TESTING OF ANR (ACTIVE NOISE REDUCTION) HEADSETS

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1 INTRODUCTION

ANR is a technique by which a signal of equal characteristics but with opposite phase is injected to neutralize the original one. Although patented in the early 30th, it was only in 1957 that it was adapted to earmuffs. And it was only in the last 20 or so years that the technique started to be applied outside of the research labs for practical applications.

The main advantage of the use of ANR headsets is the increase of the attenuation at frequencies below 1KHz. There is no significant reduction of the risk of hearing losses at those frequencies. However, due to the forward masking phenomenon, a reduction of the sound level at low frequencies results in an improvement in intelligibility and the consequent ease in oral communications. Therefore, the two main applications of those headsets is in communications and in comfort.

A typical ANR includes a microphones, processor and speakers under each of the cups. A communication headset also includes means to inject the audio signal and a noise excluding microphone. The "comfort" headset, found mainly in executive classes of airlines does not include those means.

There are two main characteristics that can be measured in an ANR headset. They are the attenuation ad different frequencies and the intelligibility as perceived by the wearer under different circumstances (types of noise and sound levels). Although testing of those characteristics is something manufacturers as well as authorities are interested in, there are still no test methods standardized or even recognized. Right now, in Canada, researches are underway (at the DCIEM and the NRC among others) trying to design a testing protocol that could be universally accepted.

The Sensory Communications group at the University of Toronto is presently studying a method that uses an Acoustical Test Fixture (ATF or Artificial Head) and allows for the measurement of Insertion Loss (IL). The attenuation could be, eventually calculated using the IL values.
At the present, we are interested in the repeatability from consecutive measurements on the same protector, between protectors of the same type, as well as comparison between protectors of different types and from different manufacturers.

2 MATERIALS AND METHOD

The protectors we are presently testing are:

a) one "comfort" supra-aural (Supra-aural are muffs that seat on top of the pinna, those providing limited attenuation even at high frequencies.)
b) two "comfort" circumaural (Circumaural muffs cover completely the pinna providing excellent high frequency attenuation), and
c) one flying helmet

Protectors are mounted on the ATF, that is a mannequin with one instrumented ear. Features of the mannequin include circumaural area, pinna and auditory canal fabricated with simulated skin and tissue which retains the correct dynamic mass and textural properties of human flesh. The auditory canal is terminated in Zwislocki type DB100 coupler and B&K type 4134 microphone that simulate the acoustical impedance of human ears. Measurements were performed on the left ear of the ATF, the only ear that is instrumented.

The measurements were performed in a IAC Double walled, double room Audiometric Cabin. The pink noise signal used for the tests was generated by a General Radio Random Noise Generator Type 1382, amplified by two Rotel Stereo Integrated Amplifiers Type RA-930AX (50W) and fed into the cabin via four Mirage Speakers Type M-90is and four horn loaded piezoelectric loudspeakers Motorola type KSN1016. The resulting signals where detected by the microphone in the ATF and analyzed by a B&K Dual Channel Real-time Frequency Analyzer Type 2144. Measurements were performed in 1/3-octave bands at the frequencies between 20 and 8,000 Hz.

Each series of measurements consisted in the IL measurements of one protector repeated three times. To do so, first, the sound level (SL_1) of the open ear was measured at each of the test bands. Then, the muff was donned on the head with the ANR switched off and the sound level (SL_2) of the passive mode was measured. Finally, the ANR was switched on and the sound level (SL_3) of the totally protected ear was measured again. The series were repeated three times. Each time the headset was donned and taken away.

3. RESULTS

Some preliminary results from tests on are shown in Figures 1 and 2.

Figure 1 shows results from a series of three tests of the supra-aural muff.

Figure 1A shows the IL of the muff in "passive" mode (difference of SL without and with the muff, with the electronics off). Shown are the results of the three tests as well as the mean IL.

Figure 1B shows results of the active IL (difference of SL with the electronics off and on).

Figure 1C shows the total IL (difference of SL without and with the muff on, with the electronics on).

Figure 2 shows results from a series of three tests of the circumaural muff.

