

ATTENUATION VALUES UNDER "REAL USE CONDITIONS"
OF QUIETEAR \ FLITEMATE EARPLUGS.

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General Quietear / Flitemate.

This document summarizes the results of attenuation tests carried out on the Quietear / Flitemate earplugs according to standard ANSI S 3.19, 1974 (ASA STD 1-1975). This standard specifies the environmental conditions and the test methods of the attenuation values of earplugs for hearing protection against exposure to harmful noise.

Method.

As stated above, the test method was based on the American standard ANSI S 3.19 1974, the main point of which is measurement under real use conditions of the threshold differences for hearing noises by the tested listener with and without earplugs.

1. Description of the earplug.

Illustration No. 1 shows the shape, components and measurements of the earplugs.

The earplug is flexible and it contains a space with a measured opening on both sides to provide ventilation. There are three different sizes according to the size of the external ear canal.

2. The test Conditions.

The tests were carried out under standard audiometric (at the Schneider Pediatric Hospital in Israel) in compliance with the requirements of standard ANSI S 1.6 – 1967 (1971) with background noises not exceeding the values specified in the said standard and in the following table:

Frequency (kHz)	Noise Frequency (dB SPL)
0.125	28
0.25	18
0.5	14
1	14
2	8
4	9
8	20

2.1 The test Stimuli and Instrumentation.

Narrow band noises within 1/3 octave around 0.125, 0.25, 0.5, 1, 2, 3, 6 and 8 kHz served as stimuli.

The noise generation device was an Amplaid 460 plus calibrated clinical loudspeakers.

A cone hanging by rigid wire from the ceiling served to provide uniform location of the listeners' head in the tight chamber.

2.2 The test listeners.

20 listeners - nine males and eleven females – took part in the tests. Their age was in the range of 19.6 – 46 years and their average age was 23.8 years (a mean standard deviation of 7.1 years). The selection of the listeners was totally random.

All the listeners had hearing thresholds in the 0.125 – 8 kHz frequency range within the norm up to 25 dB HL in each of the test frequencies (ANSI S 3.6-1969).

The variance in training the testing of the hearing thresholds in the listeners in three consecutive tests (without earplugs) was not larger than 6 dB.

3. The Test Method.

Before agreeing to take part in the test, the listeners were explained the objectives and the nature of the test and only after giving her/his consent was the listener included in the test.

Between tests of different listeners and in consecutive tests of the same listener, the participants were requested to position their head in a similar location in accordance with the reference wire.

3.1 The Testers.

An Audiologist having extensive clinical experience in measuring hearing thresholds administered all the tests. The tests were carried out using the clinical audiometric method.

Close to the hearing threshold the tester applied changes of only 1 dB.

3.2 The Test Procedure.

3.2.1 Measuring Hearing Thresholds without earplugs.

Before starting the test, each listener was allowed several minutes of acclimatization to the silent conditions in the sealed chamber.

First, hearing test was carried out for pure tones, including testing the threshold of receiving and understanding speech (discrimination) with earplugs for screening the listeners.

3.2.2 Training for measuring hearing thresholds for noise.

After the hearing test, the listener was seated in the marked location between two loudspeakers. Training for measuring hearing thresholds for narrow-band noise stimuli (125-8000Hz) without earplugs in free field was carried out. The test was carried out five consecutive times. Only listeners whose threshold variance in the last three consecutive tests was not larger than 6 dB continued with the test.

3.2.3 Measurement of hearing thresholds with and without earplugs

After the training, measurements of the hearing thresholds with and without earplugs were carried out by the two-ear method two times each (a total of 4 times) for each of the nine narrow-band noise stimuli. The order of the tests (with and without earplugs) was totally random with a short break between them.

At the conclusion of each test (with or without earplugs) the listener was asked to remove (or insert) the plugs again, so that each test actually started from the same reference point.

As required under the standard, the insertion of the earplugs and its fit to achieve maximum sealing of the ears was carried out by the same audiologist for all listeners. Before the start of the tests each listener received detailed instruction on the method to achieve maximum fit when inserting the earplugs.

