HEARING LOSS PREVENTION IN THE MILITARY ENVIRONMENT

C. Giguère & C. Laroche
Programme d'audiologie et d'orthophonie, Université d'Ottawa, 451 Smyth Road, Ottawa, Ontario K1H 8M5

1. INTRODUCTION

In the military, noise can be particularly noxious to hearing. The personnel face a wide range of noise-hazardous situations, many of which are seldom encountered in other work environments. High noise levels are associated with the operation of small and large calibre weapons, combat vehicles, aircraft, ships, vessels, and industrial equipment. Exposure to such noise can cause hearing loss, compromise speech communication, localization of sound sources and detection of warning sounds and thus, can jeopardize life or safety of the military and civilian personnel.

The ultimate goal of a hearing-loss prevention (HLP) program is to preserve hearing health as well as all hearing abilities necessary for effective operations. This paper reviews the essential elements of a prevention program proposed for the Canadian Armed Forces (CF). It has been designed to meet the Canadian Occupational Safety and Health (COSH) Regulations [1]. Additional measures and limits beyond COSH are also included to address issues specific to the military environment. A draft policy based on this proposal is currently under review by the CF.

2. PROGRAM ELEMENTS

2.1 Hazard Assessment and Identification

An effective HLP program is based on accurate and up-to-date sound level measurements for all noise-hazardous areas, facilities and operational equipment.

For steady-state or fluctuating noise, detailed surveys are to be conducted in all environments requiring the initiation of hearing-loss prevention procedures under COSH [1] (> 84 dBA). The A-weighted sound levels and the duration of exposure must be reported. For impulse noise with high peak levels, the A-weighted sound exposure level (SEL) per single impulse must be reported as well as the total number of rounds fired in a work shift or day. The noise survey data from all operational military equipment (ships, aircraft and vehicles) and weapons systems should be included in a central noise database to be maintained and updated for access by all CF personnel involved in the implementation or evaluation of the prevention program.

In assessing hazard, all sources of noise must be included in the calculation of exposure. Under COSH [1], the maximum 8-hr noise exposure limit from all sources is 87 dBA. In addition, the critical SEL limits set in a recent North Atlantic Treaty Organization (NATO) study [2] for single impulses from weapons systems are not to be exceeded (see Sec. 2.4). The new NATO data generally indicate that the risk from small calibre weapons (or short impulse duration) are under-estimated using current damage-risk criteria based on CHABA [3], while the risk from large calibre weapons (or long impulse duration) may be over-estimated.

Occupational noise regulations, like COSH, are based on a typical workday of about 8 hrs followed by a long rest period. In the military, sustained exposure largely exceeding an 8-hour workday can occur on a regular or irregular basis. For exposures lasting 12 hrs or more, a rest period at least as long as the exposure duration is recommended [4]. In all cases, the rest period should be sufficiently long to ensure that the temporary threshold shift (TTS) induced by the exposure has decreased to a value 2.5 dB or less, which is the residual TTS expected after an exposure to 87 dBA for 8 hrs and 16 hrs of rest. Data in [5] can be used to estimate such a minimum rest period, given exposure duration and level. The rest environment should be lower than 74 dBA.

2.2 Engineering Noise Control Measures

Engineering control measures is the preferred method to reduce exposure to safe levels. No other prevention method can match the long-term health, safety and workplace communication efficiency benefits of a quieter environment.

The best time for initiating engineering noise control measures is during the procurement process. The documentation for all new or retrofitted equipment and facilities should include noise specifications. If technically feasible, noise levels for all operators will not exceed COSH regulatory limit of 87 dBA during normal use. Otherwise, the specifications should ensure that all state-of-the-art engineering control measures be considered to deliver the quietest possible products, and that the noise levels from all sources at each operator position be specified upon delivery.

2.3 Administrative Controls

Administrative controls refer to measures used to inform personnel of potentially noise-hazardous area, and to staffing procedures used to further limit the duration and level of noise exposure once all engineering controls have been implemented. COSH regulations require informing all personnel of the potential risk to hearing whenever noise exposure is likely to exceed 84 dBA. In addition, there is the mandatory installation of visible and permanent warning signs to identify noise-hazardous areas, and the supplying of hearing protectors when noise levels exceed 87 dBA.

2.4 Personal Hearing Protection

Personal hearing protection devices (HPDs) are to be used to reduce noise exposure only once all engineering and administrative control measures have been exhausted. In a working environment as complex as the military (e.g. variable work schedules), the guiding rule to ensure that the daily noise exposure does not exceed the regulatory limit of 87 dBA is to require that exposure at each noise-hazardous site be below 87 dBA, through proper use of HPDs, irrespective of the duration of the exposure.

