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CLASSIFICATION	SYSTEM NUMBER
UNCLASSIFIED	511490

TITLE

Better Hearing Protection Through Electronics

System Number:

Patron Number:

Requester:

Notes:

DSIS Use only:

Deliver to:

OCCUPATIONAL HYGIENE
VOL. 21, NO 4

ASSOCIATION OF ONTARIO
OCTOBER 1998
ISSN #08436088

FORUM

President's Message

I hope everyone had an enjoyable summer.

This fall is shaping up to be busy. The Fall Symposium "Current Topics and Practical Approaches in Occupational Hygiene" will be held on October 22, 1998. The Program Committee is also working on a dinner meeting in the Ottawa area for early October. Mark these dates on your calendar and plan to attend! Your support is vital to the success of these events.

Planning for the Spring Symposium/Annual General Meeting on March 24, 1999 has already started.

The Hugh Nelson Award will be presented at the Spring Symposium/Annual General Meeting again this year. The nomination forms have been sent out with a deadline of October 31, 1998.

Neil Murray and the Local Conference Committee have had a very busy summer working on the AIHCE. Look for an update from Neil in this issue. OHAO is planning to sponsor (with some co-sponsors) a reception during the conference for Canadian delegates. Lorraine Shaw is working on the planning of this event. OHAO is also going to hold a meeting of the Board of Directors' from each Association across Canada during the AIHCE.

At the last Consultation Group meeting, we started mapping out the process for the development of the best practices document. At this time, the Focus Groups were to incorporate the final changes to their documents and send them to OHAO for technical review. The Technical Committee will be taking the lead in the review and preparation of these documents.

The CRBOH tabled a proposal to join our partnership with the Ministry of Labour for the Consultation Process. Initial reaction to this proposal was not favourable. The President of CRBOH, Vice President and Director for Ontario attended our Board Meeting in September and presented their position. After much discussion, the OHAO Board passed a motion to include the CRBOH in the partnership. A Memorandum of Understanding will be prepared to outline the agreement between all three groups in this endeavour. I'll keep you posted on our progress in the next newsletter.

Maryanne Langdon, CIH

Letter from the Editor

This issue of FORUM has something very special. We are starting our campaign on making the American Industrial Hygiene Conference & Exposition—**AIHCE '99** - for short, a resonant success. For us it is an honour and a responsibility to have this capital event held in Toronto. Also, it is very important to OHAO to be the local representative for **AIHCE '99**. You will see the importance we are assigning to this event by the coverage we will have from now until next June 1999, when the conference will take place.

You will notice **TWO NEW COLUMNS** in this issue. One deals with **Health Physics**, something we have not covered in the past. We are happy to announce that Mike Grey is joining the Editorial Team, as the Editor for that particular column.

After several attempts, we have managed to persuade Ugis Beckis to also join the Editorial team. He will be the Editor of the **Hygiene Horizons** column. Ugis is the President of the CRBOH and also sits on the board of the International Occupational Health Association. He will be keeping us informed on current national and international issues.

We are also happy to announce that our regular contributor, Tony Muc, former colleague from Ontario Hydro, has accepted a position with the World Health Organization. As a farewell gift, he is contributing an article on laser safety. More about him in **People on the Move**.

Our Editor has contributed too, with an update on the subject of **Predevelopment Reviews** (PDRs), a hot potato that the Ontario Ministry of Labour passed on to the Association of Professional Engineers of Ontario (APEO) last December. Although there are still more questions than answers, a general picture of what the PDR is and how it should be done, is slowly emerging. Still, although the subject is Health and Safety in the Workplace, there is no official requirement that a H&S professional be involved in the process.

Our **Program Committee** has been very active, as you will find through their announcements: not only the Fall Symposium is on the board, but also the Spring one, as well as an event in Ottawa. To top it all, there are some free tickets for a live TV show that can be obtained, courtesy of the same Committee.

Finally, we would like to announce, that a member of the Editorial Board, **Cathy Tracy**, is a happy new mother! Colin James

continued on page 3

FORUM

OH FORUM

OH Forum is published quarterly by the Occupational Hygiene Association of Ontario, and distributed free of charge to all members.

Deadlines for articles and advertising are as follows:

Issue	Deadline
January	10th of December
April	10th of March
July	10th of June
October	10th of September

Enquiries or suggestions should be directed to:

Editor - OH Forum
c/o OHAO Tel: (905) 567-7196
6519-B Mississauga Road Fax: (905) 567-7191
Mississauga, Ontario L5N 1A6 http://www.ohao.org

Circulation: 500 Vol 21, No 4

The Occupational Hygiene Association of Ontario is an Ontario-based organization whose members are dedicated to the practice of occupational hygiene. Occupational hygiene is concerned with the protection of people's health from hazards arising in or from the workplace.

