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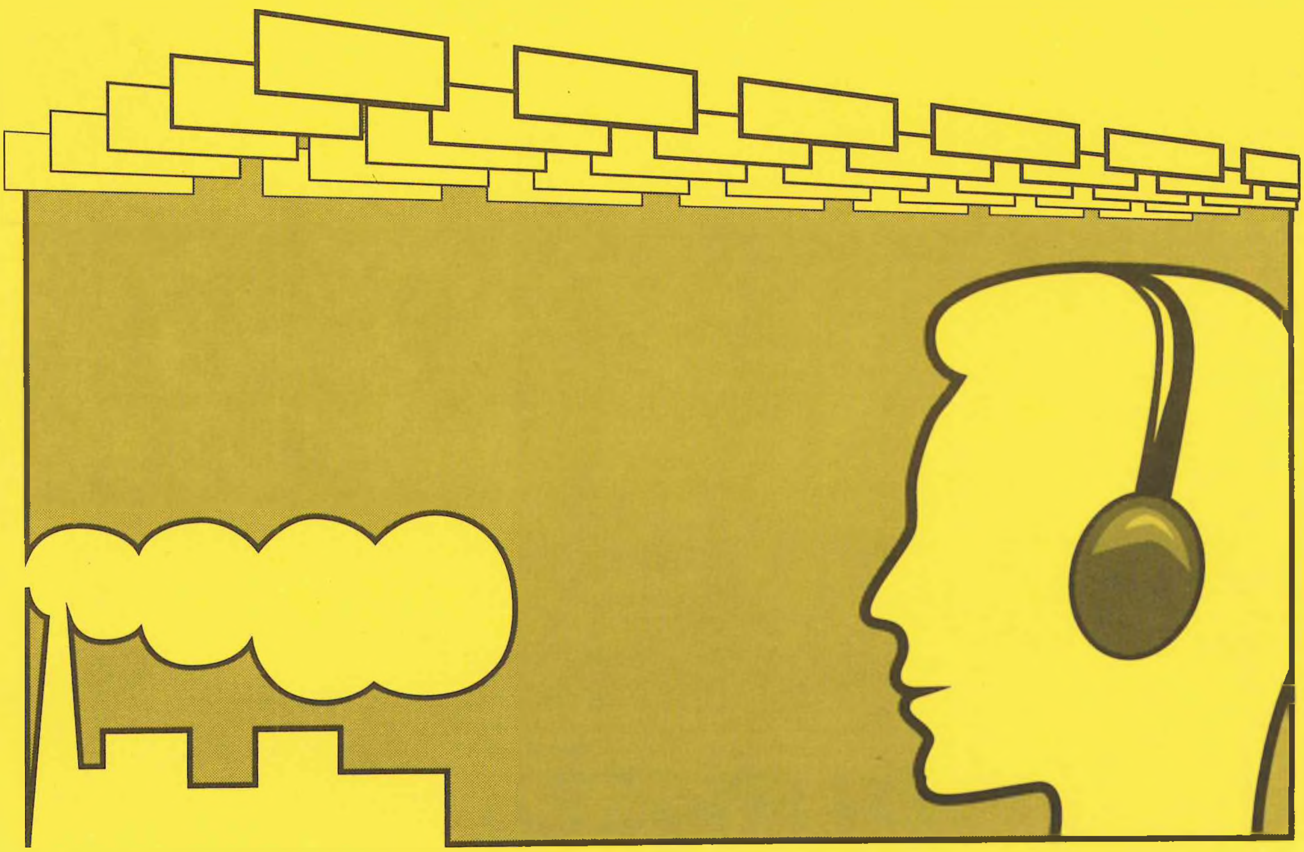

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EDITORIAL

Ceci est le dernier numéro de votre rédacteur en chef. A partir du prochain numéro, Raymond Hétu me succédera en tant que nouveau rédacteur en chef; également, Murray Hodgson se joindra à l'équipe. Bien sûr, Tim Kelsall restera et continuera son bon travail en tant que rédacteur de la publicité pour l'ACOUSTIQUE CANADIENNE. C'est en grande partie aux efforts de Tim que le nombre de publicitaire grandit, ce qui fait de ce journal un succès financier. Il est d'une importance inestimable d'avoir quelqu'un tel que Tim pour se dévouer au journal année après année.

