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acoustics and noise control in canada

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l'acoustique et la lutte antibruit au canada

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THE CANADIAN ACOUSTICAL ASSOCIATION

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The Canadian Acoustical Association
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Articles in English and French are welcome, and should be addressed to any editor.

Vous êtes invités a soumettre des articles en français ou en anglais. Prière de les envoyer a un des rédacteurs.

EDITORIAL

A reminder to our readers that the Canadian Acoustical Association Annual Symposium will be held this year at the Chateau Lacombe Hotel in Edmonton, Alberta, on October 8 and 9. This Symposium provides an excellent opportunity to meet individuals concerned with acoustics and related fields from across Canada and elsewhere, enabling useful discussions of mutual concerns and current noise problems. Immediately preceding the Symposium, on October 5, 6 and 7, two three-day courses on noise control are being planned, one for environmental noise and one for machinery noise. Detailed information on these meetings can be found on page 4 of this issue. Looking forward to seeing you there!

EDITORIAL

Nous voudrions rappeler à nos lecteurs que le Symposium Annuel de l'Association Canadienne de l'Acoustique aura lieu cette année du 8 au 9 octobre au Château Lacombe à Edmonton, en Alberta. Ce symposium offre une excellente occasion de rencontrer des personnes, venant du Canada et d'autres pays, intéressées à l'acoustique et à des domaines associés. Ces rencontres pourraient donner lieu aux discussions d'intérêt mutuel et aux échanges d'informations. Avant le symposium, du 5 au 7 octobre, deux cours parallèles seront offerts au sujet de la lutte antibruit, un sur le bruit de l'environnement, et l'autre sur le bruit de machines. Pour plus de renseignements sur ces deux cours, voir page 4. A bientôt à Edmonton!

Nota: nous nous excusons des fautes de frapper dans l'éditorial du dernier numéro.

CSA ACOUSTICS AND NOISE CONTROL COMMITTEE ANNUAL MEETING

The Annual Meeting of the Canadian Standards Association Technical Committee Z107 on Acoustics and Noise Control will be held on Wednesday, October 7, 1981 at 9:00 a.m. in the Chateau Lacombe Hotel, Edmonton, in conjunction with the CAA Annual Meeting. It is expected that several subcommittees will meet on October 5 or 6, also in the same hotel.

INDEXING

We are pleased to report that "Acoustics and Noise Control in Canada", is now indexed in the following publications: - Acoustics Abstracts (UK ISSN 0001-4974), Noise and Vibration Bulletin (UK ISSN 0029-0947), Noise Pollution Publications Abstracts, Union List of Scientific Serials in Canadian Libraries (ULSSCL), and Ulrichs International Periodicals Directory.

If readers are aware of other publications in which "Acoustics and Noise Control in Canada", could usefully be indexed, please write with details to the Editor-in-Chief.

NEW RESEARCH CONTRACTS

To University of Sherbrooke, Sherbrooke, Que., $202,556 for "Development and construction of an acoustic microscope prototype". Awarded by National Research Council.

To Roy Ball Ass. Ltd., Ottawa, Ont., $99,978 for "Software development system - bottom echo recorder". Awarded by the Department of Energy, Mines and Resources.

To Biokinetics and Associates Ltd., Ottawa, Ont., $10,000 for "Design and development of a bomb disposal unit helmet". Awarded by the Royal Canadian Mounted Police.

To Canadian Instrumentation and Research Ltd., Mississauga, Ont., $31,348 for "Design, fabrication and testing of portable bulk acousto-optic radar receiver". Awarded by the Department of National Defence.

To Arctec Canada Ltd., Kanata, Ont., $208,000 for "Installation of instruments for ice-induced vibration measurements aboard the United States Coast Guard Carrier 'Polar Sea' and the development of a model for the ice breaking excitation forces". Awarded by the Department of Transport.

To Supratec Inc., Trois Rivières, West Que. $117,611 for "Development and fabrication of a laboratory prototype of an ultrasonic holographic motion picture camera". Awarded by the National Research Council.

To Human Computing Resources Corporation, Toronto, Ont., $79,565, for "Development of an audio-signal composition system". Awarded by the Department of National Defence.

To Dr. C.A. Ward, Dept. of Mechanical Engineering, University of Toronto, Toronto, Ont., $67,375 for "Study of the mechanisms involved in inner ear damage resulting from rapid decompression". Awarded by the Department of National Defence.

To Canadian Instrumentation and Research Ltd., Mississauga, Ont., $81,853 for "Development of an experimental fibre optic hydrophone". Awarded by the Department of National Defence.

To Vemco, Armdale, N.S., $2,945 for "Development of miniature ultrasonic transmitters for fish tracking". Awarded by the Department of Fisheries and Oceans.

NEWS

ONTARIO MINISTRY OF LABOUR MEETING

The Ontario Ministry of Labour is holding a series of meetings on proposed changes to the Occupational Health and Safety Act, 1978. The meeting on the proposed noise regulation under this Act is scheduled for June 23, 1981. The Ministry has invited all those who submitted comments to attend the Ministry presentation of its analysis of submissions and proposed amendments, and to give their comments.

ASTM E-33 MEETING REPORT

The intention to withdraw ASTM Test Method C 643-76 for "Change in Acoustical Asorption of Ceiling Materials due to Repainting" was announced at the meetings of American Society for Testing and Materials (ASTM) Committee E-33 on Environmental Acoustics at the El Tropicano Hotel in San Antonio, Texas, April 20-22.

The Committee voted to withdraw Test Method C 643 because a survey of independent and industrial laboratories indicated that it is not used and there is no interest in retaining it.

According to ASTM regulations a withdrawn standard will be published for one additional year in the ASTM Book of Standards along with a note that it has been withdrawn. Thereafter, the title, scope, and date of withdrawal will be published for an additional five years.

Committee E-33 also announced the adoption of Standard Practices E 795-81 for "Mounting Test Specimens During Sound Absorption Tests" by the ASTM Committee on Standards. These practices redefine the mountings established by the Acoustical Materials Association (AMA), which no longer exists.

Tentative Practice E 597-77T for "Determining a Single-number Rating of Airborne Sound Isolation for use in Multiunit Building Specifications" will be sent to ASTM Society Letter Ballot for advancement to a full standard with minor revisions. E 597 is recommended for use in multifamily dwellings, single and double patients' rooms in hospitals, motel or hotel rooms, and small offices.

Three new task groups, on Spatial and Temporal Measurement of Masking

Noise, Insertion Loss of Noise Control Panels, and Field Measurement of Impact Sound Transmission, were formed during the meetings.

The Task Group on Spatial and Temporal Measurement of Masking Noise will develop a standard method to measure masking noise in open plan offices in order to determine whether it satisfies specifications.

The Task Group on Insertion Loss of Noise Control Panels will determine how to measure the added sound insulation provided when noise control panels are applied to heavy steel housings and ductwork in power plants and similar installations.

The Task Group on Field Measurement of Impact Sound Transmission will develop a standard field test to measure the impact sound transmission of floor-ceiling systems installed in existing buildings.

A list of all Committee E-33 Task Groups and their activities can be obtained from J.A. Thomas, ASTM, 1916 Race Street, Philadelphia, Pennsylvania 19103, U.S.A., Telephone: 215/229-5498.

The next meeting of Committee E-33 will be in Dearborn, Michigan, October 19-21, 1981. Visitors are welcome and can obtain further information about the meeting from Mr. Thomas.

SHORT COURSES IN ACOUSTICS AND VIBRATION

"12th Annual Industrial Product Noise Control", Union College, Graduate Studies and Continuing Education, Wells House, 1 Union Avenue, Schenectady, N.Y. 12308, U.S.A. Tel: (518) 370-6288.

"Machinery Vibration V Seminar", 3-5 November 1981, Sheraton Naperville, Naperville, Illinois, and "Balancing of Rotating Machinery Seminar", The Shamrock Hilton, Houston, Texas. Contact: The Vibration Institute, 101 W. 55th Street, Clarendon Hill, IL, 60514, U.S.A., Tel: (312) 654-2254.

ACOUSTICS WEEK IN EDMONTON

The 1981 Annual Meeting and Symposium of the Canadian Acoustical Association will be part of an "Acoustics Week in Edmonton". The week will commence with two seminars, "Controlling Transportation Noise" and "Machinery Noise" run in parallel from October 5 - 7. The Canadian Standards Association, Noise and Vibration Committee, will hold their annual meeting on October 7. Finally the C.A.A. Symposium on October 8 - 9 will complete the week. Hotel convention rates are in effect for all events.

A guided bus tour of the Jasper-Banff area in the Rocky Mountains is scheduled for the long weekend following Acoustics Week. C.A.A. members are encouraged to bring their spouses and take part in this unique opportunity.

"CONTROLLING TRANSPORTATION NOISE"

This 3 day course, from October 5 - 7 will feature key-note speakers from across Canada and elsewhere discussing the many aspects of controlling noise from road and rail sources. Program topics include:

- Introduction to Acoustics and Sound Measurement
- Human Response to Noise
- Prediction of Noise from Transportation Sources
- Noise Impact Assessment
- Barriers and Barrier Materials
- Architectural Noise Control
- Land Use Planning
- Source Noise Control

The course should be of interest to engineers, planners, architects, and government officials, who must face the problems of controlling transportation noise and its impact on the community. Fee for the course is $95.00.

"MACHINERY NOISE CONTROL"

This highly acclaimed course will be presented by E.J. Richards from the Institute of Sound and Vibration Research, Southampton. This is your opportunity to benefit from the vast industrial experience of Professor Richards and to learn how to apply basic principles to a wide variety of industrial noise and vibration problems. The course is intended for engineers responsible for the operation of manufacturing and processing facilities or for individuals involved in the prevention of industrial hearing loss.
The course fee of $295.00 includes a comprehensive book of lecture notes.

For anyone interested in attending either of these courses, application forms and hotel reservation forms are available from The Canadian Acoustical Association, 1981 Convention Committee, Box 5768, Station L, Edmonton, Alberta T6C 4G2.

All C.A.A. members will soon be receiving an Acoustics Week Information package. The 1981 convention committee on behalf of the C.A.A. extends an invitation to all members to attend all or a part of this event. Your participation will ensure its continued success.

SEMAINE D'ACOUSTIQUE A EDMONTON

La réunion annuelle de 1981 et le symposium de l'Association Canadienne de l'Acoustique feront partie de la "Semaine d'Acoustique à Edmonton". La semaine commencera par deux cours parallèles du 5 au 7 octobre, "La Lutte au Bruit de Transports" et "Le Bruit de Machines". L'Association Canadienne de Normalisation, Comité sur le Bruit et la Vibration, tiendra sa réunion annuelle le 7 octobre. Enfin, le symposium de l'ACA achèvera cette semaine. Des prix d'hôtel spéciaux seront offerts pour toutes ces activités.

Un tour de bus guidé de la région Jasper-Banff dans les Rocheuses est prévu pour le weekend suivant cette Semaine d'Acoustique. Les membres de l'ACA sont encouragés à emmener leur époux(se) et participer à cette occasion unique.

"LA LUTTE AU BRUIT DE TRANSPORTS"

Ce cours de 3 jours, du 5 au 7 octobre, sera donné par des spécialistes connus, venant du Canada et d'autres pays. Leur présentations de divers aspects de la lutte au bruit routier et ferrovier donneraient lieu à des discussions avec tous les participants du cours. Les sujets suivants sont inclus dans le programme:

- Introduction à l'acoustique et à la mesure sonore
- Réponse de l'homme au bruit
- Prédiction du bruit de transports
- Evaluation de l'impact du bruit
- Des écrans antibruit et leur matériaux
- La lutte antibruit et l'architecture
- Aménagement du terrain
- La lutte antibruit aux sources

Le cours devrait intéressé les ingénieurs, les planificateurs, les architectes, et les agents de gouvernement qui doivent faire face aux problèmes du bruit de transports et son impact sur la communité.

Prix de cours : $95.00

"LE BRUIT DE MACHINES"

Ce cours bien apprécié sera donné par Prof. E.J. Richards de "Intitute of Sound and Vibration Research", Southampton, Angleterre. C'est une occasion de profiter de la grande expérience du Professeur Richards et d'apprendre comment appliquer des principes fondamentaux à une large variété des problèmes de bruit et de vibration industriels. Le cours est conçu pour les ingénieurs responsables de faire fonctionner des unités de fabrication et de transformation, ou des individus engagés dans la prévention de la surdité professionnelle.

Prix de cours : $295.00 (les notes du cours sont incluses).

Pour toute personne intéressée à assister à un de ces cours, des formulaires et des réservations d'hôtel peuvent être obtenus en s'adressant à l'Association Canadienne de l'Acoustique, Comité de Convention 1981, C.P. 5768, Succursale L, Edmonton, Alberta T6C 4G2.

Tout membre de l'ACA recevra bientôt des renseignements sur cette Semaine d'Acoustique. Au nom de l'ACA, le Comité de Convention 1981 étend une invitation à tous les membres d'assister à tout ou à une partie de cette semaine. Votre participation assurera son succès continu.

"THE INTERNATIONAL INSTITUTE OF NOISE CONTROL ENGINEERING" (I/INCE)*

Excerpts from the Opening Address at Inter-Noise 80, Miami, U.S.A., by Fritz Ingerslev, President, I/INCE.

Founding of I/INCE

The great interest in noise control which was provoked during the last two decades through the demand for favourable conditions for the citizens resulted in a pronounced need for extension of the already established international co-operation. It was realized that an organization which could undertake the international leadership in applying noise control technology should be established. INCE/USA encouraged the formation of an International Institute of Noise Control Engineering. The Institute was established in October 1974 by the general chairmen and other organizers of INTER-NOISE 1972 and 1973.

The Institute is a non-profit organization.

Purpose of I/INCE

The purpose of I/INCE comprises:

a) The organization of international conferences
b) The international exchange of information and news items
c) The promotion of international co-operation in research on noise control and the application of engineering techniques for the control of noise
d) The development of interdisciplinary contacts between noise control engineering and other related fields of work.

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* The CAA INCE Representative is J.R. Hemingway (address in inside back cover).