To develop and promote the profession of occupational hygiene, and to serve the interests of our members by:

- sponsoring professional development, training and research;
- promoting public and legal recognition;
- developing partnerships with stakeholders;

News from the Program Committee

By Monica Szabo, CRSP, ROH, Committee Chairperson

Event: Fall Symposium
Title: Current Topics and Practical Approaches in Occupational Hygiene
Date: October 22, 1998
Where: Black Creek Pioneer Village
Timetable:

7 30 Registration, Continental Breakfast & Vendor Displays
8 15 President's Message, Maryanne Langdon
8 30 Diesel Exhaust: Implications of the Notice of Intended Changes to the ACGIH-TLV; Speaker to be announced
9 15 Noise Control: A Practical Approach; *Tim Kelsall (Hatch Associates)*
10 00 Vendors Displays and Refreshment Break
10 30 Dealing with Mould Contamination: Assessing Health Risks and determining appropriate remedial action; *James Scott (University of Toronto)*
11 15 Discovery, Remediation, and Follow-up of a Major Infestation of Stachybotris, Cladisporium, and Alternaria Mould Growth in an Office Environment; *John Orser (Orser Environmental and Safety)*
12 00 Lunch & Vendor Exhibits
13 00 Metal Working Fluids: Analysis Methods; *Lorraine Shaw (McMaster University)*
13 45 Toner Inhalation Studies; *Peter Zavon (Xerox Corporate Startegic Services)*
14 30 Vendor Display and Refreshments
14 45 Odour Problems:What is that smell?; *Jeanette Campbell (Phoenix OHC Inc.)*
15 30 Behaviour Based Safety/Best Practices: A Case Study; *Paul Hader (Ontario Hydro)*
16 15 Adjournment

Registration fee: Before October 8/98:
Member $125.00+GST=133.75; Non-Member $150.00+GST=$160.50; Student $40.00+ GST= $42.80
After October 8/ 98:
Member $150.00+GST=160.50; Non-Member $175.00+GST=$187.25; Student $50.00+ GST=$53.50

The **Spring Symposium** will be held at Black Creek Pionneer Village on **March 24, 1999**. The half day session will precede the Hugh Nelson Award ceremony and the AGM. In preparation for a hot, hot, hot summer, the topic is "How to Handle Heat Stress" presented by Kevin Shouppe of OSHTECH Inc. The focus of the session will be the impact of the new ACGIH gudielines, learning techniques for determining metabolic workloads and body response to work and Heat Stress Control Programs.

Occupational Hygiene Association of Ontario, **Regional Dinner Meeting, Ottawa.** Thursday, **November 19, 1998,** Gourmet Vitesse, 00 Kitimavik Road (at Davies St), Unit 5, Kanata, Ontario. Application has been made to ABIH and CRBOH for Certification Maintenance Points

Agenda
6:00-6:30 pm Cash Bar
6:30-7:30 pm Dinner
7:30- 8:30 pm Presentation and Questions: "Best Practices", Peter Robson

The presentation will focus on Best Practices in industry, and tying successful health, safety and environment processes into business practices.
Cost: $35.00 cash or cheque at the door

To register, phone, e-mail of fax registration to: Ms. Lydia Renton, EHSS, FMS
Nortel Semiconductors
185 Corkstown Road
Nepean, Ontario K2H 8Y4
Ph: (613) 763-7801 Fax: (613) 763-2328
Email: LNRenton@nortel.com

You must register before noon on Wednesday November 18, 1998

OHAO Program Committee has obtained tickets for taping of the CBC's Royal Canadian Air Farce at the Toronto studios. Tickets are available for OHAO members and spouses/guests for two tapings: **9:00 p.m. to approx 10:30 p.m. Thursday, November 12, 1998; and 9:00 p.m. to approx 10:30 p.m. Thursday, November 19, 1998**

There are twenty tickets available for each taping. Tickets are free of charge and will be given out in pairs to OHAO members. If requests outnumber tickets, they will be awarded by random draw. Requests for tickets must be received by fax or e-mail on or before October 31, 1998. To request tickets or further information, please contact Rob Stoyanoff at: fax (905) 858-4426; e-mail: stoyanoff@goodfell.com; tel (905) 858-4424 x230

People on the Move

Dr. A.M. (Tony) Muc, erstwhile contributor to our newsletter and to our symposia on occupational and environmental health and safety issues associated with non-ionizing radiation is leaving the country! He has just been taken on by the World Health Organization to work as a consultant on their EMF Project and the INTERSUN ultraviolet project. He will, however, remain as accessible as ever through his usual e-mail addresses: or rhsc@idirect.com

He has advised me that he would be happy to receive and respond to any comments, questions or concerns members might have about the WHO's activities and interests in either of the above subjects.

