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Impulse Noise: Measurement Techniques and Hearing Protector Performance

Report on Scientific Exchange at the French-German Research Institute of Saint-Louis

Ann Nakashima
DRDC Toronto

Karl Buck, Pascal Hamery, Sébastien De Mezzo and Gilbert Brom
French-German Research Institute of Saint-Louis, France

Defence R&D Canada – Toronto

Technical Memorandum

DRDC Toronto TM 2006-231

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Canada

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Abstract

Measurements of impulse noise and the performance of several hearing protection devices were done in Saint-Louis and Baldersheim, France at the French-German Research Institute of Saint-Louis (ISL) in August 2006. Hearing protector performance was evaluated using an acoustic test fixture that was designed by ISL. Impulse noises of peak levels from 110 to 190 dB were produced by detonation of explosives. The noise attenuation achieved by a Peltor communications headset (MT15H68 FB 950) and a Peltor Optime III earmuff was measured alone and in combination with a Bilsom nonlinear earplug (Model 655). The Peltor Optime III provided slightly more attenuation than the communications headset up to about 2 kHz. When used in the combination with the earplug, similar attenuation was achieved for the two devices. A prototype AEARO earplug was also tested in the blast noise, and was found to provide good attenuation at low frequencies when used in the nonlinear mode. The performance of the Nacre QuietPro active earplug system was measured in pink noise of 85, 90 and 95 dB. The device provided good attenuation in the passive mode and adequate protection in the push-to-talk (PTT) modes. It is expected that the work performed will lead to future collaborations between DRDC Toronto and ISL in the area of protection from impulse noise and blasts.

Résumé

Des mesures du bruit impulsif et du rendement de plusieurs dispositifs de protection auditive ont été effectuées à Saint-Louis et Baldersheim (France), à l'Institut franco-allemand de recherches de Saint-Louis (ISL), en août 2006. Le rendement de dispositifs de protection auditive a été évalué au moyen d'un appareil d'essai acoustique conçu par l'ISL. Du bruit impulsif atteignant des niveaux de crête de 110 à 190 dB a été produit par la détonation d'explosifs. L'atténuation du bruit obtenue par un casque de communications Peltor (MT15H68 FB 950) et un protecteur d'oreilles Peltor Optime III a été mesurée seule et en combinaison avec des bouchons d'oreilles non linéaires Bilsom (modèle 655). Le dispositif Peltor Optime III a produit légèrement plus d'atténuation que le casque de communications, jusqu'à environ 2 kHz. Lorsqu'ils étaient utilisés en combinaison avec les bouchons d'oreilles, les deux dispositifs ont produit une atténuation semblable. Un prototype de bouchons d'oreilles AEARO a également été mis à l'essai dans du bruit de souffle, et il s'est avéré qu'il produisait une bonne atténuation aux basses fréquences dans le mode non linéaire. Le rendement des bouchons d'oreilles actifs Nacre QuietPro a été mesuré dans du bruit rose de 85, 90 et 95 dB. Ces bouchons produisaient une bonne atténuation dans le mode passif et une protection adéquate dans les modes à poussoir d'émission (PTT). On s'attend à ce que les travaux effectués mènent à de futures collaborations entre RDDC Toronto et l'ISL dans le domaine de la protection contre le bruit impulsif et le bruit de souffle.

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Executive summary

Impulse Noise: Measurement Techniques and Hearing Protector Performance: Report on Scientific Exchange at the French-German Research Institute of Saint-Louis

Ann Nakashima; Karl Buck; Pascal Hamery; Sébastien De Mezzo; Gilbert Brom; DRDC Toronto TM 2006-231; Defence R&D Canada – Toronto; October 2006.

Exposure to high-level, impulsive noise is an ongoing problem for the Canadian Forces. Peak noise levels from weapons such as a howitzer can reach as high as 190 dB SPL (Buck, 2000). Given the increasing inquiries from military groups for information on how to protect from impulse noise, it was of interest to DRDC Toronto to increase knowledge in this area. An agreement for scientific exchange between the French-German Research Institute of Saint-Louis (ISL) and Canada enabled a DRDC Defence Scientist to spend one month at ISL in August 2006. It was expected that the exchange would lead to future collaborations between DRDC Toronto and ISL.

Measurements of blast noise were performed at the ISL shooting range in Baldersheim, France. A rifle was used to produce peak levels of about 110 dB, and peak levels of 130 to 190 dB were produced by detonation of explosives. The pressure-time signals were captured using standard ¼” microphones (up to 160 dB) or a shape-probe (above 190 dB), and acoustic test fixtures (ATFs). The ATF is an artificial head that simulates human hearing, and is used to measure the attenuation provided by hearing protection devices (HPDs). Several different devices were tested using the ATFs: a Peltor communications headset (MT15H68 FB 950), a Peltor Optime III earmuff, and an AEARO prototype earplug. The Peltor headset and earmuff were tested alone and in combination with Bilsom nonlinear earplugs (Model 655).

The Peltor earmuff provided slightly better protection than the communications headset at frequencies up to about 2 kHz. When used in combination with the Bilsom earplugs, the headset and earmuff gave similar attenuation levels. The AEARO prototype plug was tested in the nonlinear (open) and linear (holes plugged; closed) modes. In the nonlinear mode, the plug was found to provide good low-frequency attenuation.

The Nacre QuietPro active earplug system was tested in continuous noise (pink noise) of 85, 90 and 95 dB using an ATF. The earplugs provided good attenuation in the passive mode. In the push-to-talk mode (PTT), the system is supposed to act as a limiter by attenuating ambient noise that is in excess of 85 dBA. This was confirmed for the three ambient noise levels used. However, the active noise reduction (ANR) did not appear to provide any additional attenuation.

The knowledge gained in the area of impulse noise measurement and protection will be beneficial to research programs at DRDC Toronto. Ideas for research in this area are currently being explored to form a proposal for a collaborative project between DRDC Toronto and ISL.

Sommaire

Impulse Noise: Measurement Techniques and Hearing Protector Performance: Report on Scientific Exchange at the French-German Research Institute of Saint-Louis

Ann Nakashima; Karl Buck; Pascal Hamery; Sébastien De Mezzo; Gilbert Brom; DRDC Toronto TM 2006-231; R & D pour la défense Canada – Toronto; Octobre 2006.

