

OPTIMIZING THE APPLICATION OF EUROPEAN DIRECTIVE 2003/10/CE PERFORMING SIMPLE WED007 DOSIMETRY

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Abstract

European Directive 2003/10/EC requires that noise exposure be taken into account in order to improve working conditions in industry. To meet these requirements, 01dB-Metravib has developed the most relevant device to date, combining technological performances and user-friendliness. Based on wireless communication through a Pocket PC, Wed007 can measure sound levels simultaneously in dB(A), dB(C) and peak(C). Levels exceeding (135, 137 and 140 dB) peak levels are recorded. Based on these results, software dBLexd computes exposure Lex,8h. The dimensioning of suitable solutions can then be efficiently contemplated.

1. INTRODUCTION

European Directive 2003/10/EC deals with minimum safety and health prescriptions relative to workers' exposure to risks due to physical agents. It has recently been transcribed into all national laws of Member States.

These new regulations define exposure limit values triggering actions; employers are now under the obligation to determine occupational risks and adopt appropriate solutions to prevent them. In this statutory context, 01dB-Metravib has designed and developed dosimeter Wed007 and software dBLexd for industrial health specialists. Integrating users' operating requirements, this device allows for an innovating and optimised approach on the work place.

A methodology based on the performances of dosimeter Wed007 and associated software dBLexd is offered in order to comply very efficiently with the operating approach of European Directive 2003/10/EC.

2. EUROPEAN DIRECTIVE 2003/10/EC AND ITS TRANSCRIPTION IN THE NATIONAL LAWS OF MEMBER STATES

Nowadays, occupational noise is a matter of concern to 3 out 10 workers, which represents 3 million individuals exposed to a noise level higher than that listed in the standard1. Evolution has been particularly fast during the past 10 years. Long-time exposure to occupational noise results in irreversible occupational deafness, which has been recognised as an occupational

disease since 1963. This progressive and insidious disease becomes perceptible and annoying for the worker after several years only. The harmfulness of noise on hearing depends on the exposure level and duration. The threshold recognised by the current regulations is 85 dB(A) for an 8-hour exposure. In France, occupational deafness represents about 33% of the pensions paid by the Social Security to compensate all occupational diseases. It is worse for young and senior workers. Currently, the average cost of occupational deafness is estimated to $100 \text{ k} \in$

Noise exposure can also enhance stress and increase the risk of accidents on the work place: poor speech intelligibility, reduced perception of alarm signals, loss of information on the possible motions of the noise source. These factors are all the more present when the operators wear individual hearing protections or when their hearing capacity is degraded.

European Directive 2003/10/EC dealing with the minimum safety and health prescriptions for workers relative to the risks due to physical agents replaces Directive 86/188/EC. Its scope of application deals with the activities for which workers are or may be exposed, because of their occupation, to noise-related risks.

This new directive reinforces the noise prevention and protection measures by lowering lower and upper thresholds triggering an action at 80 dBA (ppeak = 112 Pa) and 85 dBA (ppeak = 140 Pa), respectively. The exposure limit value is equal to 87 dBA (ppeak = 200 Pa) integrating the noise reduction brought by hearing protections.

Brought into force as soon as issued, the directive deals with the following main chapters:

- Determination and assessment of risks: noise levels on the work place must be measured by competent professionals from a representative sample. The assessment must be carried out on a regular basis.
- Reduction and deletion of the exposure: the control of technical elements to attenuate noise emission must occur on site. Regular maintenance operations must be carried out on machines to avoid additional noise.
- Availability of individual protections: suitable hearing protections must be offered when allowed minimum values are exceeded. The proper use of individual protections must be checked.
- Limitation of the exposure: workers must not be exposed to a noise higher than the limit values.
- Information and training of workers: the staff must be informed of risks related to exposure, methods allowing reducing them, authorised limits and appropriate use of protections. Workers are invited to take part to noise reduction approaches.
- Health monitoring: workers exposed to levels higher than limits must take auditory tests. The employer is responsible for updating medical records, which must be made available to workers.

Member States were granted 3 years to perform the transcription of the European Directive.