His contract with the WHO is something that does not take us by surprise. Tony has had a distinguished career that started at the Ministry of Labour, before moving to Ontario Hydro. He is also a former member of the ACGIH TLV Physical Agents Committee in the area of non-ionizing radiation. After leaving Ontario Hydro, Tony started his own consulting business.

We wish Tony all the best in his new position and we hope that he will keep us informed on what is going on with his job and with the WHO in Geneva.

The Editor

Wagish Yajaman has recently joined the Central Region of the IAPA as Senior Technical Consultant. He replaces Peter Schafer who has gone on to pursue his degree in medicine. Wagish previously worked as an IAPA Health and Safety Consultant in Windsor over the past 2½ years. He will be providing technical services in the Central Region covering Brampton, Mississauga, and some of the near north areas such as Barrie, Orillia and Owen Sound.

Letter from the Editor... continued from page 1

Tracy-Foster, 9 lbs 13 oz, presented himself in the early morning hours of August 8th. We wish Cathy all the happiness in the world and, also, as few as possible sleepless nights...

Alberto Behar, P.ENG., CIH

Noisy News

Column Editor
Alberto Behar, P.Eng., CIH
A. Behar Noise Control

Nine Years Old!

Gary Harris

reprinted with permission from Spectrum. Vol 15 (3), published by The National Hearing Conservation Association, Denver, CO.

This is a pep talk about our national education efforts. This is a true story about a nine-year-old girl— call her Janie.

Janie was referred to me because the school system hearing screening program detected some "difficulties" at 4kHz. Janie's history information was unremarkable. There was no family history of hearing loss, no tinnitus, no dizziness, no health problems, no unusual childhood diseases and only a few ear infections when she was much younger.

My childhood case history form does not ask about noise exposure and I had not even considered the possibility of overexposure to noise. However, the following is an excerpt from the conversation I had with Janie and her mother following the evaluation:

Me to Parent: "I'm assuming that there is no noise exposure, such as from chain saws, firecrackers, tractors, guns or other such things."
Parent: "Oh... well, she shoots some with her father and brother, but not very often— once a week at the most. She'd shoot more if she could." (Janie is now shaking her head in agreement.)
Me to Janie: "What kind of gun do you shoot?"
Janie: "I don't know— short ones like this." (She spreads her hands about 12 inches apart).
Parent: "A pistol.:
Janie: "...and long ones. Some you have to pull back the hammer like this; some you just have to pull the trigger."
Me to Parent: "Firearm noise can certainly affect hearing. You've had the experience of shooting a gun and your ears ringing afterwards." (Janie, with widened eyes, is now enthusiastically shaking her head in agreement.)

One should not make assumptions about who may, and who may not, be overexposed to noise. Whether or not Janie's hearing loss is from firearm noise, she needs to change her ways and, at a minimum, start using hearing protection devices. Absent from some future cure, the hearing loss she now has will always be with her, giving her a head start toward significant auditory difficultuies.

Even though our message about noise and hearing may be simple, we should not be deterred from carrying that message to parents, sons, daughters, teachers and the media.

Better Hearing Protection through Electronics

R. Brian Crabtree, P.Eng.

The Defence and Civil Institute of Environmental Medicine (DCIEM), is one of several National Defence laboratories addressing the current needs of military and civilian populations. DCIEM is recognized as Canada's centre of expertise in human factors research, which studies the integration of the human in technical environments. The mission of the Noise and Communications Group (NCG) at DCIEM is to enhance communications and reduce the incidence of hearing loss through the application of modern technology.

Conventional "passive" earmuff-style hearing protectors cause noise to sound unnaturally muffled and "boomy" at the ear of the wearer. This perception of filtering is the result of high-frequency sound being attenuated more efficiently than sound at low frequencies. Larger, heavier ear shells improve low-frequency performance and sound quality, but only at the expense of user comfort and acceptability.

Active Noise Reduction, or ANR, is a technique for reducing low-frequency noise at the ear through the action of interfering sound waves. Sound within the ear shell resulting from an external noise field is sensed by a miniature microphone. The resulting signal is filtered and amplified, then reintroduced into the ear shell by a miniature loudspeaker producing sound which is out of phase with the disturbing noise. The net result is a partial cancellation of sound at frequencies up to about 1000 Hz, thus augmenting attenuation over the range of frequencies where passive protectors are least effective.

ANR hearing protectors can provide an immediate solution for reducing noise exposure in certain high-noise environments. Users will also find it easier to discriminate speech or to detect warning sounds, since ANR suppresses noise which interferes with these tasks. Of the dozen or more commercial ANR devices currently on the market, most are over-the-ear headsets which contain analog *feedback* circuitry to reduce low-frequency noise by a fixed amount. Most also have wired communications capability for use in voice-critical environments.

