Proceedings of the Institute of Acoustics

DEVELOPMENTS IN SOFTWARE FOR THE PRESENTATION OF PERSONAL NOISE EXPOSURE RECORDS

David Marsh BSc(Eng), FIOA
Industrial and Marine Acoustics Ltd

1. INTRODUCTION

With the publication of the Consultative Document "Prevention of damage to hearing from noise at work" by the HSE, and the adoption of its major recommendations in the legislature of the United Kingdom and other members of the EEC, it is again emphasised that measurement of noise levels at places of work is important where people are exposed to noise levels which could possibly cause damage to hearing. Whilst there are many uses for such measurements, perhaps the most significant is for the purpose of ensuring that proper records are kept and maintained to provide the on-going assurance that noise levels in specific job functions are not so high as to introduce a risk of hearing damage over a longer or shorter period of time.

As employees and trades unions become aware that compensation for hearing loss is becoming more readily accessible, the importance of such records is growing. Whilst it is relatively simple to demonstrate that an employee has a hearing loss problem, it is less simple to demonstrate that this occured (or did not occur) as a result of his regular exposure to excessive noise at work. Over the six years since the establishment of Industrial and Marine Acoustics Ltd, the Company has been working with the Metrosonics range of personal noise exposure data loggers, and with the cooperation of the occupational hygienists who make up the principal customer base a computer program (IMsoft 301) has been produced to assist in the assessment of personal noise measurements. Since the first appearance of this program on the market some three years ago, it has been refined in consultation with these customers. With the recent appearance of instruments even better suited to the new legislation, the time is right to step back and review the achievements to date and look at the direction for development in the near future.

2. DATA LOGGING PERSONAL NOISE EXPOSURE METERS

A personal noise exposure meter consists essentially of a compact sound level meter to an internationally recognised specification, whose output is monitored continuously by an averaging circuit to provide an overall average of the sound energy received by the wearer. Even this definition makes several assumptions - most importantly:

- that the microphone is placed at a representative location to monitor the energy actually received by the wearer's ear
- that the output is monitored sufficiently continuously to correctly record impulsive noises
- that the wearer does not abuse the instrument in some way for the purpose of falsifying readings.

Having selected a particular instrument configuration, the third of these points is always a major hazard, and anyone who has used such instruments in field measurements will be aware of the major dirty tricks - blowing into the microphone, or tapping it on the bench - and leaving the instrument off the wearer next to a noisy motor or fan. Detection of such practices becomes simple with the logging dosemeter, but until the advent of computer programs it was still difficult for the hygienist to obtain meaningful results from records corrupted in this way, and the inevitable result was time lost in re-measurement.

The instruments we have worked with employ a sampling technique - the Metrosonics db 301 takes 4 samples of the "Slow" response per second - the Larson Davis 710 takes 10 samples of "Slow" response per second - and two sets of interdependent data are easily recoverable:

- the Amplitude Distribution emerges as each incoming sample "clocks up" a count in a level bin to provide a count of the total samples collected in each measurement interval (usually 1dBA intervals) across the dynamic range of the instrument.
- a Time History of the noise exposure can be obtained by specifying a time interval across which the incoming samples are averaged logarithmically to obtain (say) a one-minute L_{Aeq} which is stored in time sequence in the instrument.

Over a number of years work with this type of logging dosemeter, we have gained experience and user feedback from a variety of industries, ranging from the relatively quiet electronics production industries to North Sea Oil Platforms and pilot monitoring in military aircraft. Many different techniques have been adopted for the different measurement purposes, which have necessitated few changes being desireable in the instruments themselves, but have caused us to introduce refinements to the software in handling the data. On the instrument side, we have obtained intrinsic safety approvals to both BASEEFA and HSE(M) requirements, the American Underwriters' Laboratory standards already obtained by the Metrosonics and the Larson Davis instruments being generally inadequate for the requirements of UK and European customers generally.

DEVELOPMENTS IN SOFTWARE FOR THE PRESENTATION OF PERSONAL NOISE EXPOSURE RECORDS

3. PROGRAM FORMAT

The original concept of the program was to provide the facility for the optimum quality of presentation of data from the personal noise exposure logger, both for the operator's report purposes and for his examination and assessment of the data on the computer screen. Additionally, it was considered that an efficient archiving and data retrieval system was essential and, whilst confining the program to the IBM-compatible comuters operating on the MS-DOS operating system, it should be practical for a non-expert computer user to install and operate the program with minimal headache.