In France, Decree 2006-892 of July 19, 2006 define safety and health prescriptions applicable in case of workers' exposure to noise-related risks. In order to assess the possible exceeding of values triggering the preventive action, the peak sound pressure level, the daily noise exposure level, and, if need be, the weekly noise exposure level, are determined according to the guidelines of Standard NF S31-084 (2002)². Methods used can include a sampling representative of the worker's exposure. The assessment of measurement results takes into account the measurement uncertainty determined according to metrological practices. Furthermore, to assess the compliance with limit values, when the worker wears individual hearing protections, the worker's effective exposure to noise is determined according to the guidelines of Standard NF EN ISO 4869 (1995)³.

3. INNOVATING PRODUCTS: DOSIMETER WED007 AND PROCESSING SOFTWARE DBLEXD

In order to meet the requirements of health and industry specialists in this statutory context, 01dB-Metravib designed a new dosimeter (Wed007) and processing software (dBLexd). This device has now proven to be the most relevant on the market, combining technological performances and user-friendliness.

3.1 Compact technology

Wed007 consists of a portable, ergonomic and miniaturised housing, hosting acquisition unit, signal processing, data storage and data transfer.

Dosimeter / exposure meter Wed007 includes 2 keys (On/Off, Calibration) and 4 LED on the front panel. LED can be set as inactive upon request, thus limiting any possible disturbance of the worker.

Wed007 can be used on site in standalone mode (instrument only) or in remote control mode.

In stand-alone mode, the instrument is started manually. Microphone calibration is performed, after which noise measurements can be launched. When the test is completed, stored data are immediately - or later on - transferred to a PC and processed with software.

In remote control mode, the operator can remotely manage measurements from up to 5 instruments simultaneously.



Figure 1: Wed007



Figure 2: Pocket PC with dBWed

This is the most technologically advanced type of use as far as monitoring of workers' noise exposure is concerned. It gives dosimeter Wed007 unrivalled power and user-friendliness, which are required for an optimised occupational noise study.

Based on a multiple-point metrological approach, a set of Wed007 is deployed in the work place. The management of the instrument set is achieved from a single Pocket PC: the user operates and controls active Wed007 instruments. All dosimeters deployed in a workshop can then be configured remotely. Several default configurations are preprogrammed for set-up simplification purposes: these are ISO and OSHA configurations. The user programs the immediate, delayed or periodic start of measurements. During the tests, the operator can control acoustic indicators that are displayed in real time on each Wed007 using his/her remote control. The Pocket PC colour screen is the remote, single and user-friendly interface of several Wed007 dosimeters. All acquired information (time/frequency data, written/oral comments synchronised with acoustic measurements, etc.) is transferred to the Pocket PC or to a PC using Bluetooth communication. Simple transfer (selected file) or global transfer (all files) is defined by the operator.

3.2 Performances

Dosimeter / exposure meter Wed007 has an operating life of 50h, with a 40 - 140 dB(A) measurement dynamic range. Wed007 can simultaneously measure instantaneous, maximum and equivalent sound levels, with Slow/Fast/Impulse time weightings and the following A/C/Z frequency weightings: LAeq LCeq LASp LAFp LAIp LASpmax LAFpmax LAIpmax LASeq LAFeq LAIeq LCpk LZpk. 135, 137 and 140 dB(C) peak values are automatically counted. Its simultaneous LAeq/LCeq (1s) and Lpk storage capacity is greater than 100 days.

Moreover, Wed007 calculate daily noise exposure Lex8h, sound energy EAT, noise dose "Dose", noise exposure level SEL (ref. 1s), global average level LAvg, noise exposure level OSHA TWA (ref. 8h), projected indicators: Projected Exposure and Projected Dose, respectively, statistical indices Lxx. Calculations are compliant with the French and international standards on acoustics and electromagnetism⁴.

Furthermore, wireless communication between Wed007 and the Pocket PC remote control offers the operators many benefits, which are greatly appreciated in situ:

- Ease of use and flexibility: instruments located within the Bluetooth range of action are automatically detected, operating control is user-friendly and intuitive
- Fast and unobtrusive operating: the implementation of Wed007 is immediate and without any wiring constraint, the monitoring of sound levels and workers' exposure levels is performed in real time and remotely (the operator can, if he/she wishes so, move, talk, etc. without disrupting the measurement process)
- Efficient and transparent with respect to the production cycle: the on-site deployment deals with a network of Wed007 performing simultaneous measurements, the worker forgets that he/she is wearing a dosimeter and performs his/her tasks with no constraint.

