INVESTIGATION OF AIRCREW NOISE EXPOSURE DUE TO THE USE OF THE INTERCOM SYSTEM ONBOARD THE RCAF CH-149 HELICOPTER

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1 Introduction

The National Research Council (NRC) Flight Research Laboratory (FRL) conducted a series of intercom signal voltage measurements onboard several CH-149 Cormorant aircraft at Canadian Forces Base (CFB) Comox in March 2019.

The purpose of this test campaign and reporting was to support the Department of National Defence (DND) in investigating several issues related to the intercom system such as: multiple types of transitory noises reported by aircrew as well as to quantify the aircrew noise exposure levels due to the use of the CH-149 intercom system [1-5]. Transitory noise is defined as undesirable audio phenomena present in an intercom signal such as tones and squeals.

2 Method

2.1 Ground Calibration

The ground calibration was performed to characterize the CH-149 ICS (Intercom Communication System) and to develop a series of transfer functions required for the data analysis of the ICS voltage signal recordings during flight. This test procedure was defined such that the GRAS 45CB Acoustic Test Fixture (ATF) need not be flown onboard the aircraft. The co-pilot and stretcher positions onboard the aircraft were selected for ground calibration to support in-flight measurement and subsequent data analysis.

A schematic diagram indicating the equipment configuration for the intercom system characterization is shown in Figure 1. Note that for the ground calibration procedure, pre-recorded voice audio signals were prepared by NRC and used to ensure consistency in the input voice signals [6, 7].

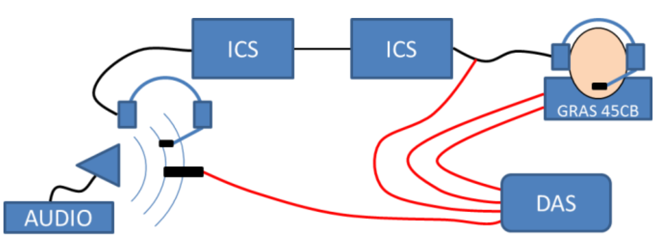

Figure 1: CH-149 Cormorant Intercom Ground Calibration Equipment Schematic [6, 7]

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The calibration measurements were used to generate transfer functions to characterize the dynamics of the CH-149 ICS within the audible frequency range. With the identified transfer functions using the input voice signal, transfer paths between the output voltage of the ICS and the left and right ear locations were used to accurately determine the overall sound pressure levels (OSPL); see Figure 2 for a visualization of the method. The SPLs at the ear drum locations of the GRAS 45CB ATF were estimated based on the voltage signals measured at the output of the CH-149 ICS. Therefore, by further considering the acoustic features of the ear canals of the GRAS 45CB ATF, the SPLs at the aircrew ear entrance locations were indirectly estimated so that the effect of the helicopter intercom system on aircrew hearing can be evaluated.

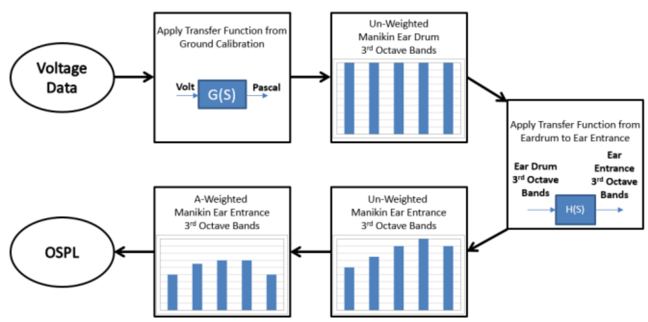

Figure 2: The method used to estimate noise exposure using intercom voltage data. [6, 7]

2.2 Flight Measurement Configuration

During the flight mission, an LMS SCADAS XS DAS was used to record the voltage signals of the CH-149 ICS at two locations: an unworn flight helmet at the stretcher location, and a flight helmet worn by the co-pilot in the cockpit location.

It is important to note that all intercom system settings for the stretcher location were consistent during the calibration procedure and the flight measurement. However, the intercom volume settings at the co-pilot location may have been adjusted by the co-pilot during the flight mission. Therefore, the data analysis presented in this paper focuses on the datasets recorded at the stretcher location to ensure consistent data comparison from both amplitude and frequency perspectives for the various flight missions.

