

FSG 200-01

Management of Aircrew Noise-Induced and Other Hearing Loss

Document Status:	Current
Document Type:	Flight Surgeon Guideline
FSG Number:	FSG 200-01
Original Source:	AUMB
Approval:	Aerospace Medical Authority
SME:	Medical Consult Services/AUMS Center/CFEME
OPI:	H/AUMS
Effective Date:	May 2008
Last Reviewed:	Dec 2012

References:

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- B. PG 4440-08 (CFAO 40-01) Hearing Conservation Program (now cancelled)
- C. (Draft Directive) PG 4040-09, Hearing Loss Prevention Program (OPI = DGHS/FHP)
- D. [A-MD-154-000/FP-000 ANNEX C \(CFP 154\)](#), Table of Hearing Standards
- E. Abel, SM 2004. Risk Factors for the Development of Noise-Induced Hearing Loss in Canadian Forces Personnel. DRDC Toronto ECR 2004-116
- F. [A-MD-154-000/FP-000 ANNEX I \(CFP 154\)](#), Guiding Principles and Complimentary Instructions
- G. Intelligibility of Speech in Noise. ASCC ADV PUB 61/103/8 30 July 1986
- H. Personal Hearing Protection Including Active Noise Reduction. RTO Lecture Series HFM-111 2004
- I. Medical Standards for Canadian Forces Aircrew
- J. [National Institute on Deafness and other Communication Disorders](#)

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FLIGHT SURGEON GUIDELINE FOR AIRCREW WITH NIHL

1. The application of this guideline for the management of noise-induced hearing loss (NIHL) is based on the principles of:
 - a. **Flight Safety**, to ensure all communication in the air and ground environment is both heard and understood at all times;
 - b. **Maintenance of operational effectiveness**, by identifying and documenting an individual's hearing loss, tinnitus or loss of speech discrimination and ensuring all aircrew members meet the bona fide occupational requirements for hearing related to their particular aircrew occupation; and
 - c. **Protection of crewmember health and preservation of trained resources**, since new or established NIHL may be aggravated by operational hazards during air operations. The Crown has a responsibility to protect, as far as reasonably possible, the health of aircrew and minimize the risk of further NIHL while performing their aviation related duties.

(See Annex C for further background and aeromedical concerns).
2. When the audiogram first shows a Standard Threshold Shift (STS) it is even more important that the member employ maximum hearing protection in all future exposure to noisy areas, particularly on the flight line.
3. An STS due to noise is defined (ref C) as a change in hearing in either ear relative to the current reference audiogram that is equal to or greater than either:
 - a. A total of 25 decibels at 2000, 3000 and 4000 Hz combined (e.g. A 5 dB change at 2000 Hz, a 10 dB change at 3000 Hz, plus a 10 dB change at 4000 Hz); or
 - b. 15 decibels at any single frequency at 1000, 2000, 3000 or 4000 Hz.
4. The hearing protection goal at this point is to ensure the hearing loss is stabilized while still allowing all activities required of him/her. It is most likely that the measured decrease in auditory acuity is a continuation of previous noise-induced hearing loss and that it is permanent.
5. The member should:
 - a. be thoroughly briefed on the need for/importance of protection of their hearing;
 - b. give their informed consent to further workplace exposure with maximum hearing protection while accepting the fact that operational realities often compromise ideal noise protection;
 - c. confirm that there have been no (subjective) speech discrimination difficulties experienced in their normal work environment;

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- d. have annual audiograms (indeed, this is part of PHA for all/any 'Group A' aircrew anyway [ref I]); and
 - e. have their medical record reflect these actions.
6. Before assigning a hearing and air category it is recommended that:
- a. a referral to an audiologist and/or ENT specialist be sought to confirm the hearing loss and rule-out any undiagnosed otologic pathology with an emphasis on the etiology of the hearing loss and establishing the level of speech discrimination; and
 - b. if the consultant's speech discrimination test is less than 96%:
 - (1) complete an in-flight or workplace environment hearing assessment (WITHOUT hearing aid(s) that may have been prescribed for use while off flying duty (*Annex A*) using the form that is attached; and
 - (2) obtain their supervisor's operational endorsement of acceptable function in the patient's current normal work environment.