3.3 Software for occupational health specialists

dBLexd is a data processing software compliant with the requirement of current standards and regulations, in particular NF S 31-084 (2002) and ISO 9612 (1997). From information transferred, relevant indicators relative to the workers' noise exposure are calculated. The operator specifies the approach selected during the tests:

- Approach with no work analysis, when exposure is unknown or too complex: measurement is systematic, i.e., applied to all persons concerned. Measurement is performed continuously, during at least 90% of a working day.
- Approach defined by Homogeneous Exposure Groups (HEG) according to the type of work: measurement is applied to a few members of the HEG, selected so as to represent all members of the group. Noise exposure is assessed over a working day. The approach based on positions is recommended when the members of a HEG are likely to have similar workdays. If an individual performs other tasks from one day to another, he/she can be assigned to several HEG defined by task.
- Task-based approach: measurement is applied to each task. After the measurement, noise exposure is re-composed from the task durations of each HEG. The task-based approach assumes a sound knowledge of work situations that allows identifying all tasks, with no omission, and specifying their respective durations

All results that are in adequacy with the standard are calculated by dBLexd. The software clearly states whether there is any incoherence in the approach used by the operator (invalid HEG, etc.) or incorrect calculation results (uncertainty too high, etc.). dBLexd is a precious help for the acoustic mission of the operator.

The dimensioning of suitable solutions can then be contemplated further to the analysis of measurement results. Various simulations are available using dBLexd:

- Wearing of permanent hearing protections
- Wearing of hearing protections in noisy areas (attenuation on threshold)
- Temporary shutdown of a machine (logarithmic attenuation)...

These simulations allow the operator to apprehend a set of solutions. These results are fundamental steps to implement long-term actions and to monitor progress based on the annual update of reporting indicators.

4. AN OPTIMISED APPROACH TO COMPLY WITH EUROPEAN DIRECTIVE 2003/10/EC

Noise generates harmful effects on each worker's health. It also affects the company in terms of productivity loss. Using the aforementioned instruments allows assessing daily noise exposures. It leads employers to contemplate and implement a set of improvements of the current situation. A methodology based on the performances of dosimeter Wed007 and associated software dBLexd offers a very efficient way to comply with the operating approach of the European Directive.

This methodology relies on the identification, assessment and control of potential noise exposures on the work place.

It includes 3 distinct stages, and is named "MAP" methodology:

- Measurement: measurement of noise at the work station
- Action: build-up of the Noise Risk matrix and implementation of action
- Prevention: realisation of long-term control plans

This MAP method is based on Standard NF S31-084. It covers all scenarios and complies with all statutory guidelines. The measurement approach selected for optimised assessment of the noise exposure is the Homogeneous Exposure Group approach.

In the MAP method, external specialists are associated with the employer or his/her representative in charge of occupational health and with the workers exposed to noise to build up the homogeneous groups, to perform and interpret the measurements and to define an action plan. These are essential conditions for the reliability of results.

4.1 Building up Homogeneous Exposure groups is a participative process

Assigning each worker to a HEG must take into account:

- Variations of the noise level in the working environment
- Variations of working activities (production conditions, quantities and type of products, incidents...)
- Variations between employees (importance of work experience, of individual operating mode, variation in the respect of procedures, ...)

After an advanced analysis of the work activity, all elementary tasks of each group are meticulously described. On the field, the specialist checks and validates the HEGs, based on prior noise measurements, if any. Finally, each worker is assigned to at least on HEG. An individual can belong to several groups. A HEG can be made up of a single worker. Configuring the instruments in Homogeneous Exposure Groups using the remote control consists in:

- Creating workshops, assigning the corresponding names and associating brief descriptions
- Assigning one or several dosimeters / exposure meters Wed007 to the previously created workshops
- Time synchronising the Wed007 instruments and the Pocket PC

Installing an individual noise dosimeter on each representative operator allows avoiding following the exposed individual throughout all his/her work activities with a sound level meter. Wed007 can be worn on the arm, on the chest pocket or on the belt of the worker. The dimensioning of suitable solutions (compulsory hearing protection, acoustic study of the workshop, control of noisy machines, etc.) can then be efficiently contemplated, if required. For the most realistic measurement of the sound energy received by each person, the optimum location of the microphone is on the shoulder with a forward orientation. A magnetic fastening device is used for the microphone to avoid any degradation of the clothes and optimise the individual wearing of the system.



