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EVALUATION OF ACTIVE HEARING PROTECTORS WITH HIGH LEVEL IMPULSE NOISE

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1. INTRODUCTION

The military noise environment, especially in tanks and helicopters, is characterized by very high levels at very low frequencies, as can be seen in figure 1. These low frequency noises cannot be attenuated significantly

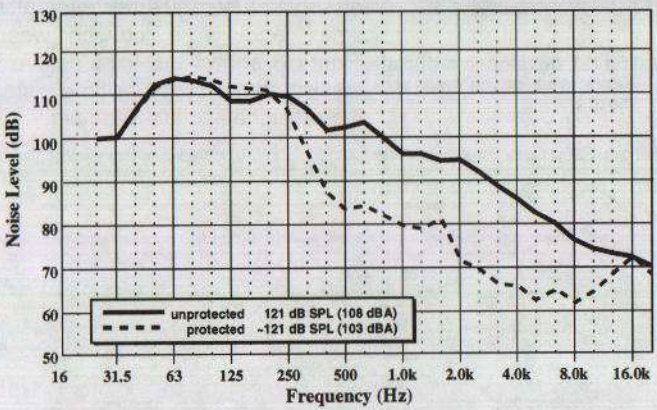

Figure 1: Third octave band levels of the noise

by passive hearing protectors, but only by protectors including **A**ctive **N**oise **R**eduction (ANR). Another type of noise, which is often encountered in the military environment (e.g. in tanks, self propelled howitzers etc.) is very high level impulse noise, and so some of the soldiers undergo both types of acoustic solicitation during a mission. It is then important to know how ANR equipped hearing protections work when they are submitted to high level impulse noise.

2. EXPERIMENTAL SETUP

Four different commercial available head sets were tested. The Insertion Losses (IL) were measured with the ISL artificial head (figure 2) [1] including an ear simulator. This artificial head was especially designed for IL measurements with high level shock waves. Its dynamic range over the whole auditory frequency spectrum is better than the IL that might be found for hearing protectors (>60 dB @ frequencies < 500 Hz, up to 90 dB for in the mid-frequency range).

Figure 2: The ISL developed artificial head used for the measurements

The IL of all headsets was first measured with continuous (pink noise) noise at 115 dB SPL.

For the test with shock waves, the hearing protectors were exposed to "Friedlander" waves ranging from about 120 dB to 190 dB. The A-durations of the signals were ~0.5 ms and ~1.8 ms. These two types of shock waves are representative for small and large caliber weapons. Figure 3 shows the third octave band levels and the pressure-time history for typical signals in the free field.

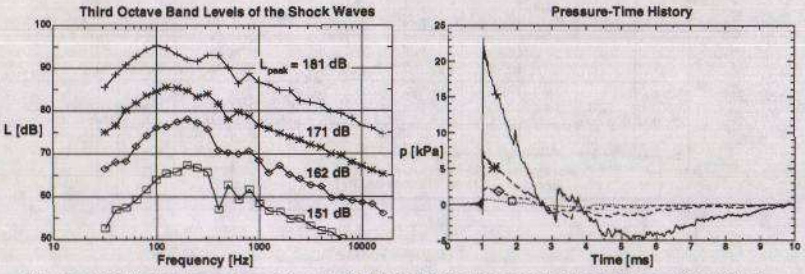

Figure 3: Third octave band levels (left) and the pressure-time history (right) of shock waves with different peak levels and an A-duration of ~1.8 ms

3. RESULTS

Continuous Noise

The overall IL of the active hearing protectors, when tested with continuous noise (pink noise, 115 dB SPL), are shown in figure 4. Figure 5 shows the contribution of the ANR to the IL. For all devices, the maximum

effect of the ANR is situated at about 125 Hz. The maximum active at-

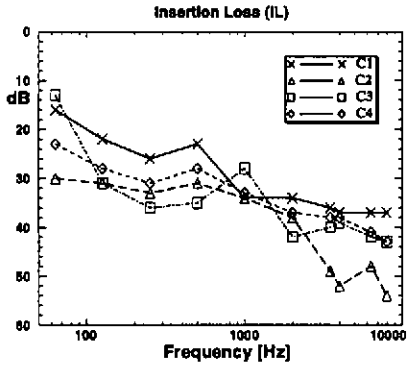

Figure 4: IL measured with pink noise for different hearing protectors

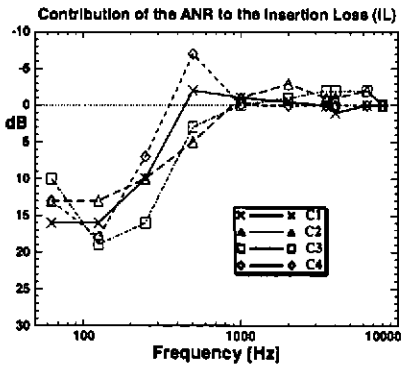

Figure 5: Contribution of ANR to the IL for the different hearing protectors measured with pink noise