Whilst these requirements are reasonably well met today, this was not always so, and again much has been learned from experience. Our minimum requirement today is for a computer with hard disk archiving (although a stripped down system provides data recovery use with a single-floppy disk portable computer if required), EGA (Enhanced Graphics Adaptor) and standard colour monitor, although the Larson Davis 710 will benefit from VGA and a high resolution colour monitor because of the data capacity and dynamic range of the instrument.

A data record may be read directly to the computer from the personal noise logger via an RS-232 serial interface. Today, that interface connection is through a box, external to the computer or logger, which incorporates the Intrinsic Safety protective interface, incorporates any data format conversion required to adapt the logger data to the serial interface, and which provides a software "key" to the system for security purposes. For each incoming record, a database "header" form can be completed to keep a proper note of the test subject, name, date, location and time of the survey, together with any individual comments which may be appropriate to the test. This, together with the overall L_{Aeq} (recalculated from the input raw data using the internal 16-bit floating point mathematics of the computer) is filed away, and individual files may be recovered by file number, or from a search on any number of the six main archiving fields.

Once the data file is archived, it may be examined on-screen. As it is retrieved, the header is presented for approval and reminder purposes and, having accepted this as the file required, a supplementary menu appropriate to the file type - Time History or Amplitude Distribution - is displayed.

4. TIME HISTORY RECORDS

A Time History record may be plotted on screen with the time scale of data expanded to fill the screen, or with a time scale of the reference number of data points filling the screen width. The data points may be scanned with the screen cursor to display the level

DEVELOPMENTS IN SOFTWARE FOR THE PRESENTATION OF PERSONAL NOISE EXPOSURE RECORDS

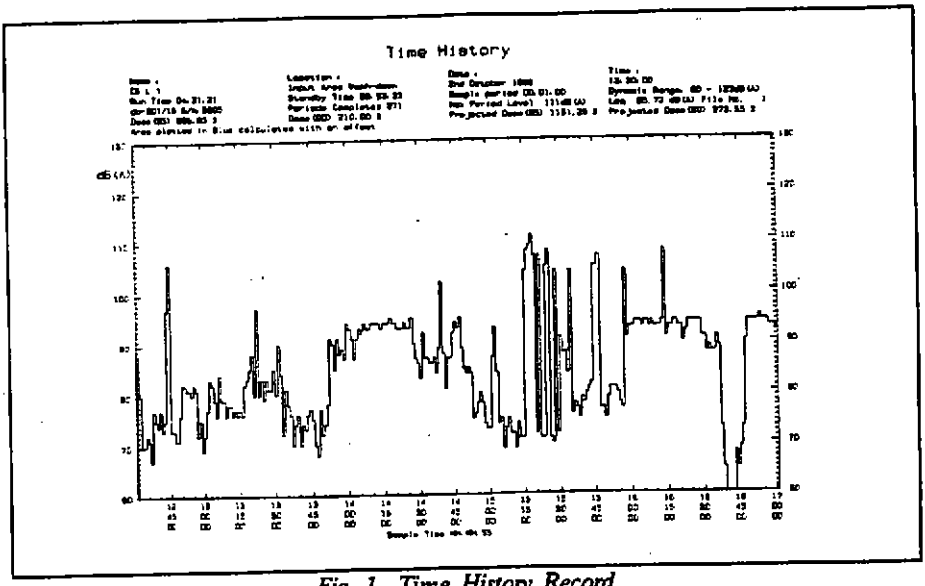

Fig. 1 Time History Record

and time of the incremental L_{eq}. For diagnostic purposes, to determine the effect of noise control measures on personal noise exposures prior to taking full time and effort in design and build, the level of any incremental L_{eq} may be changed using an "Offset". This may be used, for example, to eliminate a peak where it is determined that the test subject has accidentally bumped the microphone, or possibly blown into it. It could simulate the effect of enclosing a noisy machine, or the wearing of ear protection. As the required offset values have been marked on the screen display, a further instruction to the computer causes recalculation of the overall L_{eq} of the record with the marked offsets. This is the "new L_{eq}" value to compare with the "old L_{eq}", which is always the overall value from the unmodified data. By this means, the hygienist can examine the practical measures which are necessary to bring the noise exposure of his test subject within the acceptable limits.

For report purposes, the program facilitates output of the data file to a Printer in numerical format and graphically to a Plotter. The Plotter draws the time history graph exactly as was displayed on screen, including any offset values introduced, and incorporating a header text with relevant information drawn from the file header originally stored with the data. The Printer listing similarly gives a numeric table of data

points, with an indication of which levels have been modified from the original values by introduction of an offset. There is always an indication when data has been modified and it is not possible to save data which has been altered in any way from the original data file output from the logger.