Je trouve que le journal a fait des progrès considérables durant ces trois dernières anées. Nous avons réorganisé un peu et amélioré la qualité de notre présentation. Nous avons augmenté le nombre de bibliothèques abonnées et introduit de nouvelles parties, telles que la liste de tous nos membres et le sondage des consultants canadien en acoustique. Je pense que, grâce à nos efforts, la qualité des textes soumient à l'ACOUSTIQUE CANADIENNE s'est graduellement améliorée.

J'espère que l'ACOUSTIQUE CANADIENNE va continuer à s'améliorer et à grandir. Je suis sûr que la nouvelle équipe éditorial va emmener une nouvelle bouffée d'enthousiasme, et conduire notre journal vers de plus grands succès. Je leur souhaite du succès dans leurs efforts.

Bien que le prochain numéro va expliquer les nouveaux arrangements pour la soumission des textes et des nouveautés, veuillez les soumettre pendant l'interim à:

Professeur Raymond Hétu
Groupe d'Acoustique
Université de Montréal
Montréal, Québec, H3C 3J7.

EDITORIAL

This is the last issue for your current editor-in-chief. Starting with the next issue, Raymond Hétu will take over as editor-in-chief with Murray Hodgson also joining the team. Of course, Tim Kelsall will remain as our Advertising Editor and continue his much appreciated contribution to CANADIAN ACOUSTICS. It is largely because of Tim's efforts that the advertisements keep coming and hence that our journal is a financial success. It is invaluable to have the continuity of someone like Tim soldiering on year after year.

I feel the journal has made considerable progress over the past three years. We have reorganized a little, and improved the quality of our presentation. We have increased the number of library subscribers, and introduced new features such as the printing of the membership list, and the survey of Canadian acoustical consultants. In response to our efforts, the quality of papers submitted to CANADIAN ACOUSTICS, I believe, has gradually improved.

I hope that CANADIAN ACOUSTICS will continue to improve and to grow. I am sure that the new editorial team will have a new burst of enthusiasm, and take our journal on to greater successes. I wish them well in their endeavours.

Although the next issue will describe the new arrangements for submissions, in the interim please submit papers and news material to:

Professor Raymond Hétu
Groupe d'Acoustique
Université de Montréal
Montréal, Québec, H3C 3J7.

CANADIAN ACOUSTICAL ASSOCIATION

Acoustics Week 5th - 9th October, 1987
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Preliminary Announcement & Call for Papers

This is the first call for papers for the October, 1987 conference of the Canadian Acoustical Association. Papers will be accepted from all areas of acoustics and the other speech and hearing sciences. Papers may be of an applied nature or be results from basic research. In addition this year, for the first time, there will be poster sessions, in which written and pictorial presentations will be on open display with the author present to discuss his/her research.

There are a number of other changes in the usual procedures. There will be two categories of papers: formal papers which will be reviewed and informal or progress reports which will not be. The formal papers will be printed in their entirety in a conference proceedings. The abstracts of the informal papers and progress reports will also be printed. In the case of poster sessions the same dichotomy exists. However, more than the abstract of a poster session will be printed only if a formal paper is sent to the technical committee by the deadline date.

For all authors wishing papers to be included as formal presentations the deadline for the submission of a 300 word abstract is May 4, 1987. The abstracts will be reviewed by sometime in June and notification will be given to the author as to the acceptance or rejection of the abstract. (A rejected abstract may be resubmitted as an informal paper, if the author so desires.) Both the full paper and the abstracts for informal presentation are due by August 31, 1987. The papers will not be reviewed again unless it is clear that the paper is distinctly different in methodology or concept from the abstract. The full papers should not be longer than six typewritten pages on forms that will be supplied.