FIVE KEY STEPS IN MANAGING AIRCREW HEARING LOSS

	Step	Remarks
1.	LOOK for it.	(Group A) Aircrew need yearly screening audiograms for both type I and II periodic health assessments (ref I). Get interim audiograms with any suggestion of inner ear disorder – especially if associated with barotrauma, tinnitus, or vertigo. Plot all audiograms on a flow sheet, such as that at Annex B (promulgated Mar 03 by 1 Cdn Air Div Surgeon). - whenever suspicious Sx exist (e.g., tinnitus, vertigo, barotraumas) - with yearly audiogram, using Standard Threshold Shift (STS) as benchmark (ref B: STS is defined as a change in hearing in either ear relative to the current reference audiogram that is equal to or greater than either: (a) a total of 25 decibels at 2000, 3000 and 4000 Hz combined or (b) 15 decibels at any single frequency at 1000, 2000, 3000 or 4000 Hz) - whenever change in H-factor contemplated (but don't wait for this!)
2.	CONFIRM/ DIAGNOSE it.	While 'temporary' threshold shifts can ensue noise exposure, any HL that lingers beyond 16-48hrs needs follow-up. A threshold shift of 15 dB or greater from the 'reference' audiogram (normally the member's tracing on enrolment) that persists after any obvious reversible cause (e.g. URI) resolves, needs audiologist referral to confirm the tracing and the diagnosis (see also 4 below). Not all HL is due to noise. Other more sinister processes (e.g. acoustic neuroma) can present as HL. NIHL typically begins and is most noticeable at 3-6kHz, though other disorders can also present this way. - Refer to ENT if any doubt remains. - Ask about solvent exposure (which appears to be a common co-

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		morbid condition with NIHL [ref E] – and may even have some causal role). - Ask also about non-occupational noise, (<i>sport firearms, power tools, music</i>) and subjective features of HL: Any problems on the job? - Does their spouse complain they don't hear? - Can they hear in noisy crowds? - P/E seldom useful but note anything that might compromise ear seal (e.g., cranial abnormalities, hairstyles [esp. in females]) - Document everything.
3.	FOLLOW it.	Enter current audiogram(s) in the Annex B flow sheet, and review for signs of progression. Any HL that progresses (not necessarily enough to change H-factor) over a couple of years – especially in younger aircrew – requires AUMB review. AUMB may ask for yearly review in doubtful cases. - Review for trends (e.g. platform change, posting, other medical history). - ? 'V2H2' from glasses? Encourage eyeglass wearer to select frames with thin and flexible temples. In cases where the patient must wear glasses and protective muffs (if plugs cannot be worn instead), if the current glasses temple interfere with the acoustic seal of the muff, HS DEL Optical Services Manager can authorize out of frequency replacement to rectify the situation.
4.	REFER re: hearing/hearing protection.	- Audiologist/ENT (as per 2, above) - PMed Techs can do noise surveys in the member's workplace that will document the severity of 'emissions' from noise. Also, DRDC Toronto keeps a database of reports summarizing noise surveys on many Air Force fleets in use. While some of these data suggest noise levels that exceed attenuation of even optimal noise protection, this ought to come as no surprise. We know CF aircraft are noisy. - Operational Endorsement – consult 1 Cdn Air Div Surg re: SD <96% in EITHER ear. Arrange to carry out assessment at Annex A. <u>Note:</u> The 'In-Flight Assessment' reliability is affected by factors such as inconsistencies from presenters in the way that some speak softer or louder than others. Inconsistencies can also be present in the environment. The member is also capable of adjusting the volume control of his helmet. However, the in-flight or workplace speech discrimination test is the only readily available field test at present. Hearing in noise tests (eg, HINTpro manufactured by Bio-Logic System Corp.) may offer a more reliable and consistent assessment of a patient's ability to understand speech in noise – which is usually much worse than SD in quiet (<i>see Annex A below</i>) - AUMB/AUMS assessment at DRDC Toronto. In complicated cases, this referral can be contemplated (prior discussion with one of AUMB's consultants is required). This referral entails: – Verification of audiogram (but please note, audiologist assessment is not available, so this must precede referral