The Queen's Symposium on Musical Perception

The Donald Gordon Centre of Queen's University

14-16 July, 1981

The Symposium is designed to bring together scholars in the disciplines which contribute to our understanding of the processes involved in music creation, performance and enjoyment. At present work in this area is presented as isolated papers in the context of meetings of researchers in the broad areas of psychology, physics, music, etc. With the exception of the three Workshops on Physical and Neuropsychological Foundations of Music which were held in Ossiach, Austria, in 1975, 1978 and 1980 there have been very few opportunities to concentrate specifically on the area of musical perception.

The organizers are Dr. Lola Cuddy of the Department of Psychology and Professor David Keane of the Department of Music at Queen's University. There have been so many recent advances in both technological and intellectual resources for approaching the common problems for workers in the various disciplines concerned with musical perception that the organizers are convinced that a symposium of the following nature is certain to be exceptionally fruitful.

The basic plan of the symposium is to have sessions dealing with three fairly limited aspects of music; to have for each two speakers address different approaches or concerns related to the topic, followed by a discussion open to all participants attending the symposium.

Proposed Program for The Queen's Symposium on Musical Perception

Tuesday, 14 July

4:00 - 6:00 p.m.	Registration
6:00 - 8:00 p.m.	Dinner
8:00 p.m.	Welcoming Addresses Concert of Electroacoustic Music
10:30 p.m.	Reception

Wednesday, 15 July

9:00 - 12:00	Session on Structure in Music speakers: - Dr. Jonathan Kramer, College-Conservatory of Music, University of Cincinnati - Dr. Annabel Cohen, Department of Psychology, University of Toronto
12:00 - 1:30 p.m.	Lunch

Wednesday, 15 July (continued)

1:30 - 4:30 p.m.	Session on Auditory Sound Sources speakers: - Dr. A.E. Bregman, Department of Psychology, McGill University - Dr. Floyd Toole, National Research Council of Canada
6:00 - 8:00 p.m.	Dinner
8:30 p.m.	Concert: Iraneus Zuk, piano Discussion of Musical Perception with reference to the works on the concert program: Iraneus Zuk, Music Department, Queen's University

Thursday, 16 July

9:00 - 12:00	Session on Timbre Perception speakers: - Dr. Wayne Slawson, Music Department, University of Pittsburgh - Dr. Campbell Searle, Department of Electrical Engineering, Massachusetts Institute of Technology
12:00 - 1:30 p.m.	Lunch
1:30 - 3:00 p.m.	Open discussion (point of departure: the Wednesday evening concert and points raised by the concert commentators also to be discussed: the format, content and timing for future Symposia on Musical Perception).

- End of Symposium -

Note:

All seminars will be held at the Donald Gordon Centre of Queen's University. There is a registration fee of $25.00. Residence accommodation is available. Further information may be obtained from:

Dr. Lola Cuddy
Department of Psychology
Queen's University
Kingston, K7L 3N6
(613) 547-5748.

REPORT OF THE FOURTH TECHNICAL MEETING OF THE C.A.A. TORONTO CHAPTER

MAY 11, 1981 - 7:00 P.M.

AUDITORIUM, ONTARIO HYDRO, 700 UNIVERSITY AVE., TORONTO

CHAIRPERSON: SHARON M. ABEL

THEME:

"REPRESENTATIVE HEARING RESEARCH IN THE UNIVERISTY OF TORONTO HOSPITAL SETTING"

First Speaker:

Professor Hans Kunov

Dr. Kunov presented a study in binaural hearing, whereby equal signals of opposite phase are induced into the left and right ear. Perception of the binaural signal is observed at either center or nearer left or right ear, depending on the degree of the phase shift. Slides with oral explanation.

Second and Third Speakers:

Professor Dietrich Schwarz

"Neurophysiology of Pitch Perception" - An introduction by Dr. Schwarz describes how the brain perceives different frequencies and intensities of sound. After his short introduction, our surprise guest speaker, Dr. Suzuki, told us something about his work at the U. of T., specifically his work in using electro-pulses to stimulate the cochlea, the spiral part of the inner ear that is the seat of the hearing organ. Dr. Suzuki uses the chinchilla as a subject of his study. The dynamic hearing range of this rodent is wider than in most other species (50- 33 Kz). Object of this study is to seek out those cells that are perceptive to different frequencies.

Fourth Speaker:

Our fourth speaker was Professor Ivan Hunter-Duvar on "Cochlear Structure and Noise Damage"

Dr. Hunter-Duvar showed us the intricate layers of the cochlea via slides taken through a high-power microscope. We could observe damaged cells as a result of noise levels as high as 140 dB with very short duration. The excellence of the photography, together with the clarity of the speaker made this a fascinating presentation.

Coffee in the intermission was courtesy of Ontario Hydro, while Dr. Peter Alberti from Mount Sinai Hospital baked the cookies — each one a meal in itself.

John Manuel, explained the workings of the C.A.A. as well as all the excitement that goes on in the field of acoustics for the benefit of the special interest visitors.

Sharon Abel closed the meeting and thanked all those who participated in the presentations and discussions.

WINSTON V. SYDENBORGH

THE INCORPORATION OF THE CANADIAN ACOUSTICAL ASSOCIATION/

CONSTITUTION JURIDIQUE DE L'ASSOCIATION CANADIENNE DE L'ACOUSTIQUE

The Letters Patent and its supporting application was published in Volume 9(1) of "Acoustics and Noise Control in Canada". We follow up in this issue by publishing the By-Laws of the Association, established when the Canadian Acoustical Association became incorporated on April 22, 1977.

Les lettres patentes et la demande à l'appui furent présentées dans la revue "L'acoustique et la lutte antibruit au Canada", volume 9(1). Le numéro-ci présente les règlements de l'association établis quand l'Association Canadienne de l'Acoustique fut juridiquement constituée le 22 avril 1977.

PART (ii): THE BYLAWS OF THE CAA

PARTIE (ii): LES REGLEMENTS

BY-LAW NO. 1

OF

THE CANADIAN ACOUSTICAL ASSOCIATION

L'ASSOCIATION CANADIENNE DE L'ACOUSTIQUE

CORPORATE SEAL

1. The seal of the Corporation shall be in such form as shall be prescribed by the directors of the Corporation.

CONDITIONS OF MEMBERSHIP

2. Membership in the corporation shall be available to all persons interested in furthering the objectives of the corporation and whose applications for admission as members have received the approval of the board of directors.

3. A charge shall be made for membership and shall be levied equally upon all members.

4. Any member may withdraw from the corporation by delivering to the corporation a written resignation and lodging a copy of the same with the secretary of the corporation.

5. Any member may be required to resign by a vote of three-quarters of the members at an annual meeting.

HEAD OFFICE

6. The head office of the corporation shall be located at the City of Ottawa in the Province of Ontario, Canada, at the place therein where the business of the corporation may from time to time be carried on.

7. The corporation may establish such other offices and agencies elsewhere within Canada as the board of directors may deem expedient by resolution.

BOARD OF DIRECTORS

8. The property and business of the corporation shall be managed by a board of eight directors of whom a majority shall constitute a quorum. The board of directors may on literature of the corporation be designated as a board of governors.

9. Directors shall be eligible for re-election at the annual meeting of members for terms of service which do not exceed six years in total.

10. The office of director shall be automatically vacated

(a) if a director shall resign his office by delivering a written resignation to the secretary of the corporation,

(b) if he is found to be a lunatic or becomes of unsound mind,

(c) if he becomes bankrupt or suspends payments or compounds with his creditors,

(d) if at the annual meeting or special general meeting of members a resolution is passed by three-quarters of the members present at the meeting that he be removed from office.

(e) on death;

provided that if any vacancy shall occur for any reason in this paragraph contained, the directors may by resolution fill the vacancy with a person in good standing on the books of the corporation as a member.

11. Meetings of the board of directors may be held at any time and place to be determined by the directors provided that five days notice of such meeting shall be sent in writing to each director. No formal notice shall be necessary if all directors are present at the meeting or waive notice thereof in writing.

12. Directors, as such, shall not receive any stated remuneration for their services.

13. A retiring director shall remain in office until the dissolution or adjournment of the meeting at which his successor is elected. A director shall hold office until the next annual meeting of members following his election or appointment.

14. The directors may exercise all such powers of the corporation as are not by the Canada Corporations Act or by these by-laws required to be exercised by the members at general meetings.

15. Upon election at the first annual meeting of members, the board of directors then elected shall replace the provisional directors named in the letters patent of the corporation.

16. A majority of the directors shall have power to authorize expenditures on behalf of the corporation from time to time and may delegate by resolution to an officer or officers of the corporation the right to employ and pay salaries to employees. The directors shall have the power to make expenditures for the purpose of furthering the objects of the corporation. The directors shall have the power to enter into a trust arrangement with a trust company for the purpose of creating a trust fund.

17. The board of directors shall take such steps as they may deem requisite to enable the corporation to receive donations and benefits for the purpose of furthering the objects of the corporation.

OFFICERS

18. The officers of the corporation shall be a president, immediate past president, executive secretary, editor, treasurer, the conveners of the next and last annual meeting of the Association and such other officers as the board of directors may by by-law determine. The offices of executive secretary and treasurer may not be held by the same person. Remuneration, if any, of the officers shall be determined by the board of directors.

19. The president and other officers, apart from the immediate past president and the conveners of the next and last annual meeting, shall be elected at the annual meeting of members.

20. There may be such honorary officer or officers as the board of directors may from time to time consider advisable and they shall hold office for such period of time as may be prescribed by the board.

21. The board may appoint such agents and engage such employees as it shall deem necessary from time to time and such persons shall have such authority and shall perform such duties as shall be prescribed by the board at the time of such appointment.

22. The officers of the corporation shall hold office for one year and/or until their successors are elected or appointed in their stead.

DUTIES OF OFFICERS

23. The president shall be the chief executive officer of the corporation. He shall preside at all meetings of the corporation and of the board of directors. He shall have the general and active management of the business of the corporation. He shall see that all orders and resolutions

of the board are carried into effect and he with the executive secretary or other officer appointed by the board for the purpose shall sign all by-laws and other documents requiring the signatures of the officers of the corporation.

24. The past president shall, in the absence or disability of the president, perform the duties and exercise the powers of the president and shall perform such other duties as shall from time to time be imposed upon him by the board. He will prepare a list of candidates for presentation to the Annual General Meeting for consideration by that meeting prior to the conducting of elections.

25. The treasurer shall have the custody of the corporate funds and securities and shall keep full and accurate accounts of receipts and disbursements in books belonging to the corporation and shall deposit all moneys and other valuable effects in the name and to the credit of the corporation and in such depositories as may be designated by the board of directors from time to time. He shall disburse the funds of the corporation as may be ordered by the board, taking proper vouchers for such disbursements, and shall render to the president and directors at the regular meeting of the board, or whenever they may require it, an account of all his transactions as treasurer and of the financial position of the corporation. He shall also perform such other duties as may from time to time be determined by the board.

26. The executive secretary shall attend all sessions of the board and all meetings of the members and act as clerk thereof and record all votes and minutes of all proceedings in the books to be kept for that purpose. When the business of the Association is conducted by the directors by mail he will similarly act as clerk and keep records. He shall give or cause to be given notice of all meetings of the members and of the board of directors, and shall perform such other duties as may be prescribed by the board of directors or president, under whose supervision he shall be. He shall be custodian of the seal of the corporation, which he shall deliver only when authorized by a resolution of the board to do so and to such person or persons as may be named in the resolution.

EXECUTIVE COMMITTEE

27. The board of directors may from time to time elect from among its number an executive committee consisting of such number of members, not less than two, as the board of directors may by resolution determine. Each member of the executive committee shall serve during the pleasure of the

board and, in any event, only so long as he shall be a director. The board of directors may fill vacancies in the executive committee by election from among its number. Whenever a vacancy shall exist in the executive committee, the remaining members may exercise all its power so long as a quorum remains in office.

28. During the intervals between the meetings of the board of directors the executive committee shall possess and may exercise (subject to any regulations which the directors may from time to time impose) all the powers of the board of directors in the management and direction of the affairs of the company (save and except only such acts as must by law be performed by the directors themselves) in such manner as the executive committee shall deem best for the interests of the corporation in all cases in which specific directions shall not have been given by the board of directors.

29. Subject to any regulations imposed from time to time by the board of directors, the executive committee shall have power to fix its quorum at not less than a majority of its members and may fix its own rules of procedure from time to time.

30. Meetings of the executive committee may be held at the head office of the company or at any other place in or outside Canada. The executive committee shall keep minutes of its meetings in which shall be recorded all action taken by it, which minutes shall be submitted as soon as practicable to the board of directors.

MEETINGS

31. The annual meeting of the members of the corporation shall be held at the head office of the corporation or elsewhere in Canada as the board of directors may designate. At such meeting the members shall elect a board of directors and shall receive a report of the directors.

32. Twenty-eight days prior written notice shall be given to each member of any annual or special general meeting of members. Twelve members present in person at the meeting shall constitute a quorum. Each member present at a meeting shall have the right to exercise one vote.

AMENDMENT OF BY-LAWS

33. The by-laws of the corporation may be repealed or amended by by-law enacted by a majority of the directors at a meeting of the board of directors and sanctioned by an affirmative vote of at least two-thirds of the members at a general meeting duly called for the purpose of

considering the said by-law, provided that the enactment, repeal or amendment of such by-law shall not be enforced or acted upon until the approval of the Minister of Consumer and Corporate Affairs has been obtained. Such amendments shall be presented to the next annual meeting of the Association for its consideration.

34. A member may appoint as his proxy any other member to vote at any annual or special general meeting provided such appointment is made in writing and the secretary of the Association is so informed.

35. At all meetings of members of the corporation every question shall be determined by a majority of the votes cast at the meeting unless otherwise specifically provided by the Canada Corporations Act or by these by-laws.

36. The financial year of the corporation shall be the year starting on 1st September.

AUDITORS

37. The members shall at each annual meeting appoint an auditor to audit the accounts of the corporation to hold office until the next annual meeting provided that the directors may fill any casual vacancy in the office of auditor. The remuneration, if any, of the auditor shall be fixed by the board of directors.