DCIEM has proposed a series of performance measures for predicting whether a given ANR system will perform well in a given environment. An important characteristic is the *expected attenuation* obtainable during use, an example of which is shown graphically in Figure 1. Such data indicate the quality of passive attenuation and fitting (with ANR Off), the overall active mode attenuation (with ANR On) and the magnitude and frequency range of electronic assist (the difference between the spectra). When the expected attenuation is combined with noise data taken from an intended environment, one can model or predict the *at-ear levels* achievable within that environment, as shown in Figure 2.

DCIEM and the National Research Council of Canada have recently undertaken a collaborative effort to overcome some of the limitations of analog ANR technology. These include diminished effectiveness due to fitting anomalies as well as electro-mechanical constraints and instability. Using a novel design approach, a prototype ANR system based on *digital signal processing* technology has been demonstrated. The system employs an additional microphone located on the outside of the ear shell and *feedforward* signal processing. When energized, the digital ANR system emulates a preprogrammed "target" spectrum at the ear through successive calculations of the difference between the target and actual at-ear spectra, until the difference between them is negligible. Thus the digital system converges to the target spectrum, rather than simply reducing the disturbing noise field by a fixed amount. Because of its unique "adaptive" nature, the digital ANR system is inherently tolerant of fitting anomalies and particularly efficient at reducing noise with strong tonal content, such as the rotor noise encountered in helicop-

ters. Figure 3 illustrates the enhanced effectiveness of the digital system in reducing low-frequency noise.

With multi-national patents pending, this technology was showcased to industry at an open house hosted by DCIEM in April 1998, to encourage commercial development and marketing under license. To date, four companies have expressed an interest in pursuing this opportunity.

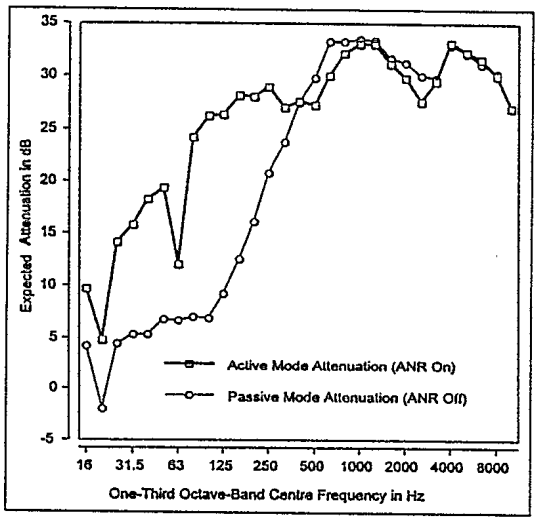
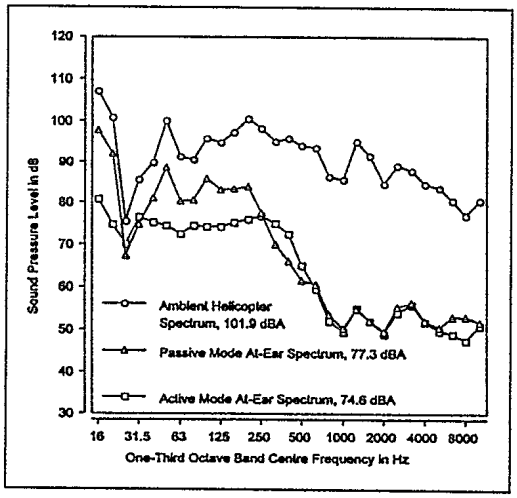


Figure 1. Expected Attenuation of Typical ANR System.
The "actual" attenuation of the device was measured using the Microphone-In-Real-Ear (MIRE) technique for 3 fits on 5 human subjects at both ears (n=30). The "expected" attenuation was then calculated as the mean values of actual attenuation less one standard deviation. This derating procedure is commonly used to account for fitting variations encountered in actual use.

Figure 3. Performance of Digital ANR System in Helicopter Noise
The at-ear data shown below resulted from an in-situ MIRE measurement made on a human subject in helicopter noise which was reproduced in DCIEM's Noise Simulation Facility. In this instance, the target spectrum programmed into the system was a constant level of 75 dB below 250 Hz. Note the closeness of the active mode spectrum to the target. At 16 Hz (the primary rotor blade pass frequency of the helicopter) the attenuation achieved was about 16 dB greater than that of the analog ANR system (see Figure 2). The A-weighted equivalents of these spectra are given in the legend.



