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A Study of Risk Factors and Prevalence for Noise-Induced Hearing Loss in Canadian Armed Forces Pilots

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Craig Burrell, PhD**

Surgeon General Report

**Surgeon General Health Research Program
SGR-2017-002
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Abstract

Introduction: The aircrew environment presents a wide variety of noise hazards, including high levels of ambient noise during flight, which may both increase the risk of permanent hearing loss and interfere with communication and flight tasks. In particular, it has been suggested that the volume of the CF-188 Hornet's (CF-18) aural alerts are sometimes insufficiently audible during normal communication traffic. To ascertain the prevalence of this problem, as well as to better understand the hearing status, risk factors for hearing loss, and current practices with respect to hearing protection measures among Canadian Armed Forces (CAF) aircrew, we undertook the present study, with a special focus on CAF pilots.

Methods: A retrospective study of hearing status in CAF aircrew was carried out in January of 2012 at several participating flying squadrons across Canada. The participants were 125 male and female pilots, ranging from 24-56 years of age. The data consisted of responses to a 56-item electronic questionnaire regarding risk factors for acquiring a hearing loss and audiometric measurements made at initial aircrew selection and every three years thereafter up to 15-years post-enrolment. Of the 125 participants who completed the questionnaire, 62 permitted access to audiometric data.

Results: We observed a mean change in hearing thresholds of nearly 20 dB between enrolment and 15 years of service, indicating that hearing damage in this population of pilots is markedly worse than what one would expect in the general public, but broadly consistent with other reported hearing threshold shifts for military pilots. By 6 years post-enrolment at least 10% of the pilots in this study registered a clinically significant hearing loss at and above 6 kHz in both ears. A majority (60%) of participants stated that they experienced tinnitus / noise in their ears at least occasionally, with 16% reporting such noise to be present constantly.

Over half of respondents agreed that their workplaces were often or constantly noisy, though a similar number also reported that they always wear hearing protection when noise levels are high. Jet pilots were the least likely to wear hearing protection consistently, with over 40% indicating that they wear it less than half the time. The rate of presentation of clinically significant hearing loss (≥ 25 dB HL) is about 3 times lower in the group that wears hearing protection consistently. Among the reasons given for not wearing hearing protection, 22% of pilots stated that their hearing protection was often or always uncomfortable to wear, and a sizable minority (17%) of jet pilots judged that hearing protection often or always poses a danger during flight.

A great majority of respondents indicated that they experienced 'no' or 'slight' difficulty understanding audio alerts in the cockpit while wearing hearing protectors and headsets, with only 1.6% of pilots (6.8% of jet pilots) reporting at least a moderate level of difficulty. This suggests that the problem of inaudible audio alerts, while significant for a subset of pilots, is not widespread.

Conclusions: This study found greater hearing loss among aircrew than would be expected in the general population. The most effective method for protecting an aircrew's hearing involves understanding the noise profile in their environment and then providing proper instruction, appropriate personal protective and communication equipment, and hearing protection measures. Early detection and monitoring are critical for prevention of hearing loss and should be developed and implemented in future work.

Keywords: Aircrew, audiograms, Canadian Armed Forces, Hearing loss, NIHL, occupational noise.



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Résumé

Introduction : Il existe, dans l'environnement du personnel navigant, une grande variété de risques liés au bruit, notamment des niveaux élevés de bruit ambiant durant les vols, ce qui peut non seulement augmenter le risque de perte auditive permanente, mais nuire à la communication et aux activités en vol. Plus particulièrement, certains ont fait valoir que les alertes sonores du CF-188 Hornet (CF-18) ne sont parfois pas assez audibles pendant le trafic de communications normal. Pour vérifier la prévalence de ce problème et mieux comprendre les problèmes liés à la capacité auditive, les facteurs de risque de perte auditive, ainsi que les pratiques actuelles en matière de protection auditive du personnel navigant des Forces armées canadiennes (FAC), nous avons entrepris la présente étude en nous concentrant principalement sur les pilotes des FAC.

Méthodes : Nous avons mené une étude rétrospective sur les capacités auditives du personnel navigant des FAC dans plusieurs escadrons aériens participants partout au Canada. L'échantillon de participants était composé de 125 pilotes masculins et féminins, entre 24 et 56 ans. Les données consistaient en des mesures audiométriques prises lors de la sélection initiale, puis chaque trois ans, jusqu'à la 15^e année de service. Nous avons également analysé les réponses à un questionnaire électronique de 56 questions concernant les facteurs de risque qui favorisent une perte auditive.

Résultats : Nous avons observé une variation de près de 20 dB du seuil d'audibilité entre l'enrôlement et la 15^e année de service, ce qui indique que les dommages auditifs dans cette population de pilotes sont nettement pires que dans le grand public, mais concordent avec d'autres changements du seuil d'audibilité rapportés pour les pilotes militaires. À la 6^e année suivant l'enrôlement, au moins 10 p. 100 des pilotes accusent une perte auditive cliniquement importante et au-dessus de 6 kHz dans les deux oreilles. Une majorité (60 p. 100) des participants a déclaré qu'ils ont vécu de l'acouphène ou des bruits dans leurs oreilles au moins occasionnellement, et 16 p. 100 rapportent que de tels bruits sont présents en permanence.

Plus de la moitié des répondants conviennent que leur milieu de travail est souvent ou constamment bruyant, et près de la moitié ont déclaré qu'ils portent toujours un dispositif de protection anti-bruit lorsque les niveaux de bruit sont trop élevés. Les pilotes de chasseurs sont les moins enclins à toujours porter un tel dispositif; plus de 40 p. 100 ont déclaré qu'ils le portent moins de la moitié du temps. Ce taux de perte auditive cliniquement importante (≥ 25 dB HL) est environ trois fois inférieur dans le groupe qui porte toujours un dispositif de protection anti-bruit. Parmi les raisons données pour expliquer le refus de porter ce dispositif de protection anti-bruit, 22 p. 100 des pilotes ont déclaré qu'il était souvent ou toujours inconfortable à porter, et une grande minorité (17 p. 100) des pilotes de chasseurs ont jugé que le dispositif de protection anti-bruit poste souvent ou toujours un danger en vol.

Une grande majorité des répondants a rapporté éprouver « aucune » ou « très peu de » difficulté à comprendre les alarmes sonores dans le cockpit pendant qu'ils portent un dispositif de protection anti-bruit et un casque; seulement 1,6 p. 100 des pilotes (6,8 p. 100 des pilotes de chasseur) rapportent au moins un niveau de difficulté modéré. Cela laisse entendre que le problème des alarmes sonores inaudibles, même s'il est important pour un sous-ensemble de pilotes, n'est pas répandu.

Conclusions : Il ressort de cette étude que les pertes auditives sont répandues chez le personnel navigant que dans la population générale. La méthode la plus efficace pour protéger l'ouïe du personnel navigant consiste à comprendre le profil de bruit dans son environnement, puis à lui donner une instruction appropriée, à lui



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fournir de l'équipement de protection individuelle et de l'équipement de communication appropriés, et à prendre des mesures de protection auditive. La détection précoce et le suivi sont essentiels pour prévenir les pertes auditives, et devraient être élaborés et mis en œuvre dans un travail futur.

Mots clés : Audiogrammes, bruit d'origine industrielle, déficience auditive due au bruit, Forces armées canadiennes, personnel navigant, perte auditive.



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Introduction

Military pilots are exposed to high levels of ambient noise during flight, which may increase the risk of permanent hearing loss and also interfere with communication and flight tasks. In particular, it has been reported to the Directorate Aerospace Equipment Program Management (DAEPM), Fighters and Trainers, that the audibility of the CF-188 Hornet's (CF-18) aural alerts is sometimes insufficient during normal communication traffic, with attendant risks to aircraft and crew.

Three possible remedies for this issue have been identified. The first relies on hardware and/or software modifications of the Amplifier Communications Interface (ACI) which controls the alert volume. The Canadian Armed Forces (CAF) has ceased efforts in that direction, as allied nations have reported little success (Flight Test Report, ACG 2009). A second remedy focuses on improving pilots' auditory perception, and this may involve making changes to helmet configurations, communication devices, and hearing protection technologies. However, since not all CF-18 pilots report difficulty hearing the alerts, a third remedy involves investigation of whether noise-induced hearing loss (NIHL) may be an underlying contributing cause. The present study was undertaken to evaluate the contribution of noise-induced hearing loss to the reduced alert audibility being reported by pilots as a first step toward resolving this problem.

This study was conducted to identify the prevalence and profile of hearing loss in CAF CF-18 pilots. Results from helicopter and multi-engine pilots were included for comparison with those of jet pilots. Its primary objective was to characterize the hearing status of CAF pilots, especially with reference to the type of aircraft flown, the number of flying hours, and age, as well as to better understand risk factors for hearing loss which affect the CAF pilot population.

Literature Review

Main Contributors to Hearing Loss

Individual susceptibility to noise-induced hearing loss varies, but the reasons for this variability are not entirely understood (Ward, 1995). In this section, we discuss several factors investigated in this study which may contribute to hearing loss.

Ageing

The effect of ageing on hearing loss is well-documented. There are several reasons why ageing contributes to the decline in hearing thresholds over time. General wear and tear accumulates over a lifetime, and hearing loss prevalence increases dramatically with age. Age-related hearing loss has been attributed to several factors, including noise exposure, genetic predisposition, diseases such as cardiovascular disease and diabetes mellitus, ear-related diseases, medication ototoxicity, socioeconomic status and lifestyle factors (Helzner et al., 2005). The presentation of hearing loss on an audiogram from ageing alone is different than that induced by noise exposure.

Noise Exposure

Normal noise exposure accumulates over a lifetime but when the shearing force is excessive it can lead to cellular metabolic overload, cell damage and cell death (Rabinoitz, 2000). Noise induced hearing loss therefore represents excessive "wear and tear" on the delicate inner ear structures (Rabinoitz, 2000). The sound exposure in a military setting typically has energy spread across a wide range of frequencies and results



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in a gradual increase in hearing threshold as frequency increases (Humes, Joellenbeck & Durch, 2006). The hearing loss reaches a maximum between 3000 and 6000 Hz, followed by a return toward normal hearing at higher frequencies. This pattern of hearing loss is referred to as the ‘noise notch’ audiogram. This clinical hallmark is often used to distinguish noise-related high-frequency hearing loss from that associated with other etiologies, such as ototoxic medications or ageing (Humes, Joellenbeck & Durch, 2006). This noise notch is important when discussing the data presented in this paper as its presence is used to determine hearing loss specific to noise exposure. However, as Humes et al. (2006) point out “discerning a noise notch in the pattern of hearing loss may be especially challenging in older adults for whom age-related hearing loss is superimposed on a pre-existing noise notch”. In the group considered in this study the oldest pilot is 56 years old. The effects of ageing will vary across individuals, but in this study the participants are relatively young.

The Development of Noise-Induced Hearing Loss in Aircrew

Noise-induced hearing loss is known to affect pilots. Previous studies in this area have shown that helicopter aircrew are exposed to a continuous noise level of up to 100 dB in flight and incorporating Active Noise Reduction (ANR) has been suggested as a promising means to keep in-flight noise exposure as low as possible (Owen, 1995). In addition, Raynal et al. (2006) found abnormal hearing levels in pilots, especially at high frequencies, with a marked notch on audiograms at 6 kHz. In addition, much of the previous literature in hearing loss trends specific to aircrew show that left ears have a significantly poorer performance compared with right ears (Lang et al., 2012; Raynal et al., 2006). The reason for this is unclear but could be attributed to their position in the aircraft and proximity to the noise. All of these issues contribute to impaired hearing, which can disturb speech communication (Raynal et al., 2006).

Individual Susceptibility

Past medical history is relevant as there are some factors that contribute to hearing loss that are not a result of a noisy environment. Three specific examples that have been documented in literature are infections, acoustic trauma, and solvent exposure.

Infections

A study by Job et al. (1999) on 1208 young recruits indicated that the harmful effect of noise exposure causing permanent threshold shift and tinnitus was strongly dependent on the presence of repeated episodes of otitis media in infancy or childhood. This was true even when there was no sequelae observable during the otoscopic examination at the time of the survey. This means that there are other factors to consider for susceptibility of NIHL other than the usual relationships between temporary and permanent threshold shifts (Dander, 2000).

Acoustic Trauma

Although the current study focuses on noise-induced hearing loss, it is important to mention the possibility of acoustic trauma as a contributor to hearing loss. Acoustic trauma can result from impulse noise, which presents several special hazards to the auditory system (Humes, Joellenbeck & Durch, 2006). Intense explosions of noise could result in cochlear lesions and significant hearing losses across most frequencies (Ward & Glorig, 1961). Intense sound stimulation results in structural changes leading to functional auditory impairment (Dancer, 2000). Synaptic repair can occur in 5 days, but most hair cell damage remains which is probably responsible for the observed long-term threshold shifts (Puel et al., 1998). Some recovery takes place after an acoustic trauma but the individual can be left with severe, permanent hearing loss (Van Campen et al., 1999). Hearing loss from an acute acoustic trauma is different from noise-induced or age-related hearing loss; it typically spans a wide range of frequencies rather than exhibiting the high-frequency noise-notch pattern of



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hearing loss associated with other types of noise exposures (Humes, Joellenbeck & Durch, 2006).

Solvent Exposure

Concurrent exposure to ototoxic substances, such as solvents and heavy metals may increase the damage potential of noise (Morata et al. 1993). Several studies have documented the effects of various industrial chemicals such as solvents, heavy metals and asphyxiants. Furthermore, although the evidence is not agreed upon as to the degree and risk in the literature, there are several studies that indicate that people who work with industrial chemicals in a noisy environment have an enhanced risk of auditory system injury (Cary et al., 1997; Franks and Morata, 1996; Prasher, 2002). Thus, simultaneous and successive exposure to certain chemicals along with noise can increase the susceptibility to noise-induced hearing loss (Vyskocil et al., 2012). It is useful for military personnel to keep track of current and past exposure to certain substances that could also affect hearing. In the literature review conducted by Vyskocil et al. (2012), it was found that lead, styrene, toluene and trichloroethylene are ototoxic and ethyl benzene, *n*-hexane and *p*-xylene are possibly ototoxic at concentrations that are relevant to the occupational setting. In addition, carbon monoxide appears to exacerbate noise-induced hearing dysfunction and toluene interacts with noise to induce more severe hearing loss than noise alone (Vyskocil et al., 2012). A proposal in a paper by (Hoet et al. 2005) suggested it is beneficial to add a 'Noise notation' to certain ototoxic substances that would serve as an alert for targeted medical surveillance of the hearing function of exposed workers.