For steady-state or fluctuating noise, selection of HPDs will be made to ensure exposure is below the 87 dBA limit, preferably in the range 77-82 dBA to avoid over-protection. A central database of HPDs should be integrated with the noise database to identify proper devices in each setting.

HPDs are to be used on firing ranges by all personnel in the vicinity of the weapons systems. HPD selection will be restricted to a range of devices tested or approved by the CF for each weapons system. The maximum daily number of rounds allowable will be calculated according to:

$$\text{MAX. DAILY ROUNDS} = 28880 \times 10^{-(\text{SEL-ATT-87})/10}$$

where 87 dBA is COSH noise exposure limit, SEL is the free-field sound exposure level in dBA per single impulse, and ATT is the attenuation (dB) of the HPD for the particular weapons impulse. When the SEL is measured under the protector, this value must be used instead of SEL-ATT in the equation above. For protection against small-calibre weapons, a minimum HPD attenuation is also necessary to ensure the critical SEL limit of 116 dBA for an unprotected single impulse [2] is not exceeded, as follows:

$$\text{ATT} \geq \text{SEL} - 116 \text{ dBA} \quad \text{(small-calibre)}$$

When the SEL is measured under the protector, then the protected SEL per single impulse will not exceed 116 dBA.

2.5 Monitoring Audiometry

Audiometric monitoring of the CF personnel at risk is needed to (1) identify and document the hearing status of individuals with hearing loss, (2) provide proper care, protection, employment follow-up for those who incur hearing loss, and (3) monitor the general effectiveness of the HLP program. It important to note, however, that audiometric testing is not in itself a prevention method if there is no effective intervention to limit noise exposure. There are also reliability issues associated with the use of audiograms in occupational settings.

Audiograms should be recorded with automatic audiometers to standardize the measurement process across CF facilities. A computerized record keeping system should be put in place to automatically identify hearing conditions requiring follow-up. Periodic audiograms should be performed at any time during the work shift, and preferably late in the shift. The standard threshold shift due to noise is to be defined as a change from the baseline audiogram of 15 dB or more at 500, 1000, 2000, 3000, 4000 or 6000 Hz, in either ear. The baseline audiogram should be taken on all personnel entering the CF, within 30 days after initial noise exposure.

2.6 Education

An educational component is required (1) to ensure the CF personnel is aware of the effects of noise on health and safety, and (2) to explain the advantages and limits of each element contained in the HLP program. Training should be provided at least annually to all personnel working in areas where noise levels can exceed 84 dBA. In the military environment, a major challenge is to ensure continuity in the training process.

2.7 Program Evaluation

The objective of program evaluation is to assess or monitor the effectiveness of the HLP program in preventing hearing damage in the CF personnel. The use of general program evaluation tools based on audiometric databases is questionable in the military environment. Instead, specific activities can include but should not be limited to (1) the identification of high-risk tasks or military occupations, (2) the field evaluation of the attenuation of hearing protectors, and (3) the validation of impulse noise damage risk-criteria and prevention measures.

2.8 Documentation

The critical documents (acoustical standards, regulations, etc.) necessary to conduct the daily procedures contained in the HLP program should be easily accessible by the responsible personnel.

3. CONCLUSIONS

In the military, the importance of accurate noise surveying, engineering and administrative noise controls, proper fit of hearing protection and regular audiometric monitoring of the hearing of exposed personnel cannot be over-emphasized. It is only through the utilization of all available methods that the hearing of the personnel will be protected.

[Work carried out under a contract from the Canadian Forces Medical Services].

REFERENCES

[1] Canadian Occupational Safety and Health (COSH) Regulations Part VII: Levels of Sound (SOR/2002-208, 30 May 2002).

[2] NATO (2003). Reconsideration of the Effects of Impulse Noise (RTO TR-017/HFM-022).

[3] Forshaw, S. (1970). Guide to Noise-Hazard Evaluation. Defence Research Establishment Toronto, Review Paper No. 771.

[4]Shaw, E.A.G. (1985). Occupational Noise Exposure and Noise-Induced Hearing Loss: Scientific Issues, Technical Arguments and Practical Recommendations (APS707; NRCC/CRNC No 25051).

[5] Shaw, E.A.G. (1983). "On the Growth and Decay of Asymptotic Threshold Shift in Human Subjects," 4th Int. Cong. on Noise as a Public Health Problem, Vol. 1: 297-308 (Turin, Italy).