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RESEARCH AND TECHNOLOGY ORGANISATION

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RTO EDUCATIONAL NOTES **EN-HFM-111**

Personal Hearing Protection including Active Noise Reduction

(Les dispositifs de protection de l'ouie, y compris l'atténuation du bruit actif)

The material in this publication was assembled to support a Lecture Series under the sponsorship of the Human Factors and Medicine Panel (HFM) presented on 25-26 October 2004 in Warsaw, Poland; 28-29 October 2004 in Brussels, Belgium; and 9-10 November 2004 in Virginia Beach, VA, USA.

Published June 2005

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The Research and Technology Organisation (RTO) of NATO

RTO is the single focus in NATO for Defence Research and Technology activities. Its mission is to conduct and promote co-operative research and information exchange. The objective is to support the development and effective use of national defence research and technology and to meet the military needs of the Alliance, to maintain a technological lead, and to provide advice to NATO and national decision makers. The RTO performs its mission with the support of an extensive network of national experts. It also ensures effective co-ordination with other NATO bodies involved in R&T activities.

RTO reports both to the Military Committee of NATO and to the Conference of National Armament Directors. It comprises a Research and Technology Board (RTB) as the highest level of national representation and the Research and Technology Agency (RTA), a dedicated staff with its headquarters in Neuilly, near Paris, France. In order to facilitate contacts with the military users and other NATO activities, a small part of the RTA staff is located in NATO Headquarters in Brussels. The Brussels staff also co-ordinates RTO's co-operation with nations in Middle and Eastern Europe, to which RTO attaches particular importance especially as working together in the field of research is one of the more promising areas of co-operation.

The total spectrum of R&T activities is covered by the following 7 bodies:

- AVT Applied Vehicle Technology Panel
- HFM Human Factors and Medicine Panel
- IST Information Systems Technology Panel
- NMSG NATO Modelling and Simulation Group
- SAS Studies, Analysis and Simulation Panel
- SCI Systems Concepts and Integration Panel
- SET Sensors and Electronics Technology Panel

These bodies are made up of national representatives as well as generally recognised 'world class' scientists. They also provide a communication link to military users and other NATO bodies. RTO's scientific and technological work is carried out by Technical Teams, created for specific activities and with a specific duration. Such Technical Teams can organise workshops, symposia, field trials, lecture series and training courses. An important function of these Technical Teams is to ensure the continuity of the expert networks.

RTO builds upon earlier co-operation in defence research and technology as set-up under the Advisory Group for Aerospace Research and Development (AGARD) and the Defence Research Group (DRG). AGARD and the DRG share common roots in that they were both established at the initiative of Dr Theodore von Kármán, a leading aerospace scientist, who early on recognised the importance of scientific support for the Allied Armed Forces. RTO is capitalising on these common roots in order to provide the Alliance and the NATO nations with a strong scientific and technological basis that will guarantee a solid base for the future.

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Personal Hearing Protection including Active Noise Reduction

(RTO-EN-HFM-111)

Executive Summary

Personal hearing protection and speech communication facilities are essential for optimal performance in military operations. High noise levels increase the risk of noise induced hearing loss and deterioration of communications. For many years passive hearing protection (earmuffs and earplugs) was used to reduce the noise dose exposure to personnel. Nowadays electronic systems, based on active noise reduction, have been used to *improve* the performance of personal hearing protection and speech communications.

In this lecture series, criteria for adequate hearing protection, the state-of-the-art of passive and active systems, the assessment and applications are discussed. The lecture series consists of five lectures and a concluding panel discussion:

- Introduction (Dr. H.J.M. Steeneken)
- Hearing and hearing protection (Dr. A. Dancer)
- Passive hearing protectors and their performance (Mr. R. McKinley)
- Active hearing protection systems and their performance (Dr. K. Buck)
- Assessment and standardization (Dr. H.J.M. Steeneken)
- Applications: overview of military noises, insertion loss, prediction of performance (Miss. S. James)
- Final panel discussion (all lecturers)

The lecture series took place in three countries: Poland (Warsaw at CIOP, 25-26 October 2004), Belgium (Brussels at the Royal Military Academy, 28-29 October 2004), and the United States (Virginia Beach, Virginia, Courtyard by Marriott, 9-10 November 2004).

Les dispositifs de protection de l'ouie, y compris l'atténuation du bruit actif

(RTO-EN-HFM-111)

Synthèse

Les dispositifs de protection de l'ouie et les équipements de communication vocale sont indispensables à l'obtention de performances optimales lors des opérations militaires. Des niveaux de bruit élevés font accroître le risque de perte de l'audition due au bruit, ainsi que de la dégradation des communications. Pendant de nombreuses années, les dispositifs de protection passive de l'ouie (les protecteurs d'oreille et les bouchons d'oreille) étaient utilisés pour réduire les doses de bruit auxquels le personnel était exposé. Aujourd'hui, des systèmes électroniques, basés sur la réduction active du bruit, sont utilisés pour *améliorer* les performances des dispositifs de protection de l'ouie, ainsi que celles des communications vocales.

Ce cycle de conférences porte sur les critères à établir pour assurer une protection adéquate de l'ouie, les performances des systèmes actifs et passifs, l'évaluation, et les applications. La présentation consiste en 5 communications, suivies d'une table ronde :

- Introduction (Dr. H.J.M. Steeneken)
- L'ouie et la protection de l'ouie (Dr. A. Dancer)
- Les dispositifs de protection passive de l'ouie et leurs performances (M.R. McKinley)
- Les systèmes de protection active de l'ouie et leurs performances (Dr. K. Buck)
- Evaluation et normalisation (Dr. H.J.M. Steeneken)
- Applications: aperçu des bruits militaires, des pertes d'insertion, et de la prévision des performances (Mlle S. James)
- Table ronde (l'ensemble des conférenciers)

Le Cycle de conférences a été organisé dans trois pays : la Pologne (à Varsovie au CIOP les 25 et 26 octobre 2004), la Belgique (à Bruxelles à l'Académie Royale Militaire les 28 et 29 octobre 2004), ainsi qu'aux Etats-Unis (à Virginia Beach, dans la Virginie, au Courtyard by Marriott les 9 et 10 novembre 2004).

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Hearing protective devices	Noise reduction	Voice communication

14. Abstract

Personal hearing protection and speech communication facilities are essential for optimal performance in military operations. High noise levels increase the risk of noise induced hearing loss and deterioration of communications.

These proceedings from a lecture series on hearing protection and speech communication discuss the state-of-the-art of these topics.

This includes:

- The physiological effects in the ear due to a high noise exposure and criteria for an adequate protection
- The construction and performance of passive hearing protectors (isolation of noise)
- Active hearing protectors (electronic generation of anti noise)
- Optimal design or selection of systems by various assessment methods
- Realistic examples of military applications

The lecture series were held in Poland, Belgium, and the USA.

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