Factors dependent on aircraft

Ambient noise in Cockpit

One of the main factors in both noise-induced hearing loss and the potential for pilots to miss auditory alerts is the intensity of ambient noise in the cockpit. Both the level and spectrum of aircraft noise vary as a function of speed, altitude, and activity, and these variables need to be taken into account (Edworthy & Hellier, 2000). As discussed above, continuous noise exposure above 85 dBA for 8 hours poses a risk to hearing (Edworthy & Hellier, 2000). It is well documented that aircraft noise commonly exceeds these levels. The American Joint Strike Fighter Program office conducted a baseline test of cockpit noise for their F/A-18 C/D model in which three 80-minute recordings were made. The Root Mean Square (RMS) for noise levels within the cockpit during carrier operation conditions measured in the 90-105 dBA range (Moblely, Loyer & McKinley, 2003). Aircraft noise exposure could be one of the major factors causing permanent loss of hearing among today's military aircrew members. Interference with speech and nonspeech communications, such as auditory warning alerts, can have both safety of flight and operational implications. Over time, the exposure to aircraft noise has the potential to cause permanent hearing damage with resultant long-term occupational and social repercussions. Several studies have corroborated an association between hearing loss and an occupation in military aviation (Lang & Harrigan, 2012).

Auditory Alerts

The auditory modality is very sensitive to change, which makes it ideal for warning presentation. Studies show that auditory alerts in aircraft perform their function well but do so at a cost (Patterson, 1982; Peryer et al., 2005). They flood the flight deck with loud, strident sounds, which has two unfortunate side effects: it makes the auditory warning system unpopular with the flight crew, and it disrupts concentration and interferes with crew communications (Patterson, 1982). False alarms augment the problem (Bliss, 2003). New technological advances in adding active noise-reduction capabilities have further exacerbated the problem of loud alerts (Peryer et al., 2005). Active noise-reduction headsets typically reduce flight deck noise levels by approximately 10 to 15 dB, which increases the perception of alert loudness and likelihood of startle. Alerts



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should be designed with a signal that is audible but does not dominate pilot attention; typical flight deck noise levels are a useful baseline (Peryer et al., 2005).

Communication Devices and Hearing Protection

Two problems specific to the F-18 auditory alerts have been cited in the literature and through correspondence with the CAF pilot community. The first is that there is only one volume control for both communication traffic and auditory alerts, so that the relative levels cannot be changed. The second is that communication devices and equipment interfere with audition of alerts. Since the fighter community acquired the Joint Head Mounted Cueing System (JHMCS) helmet they are required to wear a skull cap to protect the liner (HAZREP, 2007). The flaps come down to cover the ears and reduce the sound. This could contribute to a risk of not hearing a caution during flight. Equipment issues such as these often force pilots to operate without additional hearing protection, thereby putting themselves at risk for noise-induced hearing loss.

One proposed solution to the communication problems caused by the helmet and ear cups is to use a Custom Fit In-Ear Communications System (CFIECS), which both protects the ear from ambient noise and ensures that communication traffic is introduced directly into the ear, enhancing audibility. But there are drawbacks to this type of system. In 2005, the Swiss Air Force conducted a trial of the CFIECS on several different aircraft, included the F-18 (Military Aerodrome, 2005). It was found that some of the CEPs that were included in the trial caused intolerable pain for people with normal or small ear canals within the first minutes of flight (Military Aerodrome, 2005). Another system was comfortable in the beginning of flight but the comfort degraded beyond 2 hours of flight (Military Aerodrome, 2005). Therefore, this equipment may not be suitable for all pilots. The JHMCS HGU-55A/P helmet Shell is currently configured to utilize the Oregon Aero/Hushkit combo ear cups and H-143 Electrovoice earphones. In a HAZREP submitted in June 2007 it was indicated that this combination was not meeting the needs of pilots (Hazrep, 2007). Some pilots were missing communications and voice alerts and were suffering from short term hearing loss due to insufficient sound attenuation by the ear cup with the concern that this may lead to long-term damage to the ear.

Research Design

Setting and Participants

The CAF has approximately 1500 pilots in its Air Force that are located in squadrons across Canada (from pilot Career Manager Briefing, 2016). These squadrons are very similar in duties, experiences, and socio-demographics. A total of 125 pilot subjects (119 males and 6 females) ranging in age from 24-56 years were included in the study. The participants were assigned to jets, helicopters or multi-engine depending on which one they spent the majority of their flying career in. No restrictions were placed on age, sex, rank or length of military service. However, all participants had to be active Canadian Armed Forces pilots.

Study Design

A retrospective study of hearing loss in pilots was carried out at participating CAF flying squadrons. A letter of permission introducing the study, describing how it would be conducted, and requesting participation was sent to the Commanding Officer of each squadron in January, 2012. Only one squadron, in Bagotville, was not able to participate as they were deployed at the time but their responses were not expected to be different than the other jet squadrons. For each squadron that granted permission, an electronic questionnaire was sent to all pilots along with a voluntary consent form requesting their individual participation in the study and the release



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of their audiogram information.

The questionnaire is an expanded version of a survey developed and tested by Pelausa et al. (1995) for the study of risk factors for noise-induced hearing loss among Canadian Army recruits. Subjects responded to 56 questions about a wide range of risk factors for the development of noise-induced hearing loss. The questionnaire was comprised of four sections: the first collected demographic information, including the subject's age, sex, previous trades, flying time and type of aircraft and work-related noise exposure history; the second focused on the current work environment and included questions about noise and solvent exposure, training in and utilization of hearing protection and respirators, head injury, and perceived hearing handicap; the third collected information related to a history of ear problems, and in particular ear infections and ear symptoms, head injuries, dizziness, and medications; the final section focused on noise exposure during civilian activities, with special reference to recreational activities.

Once the questionnaire was completed, medical personnel at Canadian Armed Forces Environmental Medicine Establishment either travelled to each squadron's medical records department or electronically requested the audiogram information. While 125 individuals completed questionnaires, only 62 (49.6%) participants consented to allow access to the audiograms in their medical files. The audiogram information collected consisted of the member's enrolment or initial aircrew medical, and the subsequent audiograms that were collected every three years. The analysis of audiogram data was restricted to the first 15 years of data post-enrolment. Hearing thresholds (dB HL) from 0.5 kHz to 8 kHz were collected for left and right ears for subjects in each of the three pilot categories.

Descriptive statistics for the questionnaire data were produced by computing the frequency of responses by aircraft type (helicopter, jet, multi-engine), and were variously grouped by age and flying hours. For the audiograms, a repeated measures analysis of variance (ANOVA) and post hoc Bonferroni pairwise comparisons of levels of significant factors was applied to the data for seven test frequencies (500 Hz, 1 kHz, 2 kHz, 3 kHz, 4 kHz, 6 kHz, 8 kHz) to assess correlations between aircraft, time of measurement, ear, and test frequency (Daniel, 1983). The clinical threshold for diagnosis of hearing loss is a hearing threshold ≥ 25 dB HL.

Results

In this Section, we review the characteristics of the sample of pilots that participated in this study, then present some of the findings of the questionnaire, and finally examine the audiometric data on hearing thresholds for our respondents.

Pilot Respondents

A total of 125 pilot subjects (119 males and 6 females) participated in the study by completing the questionnaire for risk factors. The distribution of subjects by age and type of aircraft is given in

Table 1. Overall the subjects were distributed in age from 24-56 years, with a mean of 37.0 ± 8.2 years. In cases where subjects had flown more than one type of aircraft they were assigned to the aircraft category in which they had principally flown.

Table 1: Age of Pilots by Aircraft.



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Characteristic	Jets n	Helicopters n	Multi-engine n	Overall n
Age				
24 – 29	9	11	9	29
30 – 34	7	9	11	27
35 – 39	0	11	9	20
40 – 44	7	6	5	18
45 – 49	4	10	10	24
50 – 56	2	2	3	7
Mean Flying Years	11.1	12.5	10.2	11.3

Table 2 shows the number of flying years for the subjects in each type of aircraft. There was consistency across aircraft types, and the mean number of flying years was 11.3 ± 8.0 . All aircraft categories included relatively inexperienced pilots (< 5 years) and pilots with decades of experience (> 25 years). The number of flying hours in our respondents varied from a minimum of 37 to a maximum of 10140, with a mean of 2741 ± 2327 . There was a strong correlation between the age of the pilots and the number of flying years (Pearson correlation (r): 0.79, $p < 0.01$ (2-tailed)).

Table 2: Selected Questionnaire Responses

Questionnaire Item	Aircraft Type			Overall (%)
	Jets	Helicopters	Multi-engine	
1. Perceived Noisiness of Workplace				
Never	3.4	4.1	6.4	4.8
Occasionally	31.0	29.9	48.9	42.4
Often	62.1	42.9	38.3	45.6
Constantly	3.4	10.2	6.4	7.2
2. Perceived Change in Hearing Since Joining CAF				
Better or no change	17.2	14.3	10.6	13.6
Slightly worse	58.6	57.1	55.3	56.8
Moderately worse	20.7	18.4	17	18.4
Much worse	3.4	10.2	17	11.2
3. Types of Hearing Protection Used by Pilots				
None, no noise at work (will skip to question 10)	3.4	2.0	0	1.6
I don't wear hearing protection in noise	3.4	0.0	2.1	1.6
I wear plugs	20.7	14.3	10.6	14.4
I wear muffs	3.4	0.0	2.1	1.6
I wear a communication headset or CEP	51.7	46.9	78.7	60
I wear a communication headset and ear plugs	17.2	36.7	6.4	20.8



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Questionnaire Item	Aircraft Type			Overall (%)
	Jets	Helicopters	Multi-engine	
4. How Often Hearing Protection is Worn When Noisy at Work				
Never	3.4	4.2	4.3	4.0
Less than half my shift	37.9	12.5	17.0	20.2
More than half my shift	13.8	8.3	14.9	12.1
My entire shift	37.9	75.0	61.7	61.3
Other	0.0	0.0	2.1	0.8
No response	6.9	0.0	0.0	1.6
5. Training Received on Dangers of Noise Exposure				
None	10.3	10.2	17.0	12.8
Yes, 1 hour or less	75.9	55.1	48.9	57.6
Yes, less than half a day	13.8	28.6	34.0	27.2
Yes, a full day	0.0	4.1	0.0	1.6
Did not respond	0.0	2.0	0.0	0.8
6. Difficulty Understanding Air Traffic Transmissions, While Wearing Hearing Protectors/Headset, During Flight				
no difficulty	58.6	51.0	44.7	50.4
slight difficulty	34.5	38.8	44.7	40.0
moderate difficulty	6.9	8.2	8.5	8.0
great difficulty	0.0	2.0	2.1	1.6
7. Difficulty Understanding Audio Alert Warnings, While Wearing Hearing Protectors/Headset during Flight				
no difficulty	79.3	87.8	91.5	87.2
slight difficulty	13.8	12.2	8.5	11.2
moderate difficulty	3.4	0.0	0.0	0.8
great difficulty	3.4	0.0	0.0	0.8
8. Ear Status – Exposure to Solvents				
Never exposed	78.6	81.6	95.7	86.3
Exposed	17.9	16.3	4.3	12.1
Did not respond	3.6	2.0	0.0	1.6
9. Presence of Noise in Head or Ears				
No	41.4	38.8	42.6	40.8
occasionally-less than half the time	31.0	40.8	36.2	36.8
often-more than half the time	10.3	2.0	6.4	5.6
Constantly	17.2	16.3	14.9	16.0
Did not respond	0.0	2.0	0.0	0.8



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Questionnaire Responses

The questionnaire collected information on a number of different topics, including the noise profile of the environments within which pilots worked, an individual history of ear-related injuries or ailments, and information about noise exposure in civilian life. The questionnaire is reproduced in Annex A, and a full list of the responses is presented in Annex C.

In Table 2, questionnaire Item 1 shows the pilots' perception of the noisiness of their workplaces. Over half of the respondents (53%) agreed that their workplaces were often or constantly noisy, with jet pilots being the most likely (66%) to agree. Helicopter pilots were most likely (10%) to state that their workplaces were "constantly" noisy. Overall, fewer than 5% indicated that they perceived their workplace to be never noisy.

Item 2 summarizes the pilots' perceived change in hearing since joining the Canadian Armed Forces. About 14% stated that they perceived either improvement or no decline in their hearing; while 30% said they perceived their hearing to be at least moderately worse. There were no significant differences in perceived hearing loss across the types of aircraft, except that jet pilots were substantially less likely (3%) to report "much worse" hearing compared to helicopter (10%) and transport (17%) pilots.

The types of hearing protection worn by the pilots who responded to the questionnaire are shown in Item 3. A majority (60%) wear a communication headset or Custom Ear Piece (CEP), with the next most popular protection being either a communication headset in combination with an earplug (21%) or an earplug alone (14%). Only a few respondents reported wearing ear muffs (n=2) or nothing at all (n=2).

Item 4 shows the fraction of time which the pilots reported wearing hearing protection when their work environment is noisy. Most respondents (61%) said that they always wear hearing protection in a noisy workplace, and an additional 12% wear hearing protection at least half the time. Jet pilots were the least likely to wear hearing protection consistently, with over 40% indicating that they wear it less than half the time. Across aircraft types, pilots reported never wearing hearing protection in fewer than 5% of cases. The questionnaire also revealed that for approximately half (54%) of the respondents their hearing protection was provided by their superior, while approximately one-third (36%) provided their own protection.

Several questions investigated possible reasons why some pilots do not wear hearing protection consistently. A sizable minority (10%) of the pilots stated that they did not believe that their hearing protection was beneficial, while nearly one-quarter (22%) agreed that their hearing protection was often or always uncomfortable. A similar number (21%) believed that hearing protection interferes with hearing relevant sounds in the cockpit. Only 6% of respondents (though 17% of jet pilots) felt that hearing protection may often or always pose a danger during flight. (See Annex C.)

Item 5 shows that respondents reported having received relatively little training on the dangers of noise exposure, with most respondents claiming 1 hour or less (57.6%), while some had no training at all (12.8%).

A notable finding from the questionnaire is summarized in Item 7, which shows the perceived difficulty of understanding audio alerts while wearing hearing protectors or headsets. Although it is true that jet pilots were less likely than those in other aircraft to report "no difficulty" understanding audio alerts, nonetheless nearly 80% of them did report no difficulty. Indeed, only two (1.6%) of the pilots who responded to the



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questionnaire, both of them jet pilots, reported moderate or great difficulty in understanding audio alerts in flight (Item 8). This may be compared with the fraction of respondents who reported either moderate or severe difficulty understanding other crew in the cockpit (6%) or air traffic transmissions (10%) when wearing hearing protection or headsets. This suggests that the problem with inaudible or unintelligible audio alerts in jets which originally motivated this study, while significant for a subset of pilots, does not affect a large proportion of the pilot population. Reported difficulties understanding air traffic control communications were more common (Item 6).

In Item 8 only 12% of total respondents indicated that they had been exposed to solvents. Note, however, that the survey failed to include an option to respond “I don’t know”; some respondents told the researcher that they were unsure of solvent exposures because they lacked knowledge of how to identify products contain solvents.

As shown in Item 9, tinnitus or other noises in the head were common (60%), and these symptoms were also discussed in several of the pilots’ comments at the end of the survey (Annex D). The reported bother of these symptoms was less common, with some interference with hearing and some sleep disturbance reported (Annex C).

Approximately 15% of respondents reported more than two ear infections in childhood (Annex C). Fewer reported ear infections in adulthood, and only one reported experiencing hearing loss due to infection. There were few cases of head injuries outside of work (Annex C), with one causing hearing loss. There was one reported case of medications resulting in hearing loss, although the types of medications that may be ototoxic were not described to the participants in the survey so they may or may not be aware of types and risks.