L'exposition à du bruit impulsif intense pose un problème constant au sein des Forces canadiennes. Les niveaux du bruit de crête provenant d'armes comme des obusiers peuvent atteindre un niveau de pression acoustique de 190 dB (Buck, 2000). En raison des demandes croissantes de groupes militaires désireux d'obtenir de l'information sur la protection contre le bruit impulsif, RDDC Toronto a manifesté de l'intérêt à accroître ses connaissances sur le sujet. Dans le cadre d'une entente d'échange scientifique entre l'Institut franco-allemand de recherches de Saint-Louis (ISL) et le Canada, un scientifique de la défense de RDDC a passé un mois à l'ISL en août 2006. On s'attendait à ce que l'échange mène à de futures collaborations entre RDDC Toronto et l'ISL.

Des mesures du bruit de souffle ont été effectuées au champ de tir de l'ISL situé à Baldersheim (France). Une carabine a produit des niveaux de crête d'environ 110 dB, tandis que la détonation d'explosifs a permis d'atteindre des niveaux de crête de 130 à 190 dB. Les signaux pression-temps ont été captés au moyen de microphones normaux de ¼ po (jusqu'à 160 dB) ou d'une sonde profilée (au-dessus de 190 dB) et d'un appareil d'essai acoustique (ATF). L'ATF est constitué d'une tête artificielle qui simule l'audition humaine et sert à mesurer l'atténuation produite par des dispositifs de protection auditive. Plusieurs dispositifs différents ont été mis à l'essai au moyen d'ATF : un casque de communications Peltor (MT15H68 FB 950), un protecteur d'oreilles Peltor Optime III et un prototype de bouchons d'oreilles AEARO. Le casque et le protecteur d'oreilles Peltor ont été mis à l'essai seuls et en combinaison avec des bouchons d'oreilles non linéaires Bilsom (modèle 655).

Le protecteur d'oreilles Peltor a offert une protection légèrement meilleure que celle du casque de communications aux fréquences allant jusqu'à environ 2 kHz. Utilisés en combinaison avec les bouchons d'oreilles Bilsom, le casque d'écoute et le protecteur d'oreilles ont produit des niveaux d'atténuation semblables. Le prototype de bouchons AEARO a été mis à l'essai dans les modes non linéaire (ouverture) et linéaire (bouchons enfoncés; fermeture). Dans le mode non linéaire, il s'est avéré que les bouchons offraient une bonne atténuation aux basses fréquences.

Les bouchons d'oreilles actifs Nacre QuietPro ont été mis à l'essai dans du bruit continu (bruit rose) de 85, 90 et 95 dB au moyen d'un appareil d'essai acoustique. Les bouchons d'oreilles produisaient une bonne atténuation dans le mode passif. Dans le mode à poussoir d'émission (PTT), le système est censé servir de limiteur par l'atténuation du bruit ambiant qui dépasse 85 dBA. Ce résultat a été confirmé pour les trois niveaux de bruit ambiant utilisés. Toutefois, la réduction active du bruit (RAB) n'a pas semblé causer d'atténuation supplémentaire.

Les connaissances acquises dans le domaine de la mesure du bruit impulsif et de la protection contre ce bruit seront précieuses pour les programmes de recherches menés à RDDC Toronto. On examine actuellement des pistes de recherche à cet égard en vue d'établir une proposition de projet de collaboration entre RDDC Toronto et l'ISL.

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Acknowledgements

The author would like to acknowledge the support of Veterans Affairs Canada for making the travel for this scientific exchange possible. She would also like to thank Dr. Sharon Abel of DRDC Toronto for initiating and supporting this activity, and for her comments on an earlier version of this document.

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Introduction

An agreement for scientific exchange between the French-German Research Institute of Saint-Louis (ISL) and Canada enabled a DRDC Toronto Defence Scientist (Ann Nakashima) to spend one month at ISL under the supervision of Dr. Karl Buck in August 2006. This visit was initiated by Dr. Sharon Abel of DRDC Toronto and made possible by an agreement for scientific exchange between Canada and France (see Appendix) and funding from Veterans Affairs Canada. The purpose of the visit was to broaden the knowledge of noise measurement techniques and hearing protection at DRDC Toronto, specifically in the area of impulse noise. In addition, it was expected that the bridges built between the Communications Group at DRDC Toronto and the Acoustique et Protection du Combattant group at ISL would lead to collaborative efforts on future projects.

During the visit, the work that was observed at ISL mainly fell into two categories: 1) testing of acoustic transducers for the measurement of impulse noise up to 190 dB, and 2) testing of hearing protector performance in continuous and impulsive noise. Studies involving measurement of the effect of simulated mine explosions on the strain and velocity of movement of an artificial leg were also observed.

Measurement of Impulse Noise

Impulsive noises from weapons in military operational environments pose a significant health hazard to military personnel. The impulses are usually analyzed in terms of peak pressure level (in Pa or dB) and A-duration. The A-duration of an impulsive signal is the time interval between impulse onset and the first crossing with the base line (NATO, 2003). Impulses that have the same A-duration, but different peak levels, will have similar spectral composition. Impulses that have the same peak level, but different A-durations, will have different spectral compositions below about 1 kHz. As the A-duration increases, the energy levels below 1 kHz increase (Buck, 2000). For weapons, the peak levels may range from 150 dB with an A-duration of 0.5 ms for handguns, to 190 dB with an A-duration of some milliseconds for howizters and mortars. The shock waves that are created by the firing of weapons can be simulated by detonation of explosives. The generation of shock waves with specific peak pressures and A-durations was achieved with different masses of explosives as shown in Table 1. This method of generating shock waves has been shown to be highly repeatable with respect to the peak pressure level, A-duration and spectra (Buck, 2000). A sample pressure time history of a single blast is shown in Figure 1.

Table 1 Explosive requirements for production of high peak pressures at the position of the ATF (DeMezzo and Hamery, 2006).