Figures 2A, 2B and 2C shows the results from the same tests as in 1A, 1B and 1C

Figure 1A. Supra-aural, three tests, PASSIVE IL

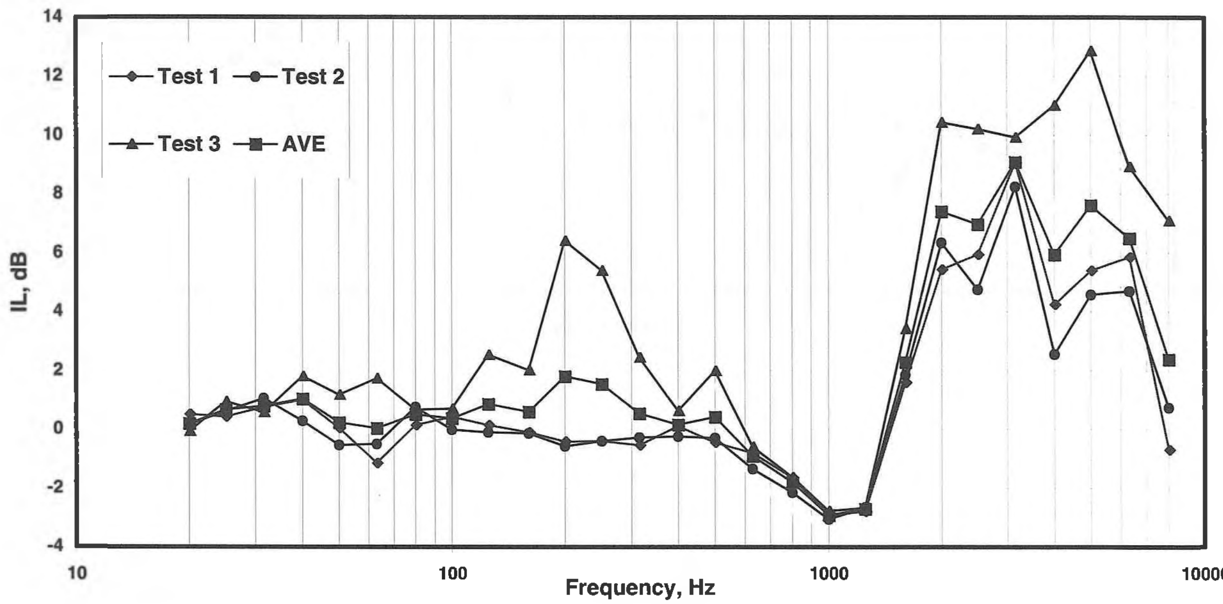