Over 80% of respondents declined to answer questions pertaining to prevalence of dizziness, which can be a symptom of hearing damage. Although the reasons for their declining to respond are unknown, we note that for pilots dizziness is a sensitive issue which could have employment and career implications.

The final section of the survey (Annex C) discusses an issue that is quite significant and difficult to measure: loud noise during leisure time from various sources such as tools, guns, off-road vehicles, motorcycles, snowmobiles, music, headphones, and dance bars. For the most part, participants reported mostly low levels of noise outside work, though some reported frequent high levels. Power tool, gun, off-road vehicle, and snowmobile use was reported as uncommon, as was exposure to loud music. Approximately 1/3 of respondents use motorcycles, but not often and 1/4 go to dance bars once a month. However, up to half of the participants use iPods (or similar), with up to 30 hours/month. Most (~70%) reported wearing some hearing protection during leisure, while only 15% wore none; ear plugs were the most common form of hearing protection.

When questioned about noise in sideline occupations and hearing protection use in sideline occupations, approximately 10% have reported having an additional job, mostly flying. Of those with a sideline job, about 80% reported only occasional noise and most reported wearing hearing protection.

Audiometric Data

Let us now consider the findings of the audiograms of the pilots who participated in this study. Only 50% of the questionnaire respondents granted access to their medical files in order to retrieve the audiogram data. In Table 3 this audiogram response rate is broken down by aircraft type. The response rate was lowest for helicopter pilots. The response rate was fairly consistent across age categories ($49.6\% \pm 7.5\%$), with the



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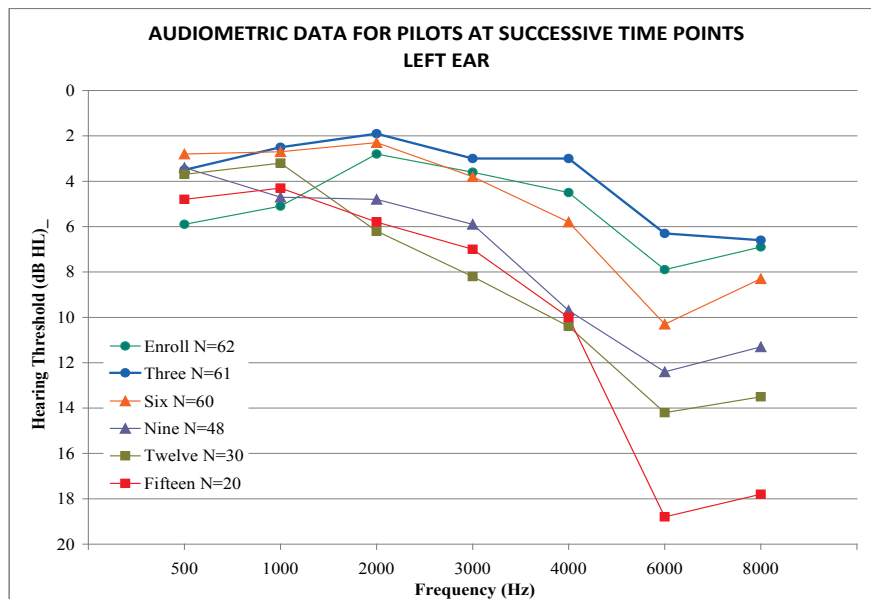
exception of the oldest age category (age 50-56) for which just 2 of the 7 pilots (29%) granted access to their medical file.

Table 3: Pilots' Response Rate for Audiograms

Type of Aircraft	N	Response Frequency	Response Percentage
Jets	29	17	58.6
Helicopters	49	17	34.7
Transport	47	28	59.6
Total	125	62	49.6

Audiometric data consisted of hearing threshold levels across a number of pure-tone frequencies ($f = (0.5, 1, 2, 3, 4, 6, 8)$ kHz). Hearing was tested separately for right and left ears. Data was typically collected at enrollment in the CAF and then every 3 years thereafter; analysis was restricted to audiograms collected at enrolment and for up to 15 years post-enrolment (maximum six audiograms per participant).

Figure 1 shows the mean hearing thresholds (dB HL) for pilots at successive measurement intervals ranging from enrollment to 15 years post-enrollment. The data show a gradual increase in hearing thresholds with time, with the increase being greater at high frequencies, as expected. Hearing loss is found to be greater in the left ear than in the right, and there is a noticeable notch at 6 kHz in the left ear.





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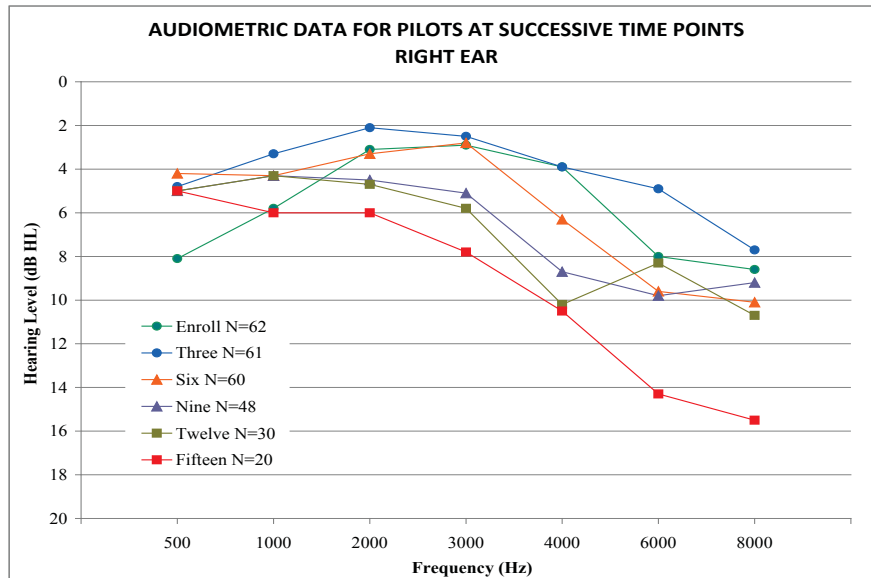


Figure 1: Mean Hearing Thresholds (dB HL) for Pilots at Successive Time Points.

The mean hearing thresholds for jet pilots alone were analyzed but were broadly consistent with the thresholds observed for all pilots in Figure 1, indicating that the hearing loss profile of jet pilots is not markedly different from those for pilots of other aircraft types.

The clinical threshold for diagnosis of hearing loss is a hearing threshold ≥ 25 dB HL. In Table 4 we show the percentage of audiograms which satisfied this clinical criterion for each measurement interval and across the frequency spectrum. By 6 years post-enrollment at least 10% of the pilots register at least a mild clinical hearing loss at and above 6 kHz in both ears. By 12 years post-enrollment at least 10% show a clinical hearing loss at and above 3 kHz in the left ear.

Table 4: Percentage of Pilots with Hearing Thresholds ≥ 25 dB HL at Successive Measurement Intervals.

Time of Measure (Years)	Ear	n	Frequency (Hz)						
			500	1000	2000	3000	4000	6000	8000*
Enrol	R	62	1.6	3.2	0.0	1.6	1.6	8.1	7.7
	L		1.6	1.6	0.0	0.0	4.8	3.2	5.1
Three	R	61	3.2	1.6	0.0	1.6	3.2	4.9	7.1
	L		0.0	0.0	1.6	1.6	3.2	1.6	7.1
Six	R	60	3.4	3.4	5.0	5.0	8.3	15.0	17.3



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	L		0.0	0.0	3.3	3.3	8.3	10.0	9.6
Nine	R	48	0.0	0.0	6.3	8.3	10.4	10.4	9.1
	L		0.0	2.1	8.3	4.2	16.7	18.8	9.1
Twelve	R	30	0.0	0.0	3.3	6.6	16.7	6.6	6.6
	L		0.0	0.0	3.3	10.0	13.3	16.7	16.7
Fifteen	R	20	0.0	0.0	5.0	10.0	10.0	15.0	25.0
	L		0.0	5.0	5.0	5.0	5.0	10.0	25.0

- * At enrolment and three, six and nine years, the n for 8000 Hz were reduced to 39, 42, 52 and 44, respectively.

The use of hearing protector among those with clinical hearing loss is shown in Table 5, where we focus on the 4 kHz and 6 kHz frequency bands. The Table shows the reported hearing protection use of those pilots for whom audiometric data was available and who showed hearing loss ≥ 25 dB HL at each of the time measurement points between enrollment and 15 years post-enrollment. At 6 and 9 years post-enrollment the number of pilots with a clinical hearing loss are roughly evenly split between those who reported that they wear hearing protection for “less than half” of their work shift in noise and those who reported wearing it for their “entire” shift. However, there are significantly more pilots in the latter category than in the former: of the 59 pilots for whom audiometric data was available at 6 years post-enrollment, for example, 36 of them reported wearing protection for their “entire” shift in noise but only 12 reported wearing it “less than half” the time. Therefore the rate of presentation of hearing loss is about 3 times lower in the group that wears hearing protection consistently. It might seem surprising from Table 5 that there is little evidence of clinical hearing loss among those who “never” wear hearing protection in noise, but recall from Table 5 that only a small number of pilots (n=5) were in that category, and only 2 of those pilots provided audiometric data.

Table 5: Hearing Protector Use During Noise at Work among Pilots with Hearing Thresholds ≥ 25 dB HL at 4 kHz and 6 kHz

Hearing Protector Use	Freq	Enrol n=61		3 n=60		6 n=59		9 n=47		12 n=29		15 n=19	
		L	R	L	R	L	R	L	R	L	R	L	R
		Never	4 kHz	0	0	0	0	0	0	0	0	0	0
	6 kHz	0	0	0	0	0	0	1	0	1	0	1	1
Less than half work shift	4 kHz	1	1	1	0	3	3	4	3	3	2	0	0
	6 kHz	1	2	1	1	2	3	3	3	1	1	0	0
More than half work shift	4 kHz	0	0	0	0	0	0	1	0	0	1	0	0
	6 kHz	0	0	0	0	1	2	0	0	0	0	2	0
Entire work shift	4 kHz	2	0	1	2	2	2	3	2	1	2	1	2



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	6 kHz	1	3	2	2	3	4	5	2	3	1	2	2
No answer	4 kHz	0	0	0	0	0	0	0	0	0	0	0	0
	6 kHz	0	0	0	0	0	0	0	0	0	0	0	0
Total	4 kHz	3	1	2	2	5	5	8	5	4	5	1	2
	6 kHz	2	5	3	3	6	9	9	5	5	2	5	3

Discussion

The audiometric findings in Figure 1 are broadly consistent with other reported hearing thresholds for military pilots (Raynal et al., 2006) which found abnormal hearing levels in pilots, especially at high frequencies, with a marked notch on audiograms at 6 kHz, and greater hearing loss in the left than right ear. Abnormal hearing was more common in older pilots, as expected, but exceeded the rate anticipated from ageing effects alone. In the general population one would expect the median change in hearing threshold at age 40 to be 9 dB relative to the hearing threshold at age 20 (ISO 7029, 2000), but we observe a mean change of nearly 20 dB between enrolment and 15 years of service. By 6 years post-enrolment 10% of the pilots registered a clinically significant hearing loss at and above 6 kHz in both ears (Table 4). A majority (60%) of respondents stated that they experienced tinnitus / noise in their ears at least occasionally, with 16% reporting such noise to be present ‘constantly’.

Over half of respondents agreed that their workplaces were often or constantly noisy (Table 2). For hearing protection in flight, about 80% reported wearing a communication headset in tandem with a Custom Ear Piece (60%) or an earplug (21%), but only 60% of respondents reported that they always wear their hearing protection when noise levels are high. Jet pilots were the least likely to wear hearing protection consistently, with over 40% indicating that they wear it less than half the time. The rate of presentation of clinically significant hearing loss (≥ 25 dB HL) is about 3 times lower in the group that wears hearing protection consistently relative to those who wear it less than half the time (

Table 5). Among the reasons given for not wearing hearing protection at all times, 22% of pilots stated that their hearing protection was often or always uncomfortable to wear, and a sizable minority (17%) of jet pilots said that hearing protection often or always poses a danger during flight. A majority (60%) indicated that they had received not more than 1 hour of hearing protection training.

A great majority of respondents indicated that they experienced ‘no’ or ‘slight’ difficulty understanding audio alerts in the cockpit while wearing hearing protectors and headsets, with only 1.6% of pilots (6.8% of jet pilots) reporting at least a moderate level of difficulty. A higher proportion of respondents indicated at least moderate difficulty understanding in-airframe communication with other aircrew (6%) and air traffic transmissions (10%). This suggests that the problem of inaudible or unintelligible audio alerts in jets which originally motivated this study, while significant for a subset of pilots, is not widespread.

It is well known that aircraft noise commonly exceeds safe levels (Owen, 1995), and it is imperative that appropriate hearing protection and communication devices be provided and properly used. Proper hearing protection must be chosen to maximize hearing protection, minimize difficulty with communication, and promote apprehension of auditory alerts. Many pilots in the CAF use personal earplugs (Question Military



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Environment 9; Annex C), the effectiveness of which is difficult to evaluate when they are not standard issue or tested for performance. Measuring the noise spectrum of each aircraft would be beneficial in order to determine how much noise reduction each requires and what products would help to achieve it.

The subjects' written comments were collected to help identify some of the unique problems associated with current hearing protection and hearing conservation programs, and are given in Annex D.

Recommendations

Based on the findings of this study, we make several recommendations:

- There is currently no program or capability within the Canadian Armed Forces to assess noise hazard in the cockpit. This service has been requested by various departments of the Air Force such as the Directorate of Air Equipment and Program Management (DAEPM), ADM (Mat), Aerospace Engineering and Test Evaluation (AETE). Currently, the only noise spectrum analysis that may be obtained is from the manufacturer of the aircraft on purchase, but this is not always available and may not always be accurate.

The National Research Council (NRC) has conducted some noise evaluation on certain aircraft such as the CH-147F Chinook helicopter (Ghinet et al., 2015) but there exists a need for the CAF to internally evaluate noise spectrum of aircraft in order to accurately assess the risk of noise exposure to their aircrew. To be thorough, a noise spectrum analysis should be done in accordance with the standards of ISO 5129 (2001), including analysis at different positions in the aircraft during all phases of flight and also at the ear of the pilot. Both ears should be assessed to gain insight as to why the left ear is subject to hearing loss more often and more severely than the right (as per Figure 1). Ideally, noise analysis would be included in the Testing and Evaluation phase of aircraft procurement. It should also be done for all current airframes (Annex B) as it provides valuable information for choosing appropriate hearing protection and communication equipment.

- Effective hearing conservation programs, including improved training for commanders and aircrew, and better enforcement of the use of hearing protectors would contribute to a reduction of noise-induced hearing loss. Early detection and monitoring of hearing loss would be advantageous in order to capture an accurate record of the incidence and frequency of these problems in the CAF. Early detection and monitoring of hearing loss would be advantageous in order to capture an accurate record of the incidence and frequency of these problems in the CAF. In the future, identification of genetic biomarkers for susceptibility to both age-related and noise-induced hearing loss should be explored further as preliminary research by other organizations have established that there is a genetic component in susceptibility to hearing loss (Temkin, 1993).
- A Record of Discussion (20 June 2012) from a panel of CAF and DND personnel on a Hearing Protection Working Group discussed the possibility of expanding the current measurement of hearing thresholds to include tests to assess fitness for duty. DFHP has initiated a study to conduct focus groups to identify mission-critical auditory tasks to optimize auditory fitness for duty hearing test development, hearing protection device selection and hearing conservation policy planning.
- Pilots are retired from active flying duties if their hearing degrades past category H2 (Canadian Armed Forces Medical Standards CFP 154, A-MD-154-000/FP-000). As such, the only way to track the true complexity and extent of hearing decline for CAF pilots is to also follow them in transition and subsequently through Veterans Affairs Canada (VAC).