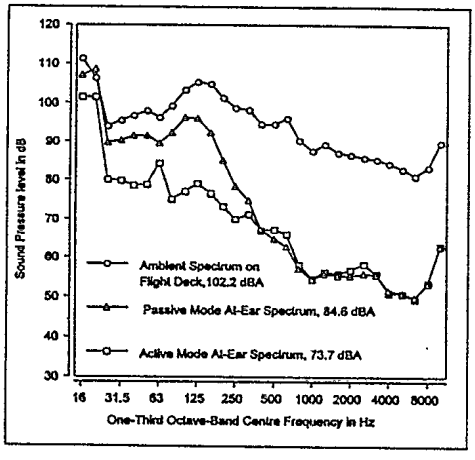


Figure 2. Predicted At-Ear Levels in Large Helicopter with ANR
This graph is a model of at-ear sound levels with analog ANR in noise, obtained by subtracting the expected attenuation data for the headset given in Figure 1 from the ambient noise spectrum of the helicopter shown above. The A-weighted equivalents are given in the legend.

As head of the NCG, Mr. Crabtree has worked closely with government and industry for many years in finding workable solutions to problems cause by exposure to noise, and has authored numerous related reports and articles. He is a member of the CSA Z94 classification sub-committee for hearing protector standards and NATO RSG.29 that is revising hearing damage risk criteria for impulse noise. Current research activities include active noise control and three-dimensional sound imaging. He also maintains strong interests in music and music reproduction.

MAPLE LEAF
FEUILLE D'ÉRABLE

16 JUNE / 16 JUIN 1999 VOL. 2, NO. 11

Peace bound for Balkans, 500 more troops committed

By Mitch Gillett

Canada committed 500 more ground troops on June 11, bringing the total to 1300, for peace implementation in Kosovo, the day after NATO announced the suspension of the air assault on Yugoslavia. Most of the additional personnel will come from 1 PPCLI, Edmonton Garrison.

"The functions they will perform there, of course, are to create a secure environment for the Kosovar refugees ... to be able to return to their homes," said Minister of National Defence Art Eggleton.

A Military Technical Agreement was signed June 9 after several long bargaining sessions and 78 days of sustained NATO bombing in Yugoslavia. The agreement is designed to clear the way for hundreds of thousands of Kosovar refugees, including some 5544 in Canada, to return to their homes.

Minister Eggleton reiterated Canada's commitment to the anticipated peace-implementation process in

Continued on page 2

Photo: Walter Tychnowicz, Edmonton Sun

Minister of National Defence Art Eggleton shakes hands with MCpl Giberson in Edmonton on June 7 as troops get set to leave for Macedonia.

Le ministre de la Défense nationale, Art Eggleton, serre la main du cplc Giberson au moment du départ des troupes d'Edmonton pour la Macédoine le 7 juin.

Paix dans les Balkans: 500 fantassins de plus

par Mitch Gillet

Le 11 juin, lendemain de l'annonce de l'OTAN concernant la suspension des attaques au-dessus de la Yougoslavie, le Canada s'est engagé à envoyer 500 fantassins de plus, pour un total de 1300, pour mettre en œuvre le processus de paix au Kosovo. La majorité du personnel additionnel proviendra de la 1 PPCLI, garnison d'Edmonton.

« Ils auront évidemment pour mandat de créer là-bas un environnement sécuritaire pour que les réfugiés kosovars ... puissent retourner chez eux », a expliqué le ministre de la Défense nationale, Art Eggleton.

Un accord militaire technique a été signé le 9 juin après de longues séances de négociation et 78 jours de bombardements soutenus de l'OTAN en Yougoslavie. L'accord est destiné à préparer la voie au retour à la maison de centaines de milliers de réfugiés kosovars, notamment les 5544 qui se trouvent au Canada.

Suite à la page 2

From Edmonton to Sveti Nikole

Op KINETIC *troops go to Macedonia*

By Capt Mike Audette

The training was complete, the waiting was over. Any anxiety over leaving loved ones behind was about to be replaced with the anticipation and reality of *Operation KINETIC* in the southern Balkan region of Macedonia and Kosovo.

With a handful of specialized staff already in Macedonia, an advance party of roughly 140 troops, led by Colonel Mike Ward, Canadian Contingent Commander, Task Force Kosovo, lifted off from Edmonton on May 27, focussed on their destination and the work that lay ahead.

Continued on page 2

D'Edmonton à Sveti Nikole

Les soldats de l'Op Kinetic *en Macédoine*

par le capt Mike Audette

L'instruction est terminée, l'attente aussi. L'inquiétude du départ et le regret de quitter des êtres chers vont bientôt faire place à l'attente et à la réalité de l'Op *Kinetic* dans le secteur sud des Balkans, en Macédoine et au Kosovo.

Quelques membres du personnel spécialisé sont déjà sur place quand le groupe précurseur, environ 140 soldats sous le commandement du col Mike Ward, commandant du contingent canadien de la Force opérationnelle du Kosovo, quitte Edmonton le 27 mai, entièrement préoccupé de sa mission.