Send abstracts or enquiries to:

Dr. Bruce E. Dunn
CAA Conference
Department of Psychology
University of Calgary
Calgary, Alberta
T2N 1N4

Three awards of $500 each will be awarded for the best formal papers given by students. Poster sessions are eligible, if a full paper has been submitted. In addition the best papers, with permission of the author(s) will be published in "Canadian Acoustics". Those who are willing to have this done should submit a letter giving permission at the time they send in their completed paper.

It is hoped that a lot of papers and poster sessions will be forthcoming, especially from students. Pre-Olympics time should be a good time to be in Calgary. Much entertainment is planned. At a later date there will be an effort to find out what sorts of group bookings should be made. In addition there will be two pre-conference applied workshops. Every effort is being made to make travel as inexpensive as possible. At the present moment negotiations are in progress with WardAir for a charter service from eastern Canada.

Even if you are not giving a paper or presenting a poster display, please come to the meeting. There surely will be sessions of interest. If possible bring your spouse. If you are not already a member, join. Conference registration will be quite a bit cheaper for members and in addition members receive "Canadian Acoustics".

Members will be notified of further details by receipt of an information package.

P. J. Vermeulen, Convenor
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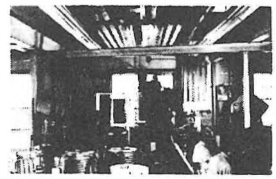

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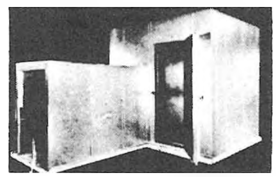

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THE EFFECT OF VARIOUS PLACEMENTS AND DENSITIES ON THE SOUND ABSORPTION OF BAFFLES

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ABSTRACT

Unit absorbers, commonly referred to as sound absorbing baffles have obtained widespread use in buildings for reverberation and noise level control. The effect on sound absorption of varying baffle densities greater than 2 m^2/unit has been investigated in the past. Little or no information exists on the sound absorption of baffles suspended at densities less than this value. To further understand their sound absorbing characteristics, laboratory tests were performed on various configurations and densities less than 2 m^2/unit. Of particular interest was the effect of horizontal and vertical placements and the mutual influence on absorbing efficiency due to the change in baffle density. Results indicate that spatial arrangement had minimal effect on sound absorption for the densities measured. However, sound absorbing efficiency did increase notably as the baffle density decreased.

SOMMAIRE

Des unités absorbantes, sont en usage commun afin de contrôler le bruit et la réverbération dans le batîment. L'éffet d'absorbtion de ces absorbants à un nombre supérieur à une unité par deux metres carrés (1 unité/2 m^2) a déja été recherché. Cependant, peu d'information existe au sujet de densités moindre à celle-ci. Afin de mieux comprendre ces charatéristiques d'absorbtion, des test en laboratoire ont été éffectué avec différentes configurations et densités moins d'une unité/2 m^2. Spécifiquement l'éffet de l'orientation horizontal et vertical, et de l'éfficacité d'absorbtion due au nombre d'absorbants par metre carré a été investigué. Les résultats indiquent que l'orientation a peu d'influence mais que l'éfficacité d'absorbtion par unité augmente quand leur nombre par metre carré diminue.

INTRODUCTION

The use of baffles as an effective method to control noise in industrial work environments is common. A successful application of these units to lower reverberant noise levels requires that they be efficient sound absorbers and placed densely throughout the entire ceiling area. Typically, sound absorption applied to the wall surfaces is not feasible in these buildings.

Baffles used to control noise and reverberation in recreation facilities; particularly swimming pools, have also proven to be useful. In many cases, baffles used in conjunction with sound absorptive wall panels are the preferred methods of placing sound absorption in these buildings. An economically feasible solution results in baffles suspended at lower densities than those normally required for industrial noise control. Sound absorbing characteristics of baffles at these lower densities is useful information in the calculation of noise reduction and reverberation time.

Measurements of sound absorption using a typical baffle configuration were performed within a reverberation chamber with a diffuse environment. The measured baffle densities ranged from 2.1 m^2/unit to 14.7 m^2/unit relative to the test room floor. This report describes the methodology of measurement, test results and related observations.

