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**Otoacoustic Emissions,
A New Tool
for Hearing Conservation Testing
(Reprint)**

By

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Aircrew Protection

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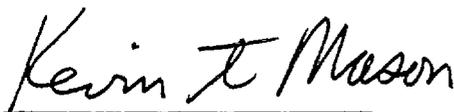
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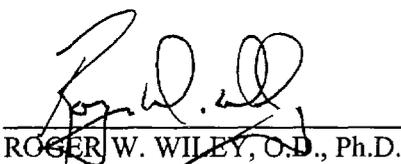
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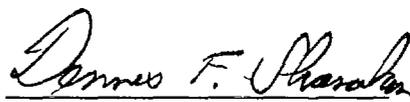


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Otoacoustic Emissions, a New Tool for Hearing Conservation Testing

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Annual hearing test

It is time for your annual hearing test. You sit in a booth. The air is stale and stuffy. You put on the familiar earphones. Make sure you have got the red one on the right ear. You grab a button in your hand and wait for tone pulses. You get the attention of the tester, "Wait, I'm tangled in these wires." There it is, a tone, and you press the button. Darn, somebody just moved . . . was that a tone? The tones get fainter and fainter. Click, click. You are straining to hear that very distant tone. Beep, beep, beep. Bang, somebody kicked the booth. Thinking to yourself, "I missed that tone. Boy, it is getting hot in here. I can not believe how loud that high-pitched whine is getting in the background. Is that the machine or me? This is not going so well." Minutes go by. Click, click. Finally, it is over. Okay, you passed!

Introduction

U.S. Army Aeromedical Research Laboratory (USAARL) scientists are investigating a revolutionary hearing test called otoacoustic emissions (OAE). With

OAE testing, your annual hearing test will be reduced to listening passively to a few tones for a few seconds. And, no more button pressing!

OAE method

An OAE ear piece is placed comfortably in the ear. It has a miniature sound source that emits two tone pulses of different frequencies (f_1 and f_2) into the ear canal. These are conducted to the inner ear (cochlea). The inner ear is stimulated by the tones and generates a third tone, called a distortion product. The distortion product tone is a biomechanical emission of acoustic energy from the inner ear; hence the name, otoacoustic emissions (ear sound emissions). With hearing loss, the inner ear loses its ability to produce the distortion product tone at affected frequencies.

A miniature microphone in the OAE ear piece detects the stimulation tones and the distortion product tone. In a few seconds, many stimulation tones of varying frequencies are sent into the ear, generating various distortion product tones. Aircrew members do

not have to actively listen for tones and push a button. They just relax, sit still, and the test is over in less than 2 minutes.

A computer measures the original stimulation tones and the distortion product tones. The computer makes a two-axis graph. Background noise is plotted on the graph by amplitude in decibels and by frequency in Hertz. The amplitude of the distortion product tone is plotted at the frequency of the second stimulation tone (f2) that caused the distortion tone. Audiologists examine the shape of the plotted curves. They measure the difference between the background noise and the distortion product amplitudes. Figure 1 shows an aircrew member with normal hearing. In contrast, Figure 2 shows an aircrew member with hearing loss. Note how the distortion product curve and the background noise curve approach each other above 3000 Hz in the patient with abnormal hearing. The inner ear is not responding properly to stimulation tones at and above 3000 Hz, producing OAE with reduced amplitudes compared to a patient with normal inner ear function.

Advantages

Current pure tone testing stations can be upgraded readily to measure OAE. Table 1 shows the advantages of using OAE testing instead of the traditional pure tone testing.

Validation tests

USAARL is conducting validation OAE tests. We are testing aircrew members of all ages and genders, with a broad range of hearing capabilities. Volunteers will undergo standard audiometric testing, speech

discrimination tests, and OAE tests during short sessions. Data will be examined to find out if new hearing conservation program standards can be based on OAE testing instead of pure tone testing. If you are interested in testing this new technology as a volunteer, contact MAJ Ribera at DSN 558-6823/6804 or COMM (205) 255-6823/6804.