Suite à la page 2

This issue: CF Personnel Newsletter and Safety Digest inserts
Dans ce numéro : le Bulletin du personnel et le Digest de Sécurité

National Defence / Défense nationale

Canada

Better Hearing Protection through Electronics

The mission of the Noise and Communications Group (NCG) at DCIEM is to enhance communications and reduce the incidence of hearing loss through the application of modern technology.

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DCIEM has proposed a series of performance measures for predicting whether a given ANR system will ►

R. Brian Crabtree, P.Eng.
Human Engineering Section
DCIEM

R. Brian Crabtree, ing.
Section de l'ergonomie
IMCME

Meilleure protection auditive grâce à l'électronique

Le Groupe du bruit et des communications (GBC) de l'IMCME a pour mission d'améliorer les communications et de réduire les risques de perte auditive, par le recours à la technologie moderne.

Avec un casque antibruit classique, le bruit semble artificiellement étouffé aux oreilles de la personne. Cette perception de filtrage résulte de l'atténuation plus efficace des sons haute fréquence que des sons basse fréquence. Les casques plus grands et plus lourds offrent un meilleur rendement en basse fréquence et une meilleure qualité du son, mais seulement aux dépens du confort et de l'acceptabilité de l'utilisateur.

La technique de la réduction active du bruit (RAB) consiste à atténuer le bruit basse fréquence perçu par l'oreille au moyen d'ondes sonores parasites. Ainsi, un microphone miniature, disposé à l'intérieur de la chambre acoustique du casque, capte le son (produit par une source externe). Le signal généré est filtré et amplifié, puis réintroduit dans la chambre acoustique par un haut-parleur miniature qui émet un son déphasé par rapport au bruit externe. Il en résulte une annulation partielle du son à des fréquences maximales d'environ 1 000 Hz, améliorant ainsi l'atténuation sur la plage de fréquences où le casque passif est le moins efficace.

Le casque à RAB procure une solution immédiate afin de réduire le bruit dans certains milieux bruyants. L'utilisateur perçoit aussi mieux la parole et les signaux sonores d'avertissement, étant donné que la RAB supprime le bruit qui interfère avec ces sons. De la dizaine ou plus de dispositifs commerciaux offerts sur le marché, la plupart sont des casques qui contiennent un circuit de réaction analogique destiné à réduire d'un certain pourcentage le bruit basse fréquence. La plupart disposent également d'une fonction de communications câblées adaptée aux milieux où la voix est essentielle.

L'IMCME a proposé des mesures de rendement pour déterminer quel ►

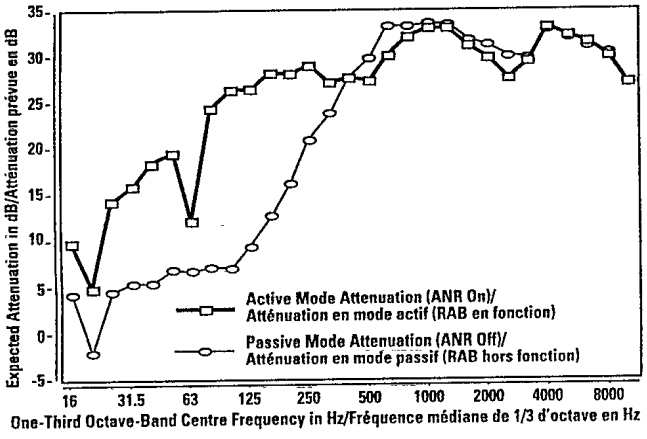

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Figure 1. Atténuation prévue d'un dispositif à RAB type.
L'atténuation réelle du dispositif a été mesurée au moyen de la technique du microphone dans l'oreille aux deux oreilles de cinq personnes selon trois ajustements (n=30). On a ensuite calculé l'atténuation prévue sous forme de valeurs moyennes de l'atténuation réelle moins l'écart normal. Ce facteur de réduction sert en général à tenir compte des divers ajustements possibles lors de l'utilisation réelle.