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Limitations

Of the approximately 1500 pilots in the CAF, just 125 completed the hearing loss survey, and only 62 consented to collection of audiogram data. The relatively low response rate negatively impacts the generalizability of our findings. Much of the data was collected from paper medical files as the information sought predated the introduction of the Canadian Armed Forces Health Information Service (CFHIS). In some cases the audiogram data was incomplete. This type of research will be more expedient and thorough in future studies by accessing the electronic records of the CFHIS.

Conclusions

We have conducted a retrospective study of hearing loss in a sample of Canadian Armed Forces pilots, including analysis of audiogram data to assess hearing thresholds and administration of a questionnaire to identify risk factors for noise-induced hearing loss. A total of 125 pilots participated in the study by completing the questionnaire, including pilots of jet, helicopter, and transport airframes. Approximately half of the participants granted consent to analyze their audiogram data at enrolment and for 15 years post-enrolment.

The aircrew environment presents a wide variety of noise hazards, and this study found greater hearing loss than would be expected in the general population. Hearing loss degrades the operational effectiveness of airmen, negatively impacts their quality of life, and may be responsible for significant financial costs in the form of disability compensation. Noise-induced hearing loss can be reduced through compliance with hearing protection measures. The most effective method for protecting an aircrew's hearing involves understanding the noise profile in their environment and then providing proper instruction, appropriate personal protective and communication equipment, and hearing protection measures. Early detection and monitoring are critical for prevention of hearing loss and should be developed and implemented in future work.



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**Your health
Votre santé**



**Our mission
Notre mission**



Annex A – Electronic Questionnaire

Hearing Loss - Aircrew

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A. PERSONAL INFORMATION

1. Which of the following best describes the majority of your flying experience?

- Jets
- Helicopters
- Transport
- Maritime patrol

2. MOSID

3. Squadron

4. Service Number:

5. Name: (last name first)

6. Rank:

7. Age



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8. Age at CF recruitment:

9. Please list the types of aircraft you have flown since joining the CF, starting with the most current. Indicate the number of years you have flown that aircraft, number of flying hours and what type of audio equipment and earplugs you wore.

Aircraft	Number of years	Flying hours	Type of headset/audio equipment and earplugs worn
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

B. MILITARY WORK ENVIRONMENT

1. Since joining the CF, in your opinion, has your hearing changed?

- better or no change
- slightly worse



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- moderately worse
- much worse

2. Is your regular place of work noisy?

- never
- occasionally
- often
- constantly

3. How bad is the noise usually?

- no noise
- mild
- moderate
- severe

4. Have you ever received any lectures or training films on the dangers of noise exposure?

- no
- yes, 1 hour or less
- yes, less than half a day
- yes, a full day

5. Were you ever given any demonstration on the proper use of audio equipment?

- no



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- yes, 1 hour or less
- less than half a day
- yes, a full day of demonstrations

6. Overall, how would you rate your CF training regarding the dangers of exposure to loud noise?

- no training
- poor
- adequate
- good

7. At work, do your superiors advise you about the need to wear hearing protection in noise?

- no
- occasionally
- often
- constantly

8. What kind of hearing protection do you usually use when it is noisy at work?

- none, no noise at work (will skip to question 10)
- I don't wear hearing protection in noise
- I wear plugs
- I wear muffs
- I wear a communication headset /CEP



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- I wear a communication headset and ear plugs

9. Who gave you the hearing protection that you wear?

- I don't wear hearing protection
- Superior/ Supervisor
- Myself

10. How often do you use these hearing protection devices at work when it is noisy?

- never
- less than half my work shift
- more than half my work shift
- my entire work shift

11. What is your opinion of the following statements? Please use the choices listed at the top.

	not applicable (no noise at work)	disagree	occasionally agree	often agree	definitely agree
a) Hearing protection is not beneficial:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) Plugs and/or headset are uncomfortable:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) I can't hear as well wearing them:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) Wearing them may pose a danger in my job:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

12. Describe any hearing difficulties you may have experienced as aircrew. Please use the choices listed at



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the top.

	no difficulty	slight difficulty	moderate difficulty	great difficulty
a) Understanding someone face-to-face, without hearing protectors, in a quiet work environment (non-flying) or office:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) Listening to someone, out of your line of sight, without hearing protectors, in a quiet work environment (non-flying) or office:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) Understanding someone face-to-face, while wearing hearing protectors/headset, in a quiet (engines off) aircraft:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) Listening to someone, out of your line of sight, while wearing hearing protectors/headset, in a quiet (engines off) aircraft:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) Understanding the crew in a cockpit, while wearing hearing protectors/headset, during the flight:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f) Understanding air traffic transmissions while wearing hearing protectors/headset during flight:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g) Understanding audio alert warnings while wearing hearing protectors/headset during flight:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

EXPOSURE TO SOLVENTS

13. Since your CF recruitment, have you ever been exposed to solvents as part of your job? (e.g., Toluene, Styrene, Xylene, Ethyl Benzene, Carbon disulfide, Trichloroethylene)

- never exposed
- exposed

14. Did you wear respiratory protective equipment during your exposure to solvents?



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- never
- less than half my work shift
- more than half my work shift
- my entire work shift

HEAD INJURIES

15. Since joining the CF, were you involved in any accidents involving head injuries at work which affected your hearing?

- none; (this choice will skip to Part C)
- one accident
- two accidents
- more than two accidents

If more than two accidents, please specify number:

Please document all head injuries, detailing place, date and circumstances as far as you recall:

16. Which ear(s) were affected?

- neither ear (hearing returned to normal)
- right ear
- left ear
- both ears



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17. Did the accident(s) permanently worsen your hearing?

- no, my hearing returned to normal
- yes, mild hearing loss
- yes, moderate hearing loss
- yes, severe hearing loss

18. Were you satisfied with any treatment you may have received?

- no treatment
- dissatisfied
- somewhat satisfied
- very satisfied

C. EAR STATUS

1. Did you have ear infections when you were a child (under the age of 18 years)?

- none
- one
- two
- more than two

2. Have you had any ear infections as an adult (over the age of 18 years)?

- none
- one
- two
- more than two



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3. Did the ear infection(s) when you were a child or adult permanently affect your hearing?

- no ear infections
- I don't know if they affected my hearing
- no, my hearing returned to normal
- yes, mild hearing loss
- yes, moderate hearing loss
- yes, severe hearing loss

4. Have you ever had any bad head injuries outside of work?

- none; (will skip to question 6)
- one
- two
- more than two

5. Did the head injuries outside of work affect your hearing?

- no
- yes, but my hearing returned to normal
- yes, I now have permanent hearing loss

6. Have you ever taken any medication or drugs which you think may have affected your hearing?

- no
- yes, but no effect on my hearing



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- yes, but my hearing returned to normal
- yes, I now have permanent hearing loss as a result

NOISE

7. Have you ever heard noises in your ears or head such as a ringing or buzzing sound after flight operations?

- no; (will skip to question 11)
- occasionally-less than half the time
- often-more than half the time
- constantly

8. Was the ringing or buzzing sound in your head or ears bothersome?

- no; (will skip to question 11)
- mildly
- moderately
- severely

9. Did the noise in your head or ears ever interfere with your hearing?

- no
- slight interference
- moderate interference
- much interference



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10. Did the noise in your head or ears ever disturb your sleep?

- no
- occasionally - less than half the time
- often - more than half the time
- all the time

DIZZINESS

11. Have you ever experienced dizzy spells?

- no; (will skip to Part D)
- occasionally - less than half the time
- often - more than half the time
- all the time

12. When you had these dizzy spells, did the world or your body seem to turn in circles?

- no
- not sure
- a little bit
- definitely

13. Did the dizzy spells ever interfere with your work?

- no



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- occasionally - less than half the time
- often - more than half the time
- all the time

14. Did the dizzy spells seem to occur together with noises in your head or ears and problems with your hearing?

- no
- not sure
- maybe
- definitely related

D. CIVILIAN LIFE

1. Are you exposed to loud sounds during your free time?

- no
- occasionally - less than half the time
- often - more than half the time
- all the time

2. Which of the following sources of loud sound you are exposed to outside of work apply to you (please mark all sources that apply to you and indicate how often you are exposed to each)

- power tools _____
- guns (hunting/gun clubs) _____



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- off-road vehicles _____
- motorcycles _____
- snowmobiles _____
- rock music _____
- disco/dance bars _____
- iPod or music through earphones _____
- others (please specify) _____

3. Do you wear hearing protection during these noisy activities?

- no, I don't participate in noisy activities; will skip to question 5
- no, I don't wear hearing protection during noisy activities
- yes, less than half the time
- yes, more than half the time
- yes, all the time

4. What kind of hearing protection do you generally use?

- none
- ear plugs
- headset or muffs
- ear plugs and headset or muffs
- other - please specify

If other, specify here:



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5. Do you work outside the military?

- no; you have completed the questionnaire (will skip to comments page)
- yes, occasionally
- yes, weekends
- yes, regularly after-hours

Please describe your sideline occupations:

6. Are you exposed to loud sounds in your sideline work?

- no; you have completed the questionnaire (will skip to comments page)
- occasionally - less than half the time
- often - more than half the time
- constantly

7. Do you wear hearing protection during your sideline work?

- no; you have completed the questionnaire (will skip to comments page)
- occasionally - less than half the time
- often - more than half the time
- constantly

8. What kind of hearing protection do you usually use?



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- none
- ear plugs
- ear muffs
- ear plugs and ear muffs
- other

If other, please specify:

COMMENTS:

Please add any information you think might be relevant to this study. We would appreciate your comments:

THANK YOU!



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Annex B – Canadian Armed Forces Aircraft Legend

Number	Name of Aircraft	Type
1	CP-140A Arcturus	Multi-Engine
2	CP-140 Aurora	Multi-Engine
3	CC-115 Buffalo	Multi-Engine
4	CC-144 Challenger	Multi-Engine
5	CH-149 Cormorant	Helicopter
6	CH-148 Cyclone	Helicopter
7	CT-142 Dash-8	Multi-Engine
8	CC-177 Globemaster	Multi-Engine
9	CH-146 Griffon	Helicopter
10	CT-156 Harvard II	TurboProp
11	CT-155 Hawk	Jet
12	CC-130 Hercules	Multi-Engine
13	CC-130J Hercules	Multi-Engine
14	CF-188 Hornet	Jet
15	CH-139 Jet Ranger	Helicopter
16	CC-150 Polaris	Multi-Engine
17	CH-124 Sea King	Helicopter
18	CT-114 Tutor	TurboJet
19	CC-138 Twin Otter	TurboProp
20	CH-147 Chinook	Helicopter
21	CT-133 Silver Star	Jet
22	CT-134 Musketeer	Single Engine prop
23	T-67C Slingsby	Single engine prop
24	C-90A King Air	Multi-Engine
25	CH-135 Twin Huey	Helicopter
26	CH-136 Kiowa	Helicopter
27	All other aircraft	



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Annex C – All Questionnaire Responses

Perceived Change in Hearing since Joining the CF							
			Type of Aircraft			Total	
			Jets	Helicopters	Transport		
Military Environment 1	better or no change	n	5	7	5	17	
		%	17.2%	14.3%	10.6%	13.6%	
	slightly worse	n	17	28	26	71	
		%	58.6%	57.1%	55.3%	56.8%	
	moderately worse	n	6	9	8	23	
		%	20.7%	18.4%	17.0%	18.4%	
	much worse	n	1	5	8	14	
		%	3.4%	10.2%	17.0%	11.2%	
Total		n	29	49	47	125	
		%	100.0%	100.0%	100.0%	100.0%	
Perceived Noisiness of Workplace							
			Type of Aircraft			Total	
			Jets	Helicopters	Transport		
Military Environment 2	never	n	1	2	3	6	
		%	3.4%	4.1%	6.4%	4.8%	
	occasionally	n	9	21	23	53	
		%	31.0%	42.9%	48.9%	42.4%	
	often	n	18	21	18	57	
		%	62.1%	42.9%	38.3%	45.6%	
	constantly	n	1	5	3	9	
		%	3.4%	10.2%	6.4%	7.2%	
	Total		n	29	49	47	125
			%	100.0%	100.0%	100.0%	100.0%
Perceived Severity of Noise in the Workplace							



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			Type of Aircraft			Total
			Jets	Helicopters	Transport	
Military Environment 3	no noise	n	1	2	1	4
		%	3.4%	4.1%	2.1%	3.2%
	mild	n	9	9	16	34
		%	31.0%	18.4%	34.0%	27.2%
	moderate	n	13	29	24	66
		%	44.8%	59.2%	51.1%	52.8%
	severe	n	6	9	6	21
		%	20.7%	18.4%	12.8%	16.8%
Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%

Training Received on the Dangers of Noise Exposure

			Type of Aircraft			Total	
			Jets	Helicopters	Transport		
Military Environment 4	no	n	3	5	8	16	
		%	10.3%	10.2%	17.0%	12.8%	
	yes, 1 hour or less	n	22	27	23	72	
		%	75.9%	55.1%	48.9%	57.6%	
	yes, less than half a day	n	4	14	16	34	
		%	13.8%	28.6%	34.0%	27.2%	
	yes, a full day	n	0	2	0	2	
		%	0.0%	4.1%	0.0%	1.6%	
	Did not respond	n	0	1	0	1	
		%	0.0%	2.0%	0.0%	.8%	
	Total		n	29	49	47	125
			%	100.0%	100.0%	100.0%	100.0%

Demonstrations Received on the Proper Use of Hearing Protectors



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			Type of Aircraft			Total
			Jets	Helicopters	Transport	
Military Environment 5	no	n	13	15	25	53
		%	44.8%	30.6%	53.2%	42.4%
	yes, 1 hour or less	n	13	25	19	57
		%	44.8%	51.0%	40.4%	45.6%
	less than half a day	n	3	8	3	14
		%	10.3%	16.3%	6.4%	11.2%
	yes, a full day of demonstrations	n	0	1	0	1
		%	0.0%	2.0%	0.0%	.8%
Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%

Perceived Quality of Training Received Regarding Loud Noise

			Type of Aircraft			Total
			Jets	Helicopters	Transport	
Military Environment 6	no training	n	1	3	4	8
		%	3.4%	6.1%	8.5%	6.4%
	poor	n	17	14	24	55
		%	58.6%	28.6%	51.1%	44.0%
	adequate	n	7	24	16	47
		%	24.1%	49.0%	34.0%	37.6%
	good	n	4	8	3	15
		%	13.8%	16.3%	6.4%	12.0%
Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%

