Investigation of Ground Crew Noise Exposure for the Royal Canadian Air Force CH-149 Cormorant Helicopter

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1 Introduction

Royal Canadian Air Force (RCAF) CH-149 Search and Rescue helicopters operate in extreme and strenuous environments often with doors open configurations. Due to the demanding nature of search and rescue activities, civilians, aircrew and ground crew may be exposed to noise exposure events without properly fitted hearing protection. This paper outlines the National Research Council's (NRC) ground external noise measurement of the CH-149 Cormorant at Comox Canadian Forces Base.

2 Method

The exterior ground measurement involved 6 personnel in addition to the aircrew. Four, 60 second duration, measurement conditions were completed, as shown in Table 1.

Table 1: Measurement conditions

ID	Auxiliary Power Unit (APU)	Engine	Avionics
#1	ON	OFF	ON
#2	ON	IDLE	ON
#3	ON	Flight	ON
#4	OFF	Flight	ON

Five ICP PCB 378B02 microphones were rotated through 10 measurement locations as depicted in Figure 1. The data acquisition system selected was a Siemens LMS Test.LAB SCADAS III.

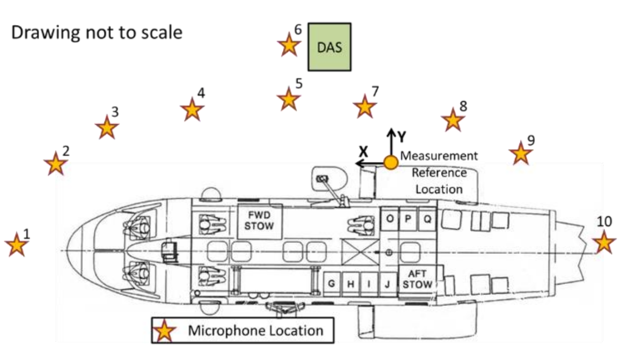

Figure 1: Exterior noise measurement locations

The measurement was conducted in accordance with MIL-STD-1294A Section 5.3.2.2 [1]. The microphones were mounted at a nominal head height of 1.65 ± 0.1 m and fitted with windscreens. The insertion loss of the windscreens was measured previously as a function of frequency, in the absence of wind, at the NRC Hearing Protection Evaluation Facility. The locations indicated in Figure 1 were selected to be representative of ground crew and flight engineer operations.

Hearing protectors

In conjunction with the in-flight and ground noise measurements of RCAF aircraft, the NRC evaluated the insertion loss performance of various in-service RCAF hearing protectors at the NRC Hearing Protection Evaluation Facility. For context, six hearing protector insertion loss performance curves are shown in Figure 2 [2], [3], [4].

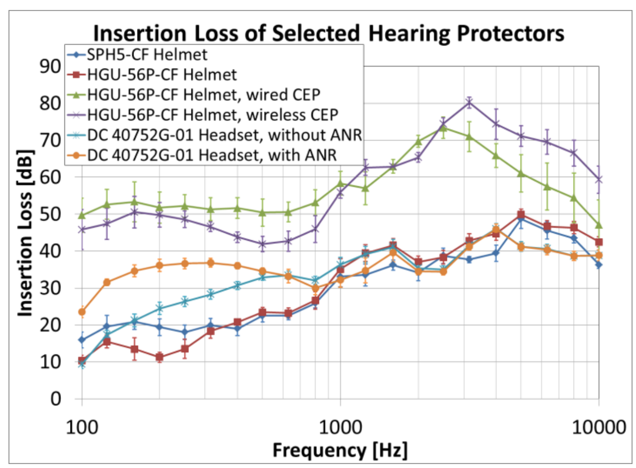

Figure 2: Insertion loss of selected hearing protectors

As shown in Figure 2, superior insertion loss performance was exhibited by hearing protection solutions utilizing a communication ear-plug in conjunction with a circum-aural hearing protector. It should be noted that a SPH5-CF hearing protector without communication ear plugs is commonly used in CH-149 Cormorant operations. The SPH5-CF hearing protector insertion loss is exhibited as the blue curve with diamond markers. Note that all hearing protectors exhibited superior high frequency noise reduction.

3 Analysis

The Sound Pressure Levels (SPL) were acquired for each measurement position and condition. The results were then post-processed and analyzed in narrow-band, 1/3rd octave band and Overall Sound Pressure Levels (OSPL). The

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OSPL data for each microphone measurement condition is exhibited in Figure 3. Additionally, the recommended maximum noise exposure dose for one 24 hour period associated with each respective OSPL in accordance with the Canadian Aviation Occupational Health and Safety Regulations [5] have been superimposed on Figure 3 as horizontal dashed lines.