BAFFLE DESCRIPTION

The acoustic material used for the baffle core was a rigid glass fibre having a physical density of 48 kg/m^3. Each baffle measured 1220 mm X 610 mm X 50 mm and was encased within an aluminum channel framework 50 mm X 25 mm X 3 mm thick. The baffles were supported on a stand that was constructed of 38 mm diameter ABS piping. To approximate the suspension of these units in a room, the support stand kept the central axis of each baffle 1000 mm ± 10 mm from the test room floor.

TEST PROCEDURES

Sound absorption tests were performed at the Mechanical Engineering Acoustics and Noise Unit (MEANU), University of Alberta located in Edmonton. Recognized as an acoustical test laboratory which meets or exceeds existing standards, the reverberation chamber used had a floor area of 58.8 m^2 with a volume of 311 m^3. All measurements were done in strict accordance to the method described in ASTM C 423-81 [1].

A random sample of the baffles was assembled to form a standard rectangular test specimen and were measured directly on the laboratory floor (Type A Mounting). This was done to assure that the rigid glass fibre conformed with absorption data of similar material tested in other laboratories. Test results were in close agreement with those from other laboratories which confirmed the sound absorbing properties of the material and accuracy of the measurement method. The various baffle placements and densities measured are described and illustrated in Figure 1. The baffles were measured both vertically (perpendicular to the floor plane) and horizontally (parallel to the floor plane).