SIGNATURE AND CERTIFICATION OF DOCUMENTS

38. Contracts, documents or any instruments in writing requiring the signature of the corporation, shall be signed by any two of the president, immediate past president, secretary or treasurer and all contracts, documents and instruments in writing so signed shall be binding upon the corporation without any further authorization or formality. The directors shall have power from time to time by by-law to appoint an officer or officers on behalf of the corporation either to sign contracts, documents and instruments in writing generally or to sign specific contracts, documents and instruments in writing. The seal of the corporation when required may be affixed to contracts, documents and instruments in writing signed as aforesaid or by any officer or officers appointed by resolution of the board of directors.

RULES AND REGULATIONS

39. The board of directors may prescribe such rules and regulations not inconsistent with these by-laws relating to the management and operation of the corporation as they deem expedient, provided that such rules and regulations shall have force and effect only until the next annual

meeting of the members of the corporation when they shall be confirmed, and in default of confirmation at such annual meeting of members shall at and from that time cease to have force and effect.

40. In these by-laws the singular shall include the plural and the plural the singular; the masculine shall include the feminine.

41. In these by-laws, the word "corporation" is deemed to refer to the Association.

An Open Letter

TRIBUTE TO ROBERT TANNER

On the Ocassion of His Receipt of the Haraden Pratt Award.

by

Gordon B. Thompson

Dear Bob:

I am very pleased that you are to receive the Haraden Pratt Award of the IEEE. It is a reward you most certainly deserve, and I am happy that the Institute has recognized you in this way.

Of all the people for whom I have worked, I hold you in the greatest respect. You taught me to search out the new and the bold and to have the courage to be creative. But you also taught me that creativity must be coupled with the strongest possible technical foundation. Through your own work as an example, you taught those who were lucky enough to work with you in their formative years, the overwhelming value of creativity coupled with competence. My only regret is that there weren't more of us who were so fortunate.

Now, the Institute has recognized your talents and efforts on its behalf. I am happy to see this, and I'm pleased to raise my voice in tribute to you, Bob. Thanks for the care and feeding you gave me. Like the Institute, I needed you. Like the Institute, too, I am pleased to say so.

Yours sincerely,

Gordon B. Thompson,
Manager, Communications Studies,
Bell Northern Research,
Ottawa, Canada.

ACOUSTICS IN THE DIVISION OF BUILDING RESEARCH

by

A.C.C. Warnock
Division of Building Research
National Research Council of Canada
Ottawa, Canada K1A 0R6

The Noise and Vibration Section of the Division of Building Research (DBR) is concerned as the name suggests, with problems of acoustics and vibration as they relate to buildings. The work in the Section includes (1) studies of basic physical processes of propagation of sound and vibration in buildings; (2) studies of responses of people to sounds and vibration in their environment; and (3) the development of standard methods of measurement of the appropriate physical descriptors. The commitment, beyond research, is to apply the knowledge gained to the solution of specific building problems and to disseminate the information in appropriate form to designers, builders and the public.

ACOUSTICAL TESTING

The major part of the building is given over to three reverberation rooms. Figure 1 is a view of the largest (250 m^3). Standard tests that are carried out include:

airborne sound transmission loss of partitions,
impact sound measurements on floors,
random incidence sound absorption,
sound power measurements,
impedance tube measurements.

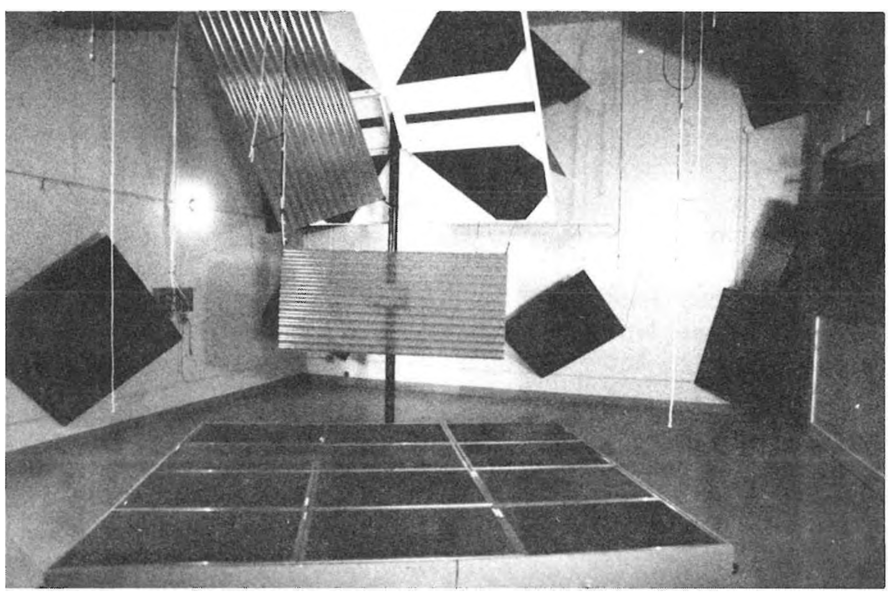

Figure 1

The large reverberation room at DBR

This paper is a contribution from the Division of Building Research, National Research Council of Canada, and is published with the approval of the Director of the Division.

In addition to the suite of reverberation rooms, there is an anechoic room that can be used in making sound power measurements. It has also served in investigations of some of the acoustical properties of the components of open-plan offices and as a quiet space for subjective evaluation of noise signals.

For many years the Section has been actively involved with standards writing groups such as ASTM, ISO and CSA. This aspect of the work is essential when commercial tests are performed and ensures that results from the laboratory will be accepted throughout the world. As a consequence, much of the research is aimed at improving the accuracy and precision of the measurements.

Over the last few years the single most important step in this direction has been the changeover to a computer-controlled measuring system that can control the sound in the appropriate room, select microphones and measure the sound pressure levels and decay curves in as many frequency bands as required. The program can then calculate any further quantities needed such as spatial averages, sound transmission losses, sound powers and so on.

The ability of real-time analysers to make measurements of sound pressure levels in several bands simultaneously over a short time-interval simplifies enormously the measurements of sound decay rates in the room. Sound decays have been measured in reverberation rooms for decades but it is only in the last five years or so that computer systems have allowed researchers to look closely at them. The beauty of the computer system is that it can sample many of these decay curves at fixed time-intervals and add them together in memory. By this means the irregularities in the curve that are due to the random nature of the room excitation can be averaged out to give a much smoother decay curve.

DEVELOPMENT OF NEW TEST PROCEDURES

In addition to the constant review and implementation of standard test procedures, DBR has a strong interest in the development of new acoustical test procedures. As one example, part of the development work for the CSA test method Z107.71 for measuring the sound power of small appliances was performed in the DBR laboratory. This work required sound power measurements in the reverberation rooms, in the anechoic chamber, and in some semi-reverberant rooms.

For many years impact testing of floor structures has been carried out, using the standard ISO hammer machine with its five steel hammers impacting ten times each second on the structure under test. A great deal of criticism has been directed at this test procedure, especially in North America where light-weight floor structures are common. The Section has examined this problem over the years in an intermittent fashion, and is at the moment fairly actively investigating a proposed new test procedure that uses hammers believed to be a better approximation to the shoe and human foot than the ISO hammer. Initial results from this research are encouraging, but a great deal of work remains to be done since only about 20 floor systems have been investigated so far.

REVERBERATION ROOM ACOUSTICS RESEARCH

The assumption underlying tests performed in reverberation rooms is that there is a good approximation to a diffuse sound field in the room. It has been known for many years that reverberation rooms have a modal response determined by the geometry of the room, and devices such as diffusers have been used to try to change the room response in such a way that the field becomes more uniform. Diffusers are panels suspended or moving (usually rotating) in the reverberation room that are supposed to break up the regular structure of the room, thereby making the sound field more diffuse. The rooms at NRC are fitted with both types (Figure 1).

Despite the fact that diffusers have been in use for many years, their effects are not completely predictable and research is needed to clarify some issues. As well, there is in North America an increasing movement towards accrediting laboratories for making acoustical measurements. This has forced the standards writing bodies to examine more closely some of the requirements written into the standards to be sure that they can in fact be satisfied by the laboratories. In parallel with these research interests, standard test measurements must still go on. For these reasons construction has recently been completed of a model of the large reverberation room on a scale of 1:2.5. It is hoped that the research to be performed in this model will answer some of the questions about diffuser performance, the measurement of the degree of diffusion, and other factors.

The experimental research program is supported by theoretical studies and computer simulations based on theoretical models in a concerted effort to extend understanding of this complicated subject.

FIELD PERFORMANCE

For many years the Section has made measurements in multi-family dwellings in order to compare field performance with results obtained in the laboratory, and to maintain an awareness of the faults and problems that arise in practical situations. It is important to remember that laboratory testing is carried out under carefully controlled conditions, in which the only significant transmission is through the partition under test. In the field situation this is not the case. Quite apart from the possibility of construction errors, sound energy can be transmitted by way of surrounding structures, a phenomenon known as flanking transmission. It is only by careful study of the details of the processes involved that the best performance can be obtained from a selected party wall or floor. The proliferation of small, highly precise instrumentation is facilitating work in this area and offers the possibility of using more modern, sophisticated techniques to investigate some of the problems.

INTRUSION OF EXTERNAL NOISE

For the past several years a large part of the activity of the Section has been committed to the study of intrusion of outdoor noise into homes. This research has included study of aircraft noise and road and rail traffic noise. The original excursion into this field began at the request of Canada Mortgage and Housing Corporation (CMHC) and the work was a joint effort that included DBR, CMHC and Transport Canada. A test house was constructed near Uplands airport in Ottawa, and penetration of noise was measured as windows and other components of the structure were changed. The result of this work was a publication entitled "New Housing and Airport Noise."[1]

Following the efforts with aircraft noise it was decided that a similar set of guidelines was necessary for traffic noise. As this naturally entailed a great many measurements on site, a van was equipped with a computer-controlled measuring system to allow real-time measurement and analysis of the data. The studies included the effects of terrain, barriers, aggregations of buildings and absorbing and reflecting boundaries on the propagation of sound. The product of this work, apart from research papers, was the document "Road and Rail Noise: Effects on Housing."[2]

In both cases the windows of the houses proved to be the dominant factor in controlling the penetration of the sound into the building. This result, together with the observation that the available literature on windows was somewhat equivocal, led to a very thorough study, performed under laboratory conditions, of the transmission losses through approximately 130 variants of single-, double-, and triple-glazed windows.

BUILDING VIBRATIONS

The study of acoustics in buildings naturally includes some study of building vibrations. Interest at DBR/NRC extends, however, outside the frequency range of acoustics to cover the low frequency motions of whole buildings and building elements. About half of the effort is devoted to experimental and theoretical evaluation of structures subjected to dynamic loads such as wind, traffic vibrations and earthquakes. The structures investigated are typically quite large and include the CN tower, the Lions Gate Bridge in Vancouver, the Manic 5 dam and some tall buildings. Apart from the intrinsic interest of these studies the information obtained is of immediate use in making recommendations for changes to the National Building Code of Canada (NBC). They are also useful in selecting benchmark structures for CANCEE, the Canadian Committee on Earthquake Engineering.

The NBC includes structural requirements for buildings constructed in areas in Canada considered to be at some degree of seismic risk. In the event of a strong shock in Eastern Canada it would be extremely valuable to have a record of the ground motion so that NBC requirements could be refined, if necessary. For this reason the Section maintains a network of strong motion seismographs at selected locations in Eastern Canada, so that if an earthquake were to occur there would be a seismograph record of it.

At the other end of the scale, the vibrations of building elements, especially floors, can cause considerable disturbance to sensitive instruments and even people. One research program concentrates on this area. This type of problem can occur with dance floors, where the amplitude of vibration can be quite unnerving. Two long floor strips have been constructed in DBR to examine more closely the parameters that control the level of vibration and possible means of economical control. Part of the study includes a subjective experiment to determine how people react to different frequencies and levels of vibration.

REFERENCES

[1] New housing and airport noise. Canada Mortgage and Housing Corporation, Ottawa, NHA 5185 M 79/08.

[2] Road and rail noise: effects on housing. Canada Mortgage and Housing Corporation, Ottawa, NHA 5156 12/77

IMPORTANCE ET FACON DE PREPARER UN PROFIL D'EXPOSITION AU BRUIT SUITE A UNE DEMANDE DE REPARATION POUR PRETENDUE SURDITE PROFESSIONNELLE*

MM. JACQUES COTE ET GUY TALBOT

Société d'électrolyse et de chimie Alcan Ltée
Service du développement technologique et
Contrôle de l'environnement
C.P. 500, Arvida, Québec, G7S 2C5

SOMMAIRE

Les auteurs rappellent l'importance de connaître la dose globale d'exposition au bruit pour établir une relation de cause à effet dans des cas de demande de réparation pour prétendue surdité professionnelle. Une brève revue est faite de différentes études et méthodes pour établir une dose globale d'exposition et le risque d'atteinte de perte d'acuité auditive. La plupart de ces méthodes sont basées sur des doses d'exposition à un bruit quasi stable. Les auteurs présentent une façon d'établir un profil d'exposition au bruit en tenant compte de la fiche de route d'un employé, des doses d'exposition présentes et passées et en tenant compte de leur variation dans le temps afin d'établir le nombre d'années à différentes classes de risque. Une bonne corrélation a été établie entre la dose globale d'exposition par cette méthode et les verdicts de perte d'acuité auditive.

SUMMARY

The authors emphasize the importance of knowing the total noise exposure dose in order to establish the cause and effect relationship in the case of a compensation request due to occupational hearing damage. A brief review of different studies and methods to estimate the total noise exposure dose and the risk of hearing loss is given. In most of these methods the noise exposure doses are based on quasi-stable noise. The authors present a method to establish a noise exposure profile which takes into account the employee's movements, the present and past doses of exposure and their variation with time to estimate the number of years at the different risk classes. A good correlation was established between the total exposure dose based on this method and the verdicts of hearing loss.

---

* Communication présentée lors du congrès annuel de l'Association canadienne de l'acoustique tenu à Montréal, les 22 et 23 octobre 1980.