Figure 4: How to wear Wed007?

In order to analyze working situations more precisely, a sound level meter can be used in addition to the Wed007 dosimeter / exposure meter to:

- Identify specific noise sources (e.g., machines or production phases)
- Assess the effectiveness of noise abatement technical solutions by performing before/after measurements.

4.2 Optimised MAP method

The various stages of the MAP methods are:

- Establishment of HEG (taking into account of production, machines, organization, procedures, work flexibility) and identification of individuals within each group. Occasional work and maintenance activities, which may generate an important noise exposure source, must of course be integrated to the measurement scheme and the establishment of the HEG.
- Establishment of the sampling program:
 - Achievement of at least 5 noise measurements per HEG. Using the Wed007 pack, which includes 5 complete dosimeters / exposure meters and a multiple battery charger, the entire HEG is characterized at once (measurements are optimized by being carried out simultaneously). For each measurement, selection of the representative worker for the acoustic monitoring, by drawing lots among the various members of the group
 - Definition of the measurement time, representative of the full working time of concerned workers (effective working time Te) depending on the number of individuals in the HEG
- Deployment of one or several networks of 5 Wed007 dosimeters / exposure meters. The microphone is placed on each selected individual, in the plane of the operator's chest, at ear level. Dosimeters / exposure meters Wed007 are clipped to the worker's chest pocket or to belt and connected to the microphones. Microphone calibration is achieved before the measurement.

- Achievement of acoustic measurements with remote monitoring of levels by the operator, using the Pocket PC. Monitoring of perceived noise doses, alarms triggered on threshold violation, etc. Writing of comments on Pocket PC relative to the progress of the tests.
- Transfer of data to software where all standard calculations are carried out: average of measured values L_{Aeq,T} and corresponding standard deviation, extended uncertainties due to sampling and measuring device, global uncertainty, equivalent pressure level L*_{Aeq,Te} and daily noise exposure level for the HEG L_{ex, 8h}, number of violations of Lpk threshold. Assistance is provided to the operator for the analysis of acoustic results. Comments are dated and observable on temporal evolution. He/she can easily edit the automatic report.
- Build-up of the risk matrix: it is a table clearly indicating the noise exposure situation in the environment under study. Required data are number of workers exposed to different noise levels grouped in N0 to N3 categories. This table summarises the risk situation and shows, based on the HEGs, the sensitive areas for which priority action is required. For an exposure lower than 80 dB(A), only information and general training of the staff on noise-related risks and preventive actions are required. For an exposure greater than 80 dB(A), an enhanced set of actions must be contemplated, which includes audiometric monitoring of workers, supply of hearing protections and regular control of the situation (< 3 years). An action plan is written, implemented and controlled for HEGs with high exposure levels.





Figure 5: Noise Risks Matrix

• Establishment of action and control plans: like for all risks, the best prevention method consists in eradicating the risk. Therefore, reducing noise at its source is the most performing method. Sound energy propagation can also be limited through acting between the source and the receiver. Noise reduction at the worker's level, using ear protections, is the most common method. Unfortunately, it is also the least efficient method for noise abatement. Workers' implication in the noise exposure reduction approach is essential for global awareness of existing situations but also of individual behaviours.



Figure 5: Summary of the MAP method

5. CONCLUSIONS

European Directive 2003/10/EC deals with minimum safety and health prescriptions relative to workers' exposure to risks due to physical agents. It has recently been transcribed into all national laws of Member States. Exposure limit values triggering actions have been imposed. Employers are now under the obligation to determine occupational risks and adopt appropriate solutions to reduce them. Dosimeter Wed007 is the most relevant device to meet these requirements, as it combines technological performance and ease of use. With its full openness with respect to the production cycle, industrial health specialists can now operate by increasing on-site measurements of Homogeneous Exposure Groups, according to MAP method (Measurement, Action, Prevention) optimised for the application of directive 2003/10/EC. Long term action and control plans based on Noise Risks Matrix are inscribed in an evolutive approach of working sites.

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