Sound pressure level (dB)	Explosive mass (g)	Explosive type	Distance from receiver (m)	A-duration (ms)	Peak pressure (Pa)
110 dB	N/A	rifle	90	2	6.3
130	1	Primer	42	0.8	63
150	7	Primer	26	2	630
160	17	Primer	11.6	2	2000
170	35	Primer	6.5	2	6300
180	93.5	Plastit	4	2	20000
190	300	Plastit	2.8	2	63000

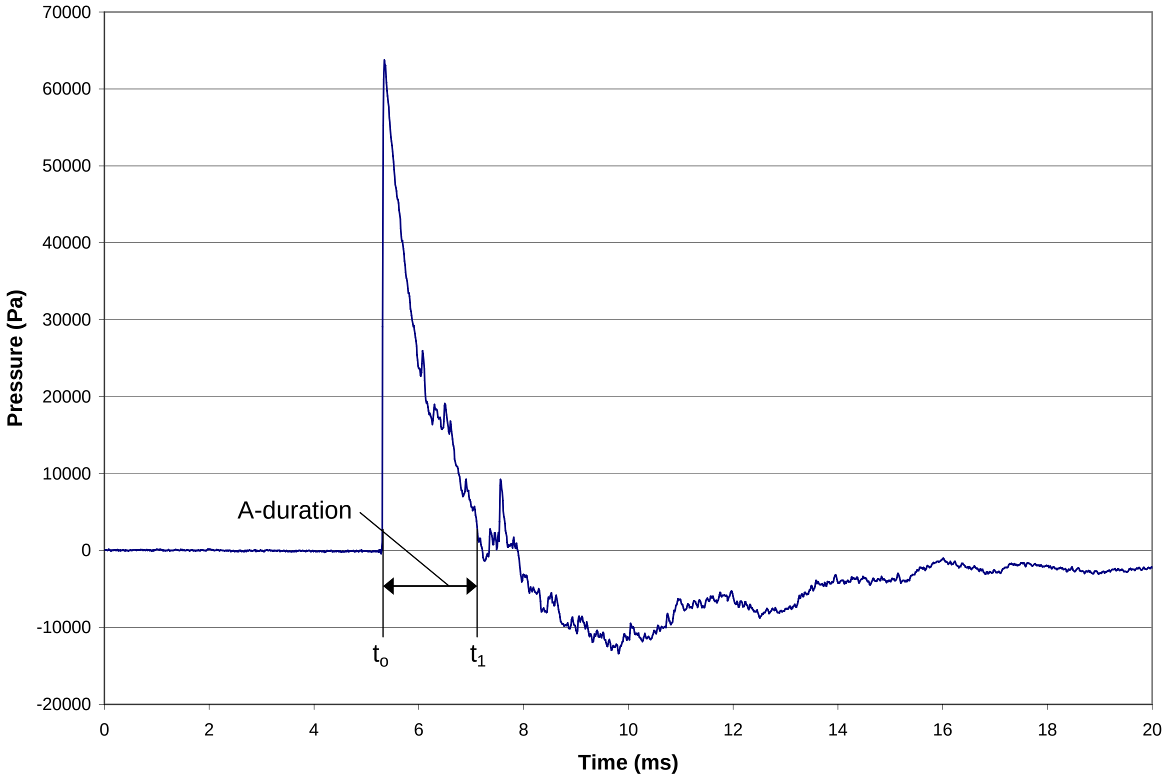

Figure 1: Sample pressure time history of a 190 dB blast.

Blast noise measurements were performed at the ISL test facility in Baldersheim, France. The blasts were performed in a secured outdoor area by a certified explosives technician. The explosives were detonated remotely from inside a building on the test site. The data acquisition system and software for the noise measurements were also operated inside the building. For noise up to 160 dB, ¼" Brüel and Kjaer microphones (type 4938 or 4136) were used. For noise exceeding 160 dB, a shape probe was used. The shape probe consists of a high pressure transducer mounted on a tapered rod. The tapered end of the rod is pointed toward the blast, as its shape causes minimal distortion of the wavefront. Noise levels and spectra at the ears are captured using an artificial test fixture (ATF) developed by ISL. The ATF is an artificial head with human ear simulators (Brüel and Kjaer 4157), ear canals, pinnae and flesh in the circumaural area (Head Acoustics). The ATF is placed on the ground and the explosive is suspended close to the ground at the ear level of the head. This is done to avoid reflections.

It was of interest to measure the TFOE (transfer function of the open ear) for the ATF at different angles of incidence to check for symmetry about the interaural axis. The TFOEs of two ATFs were measured simultaneously, at different angles of incidence in increments of 45 degrees. A shape probe was placed between the two heads to capture the reference signal. A peak level of 150 dB and A-duration of 2 ms was used. The results for overall level are shown in Fig. 2. The responses of the two ATFs were symmetrical about the interaural axis within 5 dB.

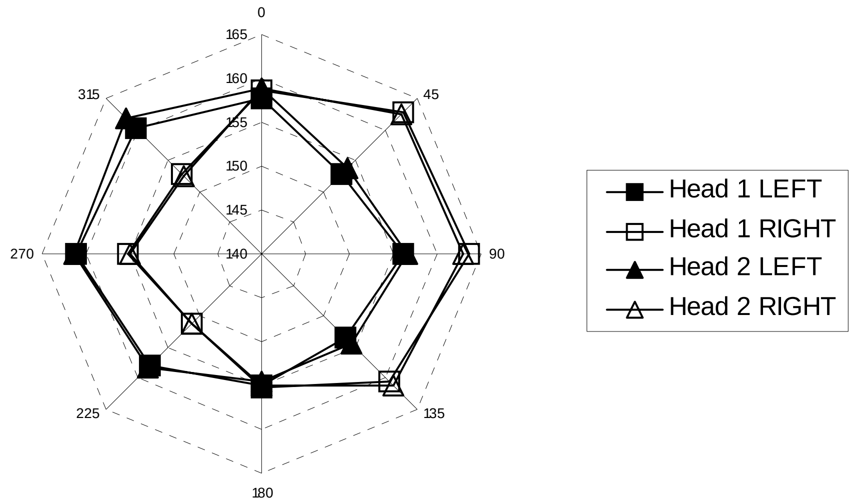

Figure 2: ATF response for different angles of incidence, 150 dB peak noise.