INTRODUCTION

La perte d'acuité auditive de nature professionnelle vient en tête des maladies professionnelles dans plusieurs provinces et pays(1-3). Dans nombre ux pays et de provinces canadiennes*, les demandes de réparation pour surdité professionnelle n'ont cessé de croître ces dernières années(1,3-7). Une brève analyse des données publiées sur les demandes annuelles de réparation dans ce domaine pourrait nous indiquer les points suivants:

a) les données ne refléteraient pas la situation réelle du nombre de travailleurs atteint d'une surdité professionnelle dite indemnisable;
b) du nombre total annuel de demandes de réparation, une proportion de celles-ci (dans l'ordre de 10 à 35%) est refusée (tableau I) pour diverses raisons (tableau II).
c) du nombre de demandes de réparation accepté, on peut dire, à juste titre, qu'un bon nombre de celles-ci est nettement relié à une exposition prolongée à des doses assez "élevées" au bruit. Cependant un certain nombre de cas serait accepté sans chercher à établir s'il existait une bonne relation de cause à effet.

TABLEAU I

PROPORTION DE DEMANDES DE REPARATION POUR PRETENDUE SURDITE PROFESSIONNELLE REJETEE POUR DIVERSES RAISONS

Source d'information	Référence	Nombre total étudié	Rejets	
			Nombre	Pourcentage
CAT** Québec 1977	Communication personnelle	1 695	221	13%
Lescouflair	(8)	556	190	34%
Sulkowski	(9)	553	198	36%

* Les barèmes de réparation varient d'une province à l'autre, d'un état à l'autre aux Etats-Unis et d'un pays à l'autre.
** Commission des accidents du travail, maintenant CSST (Commission santé et sécurité au travail).

TABLEAU II

RAISONS MAJEURES DE REJET DE DEMANDES DE

REPARATION POUR PRETENDUE SURDITE PROFESSIONNELLE

Lescouflair [8] (190 cas sur 556)		Sulkowski [9] (198 cas sur 533)	
Impossibilité d'obtenir des seuils valides	5,4%	Perte d'acuité auditive	10%
Surdité accidentelle	2,7%	Otosclérose	2%
Surdité de conduction	5,4%	Tympanosclérose	3%
Surdité mixte	0,5%	Opération radicale à l'oreille moyenne	4%
Surdité neuro-sensorielle d'origine autre que l'exposition au bruit	12,0%	Otite chronique	7%
Perte d'acuité auditive hors barème	2,0%	Déficit auditif congénital	0,4%
Insuffisance d'exposition à des bruits professionnels	6,1%	Maladie de Ménière	3%
		Désordre auditif central	0,4%
		Déficit auditif hors barème	6%
		Insuffisance d'exposition à des bruits professionnels	2%

Le noeud du problème est justement là. La plupart des experts[8-12] s'accordent à dire que dans un cas de demande de réparation pour surdité professionnelle il faut, en outre, établir sans équivoque, s'il y a eu facteur causal de nature industrielle. Ce facteur est l'étude de l'exposition au bruit. Dans le but de décrire adéquatement l'exposition au bruit une certaine classification basée sur les doses d'exposition doit être utilisée afin d'en arriver à un indice global d'exposition[13].

Les effets de l'exposition au bruit sont essentiellement une relation de cause à effet. Il serait téméraire ici d'essayer de faire une revue des nombreuses études qui ont porté sur la relation de cause à effet de l'exposition au bruit[14-28]. La majorité de ces études indique que la dégradation de l'audition est fonction de l'accumulation des doses d'exposition au bruit, c'est-à-dire niveau sonore (dBA) et durée d'exposition (années).

De plus en plus on réalise[13] que pour obtenir de bonnes corrélations entre le déficit auditif et le milieu de travail il faut utiliser la notion de dose "équivalente" hebdomadaire, annuelle ou totale. De l'évaluation de la dose équivalente il est possible d'établir le risque. Ce principe de dose équivalente ou indice total d'exposition VS le risque d'un déficit auditif a été suggéré par Glorig en 1962[28] et depuis, retenu par certains organismes[29,30] et inclus dans quelques standards [31-33].

La plupart des techniques pour établir la dose équivalente ou l'indice total d'exposition ont été basées sur des groupes de travailleurs exposés à un bruit assez "stable". En réalité ce type d'exposition au bruit ne peut se rencontrer que dans certaines industries ou postes de travail. En somme, les niveaux sonores et les durées d'exposition sont des plus variables. Pratiquement, pour établir une dose équivalente, il faut donc tenir compte des niveaux sonores et durée d'exposition, i.e. la dose journalière, la variation des doses journalières, hebdomadaires, saisonnières et des conditions d'opération présentes et passées.

Au départ il faut donc détruire le mythe que l'exposition globale au bruit ne se détermine seulement que par quelques mesures de niveaux sonores ou par évaluation subjective. Niveau sonore n'est pas dose d'exposition[13,34,35].

Dans ce qui suit nous essaierons de démontrer comment nous avons mis au point un système d'évaluation de l'exposition globale au bruit suite à une demande de réparation pour prétendue surdité professionnelle et, suite à la dose globale d'exposition, essayer de prédire le degré d'affection du déficit auditif.

Classification des mesures de doses d'exposition

Les niveaux sonores et doses d'exposition peuvent varier d'une journée à l'autre mais souvent pour un environnement donné, une période donnée et une occupation donnée, il est possible d'en établir la gamme. Pour faciliter l'étude de cause à effet plusieurs auteurs regroupent les sujets dans des classes d'exposition basées sur des niveaux sonores (si bruit stable) ou doses d'exposition. Par exemple Glorig et Braun [28] ont utilisé des classes de 78, 86 et 92 dBA. Le groupe désigné 78 dBA passait 90% de son temps dans des niveaux variant de 66 à 81 dBA, le groupe 82 dBA passait 80% de son temps entre 86 ± 4 dBA et le groupe 92 dBA passait 87% de son temps entre 92 ± 5 dBA.

Martin et coll.[24] ont mené une étude de perte d'acuité auditive en regroupant les travailleurs dans des classes de niveaux sonores de 85 et 90 dBA alors que récemment, Thiery et Damongeot[14] ont étudié une population de 8 000 dossiers audiométriques regroupée dans les classes de niveaux sonores de 95 dBA (92,5 à 97,5 dBA) et 100 dBA (97,5 à 102,5 dBA). Au lieu d'utiliser des niveaux sonores pour classification, la dose d'exposition ou niveau équivalent est de plus en plus utilisée [23,29,35].

Dans nos usines, les doses d'exposition* de la majorité des occupations ont été mesurées à l'aide d'audio-dosimètres et souvent appuyées par sonométrie. Ce sont donc des milliers de résultats de doses d'exposition qui ont été recueillis depuis des années. De tous ces résultats il est possible de dégager les groupes suivants:

---

* Dose d'exposition mesurée selon le critère proposé par OSHA en 1974 et adopté par le Québec dans le Règlement relatif à la qualité du milieu de travail, arrêté en conseil #3169-79, 28 novembre 1979.

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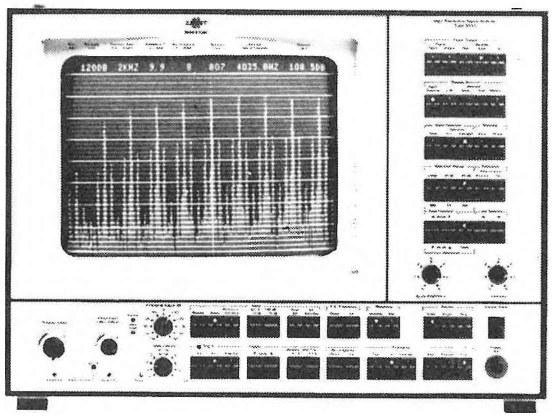

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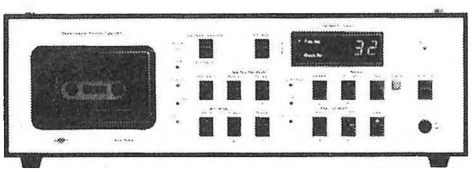

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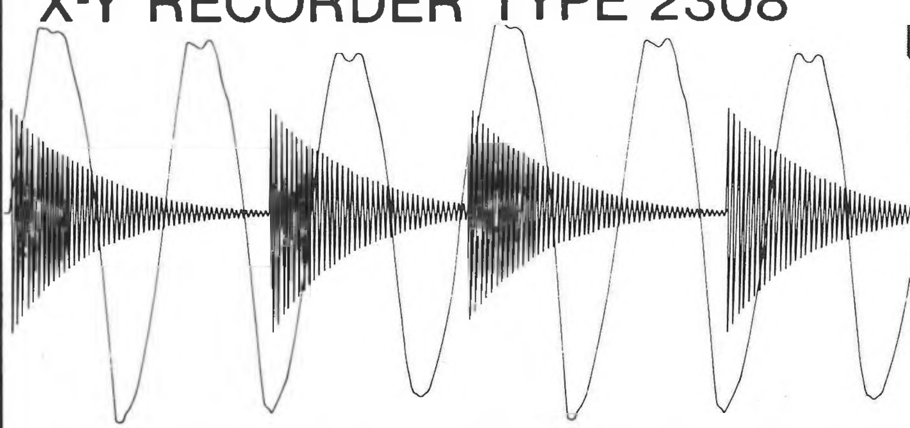

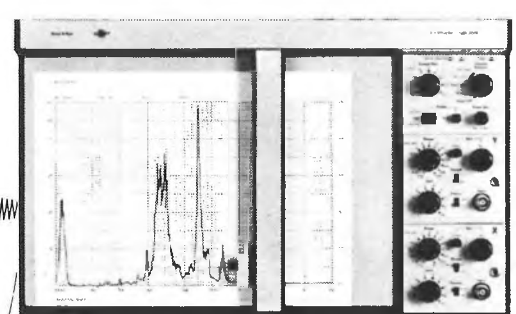

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a) Un grand nombre de résultats a donné des doses journalières (8 h) inférieures à 75% de la dose permissible, c'est-à-dire des doses variant de 0 à 75% ou exprimées en niveau équivalent (L OSHA) de moins de 70 à 87,5 dBA équivalent. Ce groupe de doses d'exposition peut être rassemblé dans la classe de 85 dBA équivalent.
b) Un certain nombre de résultats a donné des doses de 8 h variant de 75 à 133% de la dose permissible ou un niveau équivalent d'environ 87,5 à 92,5 dBA. Ces résultats peuvent être désignés dans la classe de niveau équivalent de 90 dBA.
c) D'autres résultats ont donné des doses supérieures à 133%. Toutefois dans cette dernière catégorie le nombre de résultats présentant des doses supérieures à 300% (98 dBA équivalent) est limité. Donc en général, les résultats excédant des doses de 133% peuvent être classés dans le groupe de 95 dBA équivalent, i.e. niveau équivalent 8 h variant de 92,5 à 97,5 dBA.

Variabilité des doses d'exposition journalière

Les doses d'exposition sont souvent des plus variables dépendant de l'endroit, de la nature et du poste de travail. On n'a qu'à penser ici aux équipes d'entretien. Il est donc essentiel de tenir compte de ces variations de doses d'exposition pour établir une dose ou un indice global et non en se basant sur des doses moyennes à partir d'un certain nombre de résultats.

A titre d'exemple le tableau III donne une série de résultats obtenue chez divers travailleurs de trois occupations différentes. Le nombre de résultats dans chaque classe d'exposition et la proportion du temps dans chacune de ces classes sont aussi indiqués.

TABLEAU III

REPARTITION TEMPORELLE DANS CHAQUE CLASSE D'EXPOSITION
DES RESULTATS DE DOSES D'EXPOSITION - 8 h OBTENUS PAR
AUDIODOSIMETRIE POUR TROIS OCCUPATIONS

Occupation	Nombre de tests dans le groupe de doses d'exposition (%-8 h)*			Répartition temporelle des doses d'exposition dans chaque classe d'exposition (dBA équivalent)		
	0 à 75	75 à 133	>133	85	90	95
A	24		6	4/5		1/5
B	27	10	4	∿3/5	1/4	1/10
C	10	10	10	1/3	1/3	1/3

* Résultats obtenus à des jours et sur des employés différents.

Pour certaines occupations, la nature du travail peut être saisonnière. A titre d'exemple, il se pourrait que pendant six mois, les travailleurs soient affectés à un travail résultant en une surexposition (disons dans la classe 95 dBA équivalent) et pour le reste de l'année il n'y a pas de surexposition (classe de 85 dBA). Dans ce cas la répartition en temps serait de la demi du temps dans la classe d'exposition de 95 dBA et la demi du temps dans la classe de 85 dBA.

Donc il est non seulement capital de regrouper les doses d'exposition au bruit selon une certaine classification mais aussi de tenir la répartition en temps de chacun des postes auxquels un travailleur a été affecté depuis son embauche à la compagnie.

Evaluation des doses d'exposition antérieures

A partir des nombreux résultats en main, des écarts retrouvés des tâches-types où des doses de surexposition ont été mesurées, de la connaissance des endroits actuels de travail, il est possible de prédire, avec une bonne certitude, la dose moyenne d'exposition pour une occupation non encore étudiée. A plusieurs reprises des mesures d'exposition dans nos usines ont confirmé de telles évaluations. S'il est possible de procéder à une bonne évaluation des doses d'exposition d'occupations actuelles, il est donc également possible d'effectuer aussi une bonne évaluation des doses d'exposition antérieures, c'est-à-dire pour les périodes où la mesure acoustique n'existait pas.

Pour ce genre d'évaluation il faut tenir compte des conditions de travail présentes et passées. A titre d'exemple mentionnons que si en 1940 le travail était surtout manuel et l'ambiance sonore peu bruyante, il est assez facile d'évaluer que la dose d'exposition était "faible", i.e. dans la classe 85 dBA. Si par contre aujourd'hui il n'y a plus de problème de surexposition au bruit mais qu'à une certaine époque antérieure, le travailleur était affecté pav un poste bruyant et/ou utilisait encore un outil bruyant, la dose d'exposition peut être évaluée dans une classe de 95 dBA équivalent. Souvent à cause des variations de doses d'exposition, une occupation pourrait être évaluée avec des doses se situant entre les classes 85 à 95 dBA avec une répartition temporelle proportionnelle à la fréquence possible d'affectation à un travail plus ou moins bruyant.