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		to DRDC Toronto); – Under-earcup evaluation of noise attenuation (to assess integrity of ear-seals in applicable helmets and headsets) using DRDC Toronto's Noise Simulation Facility; – Expert helmet-fit review (if this is the primary concern, medical referral need not be made – Aerospace Group can be contacted directly [ALSE Projects Officer: ext 3213 at CSN 634-2000 / commercial 416-635-2000]); and/or – Assessment and review by AUMB aeromedical consultant and/or by DRDC Toronto scientific advisers on noise/hearing protection.
5.	RESTRICT/COUNSEL as appropriate.	Key considerations in the aeromedical disposition of members with NIHL include: - Stability: Is there any 'undue progression' (see below) in the HL documented over time? Review flow sheet as per 3, above. - Flight Safety: Can the member safely/effectively communicate to do their job? Consider speech discrimination scores and operational endorsement as per 2 and 4, above. - Informed Consent: Does the member understand the implications of their HL? They should be counselled: "on the risk – as yet unquantifiable - of ongoing operational flight duty and its attendant noise exposure. It must be made clear to her/him that operational realities often compromise ideal noise protection or isolation, and that a small percentage of susceptible individuals who develop NIHL will progress even if they get 'ideal' protection. Furthermore, aging appears to progress HL independently, and NIHL must be considered PERMANENT." <i>(AUMB incorporates the foregoing passage into applicable correspondence, and it is suggested affected members be asked to review such passages in detail)</i> Assign H-factor as outlined in refs D and F (see below). If it falls below trade standards, ongoing flight duty will normally only be approved if ALL of the above apply (i.e. no undue progression; no flight safety risk; informed consent given). AUMB uses these provisions as a guide even when the H-factor lies WITHIN trade standards, for example; some candidates with H-factors within trade standards have been disqualified for aircrew training if the HL appears rapidly/unduly progressive. It should be noted, however, that no concrete definition of 'unduly/rapidly progressive' as yet exists. AUMB examines such instances on a case-by-case basis [AUMB decision Apr 07 mtg refers]. Other counselling should include reminding to use proper hearing protection in noisy environments (while this is a line responsibility,

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		medical pers can help 'remind'), reducing/protecting against non-occupational noise exposure, and avoidance of ototoxic substances (e.g. solvents).
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GENERAL APPLICATION OF CF HEARING STANDARDS

7. As per ref F, if the member's hearing factor **exceeds** the minimum MOSID standard then further evaluation must be obtained through referral to an ENT specialist before finalizing the H factor;

8. Any member with a hearing factor of **H2 or H3** or greater should have the following limitation:

"Maximum hearing protection required"

- a. With significant hearing loss (**such as H4**) there are two further issues to address. First, there is a requirement for expanded employment limitations to prevent further deterioration. Second, the member's capacity to perform within their MOSID in an effective and safe manner must be reviewed (aircrew in this guideline). Any member with significant hearing loss should have the following limitation:

"Should not be exposed to loud noise (firing range, heavy machinery, close proximity to aircraft engines, etc.) as this may exacerbate a chronic medical condition"

- b. Though PG 4040-02 on Hearing Aids refers to the assigning of G2 O3 when hearing aids are needed, D Med Pol annotates this requirement in the H factor.

HEARING PROTECTION FOR AIRCREW: KEY ISSUES FOR FLIGHT SURGEONS

9. It must be recalled that this is a LINE responsibility – and not a 'medical' one, i.e., don't get lured into 'prescribing' protection for affected aircrew (see below). That said, nothing ought to prevent flight surgeons from reminding/reinforcing the importance of same. Some key points:

- a. Earplugs. Since people come in different shapes and sizes, and thus so do their ear canals, members must try a variety of different plugs to ensure comfortable/effective fit. There is no such thing as 'one size fits all' in this regard. Fortunately, no restrictions currently exist on which earplugs may be used as long as they are 'passive' (i.e., no electronics and not attached to or interfering with any other system that might have airworthiness implications). While 'a plug is a plug', some concerns exist:

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- (1) Seal – 'in the canal' earplugs must not be so tight as to create the potential for barotraumas
- (2) Proper insertion – improperly inserted earplugs can significantly reduce their effectiveness
- (3) Custom-fit / purpose-made plugs – normally NOT approved owing to risk of barotrauma
- (4) Hygiene – must either be disposable or washable to reduce potential for otitis externa
- (5) Comfort – must be suitable for prolonged wear
- (6) Flexibility – must not crack, etc., if used in cold or other arduous conditions
- (7) Communications systems – must be compatible with same: can member 'hear through' them?