The tapered end of the shape probe is generally pointed towards the blast such that minimal disturbance of the wavefront is achieved. It is of interest to determine how accurately the probe must be positioned in order to capture the true peak pressure and spectrum of the blast. As a starting point, the response of the shape probe was tested at angles of 0, 45 and 90 degrees with respect to the blast source, at peak levels of 170 and 190 dB. The octave band levels for the two peak levels are shown in Figures 3 and 4. The octave band levels were similar for the three angles of incidence for the 170 dB peak noise. For the 190 dB peak, differences occurred starting from 1 kHz. It was expected that the spectrum would be the same shape as for the 170 dB blast, because the two signals have the same A-duration. Thus, the best representation of the blast spectrum was obtained when the shape probe was oriented at 0 degrees. It would be of interest to test the response at smaller angles of incidence using the 190 dB blast to determine how much deviation from 0 degrees gives an acceptable response.

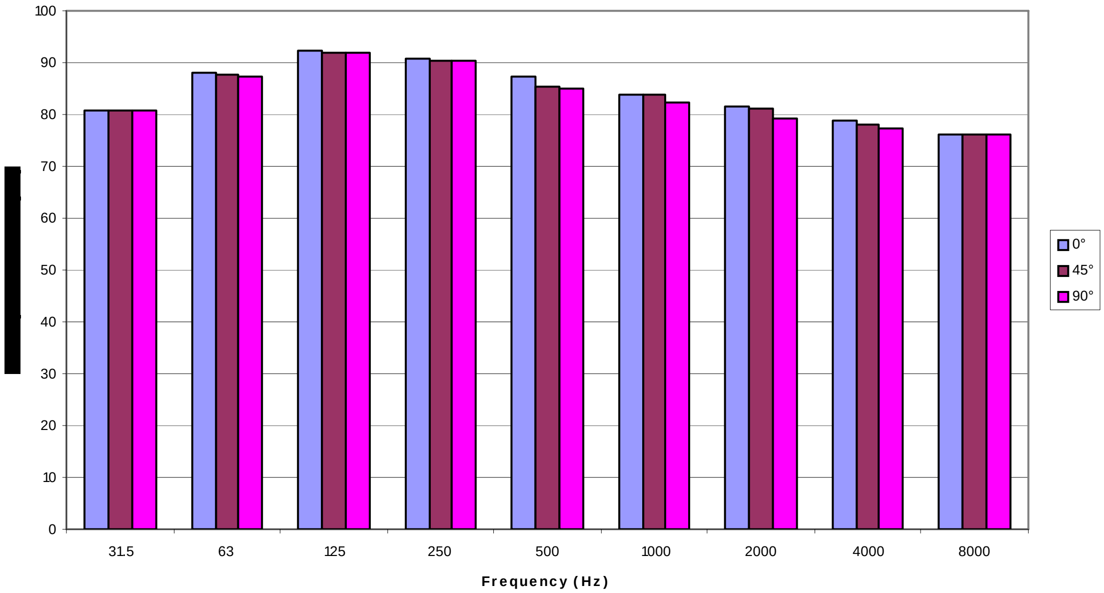

Figure 3: Octave band levels measured with the shape probe for different angles of incidence, 170 dB peak noise.

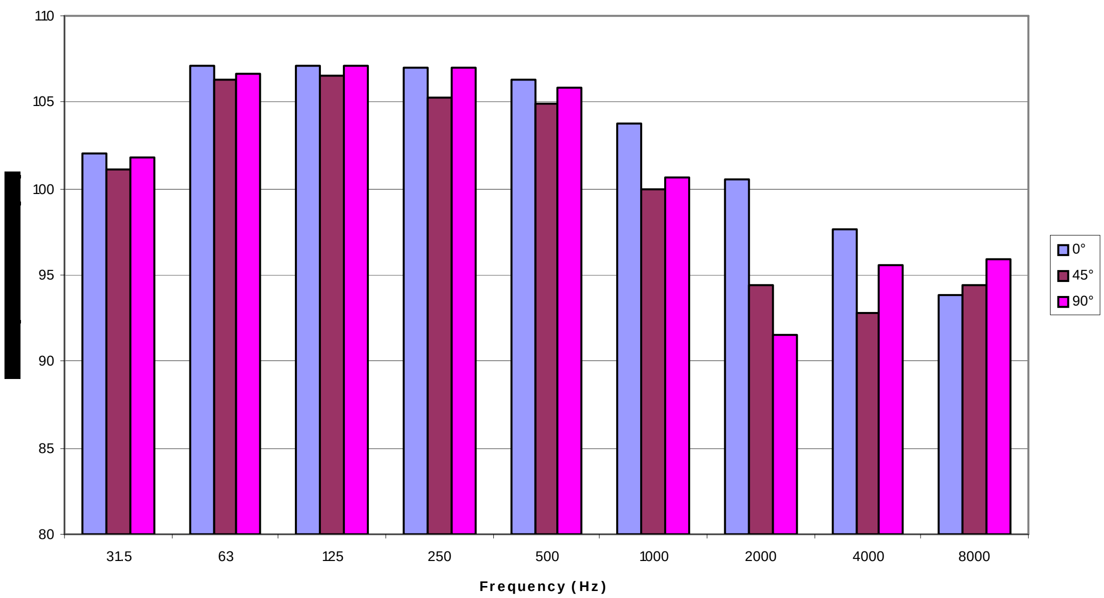

Figure 4: Octave band levels measured with the shape probe for different angles of incidence, 190 dB peak noise.