Suite à des rencontres avec d'anciens membres du personnel cadre et, quelquefois des travailleurs eux-mêmes, il est possible de reconstituer assez bien le milieu de travail (doses d'exposition) et la charge de travail antérieur (répartition en temps).

Les éléments essentiels pour établir un profil d'exposition au bruit sont donc:

a) une bonne connaissance des doses d'exposition au bruit des nombreuses occupations dans l'usine;
b) une quasi-certitude dans l'évaluation des doses d'exposition antérieure;
c) une classification et répartition temporelle de ces doses.

En rassemblant tous ces éléments, il est possible de préparer un tel profil si on connaît les occupations et endroits de travail auxquels a été exposé le réclamant.

Historique de travail

Deux dossiers essentiels pour reconstituer l'historique de travail d'un travailleur sont sa fiche de route et sa fiche de paie. De la fiche de route on peut établir la date d'embauche, les périodes d'absence, les secteurs et les postes de travail auxquels il a été affecté. La fiche de paie peut parfois être utile pour établir le nombre d'heures spécifique à certains postes de travail.

Généralement ces deux fiches sont suffisantes pour établir l'historique de travail d'un travailleur. Cependant pour vérification, il est essentiel de contacter les superviseurs immédiats et d'autres superviseurs pour qui l'employé aurait travaillé afin de mieux préciser la nature et les endroits de travail auxquels il a été exposé. Dans le cas d'incertitude une rencontre avec le travailleur est parfois nécessaire.

Elaboration d'un profil d'exposition au bruit

Pour chaque demande de réparation une fiche est préparée, décrivant pour chaque période appropriée, l'endroit et le poste de travail, si la dose d'exposition pour ce poste a été évaluée ou mesurée et la répartition temporelle de la dose d'exposition s'il y a lieu, dans l'une des classes de niveau équivalent - 8 h de 85, 90 ou 95 dBA.

Des notes explicatives peuvent être ajoutées pour justifier la répartition temporelle des doses d'exposition et données des conditions d'opération à diverses époques expliquant pourquoi les doses d'exposition ont été évaluées dans une certaine classe d'exposition.

Deux exemples-types de la préparation d'un tel profil sont montrés aux tableaux IV et V. A partir de ce profil on peut déterminer le nombre total d'années et de mois dans chaque classe d'exposition et du fait même, l'exposition globale au bruit pour la période totale de travail à l'usine.

Un profil global d'exposition au bruit basé sur le concept de dose, indice d'exposition ou niveau équivalent en dBA est une étape essentielle pour établir un diagnostic d'imputabilité, i.e. s'il existe une relation possible de cause à effet d'une atteinte dite indemnisable.

Barème de réparation de la surdité professionnelle

Avant d'aborder la relation entre exposition globale et risque ou niveau d'affection il serait peut-être utile de rappeler brièvement le barème d'incapacité partielle permanente (IPP) adopté au Québec pour perte d'audition.

Ce barème est basé sur un déficit auditif moyen à partir de 25 dB (zéro audiométrique ISO 1964) aux fréquences audiométriques par voie aérienne de 0,5 1,0 et 2,0 kHz. Pour des pertes moyennes de 25 à 65 dB, le pourcentage de l'IPP varie de 0 à 25% pour l'oreille la moins atteinte et de 0 à 5% pour l'oreille la plus atteinte pour un total possible de l'IPP variant de 0 à 30%. Pour un réclamant âgé de 60 ans et plus, 0,5 dB par année d'âge est déduit de la moyenne des pertes pour chaque oreille.

Diagnostic de risque de la perte auditive en relation avec la dose globale d'exposition

L'évaluation du déficit auditif en fonction du nombre d'années global d'exposition à diverses classes d'exposition (ou risque) demeure la tâche la plus difficile.

Cependant, suite à de nombreuses études de relation de cause à effet effectuées dans de nombreuses industries telles que l'industrie minière[22], métallurgique[15, 17-19], textile[21] et par divers organismes et auteurs[14,20,36,37], il est possible, en se basant sur les pertes médianes, d'établir le nombre d'années approximatif requis

TABLEAU IV

EXEMPLE SIMPLIFIE D'UN PROFIL D'EXPOSITION AU BRUIT

Nom: XX YY Age: 31 ans

Date d'embauche: Juillet 1966 Années de travail: 12 ans 3 mois - 2 ans 9 mois
9 ans 6 mois

EVALUATION DE L'EXPOSITION AU BRUIT

Date	Secteur de travail	Occupation	Exposition au bruit (Dose)				
			Mesurée	Evaluée	Répartition temporelle dans les classes de niveaux équivalents - 8 h (dBA)		
					85	90	95
66.07-67.07	A	1		X	2/5	2/5	1/5
67.07-69.07	Absent						
69.07-69.09	B	2		X	←→		
69.09-69.12	C	3		X	←→		
69.12-70.02	Absent						
70.02-70.07	D	4		X	←→		
70.07-70.08	Absent						
70.08-70.11	D	5		X	←→		
70.11-71.03	E	6		X	←→		
71.03-71.07	E	7		X	1/3	1/3	1/3
71.07-75.04	A	1-1		X	2/5	2/5	1/5
75.04-75.06	Absent						
75.06-76.06	A	1-2		X	2/5	2/5	1/5
76.06-76-11	Absent						
76.11-78.10	A	1-2	X		2/5	2/5	1/5

Le profil global d'exposition au bruit se résume comme suit: sur une période de 12 ans 3 mois de service: 2 ans 9 mois absent, 4 ans 7 mois dans la classe 85 dBA, 3 ans 7 mois dans la classe 90 dBA et 1 an 9 mois dans la classe 95 dBA.
Considérant les années d'exposition dans les classes 90 et 95 dBA, ce genre d'exposition est insuffisant pour résulter en un déficit auditif indemnisable.

Verdict CSST: Hors barème.

TABLEAU V

EXEMPLE SIMPLIFIE D'UN PROFIL D'EXPOSITION AU BRUIT

Nom: ZZ WW Age: 45 ans

Date d'embauche: Juin 1956 Années de travail: 23 ans 5 mois - 5 ans 7 mois= 17 ans 10 mois

EVALUATION DE L'EXPOSITION AU BRUIT

Date	Secteur de travail	Occupation	Exposition au bruit (Dose)				
			Mesurée	Evaluée	Répartition temporelle dans les classes de niveaux équivalents - 8 h (dBA)		
					85	90	95
56.06-56.08	F	8		X			
56.08-57.05	G	8		X	2/3	1/6	1/6
57.05-57.09	Absent						
57.09-58.09	G	8		X	2/3	1/6	1/6
58.09-58.11	H	8		X	1/2	1/2	
58.11-59.10	Absent						
59.10-60.05	H	8		X	1/2	1/2	
60.05-61.01	I	8		X	2/3	1/6	1/6
61.01-61.03	Absent						
61.03-61.04	J	8		X	1/3	1/3	1/3
61.04-61.07	I	8		X	2/3	1/6	1/6
61.07-62.11	Absent						
62.11-62.12	J	8		X	1/3	1/3	1/3
62.12-63.07	K	8		X	1/5	2/5	2/5
63.07-64.03	Absent						
64.03-65.04	I	8		X	2/3	1/6	1/6
65.04-65.07	H	8		X	1/2	1/2	
65.07-65.08	Absent						
65.08-70.04	K	8		X	1/5	2/5	2/5
70.04-70.08	Absent						
70.08-73.02	K	8		X	1/5	2/5	2/5
73.02-74.11	Absent						
74.11-79.11	L	8	X		1/5	1/5	3/5

Le profil d'exposition au bruit se résume comme suit: sur une période de 23 ans 5 mois de service: 5 ans 7 mois absent, 5 ans 10 mois dans la classe 85 dBA, 5 ans 6 mois dans la classe 90 dBA et 6 ans 9 mois dans la classe 95 dBA.
Considérant les années d'exposition dans les classes 90 et 95 dBA, tout en tenant compte du caractère intermittent des niveaux sonores et doses d'exposition, l'exposition globale a été jugée comme possiblement suffisante pour résulter en un déficit auditif indemnisable mais à un niveau "faible" (IPP de 0 à 5%).

Verdict CSST: 1% IPP.

dans chaque classe d'exposition pour atteindre un déficit auditif dit indemnisable. De plus il serait utile d'essayer de prédire le niveau d'indemnisation, i.e. le niveau de l'IPP, si l'exposition globale est "suffisante".

Par exemple, considérant le caractère intermittent des doses d'exposition dans notre industrie, il semble que cela prenne plus de trente années d'exposition dans la classe de 85 dBA équivalent pour être affecté d'un déficit auditif professionnnel dit indemnisable, d'environ 15-20 ans dans la classe 90 dBA et de 8-12 ans dans la classe de 95 dBA (si on avait une classe de 100 dBA équivalent, nous jugerions que cela prendrait 5 à 8 ans d'exposition pour atteindre un déficit auditif dit indemnisable).

Plus les années d'exposition dans une classe augmentent au-delà du nombre minimum approximatif pour une affection possible indemnisable, plus le niveau de perte sera grand.

Par exemple si la dose globale d'un travailleur a été évaluée à 10 ans dans la classe de 95 dBA, le déficit auditif indemnisable sera évalué "faible" (perte moyenne bilatérale légèrement supérieure à 25 dB), alors que si la dose globale avait été évaluée à 20 ans dans cette même classe, le déficit auditif indemnisable sera alors évalué plus "prononcé".

Pour prédire le niveau possible d'affection, il faut tenir compte de l'exposition globale dans chacune des classes mais principalement dans les classes 90 dBA et 95 dBA (et d'autres classes supérieures s'il y a lieu). Considérant la probabilité très faible de perte d'acuité auditive dite indemnisable dans la classe 85 dBA, l'exposition globale dans cette classe est à toutes fins pratiques ignorée. En d'autres termes il faut tenir compte de la combinaison d'exposition globale dans les classes 90 et 95 dBA. Par exemple, une exposition globale de 10 ans dans les classes 90 dBA et de 5 ans dans la classe 95 dBA est possiblement suffisante pour résulter en un déficit auditif dit indemnisable.

Facteurs additionnnels à considérer dans le degré d'affection

Quoique l'on puisse arriver à une exposition globale à différentes classes de doses d'exposition il faut de plus prendre en considération d'autres facteurs qui influenceront quelque peu la prédiction du niveau d'affection. A titre d'exemple, signalons les variables suivantes:

a) la nature du bruit résultant en des doses de surexposition, i.e. bruit et dose intermittente d'exposition (présumés moins dommageables) VS bruit et dose stable d'exposition;
b) contenu fréquentiel du bruit, i.e. bruit à prédominance basses fréquences (inférieur à 500 Hz) VS bruit à prédominance hautes fréquences (supérieur à 500 Hz, présumé plus dommageable);
c) présence ou non de bruit impulsionnel ou quasi-impulsionnel assez "élevé" (présence de ces bruits présumée plus dommageable);
d) l'âge et la date d'embauche de l'employé.

Prédiction du niveau d'indemnisation (IPP)

Le profil d'exposition au bruit d'un employé est un outil indispensable pour non seulement aviser nos médecins de la relation possible de cause à effet mais aussi d'essayer de prédire le niveau d'affection, i.e. l'ordre de grandeur du niveau de l'IPP.

Basé sur la combinaison des années d'exposition dans les classes de 90 dBA et 95 dBA, le niveau de perte d'acuité auditive dit indemnisable est évalué entre très faible (IPP entre 0 et 5%), faible (entre 5 à 10%), modéré (entre 10 à 15%) et prononcé (plus de 15%).

Une fois le profil d'exposition complété et la prédiction du niveau possible d'affection, ces informations sont fournies au service médical.

Le service médical peut se servir du profil d'exposition global d'un employé pour accepter ou contester le verdict de réparation de la CSST.

<u>Relation entre les prédictions du niveau d'un déficit auditif et les verdicts rendus par la CSST dans des dossiers de demandes de réparation pour prétendue surdité professionnnelle</u>

Les tableaux VI et VII, montrent une bonne relation entre le nombre d'années d'exposition établi, dans les classes d'exposition de 90 et 95 dBA équivalent, pour plusieurs profils d'exposition au bruit, la prédiction du niveau du déficit auditif indemnisable dans chacun d'eux et les verdicts rendus par la CSST.

Des données aux tableaux VI et VII, les observations générales suivantes peuvent être tirées:

a) pour notre industrie, une dose globale d'exposition inférieure à 8 à 10 ans pour l'ensemble des classes 90 et 95 dBA est nettement insuffisante pour résulter en un niveau du déficit auditif dit indemnisable;
b) en général, comme prévu, plus le nombre total d'années d'exposition excède 8 à 10 ans pour l'ensemble des classes 90 et 95 dBA, plus le niveau du déficit auditif indemnisable augmente;
c) le déficit auditif indemnisable semble plus relié au nombre d'années d'exposition dans la classe 95 dBA que celle de 90 dBA.

<u>DISCUSSION</u>

La préparation d'un profil d'exposition au bruit d'un employé, suite à une demande de réparation pour prétendue surdité professionnelle est une étape essentielle pour déterminer si une relation de cause à effet est possible et si oui, de prédire le niveau indemnisable du déficit auditif.

Pour préparer un tel profil d'exposition, il est essentiel d'utiliser le concept de doses d'exposition réparties temporellement en tenant compte des conditions d'opération présentes et passées. Essayer d'évaluer l'exposition au bruit d'un travailleur en se basant simplement sur quelques mesures de niveaux sonores, surtout si les bruits et les durées d'exposition sont variables, demeure la technique la moins précise.

Plusieurs organismes[29-33] ont proposé des méthodes pour établir des indices d'exposition basées sur des niveaux équivalents journaliers ou hebdomadaires. A partir de ces niveaux équivalents des abaques du risque d'affection en fonction de la durée d'exposition sont utilisés. La méthode utilisée en Angleterre[30,33] a l'avantage d'établir un indice d'exposition pour le nombre d'années d'exposition (concept de "Noise Immission Level"). Néanmoins toutes ces méthodes proposées sont basées sur une exposition à des bruits et une durée d'exposition stable qui, en réalité, ne se rencontrent pratiquement pas dans toute la carrière d'un travailleur.

