HEARING PROTECTION PERFORMANCE EVALUATION OF ACTIVE NOISE REDUCTION HEADSETS UNDER HIGH INTENSITY NOISE LEVELS

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1 Introduction

The present study focuses on assessing the performance of hearing protectors with Active Noise Reduction (ANR) systems at the limit of their capabilities. The concern addressed in this study was raised following the noise survey onboard the CH-147 Chinook helicopter when an unweighted OSPL of 132 dB was recorded by NRC during the "Open Doors Level 140 kts" flight segment at four different locations in the cabin and the cockpit. Previous performance evaluation by NRC of David Clark headsets with ANR systems at an OSPL (Overall Sound Pressure Level) of 110dB in accordance with Standard Testing Procedure ANSI S12.42 resulted in positive recommendations based on their performance.

In the present study, the four David Clark headset models e.g. 40600G-15, 40600G-20, 40750G-01 and H10-76XL were tested at various sound pressure levels such as 111 dB, 115 dB, 120 dB, 125 dB and 131 dB in order to assess their stability and performance consistency. As a result of the NRC evaluation, it was observed that the performance of the four headset systems with ANR ON was consistent for noise excitation levels below 120dB while a performance degradation was observed for excitation levels above 120dB.

2 Method

The noise attenuation performance of four David Clark headset models e.g. 40600G-15, 40600G-20, 40750G-01 and H10-76XL, equipped with Active Noise Reduction (ANR) electronic modules was evaluated in the NRC Aerospace Hearing Protection Evaluation Facility at the Flight Research Laboratory using the procedure outlined in ANSI Standard S12.42 under various sound pressure levels such as 111 dB, 115 dB, 120 dB, 125 dB and 131 dB.

The Acoustic Test Fixture (ATF): G.R.A.S. 45 CB manikin was used. This device was specifically designed for impulsive and continuous noise measurements [1].

The testing was completed in a reverberant chamber with sufficient control and volume to produce a homogeneous acoustic field with consistent sound pressure levels in the desired frequency range of 0.1 to 10 kHz.

Special care was taken to ensure the optimal fitting of the headsets. Each headset was tested following the standard series of occluded and unoccluded ear conditions. Moreover background noise was measured at the beginning and at the end of each evaluation testing series. The Insertion Loss (IL) was calculated for each unoccluded / occluded ear pairing following the ANSI Standard S12.42 procedure [2].

Throughout the measurements, the acoustic levels and temperature within the test chamber were monitored to ensure consistent and repeatable testing conditions.

The two occluded and unoccluded ear configurations are depicted in Figure 1.

Figure 1: Left: Occluded Ear (with David Clark headset) and Right: Unoccluded Ear configurations.

3 Results and Discussion

3.1 Insertion Loss (IL) Data

During this test campaign, the following four headsets, equipped with ANR, were considered:

1) David Clark headset model 40600G-20
2) David Clark headset model 40600G-15
3) David Clark headset model 40750G-01
4) David Clark headset model H10-76XL

The IL measured for the David Clark headset model 40600G-20 in passive (ANR OFF) configuration is presented in Figure 2. The tests were performed at five different overall sound pressure levels e.g. 111 dB, 115 dB, 120 dB, 125 dB and 131 dB. It can be observed that the passive IL (with ANR OFF) of the headset is consistent at all frequencies below 3000Hz and all sound pressure levels. For frequencies above 3000Hz the headset performance is so great that the GRAS 45CB ATF manikin microphones measured only background noise at low excitation SPLs. It has to be mentioned that only the IL measured for acoustic excitation superior to 125dB are accurate at frequencies above 3000Hz for which higher sensitivity microphones have to be used.