Figure 1B. Supra-aural, three tests ACTIVE IL

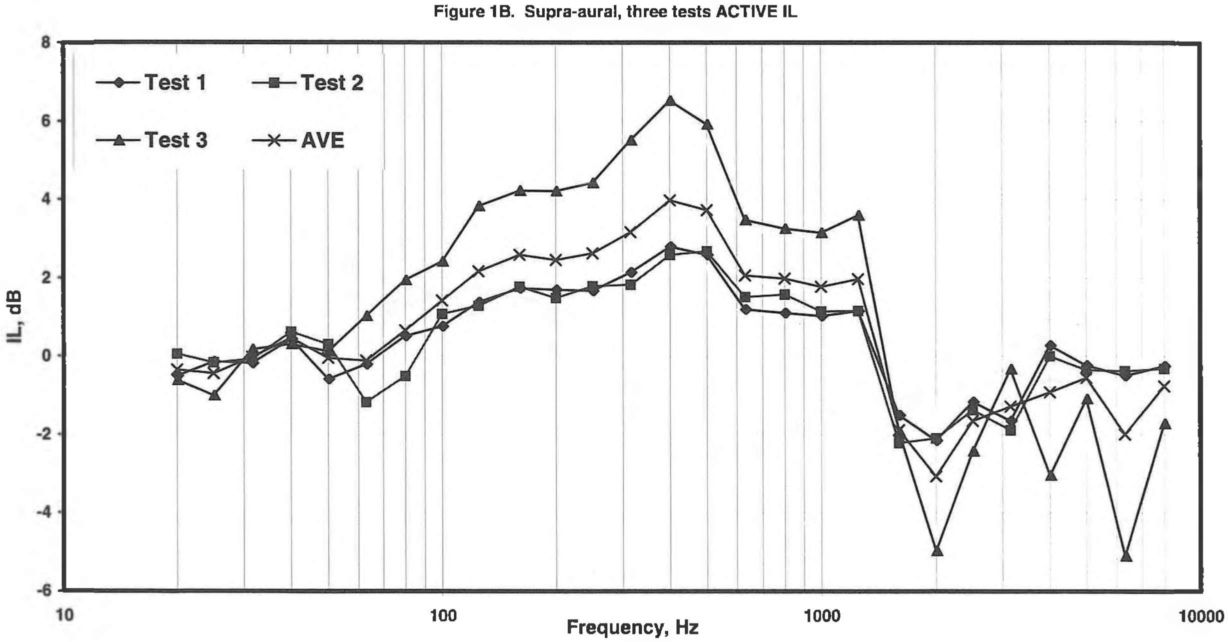

Figure 1.C Supra-aural, TOTAL IL

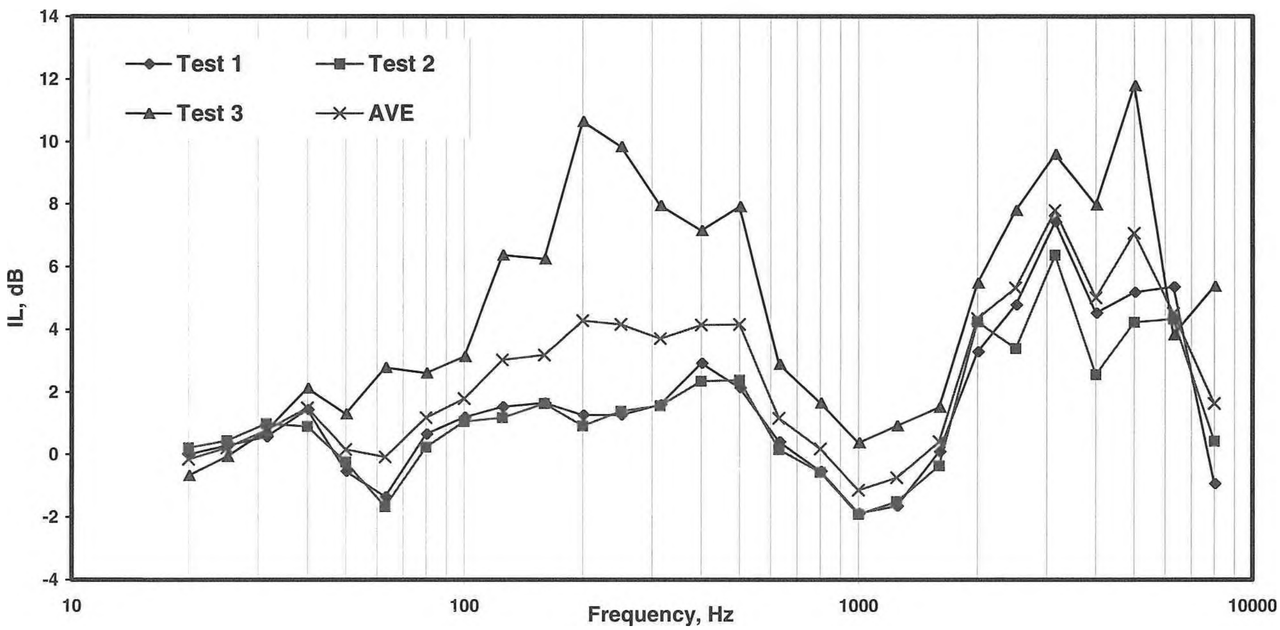