How Often Supervisors Advise the Need to Use Hearing Protectors

			Type of Aircraft			Total
			Jets	Helicopters	Transport	



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Military Environment 7	no	n	7	10	20	37
		%	24.1%	20.4%	42.6%	29.6%
	occasionally	n	13	24	17	54
		%	44.8%	49.0%	36.2%	43.2%
	often	n	9	10	10	29
		%	31.0%	20.4%	21.3%	23.2%
	constantly	n	0	5	0	5
		%	0.0%	10.2%	0.0%	4.0%
Total	n	29	49	47	125	
	%	100.0%	100.0%	100.0%	100.0%	

Types of Hearing Protectors Used by CF Personnel

		Type of Aircraft				Total	
		Jets	Helicopters	Transport			
Military Environment 8	none, no noise at work	n	1	1	0	2	
		%	3.4%	2.0%	0.0%	1.6%	
	I don't wear hearing protection in noise	n	1	0	1	2	
		%	3.4%	0.0%	2.1%	1.6%	
	I wear plugs	n	6	7	5	18	
		%	20.7%	14.3%	10.6%	14.4%	
	I wear muffs	n	1	0	1	2	
		%	3.4%	0.0%	2.1%	1.6%	
	I wear a communication headset	n	15	23	37	75	
		%	51.7%	46.9%	78.7%	60.0%	
	I wear a communication headset and ear plugs	n	5	18	3	26	
		%	17.2%	36.7%	6.4%	20.8%	
	Total		n	29	49	47	125



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		%	100.0%	100.0%	100.0%	100.0%
Who Gave the Hearing Protectors to Wear						
		Type of Aircraft				Total
			Jets	Helicopters	Transport	
Military Environment 9	I don't wear hearing protection	n	2	0	0	2
		%	6.9%	0.0%	0.0%	1.6%
	Superior/ Supervisor	n	13	29	24	66
		%	44.8%	59.2%	53.3%	53.7%
	Myself	n	12	16	17	45
		%	41.4%	32.7%	37.8%	36.6%
	other	n	1	1	3	5
		%	3.4%	2.0%	6.7%	4.1%
Did not respond	n	1	3	1	5	
	%	3.4%	6.1%	2.2%	4.1%	
Total		n	29	49	45	123
		%	100.0%	100.0%	100.0%	100.0%
How Often Hearing Protectors are Worn When Noisy at Work						
		Type of Aircraft				Total
			Jets	Helicopters	Transport	
Military Environment 10	never	n	1	2	2	5
		%	3.4%	4.2%	4.3%	4.0%
	less than half my work shift	n	11	6	8	25
		%	37.9%	12.5%	17.0%	20.2%
	more than half my work shift	n	4	4	7	15
		%	13.8%	8.3%	14.9%	12.1%
	my entire work shift	n	11	36	29	76
		%	37.9%	75.0%	61.7%	61.3%



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	Other	n	0	0	1	1
		%	0.0%	0.0%	2.1%	.8%
	Did not respond	n	2	0	0	2
		%	6.9%	0.0%	0.0%	1.6%
Total	n	29	48	47	124	
	%	100.0%	100.0%	100.0%	100.0%	

Belief that Hearing Protectors are not Beneficial

		Type of Aircraft				Total
		Jets	Helicopters	Transport		
Military Environment 11a	not applicable (no noise at work)	n	0	0	1	1
		%	0.0%	0.0%	2.1%	.8%
	disagree	n	25	38	41	104
		%	86.2%	77.6%	87.2%	83.2%
	occasionally agree	n	1	2	1	4
		%	3.4%	4.1%	2.1%	3.2%
	often agree	n	0	1	1	2
		%	0.0%	2.0%	2.1%	1.6%
	definitely agree	n	3	8	3	14
		%	10.3%	16.3%	6.4%	11.2%
	Total	n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%

Belief that Hearing Protectors are Uncomfortable

		Type of Aircraft			Total	
		Jets	Helicopters	Transport		
Military Environment 11b	disagree	n	15	13	11	39
		%	51.7%	26.5%	23.4%	31.2%
	occasionally	n	8	29	22	59



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	agree	%	27.6%	59.2%	46.8%	47.2%
	often agree	n	5	5	13	23
		%	17.2%	10.2%	27.7%	18.4%
	definitely agree	n	1	2	1	4
%		3.4%	4.1%	2.1%	3.2%	
Total	n	29	49	47	125	
	%	100.0%	100.0%	100.0%	100.0%	

Belief that Hearing Protectors Will Interfere With Hearing

		Type of Aircraft				Total
		Jets	Helicopters	Transport		
Military Environment 11c	disagree	n	5	19	19	43
		%	17.2%	38.8%	40.4%	34.4%
	occasionally agree	n	13	17	17	47
		%	44.8%	34.7%	36.2%	37.6%
	often agree	n	5	11	8	24
		%	17.2%	22.4%	17.0%	19.2%
	definitely agree	n	6	2	3	11
		%	20.7%	4.1%	6.4%	8.8%
Total	n	29	49	47	125	
	%	100.0%	100.0%	100.0%	100.0%	

Belief that Hearing Protectors May Pose a Danger at Work

		Type of Aircraft				Total
		Jets	Helicopters	Transport		
Military Environment 11d	not applicable (no noise at work)	n	0	3	2	5
		%	0.0%	6.1%	4.3%	4.0%
	disagree	n	21	38	37	96
		%	72.4%	77.6%	78.7%	76.8%



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	occasionally agree	n	3	7	7	17
		%	10.3%	14.3%	14.9%	13.6%
	often agree	n	3	0	0	3
		%	10.3%	0.0%	0.0%	2.4%
	definitely agree	n	2	1	1	4
		%	6.9%	2.0%	2.1%	3.2%
Total	n	29	49	47	125	
	%	100.0%	100.0%	100.0%	100.0%	

Understanding Someone face-to-face, Without Hearing Protectors, in a Quiet Aircraft

		Type of Aircraft				Total
		Jets	Helicopters	Transport		
Military Environment 12a	no difficulty	n	27	46	38	111
		%	93.1%	93.9%	80.9%	88.8%
	slight difficulty	n	2	3	8	13
		%	6.9%	6.1%	17.0%	10.4%
	moderate difficulty	n	0	0	1	1
		%	0.0%	0.0%	2.1%	.8%
Total	n	29	49	47	125	
	%	100.0%	100.0%	100.0%	100.0%	

Listening to Someone Out of Your Line of Sight, Without Hearing Protectors, in a Quiet Aircraft

		Type of Aircraft				Total
		Jets	Helicopters	Transport		
Military Environment 12b	no difficulty	n	22	37	30	89
		%	75.9%	75.5%	63.8%	71.2%
	slight difficulty	n	7	12	14	33
		%	24.1%	24.5%	29.8%	26.4%
	moderate difficulty	n	0	0	3	3
		%	0.0%	0.0%	6.4%	2.4%



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Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%
Difficulty Understanding Someone, Face-to-Face, While Wearing Hearing Protectors, in a Quiet Aircraft						
		Type of Aircraft			Total	
			Jets	Helicopters	Transport	
Military Environment 12c	no difficulty	n	7	18	20	45
		%	24.1%	36.7%	43.5%	36.3%
	slight difficulty	n	19	22	18	59
		%	65.5%	44.9%	39.1%	47.6%
	moderate difficulty	n	3	8	7	18
		%	10.3%	16.3%	15.2%	14.5%
	great difficulty	n	0	1	1	2
		%	0.0%	2.0%	2.2%	1.6%
Total		n	29	49	46	124
		%	100.0%	100.0%	100.0%	100.0%
Listening to Someone, out of your Line of Sight, Wearing Hearing Protectors, in a Quiet Aircraft						
		Type of Aircraft			Total	
			Jets	Helicopters	Transport	
Military Environment 12d	no difficulty	n	4	13	13	30
		%	13.8%	26.5%	27.7%	24.0%
	slight difficulty	n	16	15	14	45
		%	55.2%	30.6%	29.8%	36.0%
	moderate difficulty	n	6	14	14	34
		%	20.7%	28.6%	29.8%	27.2%
	great difficulty	n	3	7	6	16
		%	10.3%	14.3%	12.8%	12.8%
Total		n	29	49	47	125



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		%	100.0%	100.0%	100.0%	100.0%
Difficulty Understanding Crew in the Cockpit, While Wearing Protectors, During Flight						
		Type of Aircraft				Total
		Jets	Helicopters	Transport		
Military Environment 12e	no difficulty	n	18	31	24	73
		%	62.1%	63.3%	51.1%	58.4%
	slight difficulty	n	9	15	21	45
		%	31.0%	30.6%	44.7%	36.0%
	moderate difficulty	n	2	3	0	5
		%	6.9%	6.1%	0.0%	4.0%
great difficulty	n	0	0	2	2	
	%	0.0%	0.0%	4.3%	1.6%	
Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%
Difficulty Understanding Air Traffic Transmissions, While Wearing Hearing Protectors/Headset, During Flight						
		Type of Aircraft				Total
		Jets	Helicopters	Transport		
Military Environment 12f	no difficulty	n	17	25	21	63
		%	58.6%	51.0%	44.7%	50.4%
	slight difficulty	n	10	19	21	50
		%	34.5%	38.8%	44.7%	40.0%
	moderate difficulty	n	2	4	4	10
		%	6.9%	8.2%	8.5%	8.0%
great difficulty	n	0	1	1	2	
	%	0.0%	2.0%	2.1%	1.6%	
Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%



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Difficulty Understanding Audio Alert Warnings, While Wearing Hearing Protectors/Headset during Flight						
			Type of Aircraft			Total
			Jets	Helicopters	Transport	
Military Environment 12g	no difficulty	n	23	43	43	109
		%	79.3%	87.8%	91.5%	87.2%
	slight difficulty	n	4	6	4	14
		%	13.8%	12.2%	8.5%	11.2%
	moderate difficulty	n	1	0	0	1
		%	3.4%	0.0%	0.0%	.8%
	great difficulty	n	1	0	0	1
		%	3.4%	0.0%	0.0%	.8%
Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%
Exposure to Solvents						
			Type of Aircraft			Total
			Jets	Helicopters	Transport	
Military Environment 13	never exposed	n	22	40	45	107
		%	78.6%	81.6%	95.7%	86.3%
	exposed	n	5	8	2	15
		%	17.9%	16.3%	4.3%	12.1%
	Did not respond	n	1	1	0	2
		%	3.6%	2.0%	0.0%	1.6%
Total		n	28	49	47	124
		%	100.0%	100.0%	100.0%	100.0%
Use of Respiratory Protective Equipment During Exposure to Solvents						
			Type of Aircraft			Total



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			Jets	Helicopters	Transport		
Military Environment 14	never	n	13	18	15	46	
		%	44.8%	36.7%	31.9%	36.8%	
	less than half my work shift	n	1	1	2	4	
		%	3.4%	2.0%	4.3%	3.2%	
	more than half my work shift	n	2	1	0	3	
		%	6.9%	2.0%	0.0%	2.4%	
	my entire work shift	n	0	1	0	1	
		%	0.0%	2.0%	0.0%	.8%	
	N/A	n	13	28	30	71	
		%	44.8%	57.1%	63.8%	56.8%	
Total			n	29	49	47	125
			%	100.0%	100.0%	100.0%	100.0%

History of Accidents at Work Involving Head Injuries - Details of Accident

			Type of Aircraft			Total
			Jets	Helicopters	Transport	
Head injury details	N/A	n	27	46	45	118
		%	93.1%	93.9%	95.7%	94.4%
	Basic training in 1978 damaged ear drums in swimming pool	n	0	0	1	1
		%	0.0%	0.0%	2.1%	.8%
	Moose Jaw, 1989/90?/ ruptured eardrums while flying	n	1	0	0	1
		%	3.4%	0.0%	0.0%	.8%
	N/A	n	0	1	1	2
		%	0.0%	2.0%	2.1%	1.6%
	TBI while on	n	1	0	0	1



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	TD last November in El Centro CA, no impact on hearing so far.	%	3.4%	0.0%	0.0%	.8%
	Was hit on the head in 1988. Slight Concussion.	n	0	1	0	1
		%	0.0%	2.0%	0.0%	.8%
	Winter 1987 in the army, moving through brush, and a branch went in my ear canal and perforated my eardrum	n	0	1	0	1
		%	0.0%	2.0%	0.0%	.8%
Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%
Ears That Were Affected by the Accident						
		Type of Aircraft				Total
			Jets	Helicopters	Transport	
Military Environment 16	neither ear (hearing returned to normal)	n	1	8	4	13
		%	3.4%	16.3%	8.5%	10.4%
	left ear	n	0	1	0	1
		%	0.0%	2.0%	0.0%	.8%
	both ears	n	1	0	1	2
		%	3.4%	0.0%	2.1%	1.6%
N/A	n	27	40	42	109	
	%	93.1%	81.6%	89.4%	87.2%	
Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%



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Presence of Permanent Hearing Loss Due to Head Injury						
			Type of Aircraft			Total
			Jets	Helicopters	Transport	
Military Environment 17	no, my hearing returned to normal	n	2	9	5	16
		%	6.9%	18.4%	10.6%	12.8%
	N/A	n	27	40	42	109
		%	93.1%	81.6%	89.4%	87.2%
Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%
Satisfaction With Treatment Received						
			Type of Aircraft			Total
			Jets	Helicopters	Transport	
Military Environment 18	no treatment	n	1	8	4	13
		%	3.4%	16.3%	8.5%	10.4%
	somewhat satisfied	n	0	0	1	1
		%	0.0%	0.0%	2.1%	.8%
	very satisfied	n	1	1	0	2
		%	3.4%	2.0%	0.0%	1.6%
	N/A	n	27	40	42	109
		%	93.1%	81.6%	89.4%	87.2%
Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%
Effect of Ear Infections on Hearing						
			Type of Aircraft			Total
			Jets	Helicopters	Transport	
Ear Status 1	none	n	12	31	22	65
		%	42.9%	63.3%	46.8%	52.4%



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	one	n	6	10	9	25
		%	21.4%	20.4%	19.1%	20.2%
	two	n	1	2	8	11
		%	3.6%	4.1%	17.0%	8.9%
	more than two	n	9	5	7	21
		%	32.1%	10.2%	14.9%	16.9%
did not respond	n	0	1	1	2	
	%	0.0%	2.0%	2.1%	1.6%	
Total	n	28	49	47	124	
	%	100.0%	100.0%	100.0%	100.0%	

History of Ear Infections (Adulthood)

		Type of Aircraft				Total
		Jets	Helicopters	Transport		
Ear Status 2	none	n	24	39	33	96
		%	82.8%	79.6%	70.2%	76.8%
	one	n	2	5	9	16
		%	6.9%	10.2%	19.1%	12.8%
	two	n	0	2	1	3
		%	0.0%	4.1%	2.1%	2.4%
	more than two	n	3	2	3	8
		%	10.3%	4.1%	6.4%	6.4%
	did not respond	n	0	1	1	2
		%	0.0%	2.0%	2.1%	1.6%
	Total	n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%