b. Active Noise Reduction (ANR) Systems. Active Noise Reduction (ANR) Systems. The operative word here is 'system'. ANR cannot be used/considered unless it has either been incorporated with the applicable aircraft platform at the outset (which currently applies to NO CF platforms) or has been fully evaluated and approved by DAEPM(TH) for operational suitability after the fleet is in operation. This suitability is assessed during all phases of flight and the item must pass a qualitative assessment of the Electronic Noise Cancelling (ENC) headset's contribution to the performance of the aircrew, using feedback both verbal and written. The individual use of "off-the-shelf" ANR headsets without this approval is prohibited. This direction is not only because of complex airworthiness and cockpit compatibility issues ANR raises, but also because the protection it affords is very specific to noise profile (and a great variety of these may apply even within any given aircraft type).

The following Electronic Noise Cancelling (ENC) headsets are in operational use in the RCAF:

1. The H10-76XL ENC on the CC115, CC138, CC-130 and CC-130J aircraft. The specifications are: Passive NRR = 24 dB. Active noise attenuation is a further 17-22 dB depending on frequency with active noise attenuation that is most suitable for frequencies below 1000 Hz.
2. The 40600G-15 and 40600G-20 ENC on the CC-177, CP-140 and CT-142 aircraft. The specifications are Passive NRR = 23 dB. Active noise attenuation is a further 17-22 dB depending on Frequency with active noise attenuation that is most suitable for frequencies below 1000 Hz.

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- c. Communications Ear Plugs (CEPs). These systems consist of miniature loudspeakers set within earplugs. While several such systems are under consideration (operational testing planned for Griffon and CF-18 fleets – with a view to assessing suitability for Air Force-wide use), none are as yet approved for use in the CF;
- d. 'Musician's Earplugs'. These are limited-attenuation earplugs intended to afford at least some protection, but also to allow sufficient sound transmission to enable communication (same strategy as with the CEP, above). Some suppliers market custom-fit models, which are prohibited as noted in a. above. Other off-the-shelf models, e.g. AR-15, may be considered for individuals with established hearing loss, in whom 'standard' earplugs may impose too much attenuation to enable them to hear communications.

Note: In accordance with PG4040-02, HS DEL does not authorize purchase of 'musician's earplugs' since they do offer less protection than needed for those members who are more susceptible to NIHL.

- e. 'Stable' of Approved Hearing Protection. As yet, none exists, other than the items noted above. Ref B contained an annex listing 'approved' items at the time, but this list now is severely outdated. Indeed, it should also be recalled that no office (CF or military) currently can provide expert/authoritative advice on these, much less 'prescribe' same to individuals. So, as indicated above, flight surgeons should resist the temptation to do any such 'prescribing'.

OTHER PEARLS AND PITFALLS OF AIRCREW HEARING LOSS MANAGEMENT

10. Hearing Aids. As per Jun 04 Aeromedical Policy and Standards Committee (APSC) proceedings (and verified since then several times), hearing aids are **NOT** approved for anyone on flight duty. This is because of airworthiness/certification concerns, plus their use is prohibited by all of our ASIC allies, too. Anecdotes suggest some aircrew may be covertly using them on flight duty anyway, but clearly flight surgeons should not support this.

11. Tinnitus Maskers. These electronic devices are intended to fatigue the output of cochlear elements producing tinnitus, and thus lessen the symptoms of patients so afflicted. They are not intended/certified for use on flight duty. While AUMB has only encountered a handful of instances where use of these was contemplated, tinnitus maskers highlight some of the constraints of using such devices in an operational environment. **Tinnitus maskers are noise-generating devices that offer short-term relief only and reduce the member's ability to hear some sounds. Their use has been considered by the Spectrum of Care committee and excluded from the Spectrum of Care.**

12. 'Excellent' Speech Discrimination. This will often be written on audiologist's reports regarding scores well below the 96% level that ought to trigger operational endorsement. The concern is that all currently used SD testing methods measure SD only in quiet; no validated test exists for assessing SD in noise (ref G). The Hearing in 8/15

Noise Test (HINTpro) manufactured by Bio-Logic System Corp has been on the market for a few years now and may offer more reliable and consistent testing of a patient's ability to understand speech in noise – which is usually much worse than SD in quiet. So, any decrement in SD in quiet will suggest a greater decrement in the ambient noise of flight duty – which is why the action threshold for operational endorsement is set so high.