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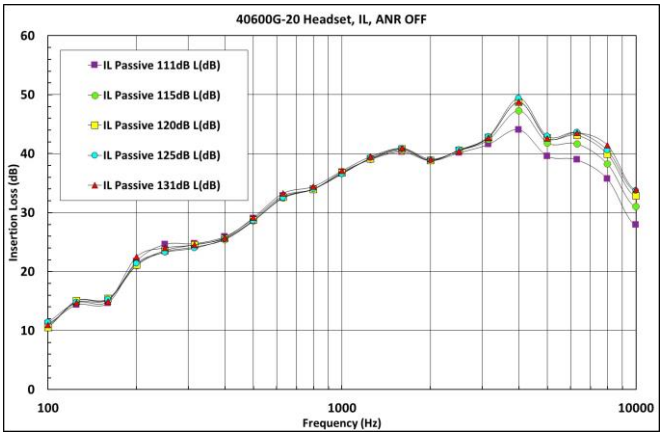

Figure 2: Insertion Loss, Left Ear, David Clark headset model 40600G-20, ANR OFF

The IL measured for the David Clark headset model 40600G-20 in active (ANR ON) configuration is presented in Figure 3. The tests were performed at five different sound pressure levels e.g. 111 dB, 115 dB, 120 dB, 125 dB and 131 dB.

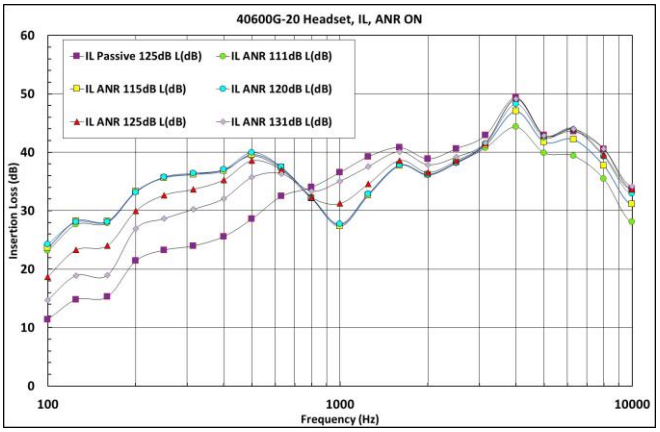

Figure 3: Insertion Loss, Left Ear, David Clark headset model 40600G-20, ANR ON

The IL results obtained for the ANR ON configuration at each sound pressure level of excitation were compared with the results of the ANR OFF configuration at 125dB of excitation – the minimum OSPL required to accurately evaluate the performance of this helmet at high frequencies. It can be observed that at a low OSPL of excitation e.g. 111dB, 115dB and 120dB the performance of the headset is consistent for frequencies below 3000Hz. Moreover the performance of the headset with ANR ON shows a gradual degradation in performance for OSPLs of excitation above 120dB. Moreover, it can be observed that above 800Hz the IL of the headset decreases. The ANR system, instead of cancelling the noise at those frequencies does the opposite and increases the noise level at the eardrum (as compared to the passive – ANR OFF configuration), by as much as approximately 10dB at 1000Hz for low SPLs of excitation. This degradation in performance regresses as the SPL of excitation increases (for OSPL of 125dB and 131dB) and the headset IL performance tends to approach the passive (ANR OFF) configuration results.

Similar behaviour was observed and similar conclusions can be drawn for all the headsets tested.

3.2 ANR Performance for Long Time Exposure

It was very important to test the headsets at high sound pressure levels and observe if their performance remains stable over long periods of exposure. The first testing case was to expose the David Clark 40752G-01 headset with ANR ON at OSPL of 131dB for 15 min. Furthermore, David Clark 10600G-20 headset with ANR ON was tested at OSPL of 125dB for 45 min. For both cases, it was observed that no degradation of the headset performance occurred.

4 Conclusion

In the present study, the four David Clark headset models were tested at various sound pressure levels As a result of the NRC evaluation, it was observed that the performance of the four headset systems with ANR ON was consistent for noise excitation levels below 120dB.

However, as is demonstrated by the present preliminary evaluation, the insertion loss performance of the four headsets with ANR systems ON, when exposed to unweighted overall sound pressure levels (OSPL) superior to 120dB, significantly degraded with each increasing noise level increment. It is also very important to mention that the passive hearing protection performance of the four headsets (ANR OFF) remained, consistent (no degradation observed) at all high intensity noise levels considered in this study. Additionally, it was observed that longtime high OSPL noise exposure did not degrade the headset performance.

Acknowledgements

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