Effect of Ear Infections on Hearing

		Type of Aircraft			Total
		Jets	Helicopters	Transport	



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Ear Status 3	no ear infections	n	12	24	12	48	
		%	41.4%	51.1%	26.1%	39.3%	
	I don't know if they affected my hearing	n	3	9	10	22	
		%	10.3%	19.1%	21.7%	18.0%	
	no, my hearing returned to normal	n	13	9	18	40	
		%	44.8%	19.1%	39.1%	32.8%	
	yes, mild hearing loss	n	1	0	0	1	
		%	3.4%	0.0%	0.0%	.8%	
	did not respond	n	0	5	6	11	
		%	0.0%	10.6%	13.0%	9.0%	
	Total		n	29	47	46	122
			%	100.0%	100.0%	100.0%	100.0%
History of Head Injuries Outside of Work							
		Type of Aircraft			Total		
		Jets	Helicopters	Transport			
Ear Status 4	none; (will skip to question 6)	n	25	37	42	104	
		%	86.2%	75.5%	89.4%	83.2%	
	one	n	3	8	5	16	
		%	10.3%	16.3%	10.6%	12.8%	
	more than two	n	1	2	0	3	
		%	3.4%	4.1%	0.0%	2.4%	
	did not respond	n	0	2	0	2	
		%	0.0%	4.1%	0.0%	1.6%	
Total		n	29	49	47	125	
		%	100.0%	100.0%	100.0%	100.0%	
Effect of the Head Injury on Hearing							
		Type of Aircraft			Total		



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			Jets	Helicopters	Transport			
Ear Status 5	no	n	3	15	9	27		
		%	10.3%	31.9%	20.0%	22.3%		
	yes, but my hearing returned to normal	n	0	0	1	1		
		%	0.0%	0.0%	2.2%	.8%		
	yes, I now have permanent hearing loss	n	1	0	0	1		
		%	3.4%	0.0%	0.0%	.8%		
	N/A	n	25	32	35	92		
		%	86.2%	68.1%	77.8%	76.0%		
Total			n	29	47	45	121	
			%	100.0%	100.0%	100.0%	100.0%	
Use of Medications that May Have Affected Hearing								
			Type of Aircraft			Total		
			Jets	Helicopters	Transport			
Ear Status 6	no	n	28	47	43	118		
		%	100.0%	95.9%	91.5%	95.2%		
	yes, but no effect on my hearing	n	0	0	1	1		
		%	0.0%	0.0%	2.1%	.8%		
	yes, but my hearing returned to normal	n	0	0	1	1		
		%	0.0%	0.0%	2.1%	.8%		
	yes, I now have permanent hearing loss as a result	n	0	0	1	1		
		%	0.0%	0.0%	2.1%	.8%		
	N/A	n	0	2	1	3		
		%	0.0%	4.1%	2.1%	2.4%		
	Total			n	28	49	47	124
				%	100.0%	100.0%	100.0%	100.0%



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Presence of Noise in Head or Ears							
			Type of Aircraft			Total	
			Jets	Helicopters	Transport		
Ear Status 7	no; (will skip to question 11)	n	12	19	20	51	
		%	41.4%	38.8%	42.6%	40.8%	
	occasionally- less than half the time	n	9	20	17	46	
		%	31.0%	40.8%	36.2%	36.8%	
	often-more than half the time	n	3	1	3	7	
		%	10.3%	2.0%	6.4%	5.6%	
	constantly	n	5	8	7	20	
		%	17.2%	16.3%	14.9%	16.0%	
	Did not respond	n	0	1	0	1	
		%	0.0%	2.0%	0.0%	.8%	
	Total		n	29	49	47	125
			%	100.0%	100.0%	100.0%	100.0%
Perceived Bother of Noise in Head or Ears							
			Type of Aircraft			Total	
			Jets	Helicopters	Transport		
Ear Status 8	no; (will skip to question 11)	n	4	12	8	24	
		%	13.8%	24.5%	17.0%	19.2%	
	mildly	n	10	15	12	37	
		%	34.5%	30.6%	25.5%	29.6%	
	moderately	n	4	5	8	17	
		%	13.8%	10.2%	17.0%	13.6%	
	severely	n	0	0	1	1	
		%	0.0%	0.0%	2.1%	.8%	
	N/A		n	11	17	18	46



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		%	37.9%	34.7%	38.3%	36.8%
Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%
Interference of Noise in Head or Ears With Hearing						
		Type of Aircraft				Total
		Jets	Helicopters	Transport		
Ear Status 9	no	n	5	11	9	25
		%	17.2%	22.4%	19.1%	20.0%
	slight interference	n	10	11	13	34
		%	34.5%	22.4%	27.7%	27.2%
	moderate interference	n	0	2	4	6
		%	0.0%	4.1%	8.5%	4.8%
	N/A	n	14	25	21	60
		%	48.3%	51.0%	44.7%	48.0%
Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%
Disturbance of Noise in Head or Ears With Sleep						
		Type of Aircraft				Total
		Jets	Helicopters	Transport		
Ear Status 10	no	n	8	14	9	31
		%	27.6%	28.6%	19.1%	24.8%
	occasionally - less than half the time	n	6	9	13	28
		%	20.7%	18.4%	27.7%	22.4%
	often - more than half the time	n	0	0	2	2
		%	0.0%	0.0%	4.3%	1.6%
	all the time	n	1	1	1	3
		%	3.4%	2.0%	2.1%	2.4%



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	N/A	n	14	25	22	61
		%	48.3%	51.0%	46.8%	48.8%
Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%
Presence of Dizzy Spells						
		Type of Aircraft				Total
		Jets	Helicopters	Transport		
Ear Status 11	no; (will skip to Part D)	n	28	45	42	115
		%	96.6%	91.8%	89.4%	92.0%
	occasionally - less than half the time	n	1	3	4	8
		%	3.4%	6.1%	8.5%	6.4%
	Did not respond	n	0	1	1	2
		%	0.0%	2.0%	2.1%	1.6%
Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%
Perception of Body Turning in Circles						
		Type of Aircraft				Total
		Jets	Helicopters	Transport		
Ear Status 12	no	n	1	9	5	15
		%	3.4%	18.4%	10.6%	12.0%
	not sure	n	0	0	1	1
		%	0.0%	0.0%	2.1%	.8%
	a little bit	n	1	0	1	2
		%	3.4%	0.0%	2.1%	1.6%
	definitely	n	0	0	1	1
		%	0.0%	0.0%	2.1%	.8%
	N/A	n	27	40	39	106



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		%	93.1%	81.6%	83.0%	84.8%
Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%
Interference of Dizzy Spells with Work						
		Type of Aircraft				Total
			Jets	Helicopters	Transport	
Ear Status13	no	n	2	9	7	18
		%	6.9%	18.4%	14.9%	14.4%
	occasionally - less than half the time	n	0	0	2	2
		%	0.0%	0.0%	4.3%	1.6%
	N/A	n	27	40	38	105
		%	93.1%	81.6%	80.9%	84.0%
Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%
Occurrence of Dizzy Spells with Noises in Head and Ears and Problems with Hearing						
		Type of Aircraft				Total
			Jets	Helicopters	Transport	
Ear Status14	no	n	1	9	7	17
		%	3.4%	18.4%	14.9%	13.6%
	not sure	n	1	0	2	3
		%	3.4%	0.0%	4.3%	2.4%
	N/A	n	27	40	38	105
		%	93.1%	81.6%	80.9%	84.0%
Total		n	29	49	47	125
		%	100.0%	100.0%	100.0%	100.0%



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Annex D – Additional Comments from Pilots

Please add any information you think might be relevant to this study. We would appreciate your comments:

#	Response
1.	Overall, I've noticed a gradual decrease in my hearing. There has been no significant impact to job performance or quality of life, however, I do recognize it as a trend. I have always been conscious of protecting my hearing; my mom is an educator of the deaf and hard of hearing, thus at a young age it was instilled in me to protect it. I do everything I feel I can to protect my hearing both at work and during leisure activities, however, avoiding loud and potentially damaging noise is not always possible. I appreciate that this is being closely looked at within the CF.
2.	This questionnaire missed a few points specific to CF flying operations. In Afghanistan, our helicopter pilots were fitted with custom-fitted, noise-reducing ear plugs which were worn inside the communications helmet. I strongly support the further use of this system. Also, our low-quality radios make it difficult to set a comfortable volume to hear intercom and external radio - it's an either/or sort of thing. While the intercom may be set to hear one crew member perfectly, the other may come across screechingly loud. There is no "perfect" setting without using more modern, digital radios.
4.	Based on my annual aircrew medical, this year's hearing result shows a slight decrease in hearing performance relative to last year.
5.	There have been occasions when I have been exposed to aircraft engine noise for brief periods where exposure was unintended and hearing protection was not avail. This is a common occurrence in a dynamic tactical helicopter environment.
7.	Have developed constant tinnitus. Significant documented hearing loss. I believe that CEPs and flight helmet should be mandatory for all CF helicopter pilots.
8.	Fitted CEP's would be of great benefit in addition to issued Ear Defenders.
10.	We need to have in-ear noise isolating headphones. So many people have tinnitus.
11.	My latest hearing test as part of my annual aviation medical will move me to H3 category. This may lead to a medical review board and job loss. I attribute my hearing loss directly to the thousands of hours spent flying in turboprop aircraft. The Aurora is loud and the Twin Otter is even louder, even with the so-called noise canceling David Clark headset. I would categorize these headsets as noise reduction rather than noise canceling. The CF was warned years ago through the ALSE chain of command about the inadequate protection of the headsets it was issuing. However, like most other things when it comes to getting the proper equipment for the members, the cost of providing adequate protection always seems to outweigh the requirement to do the right thing. The option for the member to purchase his or her own equipment is not there due to the CF's insistence on using only the issued equipment, however inadequate.



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#	Response
13.	While flying the Tutor, I found the use of a headset and earplugs to be more than adequate hearing protection and suffered no significant hearing damage during that time. When I began flying the CP140 Aurora, I found it to be a very loud aircraft and the missions flown were long duration, regularly 6-10 hours each. During an operational exercise in 2004, we were required to fly every second day for 9-12 hours per flight. During this deployment I noticed that I was starting to have tinnitus and it did not go away. Over the years the tinnitus has lessened very slightly, but I still feel the effects sometimes to the point of interrupting my sleep. I believe that the constant exposure for such long durations, without the opportunity to let my ears fully recover, has permanently damaged my hearing. I requested a noise cancelling headset to minimize any further hearing damage, but was denied. In 2011 I returned to flying the Aurora and Noise Reduction Headsets are regular issue now for aircrew, which significantly reduces the noise exposure.
14.	My concerns with the hearing protection provided by the military is that the current ALSE provided is antiquated and inadequate. The fact that foam earplugs are the solution being provided to the reduction of external noise fails to address intelligibility during critical communications. The foam earplugs block noise externally and internally when they are worn inside the earcups. The CF has failed to provide aircrew with effective hearing protection even though many superior choices are available at costs that would be far cheaper than paying hearing loss pensions. The UCR and SOCD systems are flawed in that they are process driven devices that get bogged down and never rectify any concerns in a reasonable time frame.
15.	The advent of noise canceling headsets have helped. The tech should be made more user friendly and incorporated in the SPH-5 & 190A Helmets
16.	I find the current hearing tests inaccurate. The test shows that my hearing is OK, but I cannot hear people talk during large social interactions.
17.	My hearing seems to have gotten a bit worse over the past 2-3 years, with occasional ringing (tinnitus). I'm still H1, but my tests scores seem to be lower. In general, I always try to use earplugs or my headset. I also spent a year in Afghanistan about 1.5 years ago on a ground tour) and was exposed to some explosions and gunfire--generally without hearing protection because you obviously don't wear it all the time.
18.	I have some very random and seldom acting tinnitus. Meaning that, once a month maybe, I'll get a random ringing in one ear for maybe 5 seconds... It's not related to loud noise at all, might even happen while I'm on the couch at home. I have a very good hearing, so I find it quite funny...
19.	Initial cost of procuring better personnel noise-reduction equipment may be significantly offset by the long-term medical disability expenses that are incurred, in terms of financial and HR perspective. Thank you for taking the time to conduct this important survey.



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#	Response
20.	I would desperately like to wear ear plugs under my flying helmets but have had little luck with the combinations for the following reasons: - can't hear caution and warning tones / voice annunciators at all in the F-18 with earplugs in - can't hear warning tones at all in the Hawk with earplugs in - I've only started wearing earplugs with the Snowbirds because the Tutor doesn't generate any warning tones. Having said that, I need to select all voice comms to full volume to burn through the earplugs - I've tried commercially available dual-filtered earplugs but haven't been able to find a good fit. Also, as I understand, the noise data for the Tutor fleet is over 40 years old and was based on using the Tutor as a trainer not in the Snowbirds role (which is much noisier due to close proximity to 8 other aircraft). Please get us custom fit dual-filtered earplugs!!!
21.	One main issue is volume control vs ICS and radio volume. In many aircraft it seems that these cannot be adjusted independently and as such there have been times that in order to hear ATC on the VHF radio I had to turn up the volume to the point that anytime the instructor spoke over the ICS the volume was borderline painful but could still barely hear ATC. In the Harvard I wore earplugs under the headset but once we started doing IF missions I had to stop doing that because of the above situation (unable to hear ATC VHF comms).
22.	Starting my career in helicopters I am concerned about the level of protection the military provides to me. Spending hundreds even thousands of hours in a helicopter with only the supplied protection will definitely cause hearing loss. We are provided with addition ear plugs but they are both inadequate and cause significant pain after being worn for just an hour. I believe the military should supply a supplemental fund for members in high noise positions to go to a professional ENT and get individually fitted hearing protection. Thank you
23.	Cause of my hearing loss happened when I had an aeromedical incident in the chamber during a rapid decompression, I had a slight cold and the result was burst eardrum on both sides, few years later my hearing changed.
24.	1. During my fighter days, I carried a set of ear plugs or ear defenders whenever on the ramp. 2. One tour as a navigator on CF-101s 3. Prior to reg force, I worked as a technician on the flight-line in an Air Reserve squadron that flew CSR-123 Otters (411 Sqn Downsview). I always wore ear defenders when near the aircraft. 4. Clearing ears on descent was rarely a problem although there were a couple of episodes of "oxygen ear" early in my career.
25.	I have been diagnosed with tinnitus.
26.	My hearing lost started on my first tour in Edmonton on the CC130 from 87 to 93. We were provided with the hold gray headsets which were not very efficient. I think the David Clarks headsets were introduced around 1990.
27.	I try to wear hearing protection when shooting guns. I haven't notice a significant loss of hearing but I remember the Med Tech mentioning something was unusual with my last hearing test. About the hearing test. I could hear sounds form outside the little chamber so I would argue that these outside noises are distracting to the weak beeps you are trying to hear.



