of time allocated to the various tasks likely to be encountered during a typical work day, or even a worst case scenario in which all noisy tasks can be encountered.

2.4 Uncertainty

ISO rules require measurement standards to provide means of handling the uncertainty [6]. To this end, ISO9612 has been provided with tools, both in an appendix (normative) and an Excel file (which is part of the standard).

The assessment of the uncertainty was the cause of much debate in the workgroup as well as within the standardization bodies involved. For example, the old French standard typically used an energy approach and considered the unilateral confidence interval, while other standards used the bilateral confidence interval and the noise levels. Following some complementary research and investigations, separate methods were elaborated for the task based method and the job based method. Whatever the chosen method is, a standard deviation value greater than 3 dB between measurement samples results in an oversized uncertainty, thus prompting the measurer to either expand the number of measurements within the HEG or further split that group into smaller HEGs.

3 Regulations

European regulations are based on EU directive 2003/10/EC. This Directive [4] states that the daily sound exposure level $L_{Ex,d}$ should not exceed 87 dB(A) with hearing protections on, while the warning and danger thresholds (as assessed without hearing protectors) are respectively 80 and 85 dB(A). The basic idea is that should the $L_{Ex,d}$ reach the warning mark the employer must warn the workers and provide them with individual protectors; should the $L_{Ex,d}$ reach the danger mark the employer must enforce the wearing of protectors and implement a noise reduction plan. Measuring the sound exposure level of workers is mandatory whenever they are likable to be exposed to such levels. This assessment must nowadays be performed using the relevant European standard [5].

Lastly, it has been specified in another Directive [7] that the employer is requested to reduce noise to its lowest reasonably possible level according to the state of technics.

4 Attempting to simplify the procedure

To start with, the actual requirement of EU directive 2003/10/EC is the risk assessment. Apart from the standard, one can also rely on such tools as noise maps, work analysis and past measurements. This does prompt a question: does one really has to make a very precise assessment of the noise exposure level of workers for such purposes?

Let’s turn it that way: under a certain value the worker is supposed not to be overly exposed and past another value he is supposed to be overexposed. Well, this does sound straightforward enough… as long as the uncertainty of measurement is known. The actual question is: when can one safely assume that the worker falls into one category or another, keeping in mind that the step from one limit to another is only 5 dB?

A simple answer might just be to look at the noise levels at the workstation: should they be lower by 10 dB than the warning level, then one could assume that the worker is supposed not to be overly exposed. Well, this is true as long as those noise levels really stay that low. A colleague reported a case in which the noise levels apparently never exceeded the 70 dB(A) mark, yet the noise exposure level given by the dosimeter was over 88 dB(A). It eventually turned out that during the first two minutes of the shift the worker would perform extremely noisy operations (breaking a crust using a pneumatic concrete breaker during 2 mn, which absolutely no one had pointed out to the measurer). So rule 1 is: always perform a complete work analysis (and make sure it holds itself too). By the way, this is a requirement of the standard. On the other hand, one may safely assume that the worker is overly exposed when the noise levels at the workstation are greater by 10 dB than the danger level.

One might consider performing measurements on a single representative worker for the sake of reducing measurement time. Well, that does prompt a question: what is a representative worker? It is tempting to answer that it is a person properly doing the assigned work; is this really the case of everybody? Is it according to the local prescriptions, or by the customs of the house? There are numerous examples of operators reputedly performing the same job yet featuring distinct noise exposure level values. A colleague reported a case of crane drivers supposedly doing the same job and yet eventually getting two distinct sets of results; it eventually turned out that some drivers stayed in their cab all the time while others preferred to disembark and use remote control close to the action. This does bring us back to rule 1. Furthermore, in our quest to find how to reduce the number of people under examination one eventually stumbles on the notion of homogeneous exposure groups as described in the standard: those are meant to help slim down the measurement effort.

What time should one spend on a measurement? While it is tempting enough to reduce the measurement time as far as possible, one should make sure that all noisy events are really included in the measurement samples.

Assuming that one gets a decent measurement out of whatever worker has been picked up, what is supposed to be the uncertainty? In order to answer that question, one needs a minimum of three measurements [10]. While it may seem a waste of time for chain workers (but do those still exist nowadays?), it really is a bare practical minimum for random exposed workers such as the maintenance personnel.

The standard does give the possibility of defining a nominal day. So it actually is possible to try and squeeze in all the noisy events that are likely to occur during a work day, and reconstruct various noise exposure scenarios from it. Yet, in order to do that, one must really know what the noisy events are, and what their duration is; this means once again that a thorough work analysis must have been performed. More to the point, in order to perform a decent reconstruction of the noise exposure, all the tasks likely to be part of the job must have been properly measured. This does take significant time, and such a move is eventually reserved for noise reduction study purposes.

Let's face it: the standard can actually give the measurer quite a free hand on choosing his level of precision. But usually, the shorter the measurement, the worse the associated uncertainty is. It is up to the measurer to decide whether he can afford to announce a result with more than 10 dB of uncertainty.

. Assessing whether workers are really exposed implies a serious measurement if one wants to check the efficiency of later noise reduction actions. The more exposed the workers, the more they are at risk so the more urgent it is to act. A detailed analysis of the noise exposure will come handy when attempting to decide about the required noise reduction actions.

There undoubtedly will occur a conflict between people wanting to reduce the measurement effort on the grounds of economy, and those willing to carry it out to the fullest.

5 Conclusions

Applying standard ISO 9612 to the full extend does take time. Unfortunately, when one is looking for a reliable noise exposure level result, it does take into account most contingencies and provides a method for the assessment of the uncertainty too.

So, it is probably unrealistic to try and simplify further the measurement procedure. Or is it really? When one is not looking for a precise noise exposure level value but merely for the indication on whether the worker is not supposed to be overly exposed or overexposed, simple measurements can be used. But one must remember that they are an indication of the noise exposure situation, not the real value.

An interesting possibility when assessing the risk could be to exercise the possibility given in the standard to reconstruct a nominal day on the basis of various noise events related to the job. Once again, while this is an interesting and valuable tool for noise reduction purposes, it will only provide an indication of the noise exposure situation.

Rather than attempting to simplify the standard, one might care to show how to take the best advantage of it.

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