TABLEAU VI

EXEMPLE DE RELATION ENTRE LE NOMBRE GLOBAL D'ANNEES D'EXPOSITION DANS LES CLASSES 90 ET 95 dBA EQUIVALENT - 8 h, LA PREDICTION DU DEFICIT AUDITIF ET LES VERDICTS RENDUS PAR LA CSST

Cas No	Prédiction globale au bruit Années dans les classes d'exposition		Prédiction du déficit auditif	Verdict (CSST) du déficit auditif
	90 dBA	95 dBA		
1	1	3/4	n.i. (a)	m.p. (b)
2	1-1/2	1	n.i.	m.p.
3	2	1/2	n.i.	h.b. (c)
4	1	1-1/2	n.i.	h.b.
5	1-1/2	1-1/2	n.i.	m.p.
6	2	1-1/2	n.i.	h.b.
7	3	2	n.i.	h.b.
8	2-2/3	2-2/3	n.i.	h.b.
9	3	3	n.i.	h.b.
10	3	3	n.i.	m.p.
11	-	5	n.i.	h.b.
12	6-1/2	1/2	n.i.	h.b.
13	5	2	n.i.	h.b.
14	4-1/2	4	n.i.	m.p.
15	8	1	n.i.	m.p.
16	8	2	n.i.	h.b.
17	5	5	n.i.	m.p.
18	10-1/2	1/2	n.i.	m.p.
19	8-1/2	4-1/2	n.i	m.p.
20	10	6	n.i.	h.b.

(a): n.i.: non indemnisable
(b): m.p.: maladie personnelle
(c): h.b.: hors barème

TABLEAU VII

EXEMPLE DE RELATION ENTRE LE NOMBRE GLOBAL D'ANNEES D'EXPOSITION

DANS LES CLASSES 90 ET 95 dBA EQUIVALENT - 8 h,

LA PREDICTION DU DEFICIT AUDITIF ET LES VERDICTS D'IPP RENDUS PAR LA CSST

Cas No	Exposition globale au bruit. Années dans les classes d'exposition		Prédiction du déficit auditif (Gamme % IPP)	Verdict (CSST) du déficit auditif (% IPP)
	90 dBA	95 dBA		
21	11	8	très faible (0-5)	refusé
22	8	8	très faible	refusé
23	22	-	très faible	refusé
24	4	10	très faible	refusé
25	10-1/2	3-1/2	très faible	1
26	5	6	pas à très faible	1
27	7	7	très faible	3-1/2
28	3	8	très faible	1
29	8-1/2	8-1/2	très faible	1/2
30	8-1/2	8-1/2	très faible	1/2
31	9	9	très faible	3-1/2
32	9	6	faible (5-10)	6-1/2
33	12	7	faible	7-1/2
34	14	9	faible	9
35	8	15	faible-modéré (5-15)	6
36	9	16	faible-modéré	6
37	2	12	modéré (10-15)	10-1/2
38	-	20	modéré	12
39	11	11	modéré	16-1/2
40	14	15	modéré	15
41	6	25	prononcé (>15)	10-1/2
42	11	11	prononcé (>15)	16-1/2
43	4-1/2	20-1/2	prononcé	21
44	16-1/2	13-1/2	prononcé	

Les méthodes proposées ne tiennent nullement compte de la variation temporelle des doses d'exposition, de l'effet du travail saisonnier plus ou moins bruyant, s'il y a lieu, des changements technologiques d'opération en fonction des années. La méthode proposée de classifier les doses équivalentes d'exposition (85, 90, 95 dBA) avec une répartition temporelle s'il y a lieu, apparaît de loin des plus réalistes. De plus le profil d'exposition au bruit indique et tient compte des périodes d'absences durant les années de service pour en arriver à une durée nette d'exposition. Les méthodes déjà proposées ignorent complètement ce fait.

L'idéal serait d'établir un indice de nocivité réelle du bruit, par poste de travail ou par atelier. A priori cette notion semble intéressante mais encore là, il faudra constamment que cet indice soit évolutif en relation des changements continuels des postes de travail et des conditions d'opération.

La façon suggérée de préparer un profil d'exposition au bruit pourrait être l'amorce d'une approche universelle pour établir le nombre d'années d'exposition à différentes classes de niveau équivalent - 8 h. Pour augmenter la précision dans la prédiction du niveau du déficit auditif, il y aurait peut-être lieu d'y ajouter les classes de 100, 105 et 110 dBA équivalent - 8 h, si de telles doses d'exposition se rencontrent dans une usine donnée.

Un sujet de discussion demeure sans contredit celui d'évaluer ou de reconstituer les doses d'exposition des conditions de travail antérieures. Pour une usine donnée, si l'historique de travail de cette usine est bien établi, l'évaluation des doses d'exposition est des plus fiables et alors, le profil global d'exposition. De plus, si l'on tient une statistique à jour entre les profils d'exposition, les niveaux d'imputabilité prédits et les verdicts de la CSST, le degré de confiance s'établit. A l'occasion, pour un secteur donné, certains ajustements légers peuvent être possibles, i.e. tendance à surévaluer ou sous-évaluer les doses d'exposition et leur répartition temporelle.

Pour prédire le déficit auditif et le niveau indemnisable à partir du nombre d'années d'exposition dans les classes de 90 et 95 dBA équivalent - 8 h, les déficits auditifs médians publiés dans de nombreuses études[14-28] sont utilisés. Cette approche pourrait porter à discussion mais il semble que c'est une façon plus réaliste que d'utiliser les résultats pour les déciles de population de travailleurs les moins atteints ou les plus atteints. Il est à noter que la majorité des études de cause à effet n'est pas basée sur de vrais historiques d'exposition au bruit pour chaque sujet (ce qui est long et difficile à faire), mais généralement basée sur des postes de travail avec une ambiance sonore quasi stable ou présumée stable. Considérant ces facteurs et que dans notre industrie l'exposition au bruit est généralement intermittente, il nous semble justifiable d'utiliser les valeurs médianes du déficit auditif que l'on retrouve dans plusieurs études.

En résumé il est essentiel de préparer un profil d'exposition au bruit d'un employé suite à une demande de réparation pour prétendue surdité professionnelle afin d'aider les services médicaux d'une entreprise à déterminer, le plus professionnellement possible, s'il y a relation de cause à effet et si oui, de prédire le niveau du déficit auditif indemnisable.

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Speech intelligibility in noise with ear protectors

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Abstract. Speech perception was tested in high level noise under controlled laboratory conditions in noise-exposed workmen and normal subjects, with and without a hearing protector. The group was further divided by age and English fluency, the latter group being included because of the high proportion of non-fluent Fnglish speakers in the Canadian workforce. In normal-hearing subjects the highest discrimination scores were found without background noise, they were lower with white noise as a masker, and even lower with crowd noise as a masker; wearing of a protector had no effect on intelligibility. The results for non-fluent English speakers were parallel with these results, but the scores were lower in all test conditions. In the presence of a high frequency hearing loss speech discrimination was lower than in the normals in quiet and in noise. The addition of a hearing protector dropped their discrimination score even further. In a flat hearing loss, wearing of a protector also worsened the speech discrimination score. The results are discussed.

It is generally agreed that exposure to intense sound may result in a loss of hearing, either temporary or permanent[1]. In industrial settings ear defenders have been chosen as one method of hearing conservation which is both effective and inexpensive. The practicality of this solution depends on two considerations: first, the extent to which the defender selected reduces the noise transmitted to the cochlea (*i.e.*, the attenuation of the device over a wide range of frequencies); and secondly, the possible interference with perception of warning signals[2] and instructions on the job.

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ATTENUATION

Ear plugs are made of a wide variety of materials, from paper tissue to silicone, vinyl, sponge, plastic, glass wool, and rubber. They may be either formed by the user, factory formed, or custom molded. Measurements of the attenuation spectra of 45 common brands have been published recently by Tobias[3]. The results indicated that, in general, the amount of attenuation increased with increase in frequency in the range of 250 to 4,000 Hz. Across defender types, attenuation scores varied from two to 25 dB at 250 Hz, and from 15 to 48 dB at 4,000 Hz. Within defenders, the difference in attenuation between these two frequencies varied from 0 dB (*i.e.*, a flat attenuation spectrum) to 30 dB. In the higher frequencies, from 8,000 to 18,000 Hz, attenuation values of 25 to 35 dB have been demonstrated[4] for selected types of rubber insert and polymer foam plugs and circumaural ear muffs.

Several reports in the literature comment on the effectiveness of ear defenders in reducing the incidence of noise-induced high frequency deafness for large numbers of workmen. In one study[5], 30,000 workmen were categorized according to level of noise exposure ranging from quiet surroundings to levels in excess of 90 dBA. Protectors were routinely worn in levels of 90 dBA or greater. A cross-sectional analysis of hearing thresholds for different age groups indicated that loss of hearing with age occurred at about the same rate for all exposure categories. Longitudinal studies, that is, the measurement of hearing thresholds in individual workmen over relatively long time periods have confirmed these findings[6].

SPEECH PERCEPTION

In listeners with normal hearing the wearing of ear defenders does not appear to interfere with speech intelligibility. Kryter[7] for example, asked a small group of college students to repeat monosyllables presented over a loudspeaker. Measurements were made for the open ear and with a defender in the ear canal. The level of noise varied from 65 to 105 dB SPL. The results showed that as signal-to-noise ratio was varied from –15 to 10 dB, intelligibility scores increased substantially from 0 to 80 per cent correct. The presence of an ear plug had no effect for noise less than 80 dBA and actually contributed to a gain of about 10 per cent in discrimination for higher levels.

The informal complaints of workmen that protectors prevent them from communicating adequately in a noisy work situation are in stark distinction to published reports of improved discrimination with ear protectors. Published data bear on this issue but do not answer the question directly. Coles and Rice[8], tested speech discrimination in normal hearing and in impaired subjects in quiet with and without an ear plug. Those subjects with severe high tone losses performed more poorly in both conditions. It has been argued[8,9] that in subjects with noise-induced deafness, the protector – with attenuation biased toward the higher frequencies – puts the level of speech below the already raised hearing thresholds in that range.

Study of the effect of noise on hearing, without consideration of protective devices[10], indicates that for signal-to-noise ratio of –8 subjects with hearing impairment perform more poorly than normal hearing subjects. Those with flat loss are more severely handicapped than those with increased thresholds in the high frequencies only. In quiet, with speech at about 40 dB SL, all three groups gave discrimination scores close to 90 per cent correct. The effect of combining the wearing of a muff and white noise background has been examined in subjects with high-tone loss by Lindeman[11]. The levels of speech and noise were 80 and 90 dBA respectively. The results indicated that a decrease in performance in the protected condition was significantly correlated with an increase in hearing loss. For slight impairment the muff produced some improvement in speech perception.

The present experiment is an extension of recent studies[12] of the effectiveness of ear protectors in industrial noise, for workers with pre-existing, noise-induced hearing loss. Specifically, we are attempting to assess changes in speech perception that occur with variation in age, type of hearing loss, and the spectrum and relative level of the noise background. Of particular interest is the extent to which non-fluency with the spoken language provides an additional handicap for the hard-of-hearing. According to Statistics Canada[13], approximately 23 per cent of residents in Ontario in 1971 acquired English as a second language. For this group no data are available on the extent to which poor comprehension of instructions in English, apart from a hearing disability, interferes with communication in the industrial setting.

DESIGN AND METHODS

The experimental design provided for a comparison of three groups of subjects. Those with: i) normal hearing, defined by conventional audiometric tests (*i.e.*, puretone and speech thresholds); ii) bilateral high frequency loss (*i.e.*, 5-25 dB at 500 Hz with a slope in hearing loss of 35-65 dB between 500 and 4,000 Hz); and iii) bilateral flat loss (*i.e.*, 40-60 dB at 500 Hz and 50-70 dB at 4,000 Hz.

For each of these hearing types, two subgroups were examined: those fluent in English (*i.e.*, native language or acquired in primary school), and those not fluent (for whom English was acquired as a second language). Fluency was assessed using a three point rating scale:

0 – Fluent, English is native language or language of choice (acquired in primary school and used 90 per cent of the time).

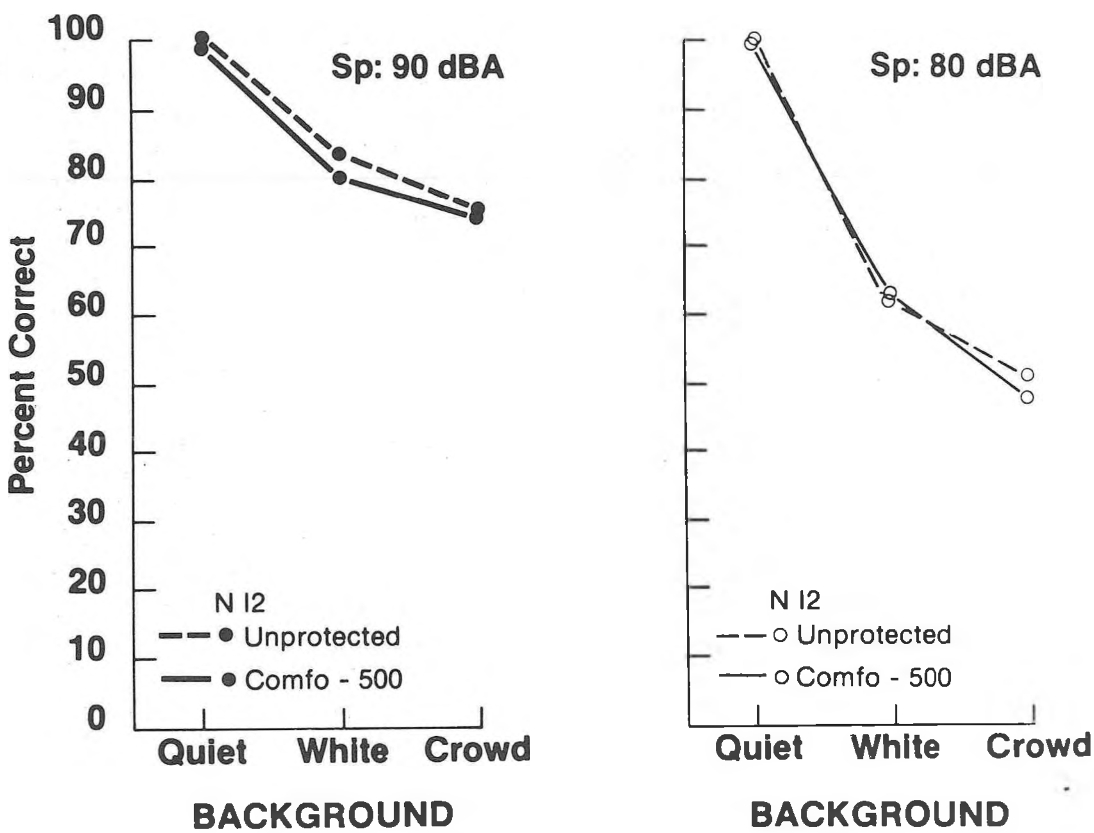

Fig. 1. Speech intelligibility in normal hearing, fluent subjects, aged 35 to 50 years.

