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THE DOSEBADGE – A NEW MEASURING CONCEPT

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1.OVERVIEW

Outside the United States, the use of noise dosimeters has never been the common tool of safety officers engaged in industrial noise measurement. However, since the widespread adoption in many countries of the European Community 'Noise Directive' it is clear that a practical dosimeter is needed to implement the resulting national regulations. Existing instruments such as the Cirrus Research CR:700 series and similar instruments, while designed for this task, were mainly designed with a highly competent professional user in mind. Dosimeters in this class are all characterised by a complex functionality, often with associated computer storage and most require acoustic knowledge on the part of the user. A second characteristic is that most current designs are far too costly for use in mass measuring exercises. With a typical unit costing well over $1000, the investment needed for a full scale noise investigation or even routine screening is very high. The final point was that a new device should meet the new IEC 1252 standard for Personal Sound Exposure Meters, which many current devices could not do. In market research the problems of complexity and cost were usually also followed by complaints against the size and weight of existing units. Most current units are 'shirt pocket' sized and are worn on the belt or in a breast pocket. They then have a cable or tube connecting the unit to a microphone which is routed in the most convenient manner. This location for a dosimeter is clearly not ideal and the preferred location is as near to the ear as possible with no cable or tube to get caught up on external projections. Looking at the reliability of current dosimeters, the cable problem became even more important. Over 50% of repairs to dosimeters are due to a broken microphone cable so simply by getting rid of this the reliability would be doubled. The specification of the

project therefore was a simple list of desirable points.

Small size and low weight
Simple to operate by unskilled staff
Low cost - target half present cost
Reliable - no microphone cable or tube
Meet IEC 1252 as well as the proposed modifications to IEC 651

2.SIZE AND WEIGHT

The largest and heaviest single element in a dosimeter is usually the battery and to reduce this a significant reduction must take place in the power taken by the circuitry. In any dosimeter, there are at least two functions; first the data must be acquired and secondly processed to give the L_{eq}, SEL, partial dose, L_{spd} and any other longer term functions. If some of these functions could be separated into an acquisition unit and a 'read-out' unit, the battery power needed in the acquisition part could be reduced. Such a separation has other advantages in that the amount of circuitry in the acquisition part is significantly reduced as no provision need be made for printer support, read-out, control or calibration; these being based in the 'reader' part of the unit. In any such separation of the parts, the acoustic performance must remain paramount and this initially militated against a very small 'acquisition' head. In the event, a cone shape was chosen, mimicking the microphone cone of a standard sound level meter, with the actual microphone on a small boss. The size and shape of the boss was controlled mainly by the need to plug the device into a standard calibrator meeting IEC 942 and thus an internationally standardised "half inch" was chosen rather than a smaller, non-standard, size. In the event, the small cone is subject to no more acoustic errors than is an actual microphone pinned onto the shoulder of the user. The outline of the unit is shown in figure 1 and it will be seen that the unit is much smaller and lighter than anything that

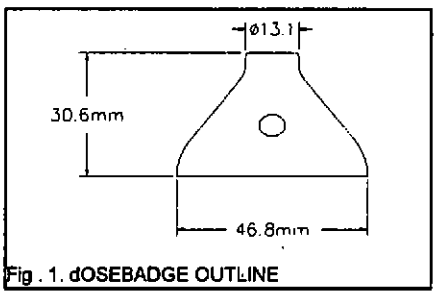

Fig . 1. dOSEBADGE OUTLINE

has gone before. As the acquisition part, or badge, has the conceptual form of most other radiation or exposure badges, the commercial name the 'doseBadge' suggested itself and describes very well the rationale behind the concept.

3.CONTROL AND READ-OUT

Such a small and light device mounted on the shoulder is clearly going to be difficult to control. Indeed, it is almost impossible to fit any meaningful control to the unit, so another strategy had to be followed. The route chosen was to control the badge remotely via an infra-red system and to this end, transmitting and receiving diodes are fitted behind a transparent window in the badge. The protocol followed is serial Infrared to the IrDA SIR standard. The control protocol is fairly simple with only 19 commands being implemented. There is no read-out whatever on the badge, but indicators are provided to tell the user that a command from the remote control unit has been received and is being actioned. This is simply done by 'flashing' the LED behind the control windows. All the parameters required by an industrial noise control specialist are provided on the reader keypad.

4.OPERATION

The battery in the badge is re-chargeable and will operate the unit for about 12 hours at a time. Charging is performed by the reader unit, or if several badges are in use, a separate charger system is provided. Charging is totally automatic and the power is shut off once the correct charge level is reached. Once charged, typically overnight, the badge is then inserted into the calibrator cavity on the reader and a 94dB 1kHz signal is presented to the badge microphone. The calibrator on the reader complies fully with IEC 942 Class 2 and thus the resultant measurement is within the accuracy required for industrial measurements. Once the microphone is in the cavity, the reader sends a CALIBRATE message via a pair of infrared diodes alongside the cavity and the calibration constant for that particular badge is also stored into the badge memory. The reader automatically uses this calibration constant to add or subtract a correction value to each acquired data. Once calibrated, the badge is put into 'sleep' mode where almost no power is consumed. The badge is then fixed to the shoulder or hard hat of the employee to be measured and turned ON by remote control from the reader. The badge is now left for as long as required, acquiring the sound exposure and the acquisition time. Provision is made for a lunch break when the badge can be put back into sleep mode if desired. After the working shift is complete, the badge is put back to sleep by the reader and the acquired data is transferred using the infra-red link. After

data transfer, the badge will be reset and then put back on the charger for the next day session.

5.THE ELECTRONIC DESIGN

Much simplified, the basis of the acquisition unit is a simple current to frequency converter which follows a very accurate mean square generator, which has as its input an 'A' weighted signal. The output from the current to frequency converter is read by a very new sophisticated low power 8 bit micro-controller. The data from the internal computer chip is stored as a simple Sound Exposure Level together with the exposure time for each measurement. At the same time, a parallel second channel, which is 'C' weighted, acquires the peak value as a 'peak hold' measurement. In this way the unit can comply with the first, second and peak action levels of the European Directive. There is no time history data stored, just a single number as simplicity, not complexity, is the key point. When the stored data is transmitted to the reader, any of the current metrics commonly in use can be readily computed and indeed are done so automatically and formatted ready for read-out on the reader display or on a printer or external computer. Even though extensive use has been made of ultra small surface mount technology, the badge can be taken apart very quickly and servicing should be simple for an averagely equipped service centre.

6.COST AND EASE OF USE

Because of the new technology employed, one single package of reader and badge is a similar cost to traditional units. Splitting the unit into two parts and allowing one reader to control up to 25 or more badges leads to a significant decrease in total cost to users, particularly those who have many units in use. Having no controls on the badge and using a simple remote control unit to turn it ON and OFF means that no long learning time is required and of the units so far in use by industry, no training whatsoever has been needed beyond the data in the slim user manual. This contrasts with the extensive training needed with traditional high performance units.

7.SUMMARY

The splitting of the dosimeter into two parts has allowed a single reader to be used with several acquisition heads, significantly reducing the cost to about 40% of previous designs. The performance targets have all been met and the units are already in use with users who would not have considered purchasing a traditional unit.