inter•noise 83

MEASUREMENT OF SHORT DURATION HIGH LEVEL IMPACT NOISES

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Earlier references [1, 2, 3] have suggested, that in our industries it is the very short sound impulses with a high peak-level, which are responsible for induced hearing loss. If this hypothesis can be accepted, then we have simultaneous and obvious explanations for the following:

a) Hearing loss occurs initially around 4 kHz, even though the maximum energy in industrial noises lies between 250 - 1000 Hz,

b) Noise levels in metal industries should be 10-17 dB lower than noise levels in wood industries for the same hearing loss risk [4, 5],

c) When A-weighted noise levels are used for establishing the risk limits for industrial noise, better correlation is achieved with hearing loss than when using C-weighting, even though C-weighting is intended for measuring high levels as opposed to A-weighting which was originally intended for measuring low levels i.e. around 40 dB(A).

One could therefore ask: are there really noises in our common industries which reach levels as high as 145-160 dB(A) in a short time interval of 30-100 μs? Such short duration impulses cannot be perceived with their correct intensity, simply because our hearing mechanism has an integration time which is 1000 times longer [6, 7]. As our

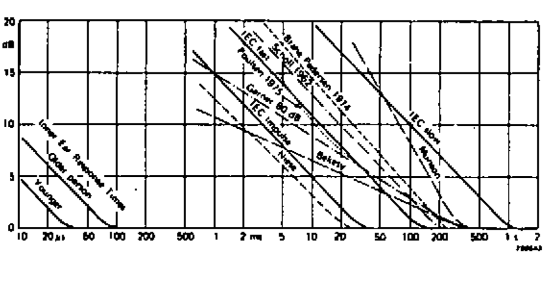

Fig. 1. Results from different researchers of the subjective perception of short impulses compared with the integration curves for time constants Fast, Slow & Impulse of the sound level meter

conventional sound level meters also have the same time constant for "Fast", neither can they measure the maximum levels of the short duration impulses, unless they are adapted specially, to hold the maximum level and with a time constant less than 30 μs, Fig.1.

Commercial sound level meters are available today, Fig.2, which with a flip of a switch can measure dB(A) Fast, dB(A) Slow, 60 s A-weighted L_{eq} as well as Peak-hold with 30 μs rise time. With the use of two such sound level meters and a two channel recorder, or two single channel recorders with synchronized paper feed, it is possible to record both the maximum sound level within each 1/3 second, as well as A-weighted L_{eq} for each minute, Fig.3. The instruments are mounted in a wooden box which can be locked and can withstand hostile environment. The sound level meters and the recorders use very little current, and are fed from four car batteries, which permit measurements to be carried out over a week without supervision. The recording papers are fed to a pocket which can accommodate a weeks continuous measurement results.

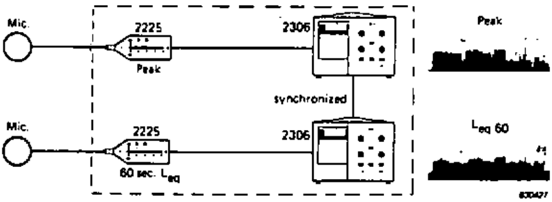

Fig.2. Two Sound Level Meters with synchronized level recorders for recording max. peak levels every 300 ms. and L_{eq} every minute

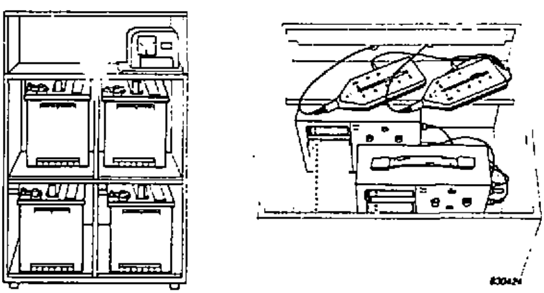

Fig.3. The instruments are protected in a waterproof box and powered from four car batteries

Fig.4 shows some results obtained from measurements over a period of two hours in a carpenters workshop. L_{eq} is approximately 91 dB(A) and the maximum peaks 121 dB(A) – a difference of approximately 30 dB. Fig.5 shows corresponding results measured in a relatively quiet workshop for drilling and sheet metal work. The L_{eq} measured was only 84 dB(A), but the peaks measured at some instances were as high as 131 dB(A) – a difference of approximately 47 dB. The results from a workshop with punch presses are shown in Fig.6, where the L_{eq} = 89 dB(A) and peak levels are 136 dB(A), illustrating again a difference between L_{eq} and peaks of 47 dB.

