UNCERTAINTY OF PEAK NOISE LEVEL MEASUREMENTS – USING STATISTICAL TOLERANCE LIMIT

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1. INTRODUCTION

According to the 2003/10/EC Directive, an assessment of noise at work measurement results should take into account measurement inaccuracies. Measurement inaccuracies are expressed by the measurement uncertainty. The possibility that values larger or smaller than the value recognized as the measurement result may occur is accepted.
The maximum peak noise level $L_{Cpeak,MAX}$ is defined as the greatest value of all values of L_{Cpeak}. By definition, there is no higher value than the maximum one.
A peak noise level measurement uncertainty cannot be determined in the usual way, like for equivalent sound pressure level, i.e. through a confidence interval, because the peak level is a random variable value not a random variable distribution parameter.

2. STATISTICAL TOLERANCE LIMITS OF PEAK LEVEL

From the statistical point of view, the lack of L_{Cpeak} values greater than the maximum one is equivalent to the assumption that the peak level probability density function is equal to zero above the sought maximum value:

$$p(L_{C,peak} > L_{Cpeak,MAX}) = 0 \qquad (1)$$

It would be very difficult to verify this assumption for the sources which occur in the work environment. A continuous probability density function would better model the reality.
Then looking for the absolute maximum value of L_{Cpeak} should be replaced with the measurement of a quasi-maximum value $L_{Cpeak,q}$ being a specified quantile of the continuous $L_{C,peak}$ distribution.

For L_{Cpeak} values measured by the sampling method with the maximum one equal to $L_{Cpeak,max}$ we are interested in determining $L_{Cpeak,q} \geq L_{Cpeak,\max}$, which is not exceeded by the given part q of the population of all the measurement results. This part can be arbitrarily low in order for the probability of the occurrence of a value higher than $L_{Cpeak,q}$ to be close to zero.

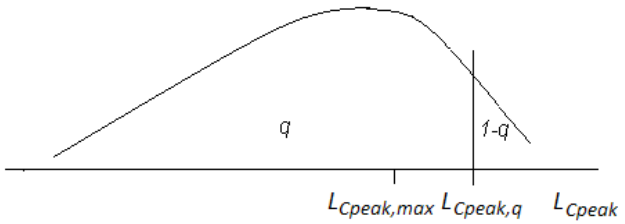

Figure 1. *Quasi-maximum value $L_{Cpeak,q}$ as q-quantile of L_{Cpeak} distribution.*

The above formulation of the problem leads to statistical tolerance limit. The statistical tolerance limit is a value which is not exceeded in q [%] measurements with the confidence $1-\alpha$.
If q is not given e.g. by appropriate regulations, we can estimate them from the results of measurements by the sampling method.
The difference between the tolerance limit and the measured maximum value can be regarded as a measure of measurement uncertainty:

$$U = L_{Cpeak,q} - L_{Cpeak,\max} \qquad (2)$$

3. CONCLUSIONS

The method was applied to the results of measurements in the work environment of opera musicians. The exemplary results indicate that the tolerance limit may be considerable, which provides a further argument for determining the uncertainty associated with L_{Cpeak} measurement.