5. AMPLITUDE DISTRIBUTION RECORDS

An Amplitude Distribution file invokes a similar sub-menu, from which the same display options as for a Time History file may be selected. In its normal form, the main use of the Amplitude Distribution is to identify the predominant noise sources in the daily exposure of the test subject. As it provides the percentage of the time for which a given sound level existed, the highest peaks on the record point out the predominant source levels, and any noise source above or close to the criterion level is then identified as a target for noise control measures. The times at which the test subject was in this target area can usually be identified from the corresponding time history record, when the experience of the hygienist, or a few questions to the test subject, will usually identify the

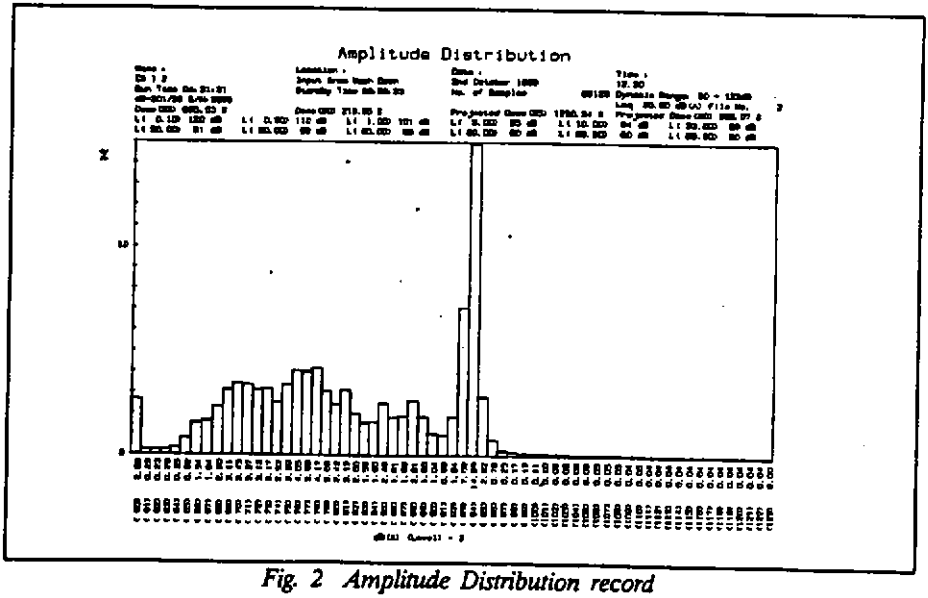

Fig. 2 Amplitude Distribution record

particular work area. Practical means of noise control can then be assessed, and having estimated what level of noise reduction is practical, this may be introduced as an offset on the time history record to determine the likely effect on the subject's daily noise exposure. By this means, the benefit of a particular noise control treatment can be assessed without expense, before deciding whether to go ahead with it.

5. FUTURE DEVELOPMENTS

In service, we have found a greater interest in the Time History record - probably because of the ease in visualising the day's events from the resulting record. This has not been without problems, however, as such a record clearly shows breaks in the work activity - at one factory in particular, it took several weeks for the union representatives to accept that this was a noise monitoring exercise for the benefit of the employees, and not a time and motion study for the benefit of the management. Uncomfortable as this may be at the time, it suggests that our presentation may be about right - and there are no immediate plans to adjust the presentation of the Time History data. Acceptance of such records, however, implies that the record taken accurately represents the typical day-to-day noise exposure of the individual, and the result is difficult to assess where there is a day-to-day variation in the work routine. There is, therefore, some ground for exploration in how we may better average several daily records to provide more information than may be obtained from the proposed legislation's calculation of $L_{EP,w}$ from the $L_{EP,d}$ which emerges from a typical 8-hour record. Although measurement of peak levels is not possible on the long-established Metrosonics instrument, the new IMsoft version which handles data from the Larson Davis 710 has auxiliary time history graphics which provide the maximum peak level in the incremental time periods.

It is in the Amplitude Distribution presentation which we feel that there is more scope for development, and discussion with various users of the IMsoft program have produced ideas which we are now experimenting with to improve the presentation and usefulness of this data. For example, it is relatively simple to average a number of amplitude distribution records, so that in addition to the $L_{EP,w}$ we can provide information on the weekly average of the level distribution. Additionally, experience has shown that the distribution of sound levels is only of interest and of only marginal value in comparison with the time history record. If by a piece of relatively simple computer mathematics we were to convert the Amplitude distribution to an Energy distribution, we would obtain a histogram whose highest peaks represent the most damaging components of the noise exposure record.

Development of the IMsoft programs continue.