Figure 2A. Circumaural, PASSIVE IL

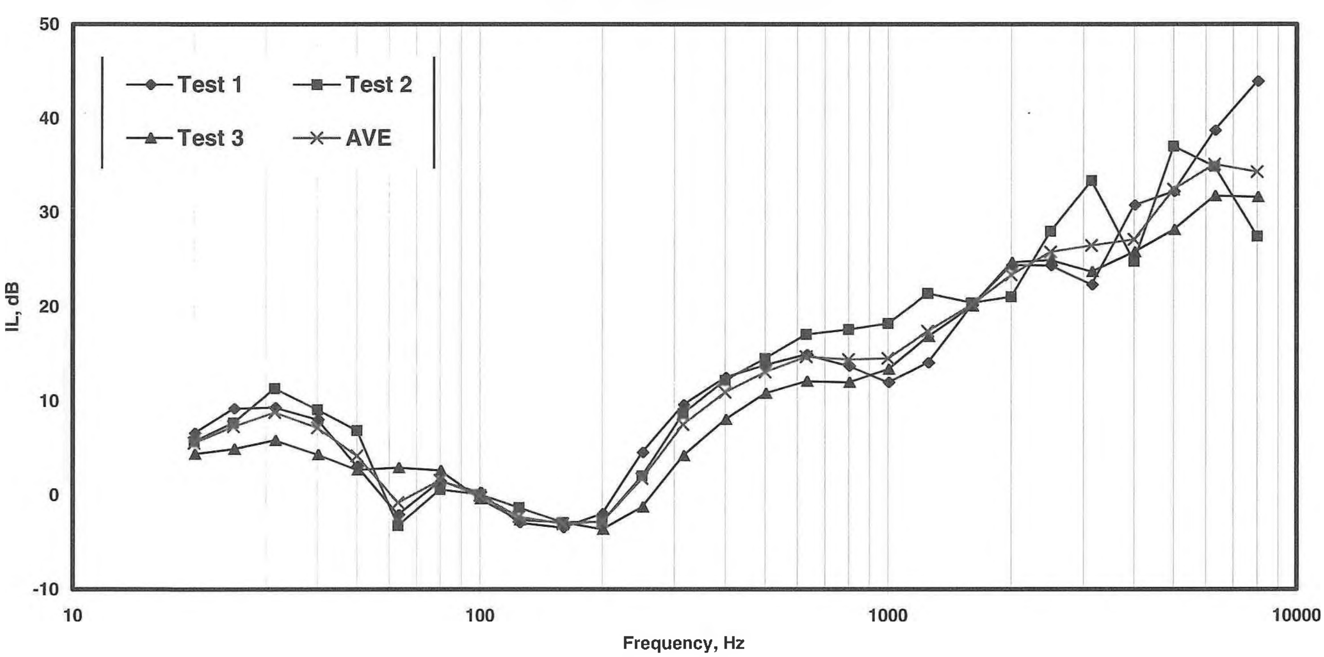

Figure 2B. Circumaural, ACTIVE IL,

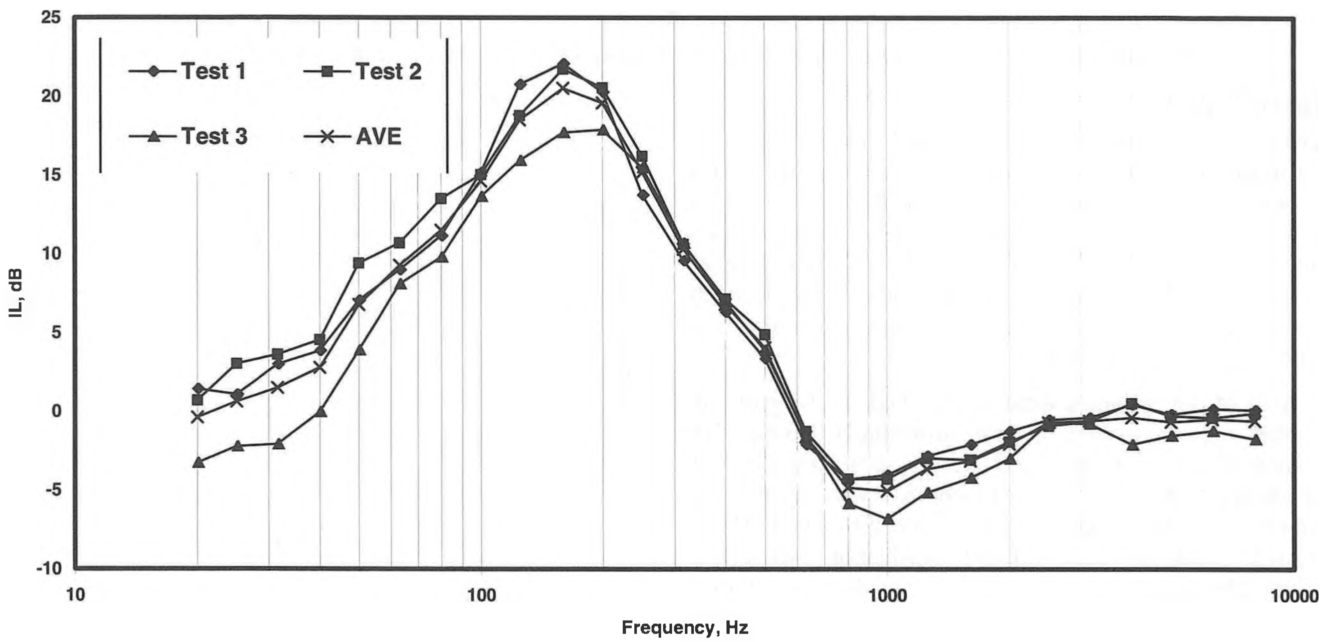

Figure 2C. Circumaural, TOTAL IL,