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#	Response
28.	I have constant ringing in my ears these days. I actually want noise to make the ringing less noticeable. When I was flying the King Air, I felt my hearing had either stopped getting worse or had actually started getting better. The ringing was not as loud. With the crappy ICS in the 412CF and the lack of ability to adjust volumes on the RTU, coupled with the ambient noise of the helicopter, the ringing in my ears seems to have become much louder. It is very difficult to hear the other pilot and clearly hear ATC instructions compared to when flying the King Air. It is really frustrating and I fear that my hearing is going fast now. If you would like to talk to me I would be happy to answer any other questions you may have, especially if this is going to make a change to the cockpit noise I am currently experiencing.
29.	In my opinion, wearing earplugs and helmet is the way to go for hearing protection in the cockpit. It is possible to do so in the Hornet without compromising the ability to hear R/T, as the radios are fairly good. It is much harder to do in the Hawk as the radios are generally weaker and the background noise level is high (especially in the rear seat), so I would only wear a helmet. Same issues for the radios in the Harvard II, but the background noise is much lower. No matter if I wear earplugs underneath the helmet or not is ensuring proper helmet fitting with ALSE.
30.	Flying as a civilian I found the Active Noise Cancelling headsets very effective. Some CF aircrew have access to earbud type helmet speakers - ie 1 Wing aircrew. while others don't.
31.	In Part A, Q12 you ask hearing others while wearing ear protection in flight. It should be noted that when the engines are running and you are wearing a headset, you're able to hear others very clearly as they are hooked into the intercom system. Not sure if you're trying to differentiate between talking in flight through the intercom system or in flight off the intercom system.
32.	My biggest hearing problem is when there is a fair amount of ambient noise, or many people talking at once, it all blends and it is very difficult to listen to someone in particular. I have to cup my ear or pretend I understand after making them repeat for too many times. Thanks.
33.	During Op Athena (Afghanistan), all aircrews had a chance to experience and use the CEP ear buds (http://www.cep-usa.com/) This was a revelation for me. I never used ear plugs inside combined with my helmet before because I had to increase all radio and ICS volume to be able to understand comms, and most of the time ran out of volume control (know turned to max), especially in the CH-146 Griffon. In my opinion, helmet offered good protection and allowed me to understand properly radios and ICS comms while keeping good range in volume control, up and down. Now with the CEP combined with helmet, still on the CH-146 Griffon. Most volumes still had to go up but not as much as when wearing ear plugs. The volumes had to go up mainly due to the fact that the system had now to power both the ear buds and the ear cups at the same time. But that slight increase in volume (and lost in volume range) was easily compensated by the increased clarity of conversations over the air, and also better earing protection with those acting as similar-ear plugs at the same time. In my opinion, all helicopter pilots should have this mod done to their helmet and be allowed to use, at their discretion.



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#	Response
34.	There are noises around us all the time and we do not wear ear protection. However, with proper education, I think the awareness level would increase. Not just for work environment but for other "civilian" activities as well. I have seen people using noise protection at work because they have to. However, they may be going to a rock concert that night or to a bar and not think about their hearing. There is a disconnection in that way of thinking but it is prevalent.
35.	The aircrew at 408 squadron are generally very conscientious about wearing their ear protection. We certainly wear ear protection 100% of the time when flying (it's an integral part of our helmet/comm system) and the vast, vast majority of the time when working around aircraft running on the ramp. My hearing has remained unchanged throughout my career, as shown by my aircrew medicals. There is better hearing protection available to aircrew that is not yet disseminated to everyone: Communication earplugs. CEPs are plugs that have little speakers inside them so you can hear the intercom system clearly while still wearing plugs underneath the regular helmet earmuffs. For a long time they were only available to crews deploying to Afghanistan and there are still shortages. The supply of CEPs should be increased so that everyone can get a pair.
36.	I have experienced hearing loss in both ears but mostly in the right ear. I attribute this to helicopter flying which as part of my duties I almost always done in the left seat (exposed to engine/transmission noise on the right side). I have had additional testing and shown high freq loss attributed to noise exposure. (Worse in the right ear). I have a constant ringing in my ears that is significant but I generally only notice it if I think about it or at night. I did conduct one flight in a Grob (3 CFFTS) around 2008 for about 3 hours with a poor fitting helmet and no ear plugs. This was a significant event and caused a noticeable increase with the ringing in my ears. I have also worn glasses my entire flying career and this increases the exposure to low freq and is significantly noticeable. Interestingly, the visor on the helmet, "if lowered" reduces some exposure to noise penetration while wearing glasses and this is probably not communicated well - if at all and may require testing to confirm.
37.	In my short experience with the military I have found them to be very good with making sure at least minimum ear protection is worn where warranted. Even with a sometimes hectic flight line I have found my supervisors to be very good with making sure we do not enter the flight line without ear protection.
38.	Back in 1995 (might of been 1996) at 407 Sqn they identified that the hearing protection issued to technicians (Yellow ear muffs) did not provide any protection at all. We then received better thicker hearing muffs that provided better protection several years later. After many years of exposure to the CP-140 Aurora engines during run-ups or parks and starts, I believe the damage was already done. I started getting a ring in my ears back then. It's gotten worse over the years but I've grown to live with it. I use a program on my iPhone called White Noise (made by TMSOFT) which assists me in sleeping. The damage to my ears has greatly affected my ability to hear others and I'm continuously asking people to repeat themselves.



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#	Response
39.	When I was on the IAP BOTP course, I had a grenade simulator explode less than a meter away from my right ear. I have been often hearing ringing in that ear since then, and my hearing on that side may not be as good as the other side.
41.	Does not take into account different ear protection setups for different tasks....ie: normal strat daytime flying we use very good active noise cancelling headsets that are very comfortable while night tactical trips demand use of helmets designed to provide the least amount of comfort available with muffs that provide a terrible seal at best although aftermarket improvements exist. More focused survey directly for flying aircrew is needed.
42.	I would like to see aircrew with noise cancelling headphones installed in their helmets.
44.	I did not answer question 13 ref the chemicals I may or may not been exposed to due to the fact , I am uncertain if I have been exposed to those chemicals. There should be an "I don't Know " option for choices.
46.	The radios in most aircraft I flew, there were no problems. The radios in the legacy model CC-130 were not very good because there was a lot of background noise in the headsets that made hearing certain parts of radio transmissions a little more difficult than it should have been, or had been in other aircraft.
47.	I worry about hearing loss and make sure to wear my headset whenever I'm around the aircraft. I tried earplugs underneath but that required the volume on the intercom to be up really high. One big problem I've noticed is with wearing glasses with my headset. They break the seal around my ears and I find it really noisy.



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Response

49. I must express my thanks and relief that someone in the CF medical community is finally taking the initiative to investigate the critical problem of aircrew hearing loss. I have been suffering from progressive hearing loss since 2002 and believe that I have some likely explanations as to why. I have brought these concerns to the attention of my respective Wing Flight Surgeons in Cold Lake and Moose Jaw every year since 2003 as my hearing has degraded from ideal at enrolment to H2 and recently, to H3. I have been seen by three independent civilian hearing specialists in Regina on several occasions since the summer of 2006. All concur that the factors I have outlined below are likely to have contributed to my own progressive hearing loss. I have attempted to explain the root causes I have experienced from one aircraft type to another. Aircraft communications systems such as VHF, UHF and HF radios all have manufacturer specified volume levels that our technicians must respect. The volume level of intercom systems, aural warning tones and voice alerts are set in a similar manner. The root of the trouble is that the minimum acceptable volume levels for these systems are often quite low and inconsistent from one system to another (for example, between VHF and UHF radios, or between the radios and the intercom). The volume level of the intercom systems is even less consistent from one aircraft to another. Aircrew can write any system up as "unserviceable" when they feel the volume levels are excessively weak but the technicians must write the system up as serviceable as long as the system meets the manufacturers minimum specified strength and clarity. The technicians almost always have the ability to boost system volume levels to sufficient strength that ear plugs can be worn without compromising radio and inter-crew communications or Flight Safety. The adjustment is usually as simple as the turn of a screwdriver and takes only minutes to accomplish. Unfortunately, the technicians have zero flexibility in deviating from the standards set in their technical manuals, regardless of the opinions of those who must actually use the equipment. CH-146 Griffon and CH 139 Jet Ranger Intercom levels in the CH-146 are prohibitively low to the point that earplugs can't be worn by many crews because they cannot hear the other Pilot or Flight Engineer (FE) with the rear doors open. As the tail of the helicopter is not visible to the Pilots, they must rely heavily on the FE to direct them in order to safely hover and/or land the helicopter in a confined area. On final approach and in the hover the rear door is open and the FE has his head fully outside of the aircraft, directly under the jet exhaust and directly in the forward airflow. The wind, rotor and turbine noise picked up through the FE's microphone is transmitted to the aircrew and is often sufficiently loud to compromise the fidelity of communications between the Pilots and FE. The wearing of foam earplugs with an intercom as weak as that of the CH-146 creates an unsafe condition where the pilots cannot hear the directions of the FE through the ambient noise at the most critical phase of flight. When this occurs, the only option is for the pilots to boost the weak intercom volume to near maximum levels and to not wear foam earplugs. By not wearing earplugs, the aircrew are further exposing themselves to harsh wind and turbine noise that causes hearing loss in the first place. Wind noise for the aircrew in the summertime is another factor. The CH-146 has no air conditioning. In the summer months, crews must fly with the side windows down to create adequate airflow through the cockpit. Rear doors are often pinned open or removed, depending on the nature of operations. The wind noise and buffeting experienced at 100-120 knots is similar to that of a motorcycle being driven at highway speed.



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Response

Crews are exposed to this noise for many hours at a time, every day. The cumulative effect of this noise, especially when ear plugs cannot be worn, must surely be damaging. All helicopters are loud but noise in the CH-139 Jet Ranger is generally not as bad as the CH-146. However, the volume levels between radios and Navigational aids is (was) inconsistent and occasionally made wearing ear plugs impractical. CT-156 Harvard II On this aircraft, the volume levels of the VHF radios are all significantly weaker than the volume of the UHF radios. This is a consistent and well known nuisance with this aircraft type. Intercom volume levels are very inconsistent from one aircraft tail number to another. Both radios are required to operate away from Moose Jaw and a strong intercom is required for any mission with two pilots on board. Many aircrew have found the volume level of the VHF radios and intercom weak enough that they cannot wear foam earplugs without blocking the VHF radios and impairing instructor-student communication. As this is an obvious Flight Safety concern, many aircrews have to fly without ear plugs in order to hear the radios and safely communicate with their students. The CT-156 aircraft are owned and maintained by a civilian company. However, the civilian technicians are as equally ham strung as our military technicians by technical directives that prevent them from making an adjustment to the volume level of these systems in spite of the aircrew's repeated complaints. CT-114 Tutor By and large, the volume levels of the UHF and VHF radios in the Tutor are much louder than those in the Harvard II or CH-146. The intercom is also more powerful. Whenever I have written an aircraft up as unserviceable for a weak radio, the technicians see to it that the radio is either adjusted or replaced. Aural warning tone volume is another matter. This volume level can only be set by the techs before flight. If the technicians raise the volume loud enough that it can be heard by a pilot who is wearing ear plugs, the tone is painfully loud (and possibly damaging) for a pilot who is not wearing ear plugs. Conversely, an aural tone set up for one who does not wear ear plugs can be difficult to hear for those who wear earplugs. As crews mix and frequently move from one aircraft to another throughout the training season, finding a single comfortable, safe and effective volume level for the aural warning tone can be nearly impossible. The larger problem creating hearing loss for those who fly the Tutor is, in my opinion, due to the Snowbird's obvious requirement to fly in close formation. The data we have for cockpit ambient noise states that the approximate noise level in the cockpit is 100 db in level flight at an average power setting. However, we often fly with the tail pipe of another jet only a few feet over our heads at near maximum power for much of every mission, each day. The noise level becomes significantly higher the further back from the front of the formation you are flying. It is my understanding that cockpit noise levels under these conditions frequently exceed 108 db or more. Most of us wear foam earplugs but are unable to employ any additional alternative protective measures due to the limitations of the LCMM shops. Gentex manufactures an off-the-shelf helmet noise reduction kit that incorporates liquid filled ear cups and a hush skirt that snaps directly into our existing helmets without modification. We've had no success in obtaining this kit due to a regulation that prohibits the use of liquid filled ear cups in our application and because the kit has not been fully tested by the CF. I wore such ear cups with a David Clark head-set in the C90A King Air (a civilian owned and maintained aircraft used by the RCAF, not subject to the aforementioned limitations) and can speak to their effectiveness at reducing noise, fatigue and (likely) hearing loss. The



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#	Response
	<p>bottom line is that our technical orders must provide more flexibility for the technicians to raise or adjust the volume levels of our aircraft radios, intercoms and warning tones sufficiently to allow safe, unimpeded communications with the maximum level of hearing protection in place (ear plugs). I have no doubt that a simple clause in the CF technical standards to permit such freedom of adjustment will greatly contribute to the preservation of aircrew hearing. The testing and acquisition process of noise reduction kits for aircrew must also be accelerated or restrictions lifted to allow aircrew to help themselves. In the case of the Snowbirds, this must happen immediately. Most of our current pilots have experienced significant hearing degradation since their arrival at the unit and this trend will continue until we are provided with better equipment which is readily available. Aircrew alone are virtually incapable of effecting change on technical standards. It has been my experience that the Flight Safety system can occasionally help to remedy such deficiencies but typically does little or nothing other than report trends until we lose an aircraft or personnel. It has also been my experience that the CF Medical community has more administrative weight than any other. Please carry these concerns to whomever you must in order to get these changes put into place. In most cases the solution is obvious, costs little or nothing and will help us all.</p>
50.	<p>I think bars and rock concerts are more damaging to hearing as hearing protection is not normally worn in those environments. Disposable ear plugs are normally available at work. The audio warning tones and voice alerts in the F-18 too loud for me without wearing disposable ear plugs in addition to the helmet. I have no trouble hearing the radio, or the warnings while wearing the ear plugs. The ear plugs also provide protection from the noise of other aircraft starting while doing my walk around when I don't want to wear my helmet. The best ear plugs are the soft red and white ones. They stay in the ears best with the helmet. I don't like the hard yellow ones.</p>
51.	<p>CC150 OPERATIONS: The aircrew involved in flying the Airbus are provided with a fitted earpiece to wear during flights. There is no hearing protection provided for crews when doing walkarounds with the APU (Auxillary Power Unit) running. The fitted earpiece offers no hearing protection. KINGAIR OPERATIONS: The David Clarke headset provided for flying the KingAir provided a significant amount of hearing protection. It was not worn when doing a "hotturn" (engines running crew change), however, earplugs were readily available at Ops at 3 CFFTS to be worn in place of the headset on the ramp. G120 OPERATIONS: The SOP for Grob Flight was to wear the helmet from Ops to the aircraft, so hearing protection was provided on the flight line at all times. However, the headset was not an active noise cancelling headset and the level of noise inside the cockpit was quite substantial.</p>



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#	Response
52.	Although my "normal" work environment is in a quiet office, I do firmly believe that my exposure to loud noises on the flight line has negatively affected my hearing. I have always worn hearing protection on the ramp when walking around aircraft and have always worn CF issued hearing protection inside the cockpit (although in the CC150 we do not wear hearing protection in the cockpit - all checklists are carried out by voice, not intercom). I now have very annoying tinnitus, and although I can hear vocal frequencies just fine, I note that I have significant difficulty picking out voices when there is significant background noise (i.e. at a social function). The ringing in my ears is constant, annoying, and slowly and progressively increasing in perceived volume - I am only now beginning to appreciate that it will never stop. Thanks for your interest in this issue.
53.	As far as I know I have no hearing loss since I enrolled however my wife comments that I usually talk quite loud when I come home after flying and after a few hours I return to a normal volume. I do not notice this change in speaking volume whatsoever.
54.	In 2005 I was diagnosed with an acoustic neuroma in my right ear. It causes tinnitus. I was grounded for a period of 1 year when first diagnosed and my hearing had improved over that time. Since flying again, my hearing has deteriorated to the level it was in 2005.
56.	I lost a lot of my hearing in the CF. Please help us.
57.	In one of the questions you asked "who had provided my hearing protection" I answered my supervisor / superior, however "the supply system" is a more accurate answer.
59.	The Cormorant communications system is prone to failure; during this failure it produces a very loud squealing noise. If a person is not wearing earplugs this squeal is very painful.
60.	CF-18 pilots wear 2 different types of helmet, the JHMCS and the 190A. Some pilots (including myself) find that the audio level in the JHMCS is lower than in the 190A. Therefore, if I wear foam ear plugs in the JHMCS, I have difficulty hearing audio alerts and radio transmissions. When I use my JHMCS, I do not wear additional hearing protection, but when I use my 190A helmet, I also wear foam ear plugs at the same time.
61.	Many of the types of hearing protection (headsets) supplied by the military are out of date and actually pose their own problems. Until recently, the headsets supplied to the CP 140 crews were completely unsatisfactory. They let in large amounts of ambient noise and needed to be turned up to dangerous levels in order clearly understand ICX or radio transmissions. This problem is significantly reduced with the noise reduction headset but the new headset also has its own set of problems. It is powered by a battery that runs out after a couple of flights and therefore, most people either do not turn the unit on or have dead batteries. Also, the battery pack is cumbersome gets in the way while trying to perform flight duties. Having said that, they are a significant improvement.