Measurement of Hearing Protector Performance

Nacre QuietPro in Continuous Noise

The QuietPro (Nacre) active earplug system has been tested at ISL for protection from firearms noise for the EPIGN (Escadron Parachutist d'Intervention de la Gendarmerie Nationale [De Mezzo and Hamery, 2006]) and for protection from blast noise (Buck et al., 2006). It was also of interest to test the performance of the QuietPro in continous noise. The insertion loss of the QuietPro for pink noise was measured in the reverberant test chamber at ISL. Three background noise levels were used: 85, 90 and 95 dB SPL. The insertion loss of the QuietPro was measured in passive (active noise reduction [ANR] off) and PTT modes (ANR on), with the PTT volume set to the minimum and maximum levels, using the ATF described in the previous section. To calculate the insertion loss, the noise levels captured at the ear microphones with the ears occluded were subtracted from the open ear levels. The results are shown in Figure 5. From the data shown, it appears that the performance of the system is worse in the PTT mode than the passive mode at frequencies between about 200 Hz and 8 kHz. It is stated in the QuietPro users manual that the PTT mode is effective for attenuating the ambient noise when the levels are above 85 dBA. Thus, although the insertion loss much less in the PTT mode than in the passive mode, the device appears the limit the noise level at the ears to 85 dBA. It would be of interest to repeat the measurements in noise above 95 dB to determine how well the limiting function performed in high noise levels. Previous tests performed at ISL using the QuietPro for blast noise showed that there was a large standard deviation in the insertion loss in both the passive and PTT modes (Buck et al., 2006).

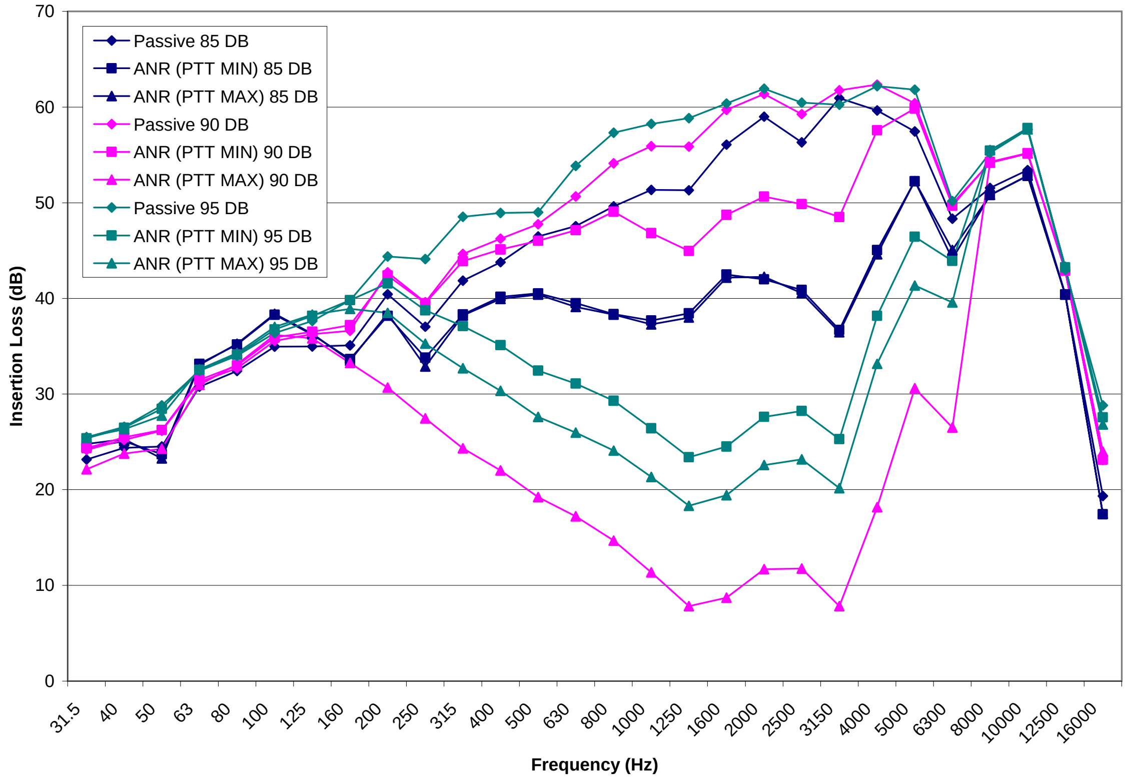

Figure 5: Insertion loss measured with the QuietPro active earplug system in passive and ANR modes.

Testing of Hearing Protectors in Blast Noise

Testing of two different earmuff and earplug combinations was done at Baldersheim, using explosives as described previously. Peak levels of 110, 130, 150, 170 and 190 dB were used. The first combination tested was a Peltor communications headset (type MT15H68 FB 950) and Bilsom nonlinear earplugs (Model 655). The tests were performed first with the headset alone, then with the headset and earplugs in combination. The open-ear levels were not measured for all of the peak levels for these tests; thus, the results are given as attenuation (ambient – occluded) values rather than insertion loss. The results are shown in Figure 6. Results could not be obtained for the headset alone at 190 dB due to overloading of the ear microphones. It was suspected that overloading occurred because the force of the blast caused the earcups to lift off of the ears. The combination of the headset and plug provided more attenuation than the headset alone, particularly above about 400 Hz.

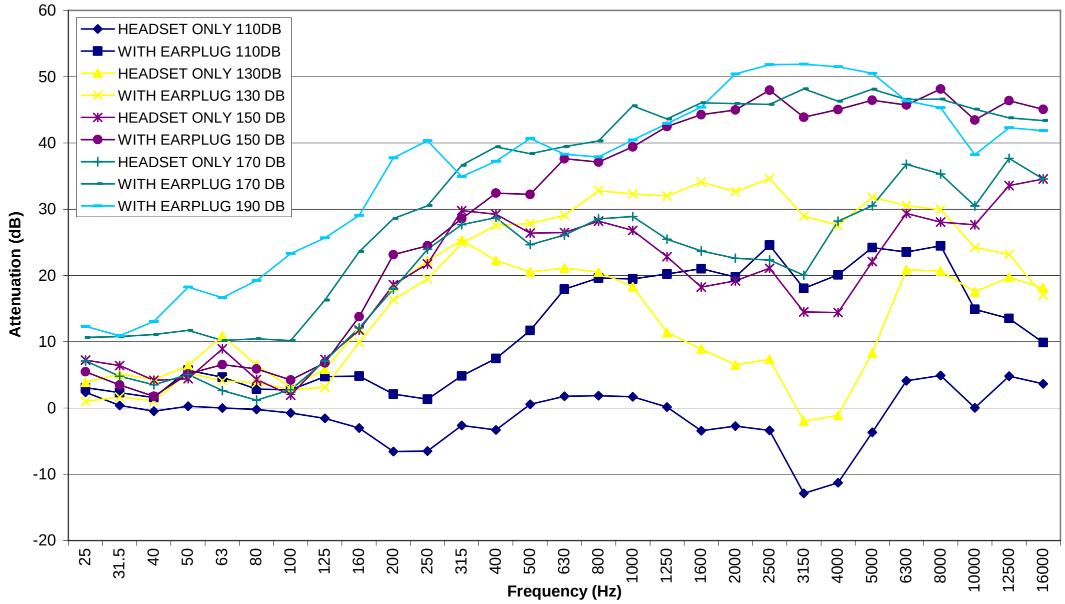

Figure 6: Attenuation measured with the Peltor (Type MT15H68 FB 950) communications headset alone, and in combination with a Bilsom nonlinear earplug (Model 655).