13. 'Maximum Hearing Conservation'. While ref F dictates so annotating files of H2 and H3 personnel, neither operators nor patients (nor flight surgeons for that matter) have any idea what they are supposed to do with such advice, since hearing protective efforts are always supposed to be 'maximum' anyway. AUMB has opened this issue with the operational community (APSC mtg Apr 05 refers) but at the time of writing can offer no further clarification.

14. 'Impulse' vs. 'Rumbling' Noise. Recall that noise profiles are not created equal, and that different strategies are required in order to protect against different noise footprints. For example, the noise of the blast wave from a gunshot needs different hearing protective equipment from that required to protect against onboard aircraft engine or air-conditioning noise. Digital ANR systems theoretically can protect against a wide variety of noise profiles, but so far have not been developed sufficiently to prove operationally useful (ref H).

IN-FLIGHT HEARING ASSESSMENT

Introduction

The following is a simple operational tool used to confirm that individuals with speech discrimination scores less than 96% (when measured at 40 dB over the speech reception threshold (SRT) in either ear), can in fact hear instructions in their normal operational flying environment. It is based on a similar test used by the US Navy. Ideally, the examiner should be a Flight Surgeon who would then conduct the test over the ICS (internal communication system) while in flight with the subject facing away from the examiner. Check marks (✓) are to be placed after each correct answer and an (X) after each incorrect answer. There is no failure cut-off but any errors would raise concern about flight safety. Both the test form and the response form should be retained on the permanent medical file.

Part I: Phrase Testing

Do not allow the test subject to see the test phrases prior to testing. The examiner speaks each phrase clearly into the microphone and the subject must repeat each phrase. The subject must state the exact wording shown in quotations and have the correct context. Care must be taken by the examiner to not exaggerate the words in quotations. Normal tone and rate of speech is to be used.

Part II: Terminal/Frontal Rhyme Testing

For this part the subject must have a copy of the subject response form. The examiner randomly states one of the words in each of the 10 sets of three for both the terminal and frontal rhymes. The subject must then choose the same word. The examiner should circle the stated word on the test sheet and the subject circles the answer on the response form. The lists are then compared at the end of the test.

Part III: Examiner Comments

Comments from the examiner are very helpful. These could include any possible problems with the test (e.g. language issues, problems with the ICS) and at minimum should include a statement summarizing examiner's opinion of patient's hearing ability.

Patient Name:	IN-FLIGHT HEARING ASSESSMENT Examiner's Form
Service Number:	
Date:	

Part I: Phrase Testing

1. You are "south west" of the field.	2. Did you reserve the "racquetball court?"
3. Are there any "chocolate doughnuts" left?	4. Someone parked in my "reserved" space.
5. It is not healthy to "smoke in the cockpit".	6. The "photocopier" is broken again.
7. I'll buy 100 shares of Bre X at "fifty-two dollars."	8. The "all you can eat buffet" starts at 1145.
9. You have an "official call" on line 3.	10. I Drove the car 120 km with the "low oil Pressure" light on.

Part II: Rhyme Testing

Terminal Rhyme Test

- | | | | |
|-----|-------|-------|--------|
| 1. | date | rate | skate |
| 2. | car | jar | tar |
| 3. | me | tree | see |
| 4. | boat | coat | goat |
| 5. | gun | run | sun |
| 6. | mind | bind | find |
| 7. | seat | treat | eat |
| 8. | boy | toy | coy |
| 9. | sane | rain | train |
| 10. | house | mouse | grouse |

Frontal Rhyme Test

- | | | | |
|-----|-------|-------|-------|
| 1. | late | laid | lane |
| 2. | beat | bean | beef |
| 3. | seat | seen | sear |
| 4. | back | band | bat |
| 5. | float | flat | fly |
| 6. | rake | rain | rate |
| 7. | clam | clout | clock |
| 8. | jack | job | jail |
| 9. | cat | car | can |
| 10. | job | Jon | jot |

<u>Part III: Examiner Remarks:</u>

Flight Surgeon

(name/signature): _____ **Date:** _____

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Patient Name:	IN-FLIGHT HEARING ASSESSMENT Patient Response Form
Service Number:	
Date:	

Part I: Phrase Testing (as read by Examiner)

Part II: Rhyme Testing (Patient circles words heard)