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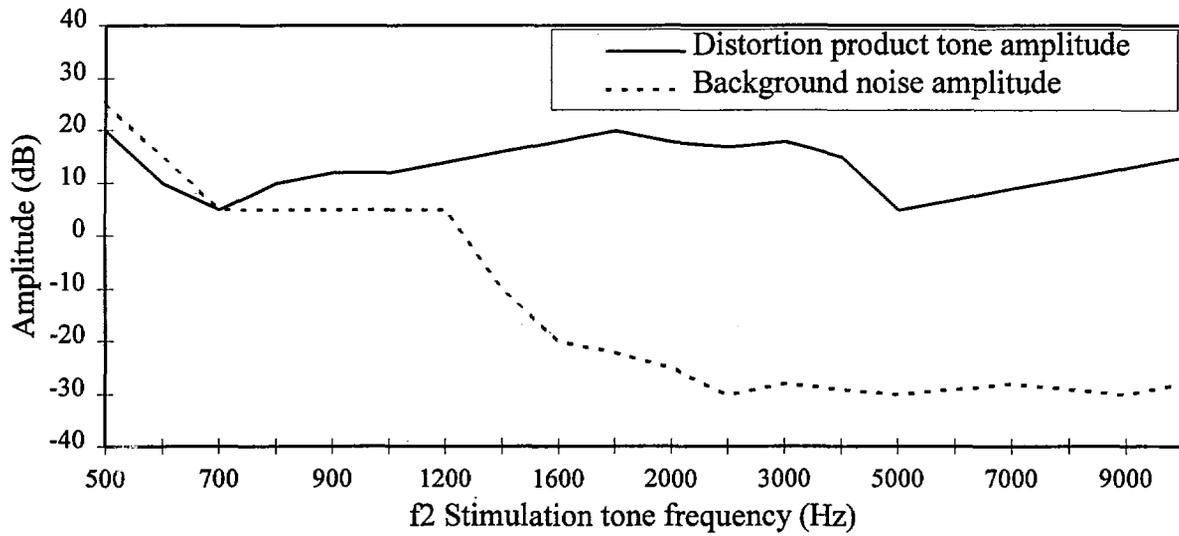


Figure 1. Otoacoustic emissions plot in an aviator with normal hearing.

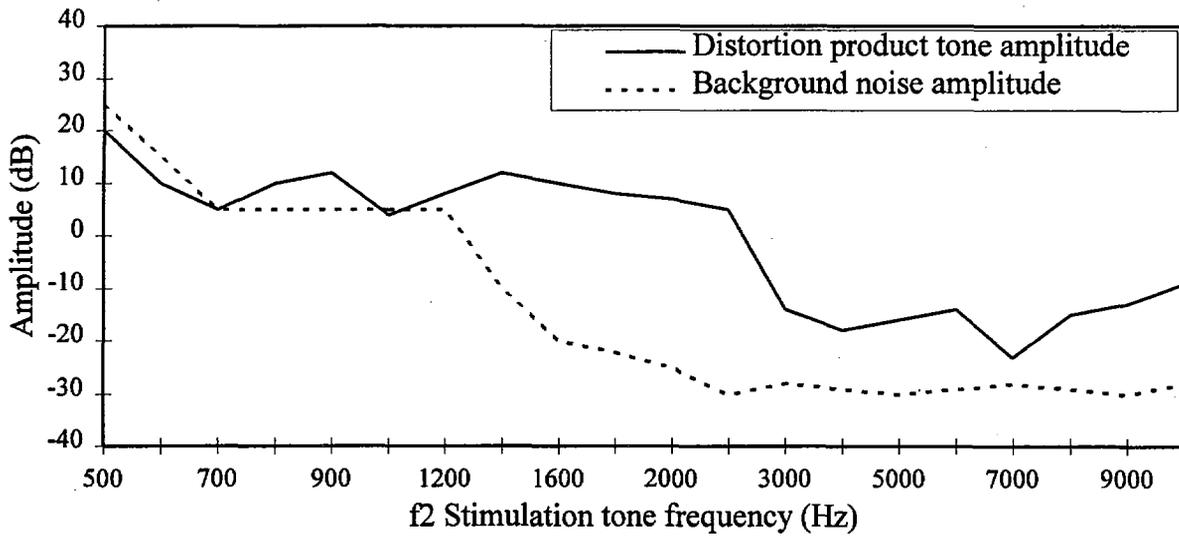


Figure 2. Otoacoustic emissions plot in an aviator with abnormal hearing at and above 3000 Hz.

Table 1.

Advantages of using otoacoustic emissions compared to standard pure tone testing.

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1. Simple, passive, automated measure of hearing.
 2. Provides objective results.
 3. Provides frequency-specific measure of inner ear function.
 4. Results are highly reproducible between examinations.
 5. Reliable indicator of noise-induced hearing loss.
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