tenuation ranges between 13 and 19 dB. The 0 crossover is found between 400 and 800 Hz.

Impulse Noise

Figure 5 shows the influence of ANR on the pressure-time history of the signal at the "ear-drum" of the ear simulator for two different shock waves (left: L_{peak} = 150 dB; right: L_{peak} = 160 dB). The A-duration is about 1.8 ms for both signals.

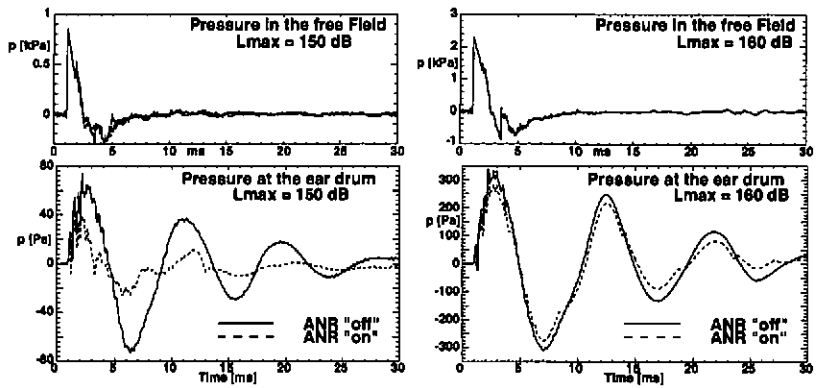

Figure 6: Pressure at ear drum (lower) with and without ANR for two shock waves with different peak pressure levels (left: 150 dB; right: 160 dB) in the free field.

It can clearly be seen:
- only the low frequency components in the signal under the protector are attenuated
- that the ANR is no more efficient for the 160 dB peak pressure level.

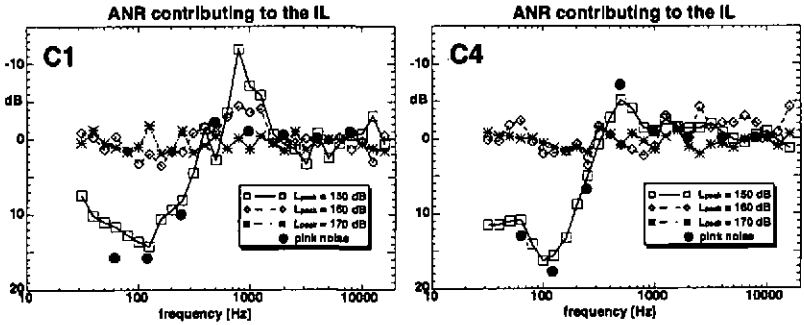

Figure 8: ANR in different third octave bands, contributing to the insertion loss for different peak levels (150, 160 and 170 dB) of impulse noise (A-duration = ~ 1.8 ms), measured for two different protectors (C1, C4). The filled circles correspond measurements with continuous pink noise (figure 4).

If the contribution of ANR for different third octave bands is measured at different peak pressures (figure 8), the values measured at "moderate" pressures (up to 150 dB) are close to those found with continuous noise.

For higher peak pressures however, the ANR-contribution disappears. For shorter "Friedlander" waves we have seen equivalent results.

4. CONCLUSIONS

The active noise reduction (ANR) in hearing protection devices (ear muffs) contributes for impulse noise in the same way as it does for continuous noise. However, at high levels, this effect disappears. This is certainly due to some protective mechanisms and/or to the saturation of the system that avoids an overload of the electroacoustic system and possible instabilities. Therefore, if using ANR-devices when undergoing high level impulse noise, only the passive part of the IL should be taken into account.

Reference

Franke R., Parmentier G., Buck K., ISL-Report, R 112/94 (1994)

Acknowledgment

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