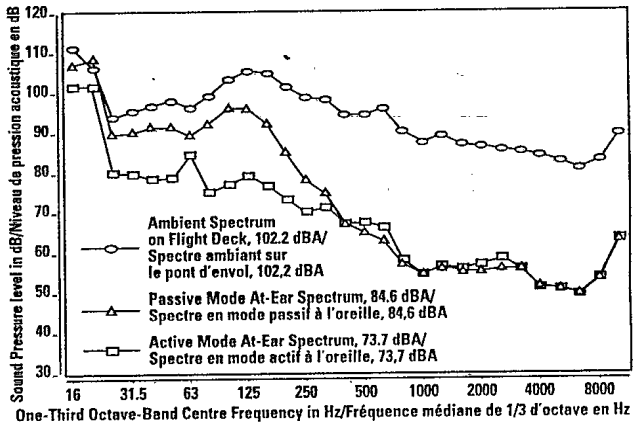

Figure 2. Predicted At-Ear Levels in Large Helicopter with ANR.
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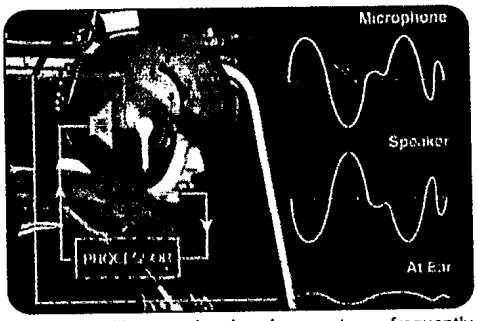
Figure 2. Niveaux prévus à l'oreille dans un grand hélicoptère avec la RAB.
Le présent graphique illustre le modèle des niveaux sonores à l'oreille avec la RAB analogique, obtenu par la soustraction de l'atténuation prévue du casque, donnée à la figure 1, du spectre de bruit ambiant d'un hélicoptère, illustré ci-dessus. La légende fait état des équivalents à pondération A.



CF personnel in operational environments are frequently exposed to noise levels that can interfere with communications or potentially damage hearing. Active noise reduction (ANR) reduces noise exposure through the action of interfering sound waves. Noise within the ear shell of a headset or helmet is processed electronically and fed back out of phase, causing a net cancellation of noise at the ear. ANR research at DCIEM provides a Canadian testing and resource centre in which developments in ANR technology can be monitored and promoted.

Les membres des FC à l'oeuvre dans des milieux opérationnels sont souvent exposés à des niveaux de bruit qui peuvent perturber les communications ou endommager l'ouïe. La réduction active des bruits (RAB) atténue le bruit ambiant sous l'action d'ondes sonores parasites. Le bruit à l'intérieur de la chambre acoustique d'un casque fait l'objet d'un traitement électronique qui le déphase pour ainsi l'annuler à l'oreille. La recherche sur la RAB réalisée à l'IMCME a permis de faire de ce dernier un centre canadien d'essais et de ressources qui suit les progrès de la technologie de la RAB et en fait la promotion.

CF personnel, especially those in artillery, infantry, armour and related trades, can sustain hearing loss as a result of occupational noise exposure. This can be costly in both human and financial terms. As an advisor to the Surgeon General, DCIEM studies and implements ways of reducing exposure to noise while maintaining operational effectiveness. Working closely with field units, DCIEM is involved in many aspects of noise measurement and analysis, noise control, and psycho-acoustics.

Les membres des FC, surtout ceux affectés à l'artillerie, à l'infanterie, aux blindés et aux métiers connexes, risquent de perdre leur ouïe en raison de leur exposition au bruit dans le cadre de leur profession. Cette perte peut se révéler coûteuse tant sur le plan humain que sur le plan financier. À titre de conseiller du chef – Services de santé, l'IMCME étudie et met en pratique des méthodes permettant de réduire l'exposition au bruit tout en maintenant une efficacité opérationnelle. Par une collaboration étroite avec les unités en campagne, l'IMCME oeuvre à de nombreux aspects de la mesure, de l'analyse et du contrôle du bruit, ainsi que de la psychoacoustique.

perform well in a given environment. An important characteristic is the expected attenuation obtainable during use, an example of which is shown graphically in Figure 1. Such data indicate the quality of passive attenuation and fitting (with ANR Off), the overall active mode attenuation (with ANR On) and the magnitude and frequency range of electronic assist (the difference between the spectra). When the expected attenuation is combined with noise data taken from an intended environment, one can model or predict the at-ear levels achievable within that environment, as shown in Figure 2.

DCIEM and the National Research Council of Canada have recently undertaken a collaborative effort to overcome some of the limitations of analog ANR technology. These include diminished effectiveness due to fitting anomalies as well as electro-mechanical constraints and instability. Using a novel design approach, a prototype ANR system based on *digital signal processing* technology has been demonstrated. The system employs an additional microphone located on the outside of the ear shell and *feedforward* signal processing. When energized, the digital ANR system emulates a preprogrammed "target" spectrum at the ear through successive calculations of the difference between the target and actual at-ear spectra, until the difference between them is negligible. Thus the digital system converges to the target spectrum, rather than simply reducing the disturbing noise field by a fixed amount. Because of its unique "adaptive" nature, the digital ANR system is inherently tolerant of fitting anomalies and particularly efficient at reducing noise with strong tonal content, such as the rotor noise encountered in helicopters. Figure 3 illustrates the enhanced effectiveness of the digital system in reducing low-frequency noise.