Terminal Rhyme Test

- | | | | |
|-----|-------|-------|--------|
| 1. | date | rate | skate |
| 2. | car | jar | tar |
| 3. | me | tree | see |
| 4. | boat | coat | goat |
| 5. | gun | run | sun |
| 6. | mind | bind | find |
| 7. | seat | treat | eat |
| 8. | boy | toy | coy |
| 9. | sane | rain | train |
| 10. | house | mouse | grouse |

Frontal Rhyme Test

- | | | | |
|-----|-------|-------|-------|
| 1. | late | laid | lane |
| 2. | beat | bean | beef |
| 3. | seat | seen | sear |
| 4. | back | band | bat |
| 5. | float | flat | fly |
| 6. | rake | rain | rate |
| 7. | clam | clout | clock |
| 8. | jack | job | jail |
| 9. | cat | car | can |
| 10. | job | Jon | jot |

Patient Signature: _____

Flight Surgeon
(name/signature): _____ Date: _____

CANADIAN FORCES ENVIRONMENTAL MEDICINE ESTABLISHMENT

AEROSPACE and UNDERSEA MEDICAL BOARD

'REVIEW OF AUDIOGRAMS' FLOWSHEET

Date Initiated: _____

Service Number	Surname	Initials	Rank	MOC	Intake Date

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AIRCREW NIHL -

ADDITIONAL BACKGROUND

1. Noise Induced Hearing Loss (NIHL) is the #1 leading cause for Veterans Affairs Canada (VAC) payouts (\$140M per annum; ref A). Given that some regard NIHL as “at least 99% preventable” (ref A), there is room for improvement in the CF’s approach to this problem. While the CF once led industry with the program detailed at ref B, it remains without update since implemented in the 1950s. Industry has made significant inroads since then, and is now much more proactive in managing NIHL than is the CF. Specifically, companies now are accountable for compensation claims in their employees, and are in most jurisdictions assessed for some of the costs of same. Such agreements do not (yet) exist between Veterans Affairs Canada (VAC) and DND.
2. A new program for the CF is forthcoming (ref C), which is intended to bring DND into compliance with provisions in the Canada Labour Code, by which the CF has been directed to abide (ref C). However, provisions surrounding surveillance, training of Chain of Command responsibilities, and hearing protection strategies have been deemed unaffordable. Mitigation measures for these must be developed before this new directive can be implemented.
3. The Air Force identified that Airworthiness and other accountability governance dictate that the Air Force develop its own program – at the very least to complement the CF-wide provisions of ref C. (April 05 Aeromedical Policy and Standards Committee (APSC) meeting refers).

AEROMEDICAL CONCERNS (*further to para 1 above*)

4. NIHL is a form of sensorineural hearing loss that involves irreversible/permanent damage to delicate cilia in the cochlea. Established NIHL tends to get worse with age even without ongoing noise exposure because of Presbycusis (ongoing loss of neurocilia due to aging).
5. Existing standards for hearing protection only address ~ 90% of target population (i.e., no provision for ‘outliers’). No way at present exists to identify these individuals except to follow serial audiograms (e.g. using the flowchart at Annex B), scrutinizing for progression of HL.
6. No one office/trade/specialty boasts comprehensive expertise in hearing protection, nor prescribing same. Modalities are very fleet, job/mission, and individual specific.
7. As noted above, in contrast with civilian industry, no feedback from compensation authority (i.e., VAC) exists to alert the operators to the magnitude of the NIHL problem, let alone mandate interventions. Medical and other ‘watchdogs’ monitor audiograms, but at present have no clear-cut role in compelling the Chain of Command to act.

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8. Existing CF standards as expressed in the current H-factor category system (ref D) may be too liberal. Moderately advanced NIHL exists before H1 crosses to H2 (ref C).

Civilian Action Thresholds for threshold shifts are set at 10-15 dB – vice 30 dB for H1-H2. *While CF Standards and category system remain unchanged, the PHA form entails a screening approach compatible with ref C and formulas for comparing a 'Reference Audiogram' to current tracings.* Other shortcomings of the current H-factor schema include 'in the better ear' provisions of H3 which fail to address concerns over sound localization and attending comms on more than one channel.

9. The tradeoff between operational effectiveness and protection against NIHL sometimes drives members to crack their hearing protection (or indeed not wear it at all) in order to hear, (e.g. shouted commands [ref E]). This bears witness to a lack of effective but operationally viable hearing protective devices.