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#	Response
62.	For the work environment (part B), the responses are for working in the Buffalo aircraft, not in the office. The aircraft is by far the loudest of aircraft I have flown. The noise cancelling headsets do make a large difference. If earplugs are worn in addition to the headset, it is difficult to hear anything over the intercom or radio. When we fly above 10,000 feet, we have to wear a helmet which does not have any noise cancelling capabilities. After long flights using the helmet, even with earplugs, you will get ringing in the ears as the noise the aircraft makes is LOUD. The changing of headsets and helmets makes answering the questions somewhat difficult, so my answers are written for headsets, which is used probably 80% of the time.
63.	Whenever I use the snow blower or chainsaw, I use ear defenders as well.
65.	WEARING THE A190 HELMET, THE CF DOES NOT SUPPLY A GOOD EARPLUG THAT FITS INSIDE THE HELMET TO TAKE ADVANTAGE OF DOUBLE PROTECTION. THIS SHOULD BE WORKED ON.
66.	It's my belief that amongst the Fighter Force, pilots are NOT inclined to wear earplugs at all as it interferes with the ability to understand radio communications. With the new Joint Helmet Mounted Cueing System (JHMCS) helmet the ability to understand radio communications is even more difficult. Personally I have worn earplugs with the Helmet and with the volume knobs turned all the way up I have extreme difficulty hearing / understanding radio communications. As it is now the standard helmet that pilots wear, I can categorically say that the hearing protection offered is worse than the regular helmet, and the strength of radio communications is much weaker. There are earplugs which work in accordance with radio communications specifically in use with the USAF, off the top of my head I know of one: http://www.westone.com/military/acces Regardless, the cockpit noise level in the JSF will be much higher. I have little confidence in the CF's or CFEME's current policy on hearing loss amongst jet aircrew (I surmise the aircrew with the HIGHEST risk factor). We've been flying fighter jet aircraft for over 50 years; this problem is nothing new.
67.	The new Griffon helmet has significantly cut down on noise. As such, I can reduce the volumes (intercom and radios).
69.	I have always taken precautions to protect my hearing. I have noticed steady decline of hearing ability as indicated in my Med records. Aircraft noise on current airframe (Buffalo) is beyond reasonable levels, with current headsets/helmets inadequate. Communication in the cockpit is essentially impossible during critical phases of flight such as Take-off and Go-around. Wearing earplugs with headset or helmet not practical as this softens radio comms to a point of "in-audible" on the Harvard, Grob and Buffalo aircraft. This was, however, possible and necessary on the Labrador.
70.	I swim a lot and also Scuba dive and get ear infections if I don't dry my ears properly and have to be careful when in a boat with the wind from the boat speed.



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#	Response
71.	1. The headsets supplied by Lockheed when the Aurora was new were absolute crap. Foam ear plugs were essential. The David Clark headsets eventually supplied after a couple of years were a huge improvement. 2. On the Aurora at least, the high pitched noises emanating from the electronic mission systems equipment and electrical load centre were probably worse for hearing than the engine noise. I once gave a static aircraft tour with all electrical systems turned on and running on ground power to a lady who happened to be a hearing specialist. She thought that the noise was awful. I said, "And the engines aren't even running yet!"
72.	I have Tinnitus almost constantly now and I am beginning to wonder if it is possible for me to stop its progression with the exposures I get in the cabin of the CH149 Helicopter.
74.	Even with a helmet the helicopter environment is loud inside the cockpit with the engines running. Radios and ICS have to be turned up. I was H3 for a few years and now I believe that I am back at H2: I do believe that my line of work has contributed some to the degradation of my hearing.
75.	The CC115 buffalo is a very noisy plane. At high power settings, it is almost impossible to hear any voice/radio transmissions from the cockpit, even with noise cancelling headsets. For some, this is alleviated wearing earplugs under their noise cancelling headsets, but I have found that the disposable earplugs stick too far out of my ears, and are inevitably knocked out of place by my headset. Has the CF looked into issuing fitted earplugs to aircrew? Thanks for putting together this survey - I believe it is a very important issue that needs to be addressed.
76.	In my work I had tried the noise canceling David Clark headset but stop using it because it removed my ability to hear the aircraft and notice pending malfunctions such as out of pitch propellers, air conditioning packages, and ice accumulation on the aircraft. Over the years I have developed two hearing related issues. The first is my ability to correctly determine the direction from which a noise is coming. The second is my ability to focus on a single voice which makes conversation in a crowded room difficult as I can't hear the primary speaker if there is a louder voice in the background.
77.	Use of noise cancelling headsets should be mandatory equipment.
78.	Prior to becoming aircrew I was an Airframe/ AVN tech for 12 years. Hearing protection wasn't always used.
81.	Our Hearing Categories are in need of update and review. As in our vision categories they are old! Our international partners have more up-to-date categories. For example, I recently was given a H2 category, while if I was in the USAF I would be H1. Similarly V3 brings employment limitations that other Nations would not levy against our aircrew.



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#	Response
83.	There were a few questions where a "Don't Know" or "Unsure" would have been good to have. I have sometimes experienced tinnitus 'out of the blue'. It only lasts for under 10 seconds and then goes away. It has happened after not flying for several weeks but does not have an effect on my overall hearing. I believe that my hearing tests have been excellent over the years and have not shown signs of decay (that I have heard about).
84.	Requested "musician" earplugs while in Greenwood, MO said not required. After years of trying, CC-130s finally approved to use noise cancelling headsets.
85.	1. I answered the Military Work Environment portion as if I were working in the Helicopter although the majority of my time at work is spent in an office. 2. The ear plugs are provided around the Wing but neither encouraged or discouraged. I have never received training for their use and actually just recently learned something else about effective placement in the ear canal. I have been using them for years. 3. The ringing in my ears. I get that occasionally after flight but there was this one period at the end of my second flying tour when I had constant ringing that drove me batty at night trying to sleep. That lasted about 3 months but I have not experienced something like that again. Just started my 3rd flying tour in October 11. 4. I have been in accidents but have no idea if it affected my hearing or not.
86.	Often the supplied earplugs were too long for my ear. It felt that when inserted there was additional earplug that extended from my ear which was pushed inward by the ear cup of the helmet. It caused discomfort while flying and I had to remove my helmet and earplug to adjust the fit.
87.	I would like to mention that the earplugs provided at the different places where I worked are not to ones I prefer and I was not able to wear the ones provided due to comfort issues. They are often not comfortable or do not fit my size of ear canal. I ended buying a box of earplugs on my own for my earing protection at work and at home. I fund only one king of earplugs I can wear comfortably and it's the E-A-R regular.
88.	I have been on 2 tours to Afghanistan with the CH-146 and noticed that both the Canadian and Allied force Chinooks were very hard on the ears. They always came across extremely loud and at times, intolerable. I would have to turn down the volume on my ICS and often miss what they said because of the harsh carried or background tone associated with their Comms



**A Study of Risk Factors and Prevalence for
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12. KEYWORDS, DESCRIPTORS or IDENTIFIERS (Use semi-colon as a delimiter.)

Aircrew; audiogram; Hearing Loss; Occupational Noise

13. ABSTRACT/RÉSUMÉ (When available in the document, the French version of the abstract must be included here.)

Introduction: The aircrew environment presents a wide variety of noise hazards, including high levels of ambient noise during flight, which may both increase the risk of permanent hearing loss and interfere with communication and flight tasks. In particular, it has been suggested that the volume of the CF-188 Hornet's (CF-18) aural alerts are sometimes insufficiently audible during normal communication traffic. To ascertain the prevalence of this problem, as well as to better understand the hearing status, risk factors for hearing loss, and current practices with respect to hearing protection measures among Canadian Armed Forces (CAF) aircrew, we undertook the present study, with a special focus on CAF pilots.

Methods: A retrospective study of hearing status in CAF aircrew was carried out in January of 2012 at several participating flying squadrons across Canada. The participants were 125 male and female pilots, ranging from 24-56 years of age. The data consisted of responses to a 56-item electronic questionnaire regarding risk factors for acquiring a hearing loss and audiometric measurements made at initial aircrew selection and every three years thereafter up to 15-years post-enrolment. Of the 125 participants who completed the questionnaire, 62 permitted access to audiometric data.

Results: We observed a mean change in hearing thresholds of nearly 20 dB between enrolment and 15 years of service, indicating that hearing damage in this population of pilots is markedly worse than what one would expect in the general public, but broadly consistent with other reported hearing threshold shifts for military pilots. By 6 years post-enrolment at least 10% of the pilots in this study registered a clinically significant hearing loss at and above 6 kHz in both ears. A majority (60%) of participants stated that they experienced tinnitus / noise in their ears at least occasionally, with 16% reporting such noise to be present constantly.

Over half of respondents agreed that their workplaces were often or constantly noisy, though a similar number also reported that they always wear hearing protection when noise levels are high. Jet pilots were the least likely to wear hearing protection consistently, with over 40% indicating that they wear it less than half the time. The rate of presentation of clinically significant hearing loss (≥ 25 dB HL) is about 3 times lower in the group that wears hearing protection consistently. Among the reasons given for not wearing hearing protection, 22% of pilots stated that their hearing protection was often or always uncomfortable to wear, and a sizable minority (17%) of jet pilots judged that hearing protection often or always poses a danger during flight.

A great majority of respondents indicated that they experienced 'no' or 'slight' difficulty understanding audio alerts in the cockpit while wearing hearing protectors and headsets, with only 1.6% of pilots (6.8% of jet pilots) reporting at least a moderate level of difficulty. This suggests that the problem of inaudible audio alerts, while significant for a subset of pilots, is not widespread.

Conclusions: This study found greater hearing loss among aircrew than would be expected in the general population. The most effective method for protecting an aircrew's hearing involves understanding the noise profile in their environment and then providing proper instruction, appropriate personal protective and communication equipment, and hearing protection measures. Early detection and monitoring are critical for prevention of hearing loss and should be developed and implemented in future work.

Introduction : Il existe, dans l'environnement du personnel navigant, une grande variété de risques liés au bruit, notamment des niveaux élevés de bruit ambiant durant les vols, ce qui peut non seulement augmenter le risque de perte auditive permanente, mais nuire à la communication et aux activités en vol. Plus particulièrement, certains ont fait valoir que les alertes sonores du CF-188 Hornet (CF-18) ne sont

parfois pas assez audibles pendant le trafic de communications normal. Pour vérifier la prévalence de ce problème et mieux comprendre les problèmes liés à la capacité auditive, les facteurs de risque de perte auditive, ainsi que les pratiques actuelles en matière de protection auditive du personnel navigant des Forces armées canadiennes (FAC), nous avons entrepris la présente étude en nous concentrant principalement sur les pilotes des FAC.

Méthodes : Nous avons mené une étude rétrospective sur les capacités auditives du personnel navigant des FAC dans plusieurs escadrons aériens participants partout au Canada. L'échantillon de participants était composé de 125 pilotes masculins et féminins, entre 24 et 56 ans. Les données consistaient en des mesures audiométriques prises lors de la sélection initiale, puis chaque trois ans, jusqu'à la 15^e année de service. Nous avons également analysé les réponses à un questionnaire électronique de 56 questions concernant les facteurs de risque qui favorisent une perte auditive.

Résultats : Nous avons observé une variation de près de 20 dB du seuil d'audibilité entre l'enrôlement et la 15^e année de service, ce qui indique que les dommages auditifs dans cette population de pilotes sont nettement pires que dans le grand public, mais concordent avec d'autres changements du seuil d'audibilité rapportés pour les pilotes militaires. À la 6^e année suivant l'enrôlement, au moins 10 p. 100 des pilotes accusent une perte auditive cliniquement importante et au-dessus de 6 kHz dans les deux oreilles. Une majorité (60 p. 100) des participants a déclaré qu'ils ont vécu de l'acouphène ou des bruits dans leurs oreilles au moins occasionnellement, et 16 p. 100 rapportent que de tels bruits sont présents en permanence.

Plus de la moitié des répondants conviennent que leur milieu de travail est souvent ou constamment bruyant, et près de la moitié ont déclaré qu'ils portent toujours un dispositif de protection anti-bruit lorsque les niveaux de bruit sont trop élevés. Les pilotes de chasseurs sont les moins enclins à toujours porter un tel dispositif; plus de 40 p. 100 ont déclaré qu'ils le portent moins de la moitié du temps. Ce taux de perte auditive cliniquement importante (≥ 25 dB HL) est environ trois fois inférieur dans le groupe qui porte toujours un dispositif de protection anti-bruit. Parmi les raisons données pour expliquer le refus de porter ce dispositif de protection anti-bruit, 22 p. 100 des pilotes ont déclaré qu'il était souvent ou toujours inconfortable à porter, et une grande minorité (17 p. 100) des pilotes de chasseurs ont jugé que le dispositif de protection anti-bruit poste souvent ou toujours un danger en vol.

Une grande majorité des répondants a rapporté éprouver « aucune » ou « très peu de » difficulté à comprendre les alarmes sonores dans le cockpit pendant qu'ils portent un dispositif de protection anti-bruit et un casque; seulement 1,6 p. 100 des pilotes (6,8 p. 100 des pilotes de chasseur) rapportent au moins un niveau de difficulté modéré. Cela laisse entendre que le problème des alarmes sonores inaudibles, même s'il est important pour un sous-ensemble de pilotes, n'est pas répandu.

Conclusions : Il ressort de cette étude que les pertes auditives sont répandues chez le personnel navigant que dans la population générale. La méthode la plus efficace pour protéger l'ouïe du personnel navigant consiste à comprendre le profil de bruit dans son environnement, puis à lui donner une instruction appropriée, à lui fournir de l'équipement de protection individuelle et de l'équipement de communication appropriés, et à prendre des mesures de protection auditive. La détection précoce et le suivi sont essentiels pour prévenir les pertes auditives, et devraient être élaborés et mis en œuvre dans un travail futur.