The same Bilsom nonlinear plug was also tested in combination with a Peltor Optime III earmuff. The earmuff gave better attenuation than the communications headset up to about 2 kHz. When used in combination with the earplug, the attenuation with similar to that of the headset with the plug. The results are shown in Figure 7.

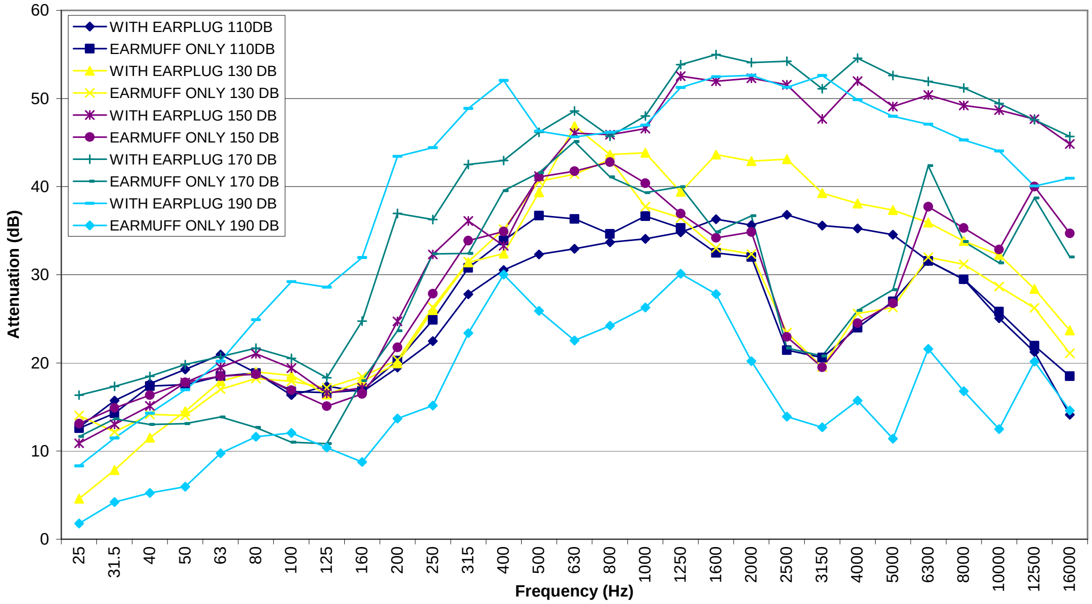

Figure 7: Attenuation measured with the Peltor Optime III earmuff alone, and in combination with a Bilsom nonlinear earplug (Model 655).

A prototype earplug manufactured by AEARO was tested under the same conditions as listed above. The earplugs can be worn in the nonlinear mode (open) or linear mode (with the holes plugged [closed]). The results are shown in Figure 8. The earplugs do not give as much attenuation as double protection at higher frequencies (see Figure 7), but the low frequency (up to 1 kHz) attenuation is superior to double protection.

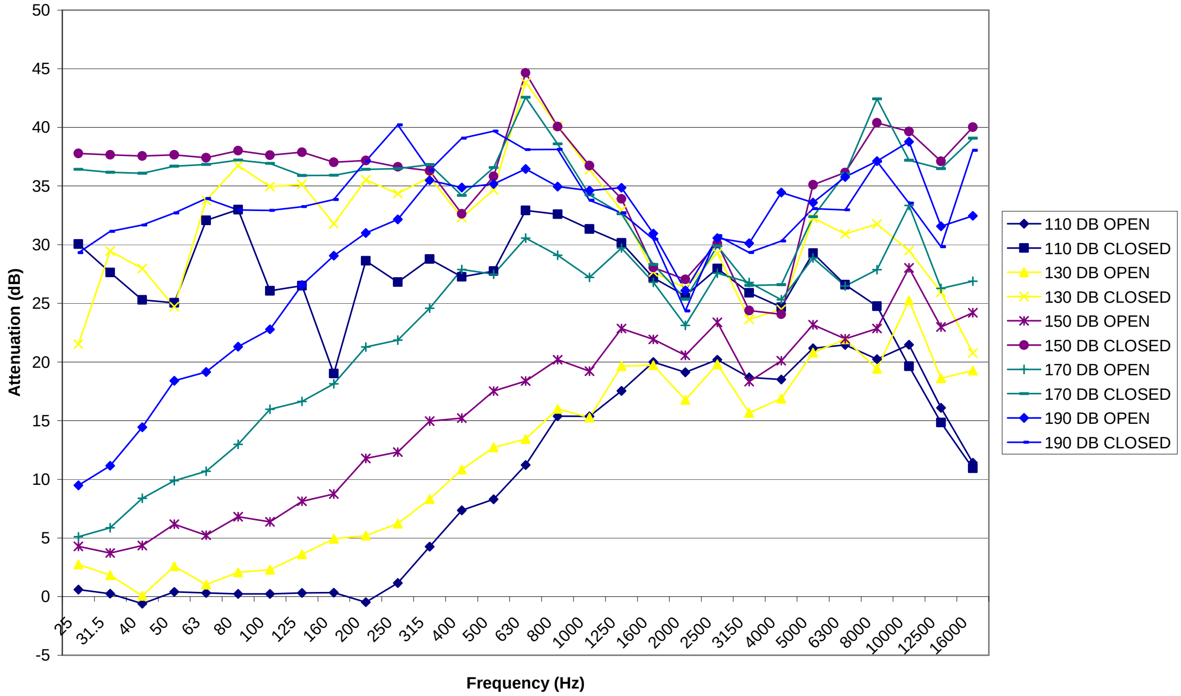

Figure 8: Attenuation measured with the AEARO prototype plugs, in the open and closed configurations.

