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EXPOSURE TO INDUSTRIAL IMPULSE NOISE

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INTRODUCTION

Exposure to noise is related to both the equivalent level and the impulsiveness of the noise. The level of noise exposure is measured outside hearing protectors, which are commonly used in noisy workplaces. Although hearing protectors were acoustically tested, their attenuation in field conditions can differ remarkably from the test value. A second problem is how the hearing protectors attenuate impulses. In this study a method for simultaneous measurements outside and inside the earmuffs were developed. The method provides the equivalent level as well as information about the impulsiveness, which is based on our new definition as presented and approved at the International Symposium on the Effects of Impulse Noise on Hearing at Malmö in 1980 /1/. This method will be applied for the measurements of noise exposure in eight main industrial branches. In this paper the method is described, and the results from a foundry are presented.

Impulsiveness

The new definition of impulsiveness (I) is based on the difference between the A-weighted peak levels (L_{AP}) and rms-levels (L_{AS}).

$$I = L_{AP} - L_{AS}$$

The definition is related to the effective length of an impulse. Impulsiveness, especially for single impulses, is easily determined with a sound level meter.

Impulsiveness I varies continuously, especially in industrial noise. This variation leads to the use of the cumulative distribution function denoted by F which can be calculated with a microcomputer and a digital signal analyzer. From this function the impulsiveness percentage F_{15} was selected to describe the impulsiveness. This parameter gives the portion of the time of the recording when the impulsiveness value of 15 dB was exceeded /2/.

Measurements

For the measurements inside the earmuff a miniature microphone was attached to the earlobe at the middle of the ear canal. A normal microphone of the same type (Knowles 1802) but with a 1/2" cylindrical housing was attached outside the earmuff /3/. Two noise dosemeters and detectors were connected to a PCM transmitter (weight 1.5 kg) carried by the worker. The L_{AP}-levels were detected with a peak-hold circuit to transmit the envelope of the impulses with the telemetric equipment, which had a limited 200 Hz bandwidth. The rise time of the peak detector is 50 µs, the hold time 20 ms.

The signals received were recorded with a FM tape recorder. The range in the wireless transmission of the telemetric signals was about 40 meters. Totally 14 ten minute samples were recorded during the main work periods. In addition the sound pressure signals from inside and outside the microphones were recorded on tape in order to analyze the transfer functions of the earmuffs. This was possible only for grinders and founders, who were in the same positions while they worked.

The correction for the frequency responses between the miniature and normal size microphones together with the noise dosemeters was measured in an anechoic chamber.

RESULTS

Both the equivalent level and impulsiveness were attenuated by the earmuff (Fig. 1).

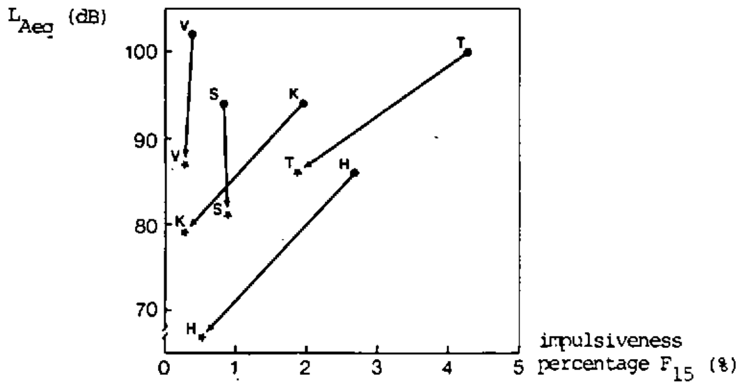

Fig. 1. The A-weighted equivalent levels and impulsiveness measured both inside and outside the earmuffs of foundry workers • = outside, * = inside, K = molder, T = cast inspector, S = smelter, V = founder, H = grinder.

The attenuation of L_{Aeq} was between 13 and 19 dB, and the effect on the impulsiveness percentage ranged between +2,2 % and -0,1 %.

Table 1. The attenuation of the A-weighted equivalent levels and impulsiveness measured both inside and outside the earmuffs

Occupation	L_{Aeq} outside	L_{Aeq} inside	L_{Aeq}	F_{15} outside	F_{15} inside	ΔF_{15}
Grinder	86	67	19	2,7	0,5	2,2
Cast inspector	100	86	14	4,3	1,9	2,4
Molder	94	79	15	2,0	0,3	1,7
Smelter	94	81	13	0,8	0,9	-0,1
Founder	102	87	15	0,4	0,3	+0,1

The transfer functions of two earmuffs of the same type worn by a grinder and a founder are presented both with and without correction (Fig. 2). A microcomputer was used for the integration of the corrected narrow band transfer function over octave bands. The earmuffs were tested with a subjective method (DIN 32760, 1982).

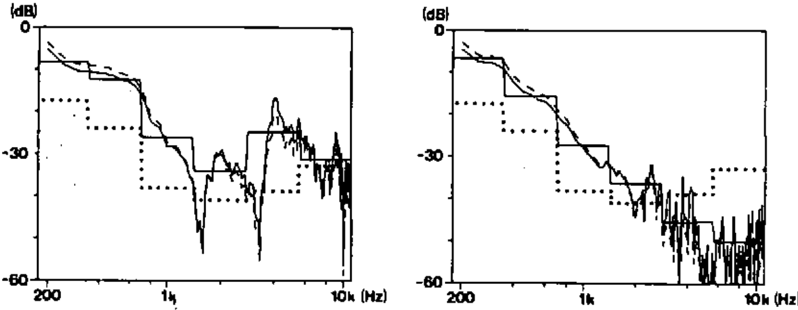

Fig. 2. The transfer functions of the earmuffs ---- original. —— corrected narrow and octave band ..... tested in laboratory a) grinder b) founder

CONCLUSION

The earmuff attenuates both the equivalent level and impulsiveness. The smelters and founders were exposed to the least impulsive noise, and the attenuation of impulsiveness by their earmuffs was also the smallest. The cast inspectors and grinders were exposed to impulse noise caused by the impacts between the castings in the conveyor belts. The attenuation of the earmuffs varied highly within the frequencies of 4 kHz and 8 kHz, which may be caused by the poor fitting of the earmuffs. Outside the earmuffs of the founders and grinders, the noise spectra proved to be similar also at high frequencies. In the lower frequencies the attenuation measured in the laboratory was about 10 dB better than that measured in real work conditions.

REFERENCES

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