3.2.4 Measurements of Speech Reception.

In Addition, speech reception thresholds (SRT) and speech understanding (discrimination) were measured with and without the earplugs. These tests were carried out in the presence of 70-dB HL “white” noise background.

4. Data Processing.

All the listeners attaining maximum tightness were included in the data processing.

The average hearing threshold was calculated for each listener for each stimulus in the two tests with earplugs and in the two tests without earplugs.

The real attenuation values provided by the earplug were calculated as the difference between the thresholds with and without the earplugs.

5. Results.

The average attenuation values frequencies achieved by real use of the Quietear / Flitemate earplugs are given in Table No. 1 and visually in Graph No. 1 (NB attenuation).

Graph no. 2 shows the range of the attenuation averages (the lowest and the highest) of the earplugs.

Table No. 1 Attenuation Average (and standard deviation) for the various frequencies

Frequency kHz	0.125	0.250	0.5	1	2	3	4	6	8
Average (dB)	9	10.5	14.2	16.7	22.5	28.8	32.2	36.1	36.6
Standard deviation	5.9	5.2	5.8	5.1	5.5	4.6	5	9	9.7

The attenuation average value in the low frequencies (up to 1 kHz): 12.6 dB.

The attenuation average value in the high frequencies (from 1 kHz): 31.24 dB.

Since the measurements took place under silent conditions, correction should be made with the assistance of the standard deviation to evaluate the real attenuation of using the earplugs under noisy conditions.

Graph no.3 shows the mean attenuation curve attained by at least 50% of those exposed to industrial noise, the (- 1 SD) curve represents the attenuation attained for 84% of those exposed, and the – 2 SD curve represented the attenuation attained for 98% of those exposed, provided that those exposed are represented by the listeners and use the ear plugs as they were used in the test.

The NRR (noise reduction rating) index reflects the attenuation expected to be attained by 98% of those exposed to typical industrial noise (85-dB (A)), assuming that they are represented by the test subjects and use the earplugs as they were used in the test.

The NRR Value for Quietear / Flitemate earplugs is: 21.7 dB

6. Results of the Speech Tests.

Table No. 2 and Table No. 3 summarize the results of the speech tests, which included the SRT (speech reception threshold) test and the speech discrimination test with and without earplugs and with and without 70 dB HL background white noise.

The SRT test measures the minimum volume (HL) where the listener can repeat two of three two-syllable words spoken to him/her.

The results of the speech understanding tests are given as percentage of understanding a series of single-syllable significant words given at a volume of dB HL above the speech reception threshold or at the most convenient volume for the listener.

Table No. 2: Average of the Speech Reception Threshold Test

SRT (dB HL)	Without noise	With background Noise
With ear plugs	4.8	48
Without earplugs	22	52

Table No. 3: Average of the speech Discrimination Test

SRT (dB HL)	Without noise	With background Noise
With ear plugs	99	94.6
Without earplugs	98.2	97

As can be seen, The earplugs do not damage the speech discrimination with and without background noise.

7. Convenience and Tightness.

The Listeners were requested to evaluate the convenience of the earplugs from 1 (very inconvenient) to 10 (very convenient). Four listeners (20%) graded the earplugs as "very convenient" (grades of 9 and 10). 11 listeners (55%) graded the earplugs as "convenient" (grades of 7 and 8), 4 listeners (20%) graded the earplugs as very inconvenient (grades 4, 5, 6) and one listener (5%) graded the earplugs as totally inconvenient (grade 3).

8. Summary.

The Quietear / Flitemate earplugs attenuation tests reveal that the average attenuation in the lower frequency range, which is also regarded as the speech range (up to 2 kHz) is only about 14.5 dB, while it is 33.4 dB in the higher range (3-8 kHz).

The NRR value for this earplug is 21.7 dB.

The speech discrimination tests revealed that using the earplugs does not damage the speech discrimination with or without background noise.

The majority of the subjects (75%) graded the earplug as very convenient or convenient and not interfering with communication.

The earplug provides proper protection under very extreme background noises (up to 100 dB HL) and it also enables very good verbal communication with and without background noises.

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