Other Research Activities

Another type of experiment that was performed at the Baldersheim shooting range involved the simulation of mine explosions. A steel leg was suspended over a sand pit, such that the leg had freedom to swing back and forth in a single plane. Attachments of varying weights and materials were used to model the foot and footwear. Steel of various thicknesses, sometimes in combination with a stiff foam, were used in the experiments. The explosive was encased in a plastic container (Amtech Aeronautical Ltd., Medicine Hat, AB) and buried 2 cm in the sand below the foot. The pressure near the point of explosion was measured with a shape probe. The strain on the leg and the velocity of the leg movement caused by the explosion were also captured. These experiments were being done to better understand how to protect against mine explosions.

Other research activities in the group included digital filtering of speech signals for noise removal, and inverse acoustics for the location of a source in the interest of sniper detection.

Discussion and Possibilities for Future Work

There is an increasing demand from military groups for recommendations on types of hearing protection devices (HPDs) and communication systems that should be used in specific operational environments. There is no single HPD that is effective for all environments. For example, personnel who are inside an armoured personnel carrier require protection from continuous noise and radio communication capability, but likely do not require protection from impulse noise or sound localization capability. Dismounted soldiers require the ability to hear warnings, localize sounds and communicate with other members of their platoon, in addition to being protected from impulsive noise. In all cases, the HPD must be compatible with the rest of their equipment without compromising the noise attenuation, and must be acceptably comfortable to wear and easy to operate.

The facilities and capabilities at ISL enable scientists to carry out experiments that are not possible at DRDC Toronto. These include the blast site and access to explosives for impulsive noise measurements, and the possession of ATFs for measuring in-ear levels. DRDC Toronto has access to human test subjects and facilities that can be used to evaluate the performance of HPDs in continuous noise. HPD performance can be measured in terms of insertion loss (alone and in combination with other headgear), speech intelligibility and sound localization. However, when using human test subjects, the HPDs can only be evaluated in moderate noise levels. The combined capabilities of ISL and DRDC Toronto could facilitate the development of a project that would address the issues of choosing HPDs mentioned above for use in military operations. The issue of improvised explosive devices (IEDs) is of increasing importance to the military. As ISL is already using blasts for the simulation of mine explosions in the interest of limb protection, it may be possible to design experiments to investigate the protective capability of other types of kit (HPDs, helmets, etc.).

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[2] Buck, K., De Mezzo, S. and Brom, G. (2006). Evaluation of the behaviour of the QuietPro hearing protection devices when undergoing impulse noise simulations with peak pressure levels between 160 dB and 195 dB. French-German Institute of Saint-Louis, unpublished document.

[3] De Mezzo, S. and Hamery, P. (2006). Evaluation acoustique de bouchons d'oreilles moulés avec atténuation électronique: Comportement en régime impulsionnel. French-German Institute of Saint-Louis, unpublished document.

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Annex A Agreement for Scientific Exchange between Canada and the French-German Institute of Saint-Louis

AGREEMENT

BETWEEN

Her Majesty the Queen in right of Canada, acting through and represented by the Minister of National Defence,

hereinafter called the MND,

AND

L'Institut franco-allemand de recherches de St Louis, (The Franco-German Research Institute of St. Louis)
5, Rue du Général Cassagnou, BP 34, 68301 St Louis (France)

represented by its directors, Ingénieur Général Dominique LITAISE and EDirBWB Volker SCHMITT,

hereinafter called the ISL,

the MND and the ISL being collectively referred to as "the Parties" and individually as "the Party",

considering the NATO Agreement on the Communication of Technical Information for Defence Purposes of 19 October 1970 ;

considering the Arrangement between the Minister of National Defence of Canada and the Minister of Defence of the French Republic concerning Cooperation in Defence research dated 3 November 1993 ;

considering the Arrangement between the Minister of National Defence of Canada and the Minister of Defense of Germany dated 31 March 1958;

considering the Agreement between the French Republic and the Federal Republic of Germany relative to the Franco-German Research Institute of St. Louis dated 31 March 1958;

have reached the following understandings:

Article 1 - PURPOSE OF THE PRESENT CONVENTION

1.1 Ann Nakashima, scientific researcher employed by MND – DRDC Toronto is hereby authorized to occupy the position of guest researcher at the ISL from 1 August 2006 to 30 August 2006. The work to be carried out shall concern the fields of noise measurements and hearing protection. The purpose of the present Agreement is to define the terms of this collaboration.

Article 2 - FINANCIAL ASPECTS

2.1 The MND shall maintain Ann Nakashima's salary and benefits. Her travel expenses and accommodation fees shall be borne by the MND.

2.2 ISL will not charge for the use of facilities or equipment necessary for the performance of individual or collaborative tasks.

Article 3 - TERMS FOR THE PERIOD OF THE COLLABORATION

3.1 Ann Nakashima shall be subject to the general rules and regulations regarding access to the premises (work areas, administrative and general services, food service) hygiene, safety and security, and working hours.

Article 4 - CONFIDENTIALITY - PUBLICATIONS

4.1 Confidentiality

4.1.1 Each Party hereby undertakes not to publish or in any way disclose any scientific or technical knowledge belonging to the other Party of which a Party should become aware as a result of the fulfillment of the present Agreement, unless:

4.1.1.1 the aforementioned information has entered the public domain, or
4.1.1.2 the Party seeking to disclose the information has obtained the prior written authorization of the other Party.

This commitment shall remain in force for a period of five years following the date of this Agreement.

4.2 Publication

4.2.1 The Parties shall determine the appropriateness of any publication or communication of the results of the collaboration jointly.

4.2.2 Prior to the publication or the communication of any information, the disclosing Party shall be required to obtain the written authorization of the other Party by registered letter, with acknowledgement of receipt, or by any other means proving the date on which the request was issued. The other Party shall be required to reply by registered letter, with acknowledgement of receipt, within two months of receiving the request. Should no reply be made within this period, it shall be considered that the request has been granted.