1 – Non-fluent, *i.e.* English spoken ungrammatically, difficulty in finding appropriate words but able to converse and to understand instructions adequately.

2 – Non-fluent, *i.e.* one word English sentences or short phrases used, frequent gesturing and difficulty in understanding instructions.

Potential candidates for the study were rated independently by two audiologists and the attending otolaryngologist. Those with a rating of 2 were rejected from the study. Subjects with high-frequency loss, both fluent and non-fluent, were further subdivided into two age groups: 35-50 years and 51-65 years. Normal subjects ranged from 35-50 years of age. Subjects with flat loss were difficult to find and therefore were taken at any age between 35 and 65 years. In each of the eight subgroups 12 subjects were tested. Most subjects were patients referred to the Department of Otolaryngology for assessment of occupational hearing loss. Normal hearing subjects were volunteers from the hospital's housekeeping staff.

Subjects were tested individually while seated in an IAC booth. The ambient noise level of the booth met ANSI[14] standards. Speech stimuli were presented over a single 12 inch diameter conical loudspeaker (Madsen Electronics, Model FF73) placed free-standing on the floor at a distance of 80 inches directly in front of the subject. Noise was presented through two six-inch diameter conical speakers (Madsen Electronics, Model FF72) mounted on the side walls of the booth at a distance of 54 inches from the subject's ears and 11 inches above the head.

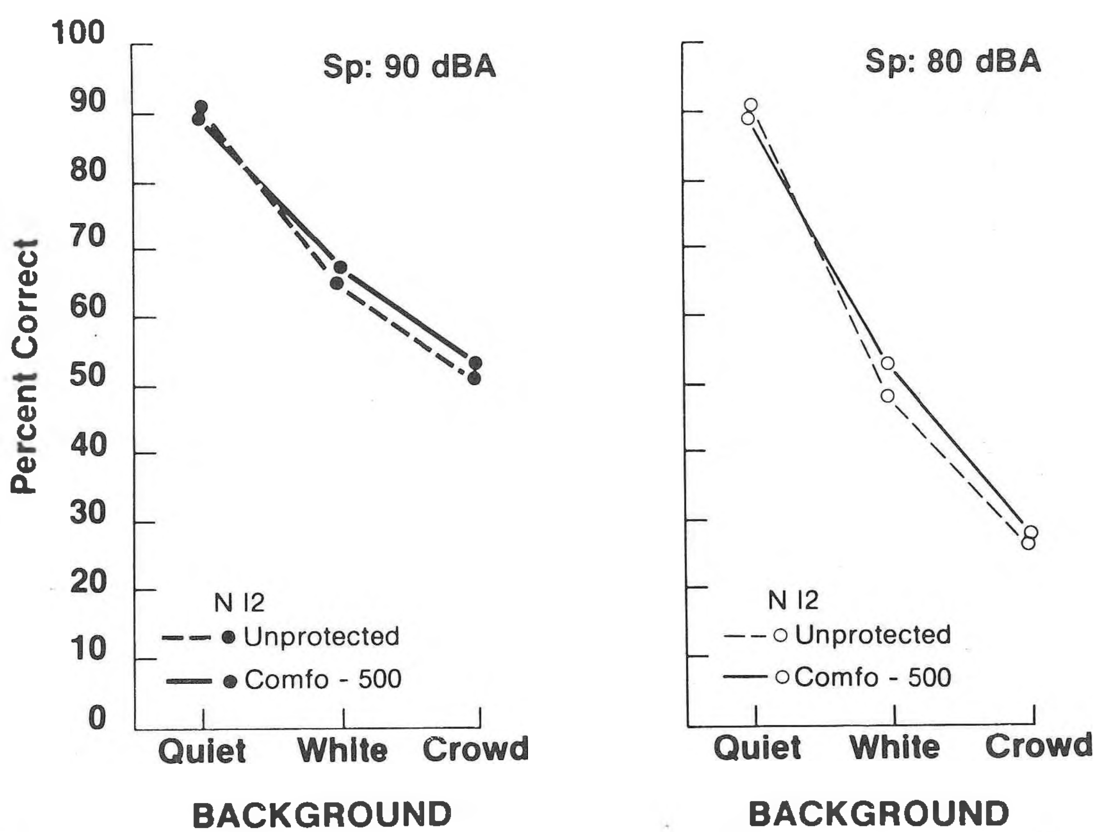

Fig. 2. Speech intelligibility in normal hearing, non-fluent subjects, aged 35 to 50 years.

Each subject was presented 12 lists of 25 monosyllabic words. The lists were constructed using the PAL-PB50 word lists and recorded on tape by a male speaker. The average discrimination threshold (level for reporting 75 per cent of the words correctly for five experienced listeners with normal hearing) ranged from 19 to 23 dBHL across the 12 lists.

Each list was presented under one of 12 listening conditions. We varied the background noise (quiet, white, or taped crowd noise), the amplitude of speech (80 or 90 dBA), and the presence of ear protection (Comfo-500 muff)*. The level of background noise when present was constant at 85 dBA. Across the 12 subjects in the group both the order of listening conditions and the lists used for each condition were randomized.

In addition to this procedure, thresholds for 1/3 octave narrow band noise were measured with the open ear and with the muff in place at each of 10 centre frequencies. The difference in each pair of measures gave the attenuation provided by the defender at each frequency.

Manufacturer: MSA

RESULTS

Preliminary results are presented in Figures 1-6 for six of the eight experimental subgroups. Testing of two groups: high frequency, non-fluent, 35-50 years; and flat loss, non-fluent, 35-65 years, were not completed at the time of analysis of results. In each figure the percentage of words correctly repeated is plotted against the noise back-

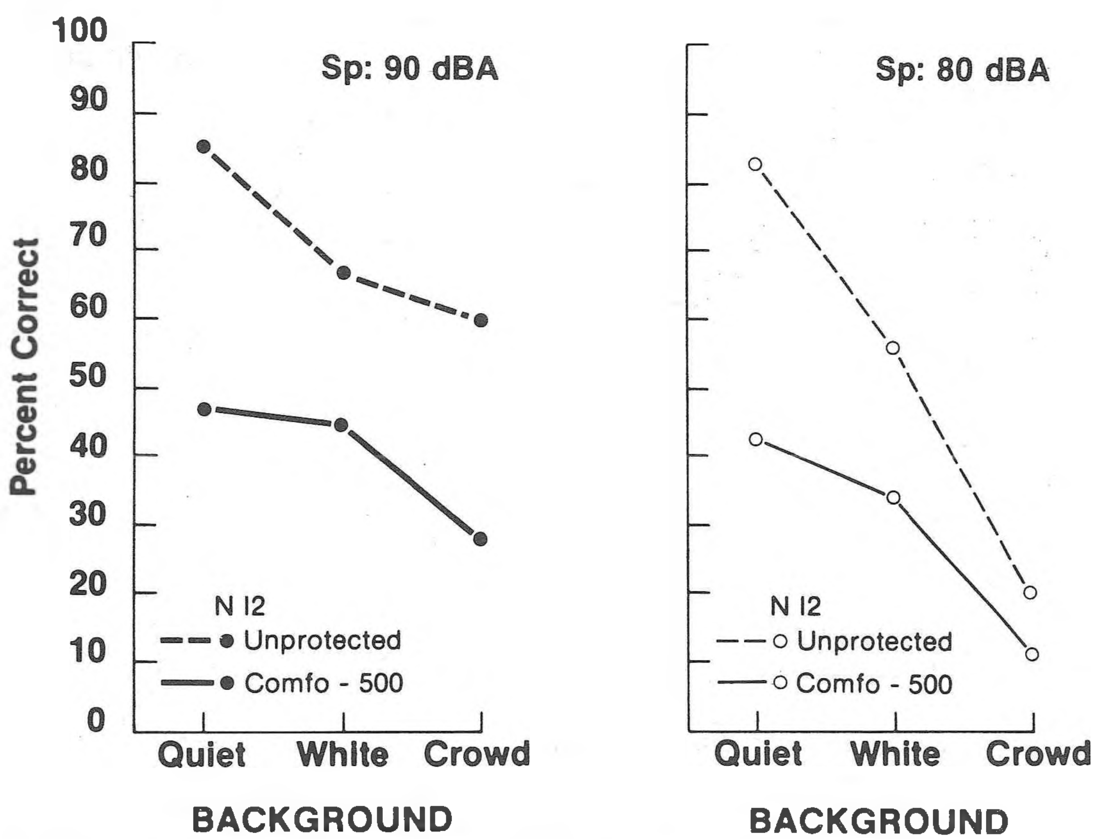

Fig. 3. Speech intelligibility in fluent subjects with high frequency loss, aged 35 to 50 years.

ground. Each data point is the average result for the 12 subjects in the group. The dotted line shows the unprotected score and the solid line gives the score obtained with the muff worn. For the left panel in each figure the speech was presented at 90 dBA, and for the right at 80 dBA.

Attenuation

The attenuation data for the six groups are presented in Figure 7. Each data point is the average for the 12 subjects in the group. No systematic differences were observed between groups. The muff gave little attenuation, about 5-10 dB in the low frequencies. From about 1,000-4,000 Hz average attenuation scores of about 20-30 dB were observed. About 4,000 Hz attenuation scores began to decrease.

Within and Between Group Comparisons

1. Normal hearing (Figures 1 & 2)

Fluent: several results are evident from these data. A significantly greater score is achieved listening in quiet than in noise, and crowd noise provides a more effective masker than white noise. In either of the two noise backgrounds intelligibility decreases significantly with a 10 dB drop in the amplitude of speech. For any combination of background and speech level, the protector has no effect on intelligibility. Each of these effects was evaluated using paired comparison t-tests and found to be statistically significant beyond the .001 level.

Non-fluent: the results for non-fluent subjects are essentially the same as those for fluent subjects. Comparison across the two

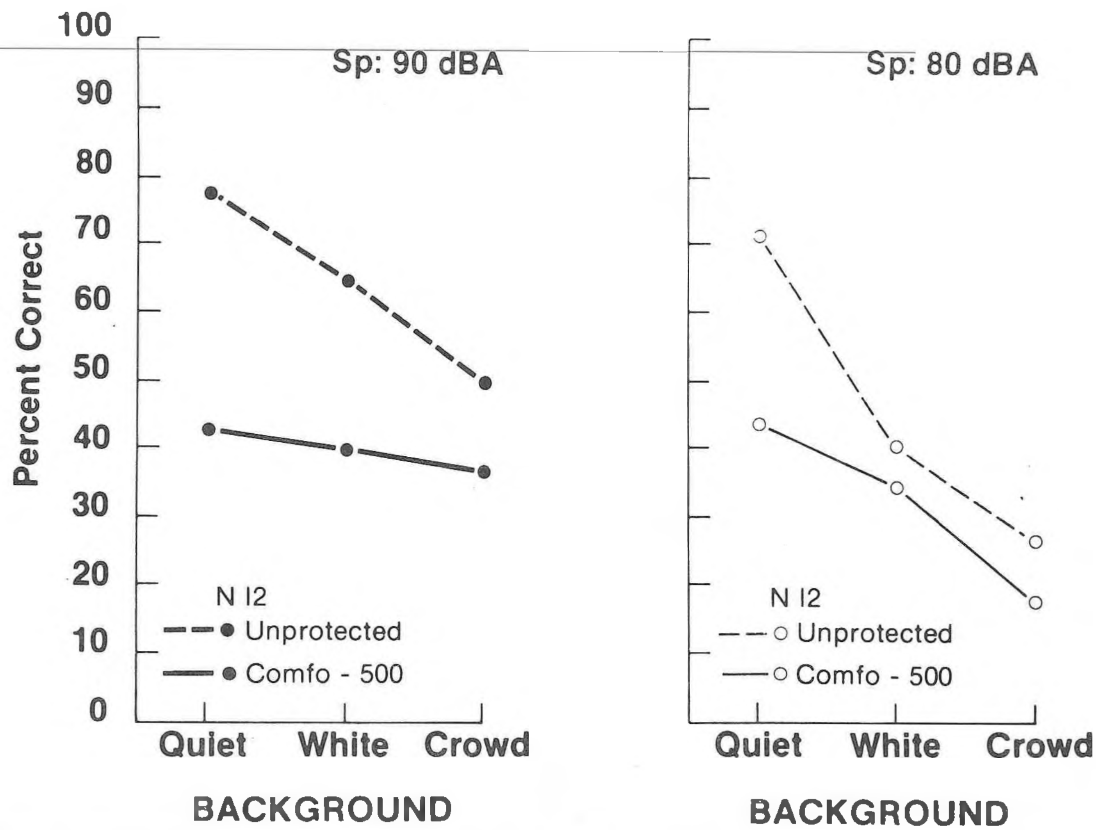

Fig. 4. Speech intelligibility in non-fluent subjects with high frequency loss, aged 51 to 65 years.