3 Results and Discussion

3.1 Spectral Analysis of the Intercom Signals

Spectral analysis of the recorded signal voltages revealed that several types of transitory noise existed, and each type of

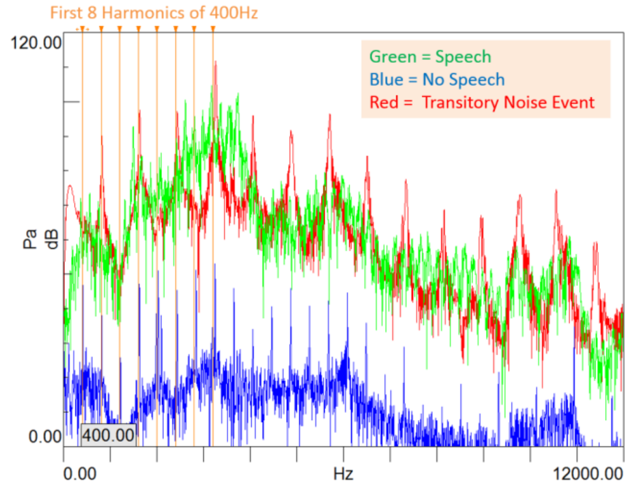

Figure 3: Comparing spectra from March 7th flight recording.

transitory noise contained acoustic energy at multiple discrete frequencies. Due to the short nature of transitory noise events, the spectral plots were generated with a frequency resolution of 5Hz. The ICS Sound Pressure Level measured in three different situations shown in Figure 3, highlights a harmonic behaviour of approximately 400Hz (signal without speech) and 800Hz during the transitory noise event. Figure 3 shows the SPL of a transitory noise event which occurred on the March 7th flight, and the 400Hz harmonics behaviour. It is important to note that 400Hz is the frequency of the aircraft AC power. This may indicate that the transitory noise is related to the AC power supply of the aircraft.

3.2 Assessment of Aircrew Noise Exposure

The ICS signal recorded during the flight mission on March 7th consisted of some instances of transitory noise occurring throughout the flight. Many of them were observed during normal flight operations and as such, there was no clear indication of a specific cause for them. It can be observed in Figure 3 that the transitory noise event chosen for this analysis comprised of a harmonic tone with a maximum peak amplitude at approximately 3250Hz and had a measured OSPL shown in Figure 4 of approximately 11.27 dB(A) higher than the normal speech sound level at the stretcher location (both recorded with a maximum ICS gain setting).

4 Conclusion

The data analysis of the recorded CH-149 ICS voltage signal showed that the aircrew are exposed to a variety of intense transitory noise events on a regular basis. Moreover, analysis of the recorded ICS signal showed that the CH-149 intercom system exposed the aircrew to relatively high sound pressure levels during a flight mission. With the maximum ICS gain setting, the CH-149 ICS generated an average OSPL of 96.45 dB(A) at the aircrew ear entrance during regular speech at the stretcher position in the measured flight missions. Several types of transitory noises were recorded and analyzed, including night-mode lighting transitory noise, slow-plug-in of helmet plugs transitory noise and other random transitory

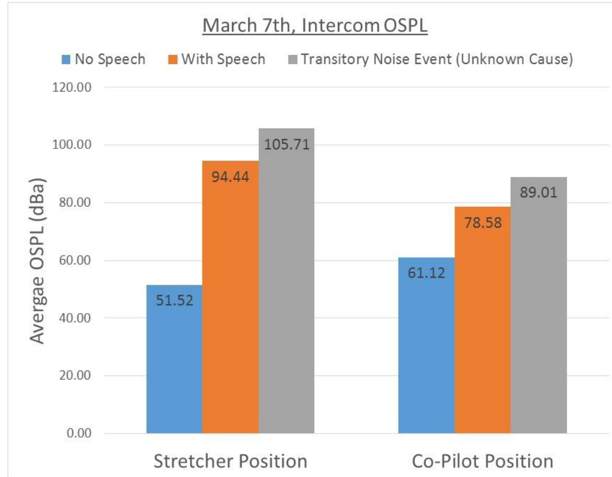

Figure 4: OSPL comparisons from March 7th flight recording.

noise events. The intercom transitory noise introduced high noise levels to the aircrew. For example, the slow plug-in transitory noise was the loudest transitory noise event, exposing the aircrew at the stretcher position to approximately 112.65 dB(A) OSPL for about 2 seconds.

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