4.2.3 Any publications and communications shall cite the contribution of each of the Parties. An exception to this rule shall be made in the event that one of the Parties expresses, explicitly in writing, its wish not to co-sign a publication which nevertheless meets with its approval.

4.2.4 These provisions shall in no way override the obligation of each of the scientific officials and/or of his/her colleagues to produce an activity report for in-house usage within the entity employing them insofar as any such communication shall not be considered as disclosure of intellectual property.

ARTICLE 5 - INTELLECTUAL PROPERTY

5.1 Knowledge Acquired by a Party Prior to and Outside of the Collaboration

5.1.1 Any knowledge in the said field acquired by either Party prior to and outside of the collaboration shall remain the property of that Party.

5.1.2 Should any results obtained prior to or outside of the collaboration be needed for the purposes of the collaboration, they shall be made available for this sole purpose by the owning Party in compliance with Section 6.3 hereafter. This disclosure shall not constitute a transfer of ownership nor a right of free usage unless the express approval of the owning Party is granted in writing.

5.2 Results Arising from the Collaboration

5.2.1 The Parties do hereby expressly agree that any results arising from the present study carried out in collaboration with Dr. Abel and one or more staff of the MND shall be co-owned by the MND and the ISL, unless one of the Parties should waive its rights of co-ownership in writing. For this purpose, the Parties shall take all necessary measures with a view to protecting this co-owned property, including: non-disclosure, patenting, copyrighting or any other appropriate means.

5.2.2 Prior to the filing of a joint patent application, the Parties shall establish a co-ownership agreement. This co-ownership agreement shall determine the contribution of each Party to the patenting, renewal and maintenance fees and expenses for each patent as well as the usage privileges and royalties due to each of the Parties. If, subsequent to the decision to file a patent, one of the Parties should waive its right to:

5.2.2.1 file a priority patent application,

5.2.2.2 and/or file an application for the corresponding foreign patents,

5.2.2.3 and/or to pursue the application process for the said patents

5.2.2.4 and/or to renew the said patents,

that Party shall inform the other Party by registered letter, with acknowledgement of receipt, within three months of the first filing in order that the other Party may, should it so wish, undertake the formalities involved in filing for and/or renewing the patent or patents.

5.2.3 The Parties undertake to:

5.2.3.1 ensure that the names of any inventors be mentioned (unless they should waive this right) in accordance with the applicable legal provisions in any patent application filed by either Party;

5.2.3.2 ensure that their respective personnel, named as inventors provide all signatures and carry out all formalities required for the patent applications and renewals;

5.2.3.3 inform each other as to any patent filings and renewals carried out.

5.2.4 A Party may not, under any circumstances, assign the patents to a third party without the written approval of the other Party. In any assignment document, the rights and the interests of the non-assigning Party shall be respected.

ARTICLE 6 - USE OF THE RESULTS

6.1 Each Party may use the results of the collaborative study for the needs of its own research. In accordance with article 9.2 of the Franco-German Convention of 31 March 1958 (JO RF of 19 January 1960 Page 567), the ISL is obliged to provide the results of its work free of charge to the governments of the French Republic and the Federal Republic of Germany. The MND undertakes to foster the execution of this provision by providing user rights to its own intellectual property on fair and reasonable terms.

6.2 In the event of any direct or indirect use of the shared results, the Party using the results undertakes to pay to the other Party the remuneration or royalties defined in the co-ownership agreement.

6.3 Should the exploitation of the shared results by one of the Parties require the use of know-how or patents held prior to the date of this Agreement by the other Party, the Party holding the intellectual property rights shall make all reasonable efforts, without prejudice to any rights conceded to third parties, to foster this exploitation. The rights of usage for any rights held by a Party prior to the date of this Agreement shall be defined on a case by case basis.

Article 7 - LIABILITY

7.1 Each Party shall assume the consequences of any damages caused to its own property and personnel during the execution of the present Agreement, with the exception of instances of negligence committed by the other Party or by the personnel of the other Party.

Article 8 - DENUNCIATION

8.1 The MND and the ISL reserve the right to terminate the present Agreement at any time without the obligation to provide any particular justification.

Article 9 - SETTLEMENT OF DISPUTES

9.1 Any disputes regarding the interpretation or application of this Agreement will be resolved by consultation between the Parties and will not be referred to any national or international tribunal or any other third party for settlement.

In witness whereof this Agreement has been executed this
day of 2005.

For Her Majesty	**For the ISL,**
______________________	______________________
R.W. Walker	IGA D. LITAISE
Assistant Deputy Minister (Science & Technology)	

EDirBWB V. SCHMITT

Date______________________________ Date________________________________

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Bruit impulsif − Techniques de mesure et rendement des dispositifs de protection auditive − Rapport d'échange scientifique à l'Institut franco allemand de recherches de Saint−Louis

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Ann Nakashima; Karl Buck; Pascal Hamery; Gilbert Brom

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(U) Measurements of impulse noise and the performance of several hearing protection devices were made in Saint−Louis and Baldersheim, France sponsored by the French−German Research Institute of Saint−Louis (ISL) in August 2006. Hearing protector performance was evaluated using an acoustic test fixture that was designed by ISL. Impulse noises with peak levels from 110 to 190 dB were produced by detonation of explosives. The noise attenuation achieved by a Peltor communications headset (MT15H68 FB 950) and a Peltor Optime III earmuff was measured alone and in combination with a Bilsom nonlinear earplug (Model 655). The Peltor Optime III provided slightly more attenuation than the communications headset up to about 2 kHz. When used in the combination with the earplug, similar attenuation was achieved for the two devices. A prototype AEARO earplug was also tested in the blast noise, and was found to provide good attenuation at low frequencies when used in the nonlinear mode. The performance of the Nacre QuietPro active earplug system was measured in pink noise of 85, 90 and 95 dB. The device provided good attenuation in the passive mode and adequate protection in the push−to−talk (PTT) modes. It is expected that the work performed will lead to future collaborations between DRDC Toronto and ISL in the area of protection from impulse noise and blasts.

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(U) Impulse noise, blast noise, hearing protection devices

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