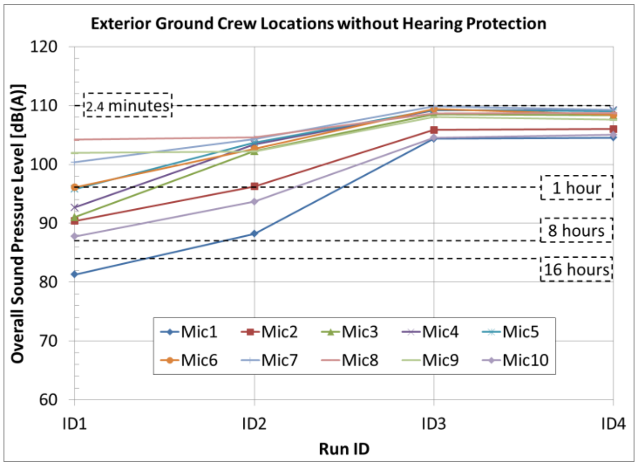

Figure 3: Exterior microphone OSPL levels

It is observable in Figure 3 that civilians or crew without hearing protection could be at risk of hearing damage after 2.4 minutes of cumulative noise exposure with the engines configured for flight and main rotor turning (ID 3 and ID 4). It is interesting to note that the Mic 1, Mic 2 and Mic 10 measurement locations exhibited consistently lower OSPLs. Additionally, the Mic 7, Mic 8 and Mic 9 exhibited higher OSPL levels, specifically during the ID 1 and ID 2 conditions; observing Figure 1, it can be shown that the Mic 7 - 9 locations are directly in line with the aircraft engine and APU exhaust ports. Observing the noise directivity characteristics of the aircraft when the rotors are not rotating (ID 1 and ID 2), significant reductions in OSPL can be made by avoiding specific Mic locations. Once the rotors are turning (ID 3 and ID 4) the noise environment is dominated by the N/rev rotor harmonics and the noise directivity of the aircraft environment is less prevalent.

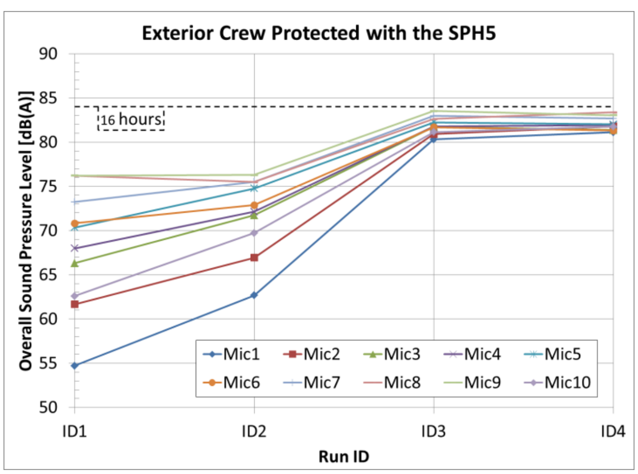

Figure 4: Hearing protected microphone OSPL levels

The OSPL data for each microphone measurement condition with SPH5-CF hearing protector insertion loss applied is exhibited in Figure 4. It can be shown that with a properly fitted SPH5-CF pilot helmet, all recommended noise exposure dose limits are safely in excess of 16 hours regardless of microphone measurement locations.

4 Conclusion

The RCAF CH-149 Cormorant Search and Rescue helicopter exhibited highly directional noise propagation during the measurement conditions without rotors turning (ID 1 and ID 2). During these conditions, a civilian or crew member can reduce their noise exposure significantly by standing near the front of the aircraft or underneath the aft tail boom (Mic 10 location). In contrast, with rotating rotors (ID 3 and ID 4), the low frequency N/rev rotor harmonic noise propagates with less sensitivity to aircraft orientation; with rotors turning, an individual without properly fitted hearing protection can exceed their maximum recommended noise exposure dose for one 24 hour period within 2 minutes and 24 seconds in accordance with the Canadian Aviation Occupational Health and Safety Regulations. When equipped with properly fitted SPH5-CF hearing protection, all exterior measurement locations exhibit maximum recommended noise exposure dose limits in excess of 16 hours.

Acknowledgements

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References

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