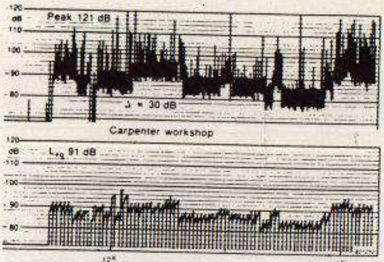

Fig.4. Recordings of Peak Levels and L_{eq} from a carpenter's workshop

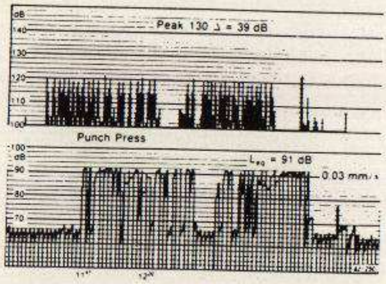

Fig.6. Recordings of noise from punch presses

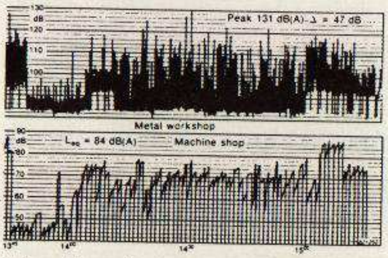

Fig.5. Recordings from a metal workshop

Using this method, measurements have been and are still being carried out in several workshops. However, the overall findings are the same: when working with metal, nail guns, stone crushing plants, bottle cleaning plants etc., there is a large difference between L_{eq} and peak levels from 30-50 dB, and in some cases even up to 60 dB. On the other hand where work is carried out on wood, plastic and other soft materials, the difference between peak levels and L_{eq} is rarely over 35 dB, and as a rule as low as 20-25 dB. This verifies W. Passchier-Vermeer's results [5] for comparing the different industrial noises for hearing loss risk, which was found from direct correlation between L_{eq} and actual hearing losses.

We have found, that the short duration high level sound impulses were in general caused by two metal parts striking each other at short distances from the ear. Work with even small hammers can produce very high sound levels of short duration. Fig.7 shows the time histories and frequency spectra of sound impulses from some hammer blows. The short duration of the impulses (30-50 μs) should be noted, and that the maximum levels of the impulses are in the frequency range above 4 kHz. The latter explains why the induced hearing losses occur mainly in the frequency range around 4 kHz.

At present it is normal practice to set the limits for hearing loss from A-weighted L_{eq} levels. Even with the assumption that the short duration impulses are the primary cause of hearing losses, L_{eq} can nevertheless, in many cases be used as a measure for setting

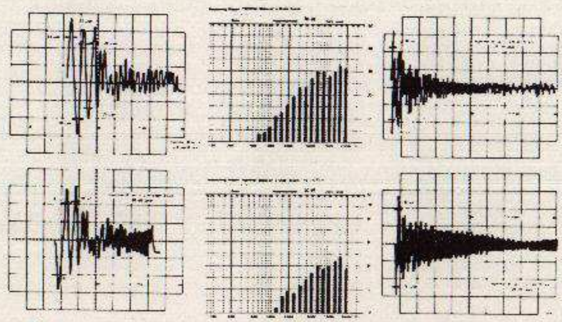

Fig.7. Hammer blows on different metals

the limiting values, as there is often relation between L_{eq} and peak levels. However, if this has to be done realistically, it is necessary to establish different limiting values depending on the character of the work. For example, the maximum L_{eq} in a carpenter's workshop should be set approximately 15 dB higher than the corresponding L_{eq} for metal workshops. Our results indicate that peak levels up to 145 dB as a rule are harmless, whereas levels above this start to have risk for the most sensitive persons. Under the assumption, that the maximum difference between Peak levels and L_{eq} measured to date, is approximately 60 dB for metal workshops with hammer blows and 45 dB for wood working industries with hammer work, the maximum permissible L_{eq} values should be 85 dB(A) for metal industries, and levels as high as 100 dB should not present significant risk for hearing loss for working with wood.

There is still need for further investigations for correlation between the induced hearing loss and the measured Peak- and L_{eq} levels. Among them the role of the number of high level short duration impulses for hearing loss should be investigated. It can be assumed that the number of high level impulses and their duration will have some influence on the hearing loss, completely analogous to our findings about hearing losses caused by light weapons.

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