With multinational patents pending, this technology was showcased to industry at an open house hosted by DCIEM in April 1998 to encourage commercial development and marketing under license. To date, four companies have expressed an interest in pursuing this opportunity. ✠

dispositif à RAB convient le mieux à un milieu donné. Un facteur important est l'atténuation prévue durant l'utilisation, comme le démontre le graphique de la figure 1. Les données font état de la qualité de l'atténuation dans un dispositif passif (RAB hors fonction), de l'atténuation active dans l'ensemble (RAB en fonction) ainsi que de l'amplitude et de la plage de fréquences de l'aide électronique (la différence entre les spectres). Lorsque l'on combine l'atténuation prévue avec les données de bruit tirées d'un milieu, il est possible de modéliser ou de prévoir les niveaux sonores que percevra l'oreille dans ce milieu, comme l'illustre la figure 2.

L'IMCME et le Conseil national de recherches du Canada ont récemment entrepris un projet conjoint dans le but de surmonter certaines des limites de la technologie RAB analogique, dont la réduction de l'efficacité en raison des anomalies du casque, des contraintes et de l'instabilité électromécaniques. À partir d'une conception innovatrice, on a produit le prototype d'un dispositif à RAB reposant sur le *traitement des signaux numériques*. Le dispositif comporte un second microphone, externe celui-là, et recourt au traitement des signaux à *correction aval*. Lorsque le dispositif à RAB numérique est mis sous tension, il émule un spectre cible préprogrammé à l'oreille selon une suite de calculs de la différence entre la cible et le spectre réel à l'oreille, jusqu'à ce que la différence devienne négligeable. Le circuit numérique converge donc vers le spectre cible, au lieu de simplement réduire le bruit parasite d'un taux fixe. En raison de sa nature adaptative distincte, le dispositif à RAB numérique tolère de manière inhérente les anomalies du casque et est particulièrement efficace pour réduire le bruit à forte teneur tonale, comme le bruit d'un rotor d'hélicoptère. La figure 3 illustre l'efficacité du circuit numérique à réduire le bruit basse fréquence.

Cette technologie, en attente de brevets multinationaux, a été présentée au secteur privé lors d'une journée portes ouvertes commanditée par l'IMCME en avril 1998 pour encourager le développement commercial et la commercialisation sous licence. Jusqu'à maintenant, quatre sociétés ont démontré de l'intérêt à cette technologie. ✠

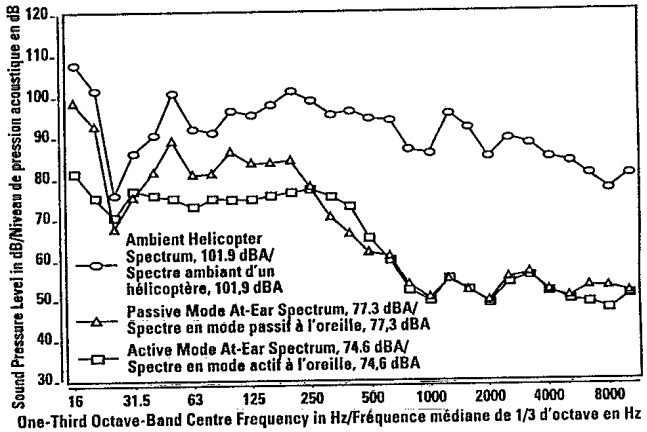


Figure 3. Performance of Digital ANR System in Helicopter Noise.
The at-ear data shown above resulted from an in-situ MIRE measurement made on a human subject in helicopter noise which was reproduced in DCIEM's Noise Simulation Facility. In this instance, the target spectrum programmed into the system was a constant level of 75 dB below 250 Hz. Note the closeness of the active mode spectrum to the target. At 16 Hz (the primary rotor blade pass frequency of the helicopter) the attenuation achieved was about 16 dB greater than that of the analog ANR system (see Figure 2). The A-weighted equivalents of these spectra are given in the legend.

Figure 3. Rendement du dispositif à RAB numérique avec le bruit d'un hélicoptère.
Les données de perception à l'oreille illustrées ci-dessus ont été obtenues sur place dans le cadre de mesures selon la technique du microphone dans l'oreille sur une personne oeuvrant dans un bruit d'hélicoptère, reproduit dans la chambre de simulation des bruits de l'IMCME. Dans le cas présent, le spectre cible programmé dans le système affichait un niveau constant de 75 dB à une fréquence inférieure à 250 Hz. Remarquer la proximité du spectre en mode actif par rapport à la cible. À 16 Hz (la fréquence de rotation des pales du rotor principal de l'hélicoptère), l'atténuation obtenue était d'environ 16 dB supérieure à celle du dispositif à RAB analogique (consulter la figure 2). La légende fait état des équivalents à pondération A de ces spectres.

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