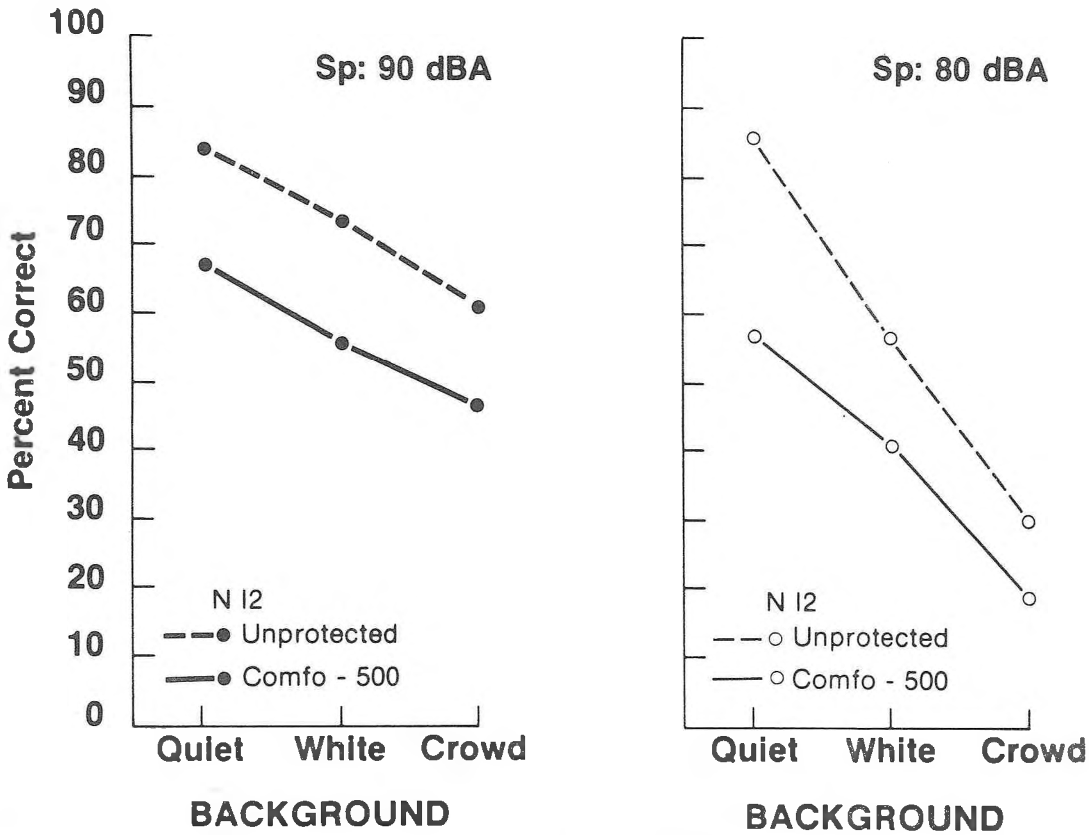

Fig. 5. Speech intelligibility in fluent subjects with high frequency loss, aged 51 to 65 years.

groups for each of the 12 conditions indicates that the scores for non-fluent subjects are significantly lower by about 15 per cent ($p < .01$).

2. *High frequency loss (Figures 3, 4, & 5)*

Fluent, 35-50 years: subjects with a high frequency loss show a different pattern of results from those with normal hearing. Again listening is easier in quiet than in noise and the percentage of words correctly repeated decreases with the lower amplitude of speech when presented in noise. In addition, these subjects show a substantial protector effect. In quiet there is a drop of about 40 per cent in speech discrimination when the muff is worn. In noise the difference between unprotected and protected values is smaller but still statistically significant ($p < .05$).

Non-fluent, 51-65 years: non-fluent subjects with a high frequency loss show a significant decrease in score for unprotected listening as the background changes from quiet to white to crowd noise ($p < .01$). When the muff is worn, background is an effective variable only for the lower amplitude of speech ($p < .005$). No differences are apparent at the higher speech-to-noise ratio.

If the results of this group are compared with fluent subjects matched for age and hearing loss, it is found that the non-fluency contributes a shift of 6-24 per cent across the various conditions. The effect is significant ($p < .005$) in only three instances: unprotected, low speech; quiet or white noise background; and protected, high speech, quiet background.

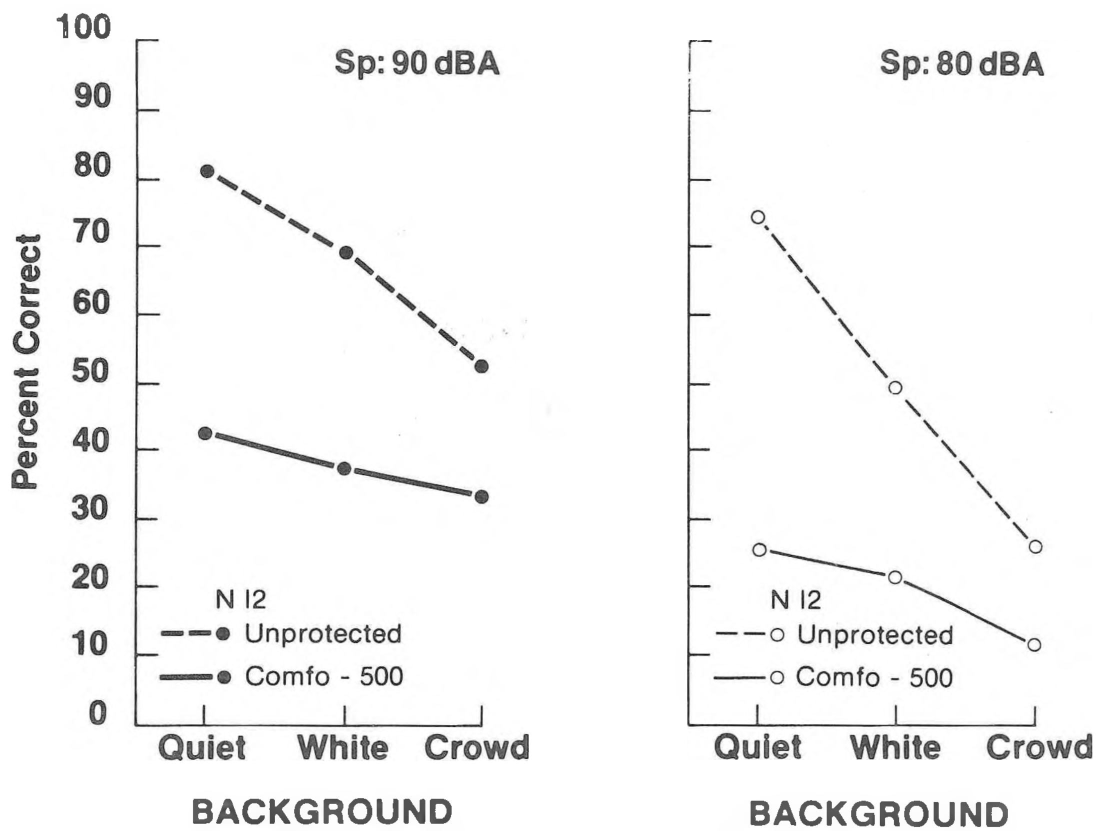

Fig. 6. Speech intelligibility in fluent subjects with flat loss, aged 35 to 65 years.

3. Flat loss (Figure 6)

Fluent, 35-65 years: the results for this group indicate that the protector used produced a significant decrement in speech perception for the six combinations of level of speech by background ($p < .001$). For each background by protector condition, scores decrease significantly with amplitude of speech ($p < .001$). With the muff, scores are similar for the three backgrounds at each signal amplitude.

Comparison of these subjects and those with high frequency loss, shows that for the protected conditions the flat loss results in a significantly poorer score in quiet and white noise, regardless of the signal amplitude ($p < .005$). Scores are similar in crowd noise. In the unprotected condition, the two groups differ only for listening in quiet at the lower level of speech ($p < .05$).

DISCUSSION AND CONCLUSIONS

Several conclusions may be drawn from the results presented. As might be expected, the attenuation provided by the Comfo-500 muff for noise presented free-field at threshold levels is essentially the same for all the experimental groups tested. On the contrary, intelligibility scores vary widely for listening with the open ear and muff, the difference depending on the particular combination of hearing configuration, fluency with the English language, level of speech, and noise background. Discrimination scores of subjects with normal hearing are unchanged by the wearing of an ear defender, but non-fluency,

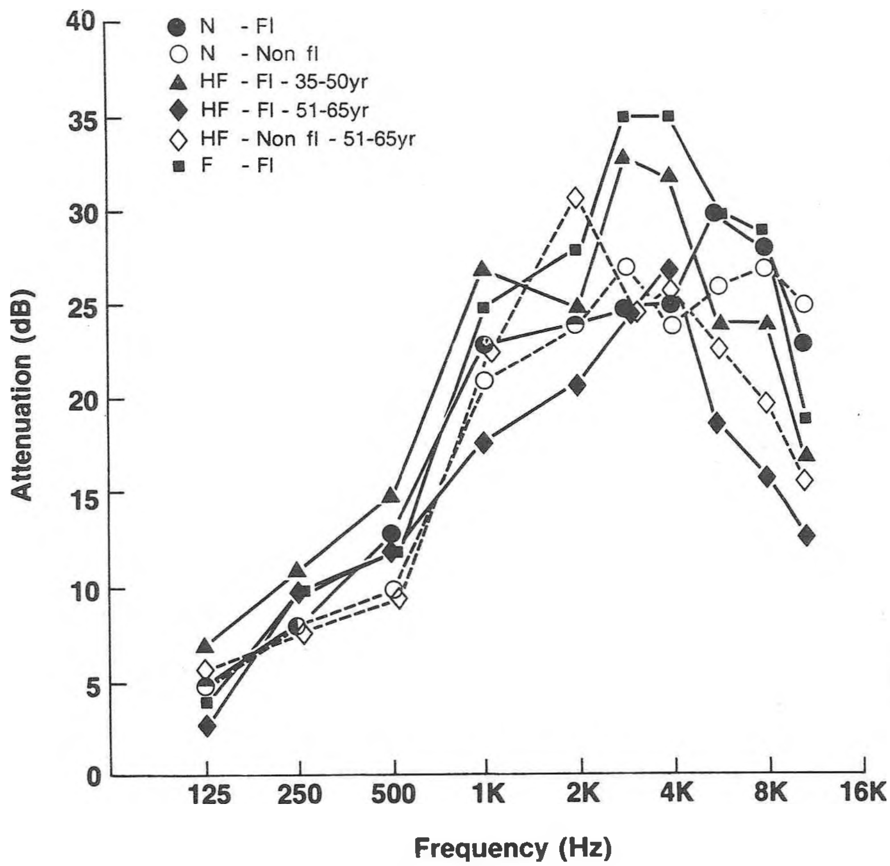

Fig. 7. Attenuation scores obtained with the Comfo-500 muff.

presence of a background noise, and lower speech-to-noise ratio all produce significant decrements in performance. Subjects with either high-tone or flat losses are substantially affected by the wearing of a muff. For a high-frequency loss, non-fluency does not appear to produce a clear and consistent decrement above that already produced by the hearing loss.

The practical consequences of these findings are substantial, particularly during the transitional phase from no hearing protection to full hearing conservation, which is currently taking place in so much of industry. There are substantial numbers of noise-exposed workers, whose hearing has already been damaged, who are now to wear personal protectors and in whom the ability to communicate may be significantly worsened by the devices. The question of linguistic ability has only been addressed marginally although, *de facto*, it is well known that to listen in a foreign language requires better listening conditions than in a language with which one is fluent. This series of experiments has shown that the non-fluent speaker is already at a greater communication disadvantage than the fluent, even before protectors are used, and strongly suggests the need for non-auditory means of communication in intense noise where language fluency cannot be guaranteed.

ACKNOWLEDGMENT

The authors wish to thank the staff of the Division of Audiology, Mount Sinai Hospital, for their considerable help in the testing of subjects and tabulation of data.

Résumé. Nous avons mesuré la perception du langage dans des niveaux de bruit élevé, sous des conditions de laboratoire, chez des travailleurs exposés au bruit et chez des sujets normaux avec et sans protecteurs d'oreilles. Le groupe fut de plus sub-divisé selon l'âge et la connaissance de la langue anglaise à cause du grand nombre de travailleurs dont la langue première n'est pas anglais parmi la main-d'oeuvre canadienne. Chez les sujets normaux, nous avons trouvé les meilleurs taux de discrimination dans le silence et les moins élevés en présence de bruit blanc et encore moins élevés avec un bruit de foule; un protecteur ne modifie en rien ces résultats. Les résultats obtenus chez les groupes non-anglais furent parallèles mais inférieurs dans toutes les conditions. En présence d'une surdité affectant les hautes fréquences, la discrimination était inférieure à celle des sujets normaux dans le silence et dans le bruit. Le port d'un protecteur diminuait la discrimination encore plus. Les sujets atteints d'une surdité à courbe plate présentaient une déterioration de la discrimination en portant un protecteur.

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Book Review Of: "Acoustical Design of Concert Halls and Theatres - A Personal Account"

Author: Wilhelm L. Jordan

Published By: Applied Science Publishers Ltd., 1980

The acoustical design of concert halls is a subject that fascinates many, both within and outside the acoustical community. A book such as this one that is a personal account of one of the world's best known acoustical consultants will no doubt be eagerly sought after as both interesting reading and as an authoritative compilation of an expert's experiences over a nearly 40-year period. The potential reader should be warned that the book is not, and certainly does not pretend to be, a text book on concert hall acoustics. The book provides an interesting, and sometimes refreshingly candid insight into the author's experiences and the many practical difficulties that can result from dealing with a combination of architects, planners, owners, and site restrictions. Chapters on the details of experiences with particular halls, which include tabulated data on each hall, are interspersed with more technical chapters describing related research development. The research chapters describe Jordan's increasing sophistication in the use of acoustical models, as well as major concurrent research developments. This is particularly useful in the final research chapter where recent German subjective studies, which are generally not yet published in English, are summarized. Although there is perhaps a tendency to interpret the new German work so as to justify the author's own design approach, it is made clear that the new German results indicate a major new advance, and a new direction in concert hall acoustics. In addition, there is a brief but interesting chapter considering the historical development of halls. The book is well written, easy to read, and certainly a very worthwhile contribution.

J.S. Bradley
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