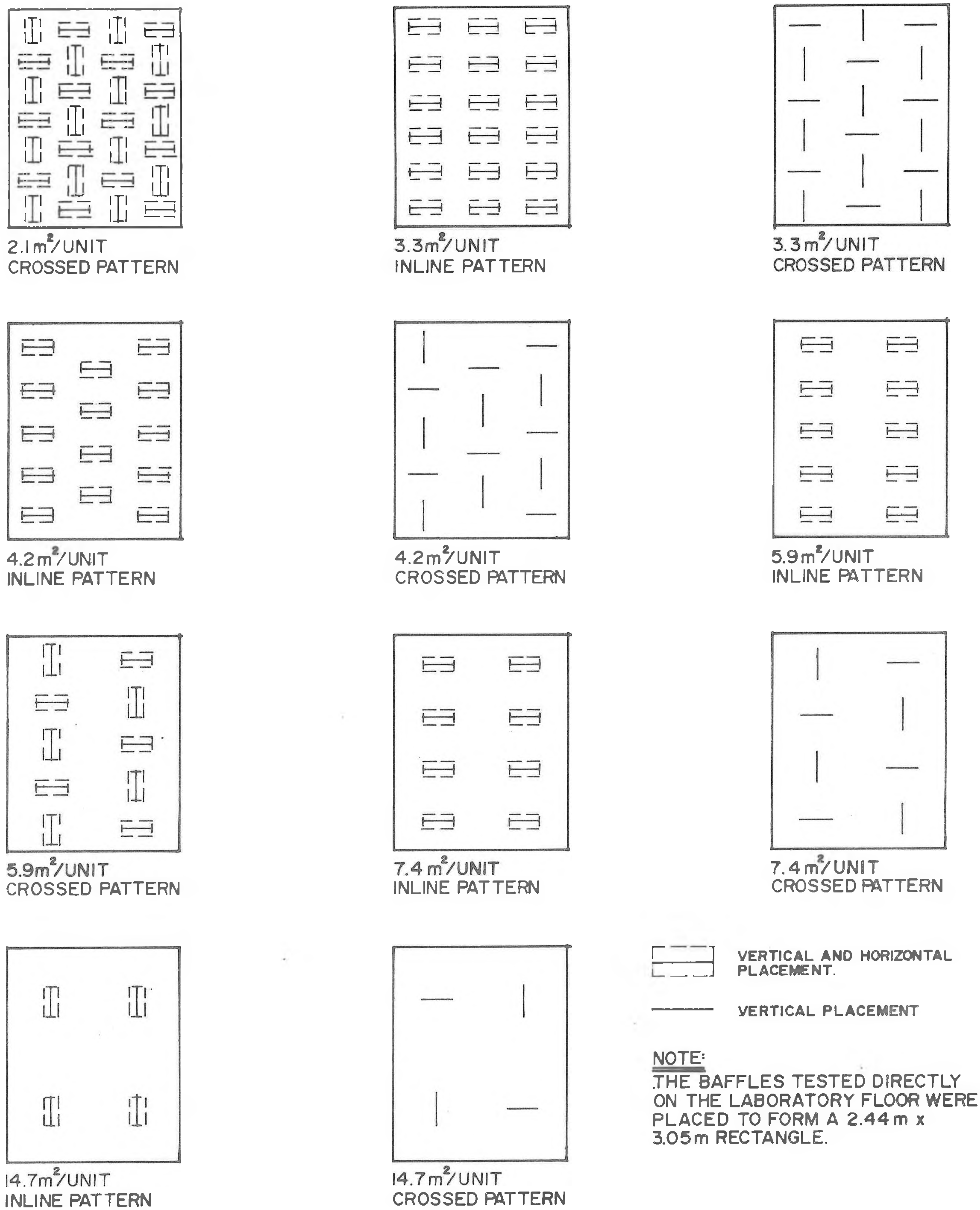

Figure 1. Plan View of Baffle Test Layouts

Sound absorption in metric sabins per baffle was calculated for each one-third octave band from 100 Hz to 5000 Hz. Results for the individual tests were compared at the standard ISO octave band centre frequencies from 125 Hz to 4000 Hz.

TEST RESULTS

Table 1 lists the sound absorption measured for the various baffle densities and layouts:

TABLE I

Sound Absorption Of Standard Baffle For
Various Placements and Densities In Metric
Sabins Per Unit

DENSITY (m^2/UNIT)	PLACEMENT	FREQUENCY (Hz) 125	250	500	1000	2000	4000
2.1	Vertical, Crossed	0.36	0.48	0.96	1.32	1.17	1.13
2.1	Horizontal, Crossed	0.28	0.62	0.93	1.18	1.05	1.09
3.3	Vertical, Inline	0.26	0.58	1.09	1.38	1.23	1.16
3.3	Horizontal, Inline	0.37	0.64	1.12	1.40	1.28	1.12
3.3	Vertical, Crossed	0.40	0.58	1.09	1.37	1.30	1.30
4.2	Vertical, Inline	0.26	0.51	1.14	1.47	1.25	1.13
4.2	Horizontal, Inline	0.28	0.63	1.18	1.45	1.32	1.21
4.2	Vertical, Crossed	0.35	0.64	1.16	1.49	1.31	1.25
5.9	Vertical, Inline	0.35	0.58	1.16	1.46	1.21	1.11
5.9	Horizontal, Inline	0.32	0.64	1.19	1.48	1.31	1.17
5.9	Vertical, Crossed	0.40	0.58	1.15	1.51	1.35	1.20
5.9	Horizontal, Crossed	0.18	0.64	1.18	1.49	1.30	1.16
7.4	Vertical, Inline	0.34	0.65	1.15	1.54	1.32	1.17
7.4	Horizontal, Inline	0.24	0.64	1.25	1.53	1.34	1.29
7.4	Vertical, Crossed	0.35	0.67	1.16	1.57	1.38	1.33
14.7	Vertical, Inline	0.31	0.68	1.21	1.59	1.33	1.23
14.7	Horizontal, Inline	0.31	0.73	1.31	1.59	1.37	1.18
14.7	Vertical, Crossed	0.36	0.70	1.28	1.57	1.34	1.21
10 Baffles directly on Laboratory Floor *		0.19	0.57	0.83	0.82	0.74	0.68

* Values are given in metric sabins per baffle. To convert to absorption coefficients, multiply by 1.34.

To obtain a single number rating for sound absorption, values for each placement in Table 1 were averaged from 250 Hz to 2000 Hz. These have been plotted in Figure 1.

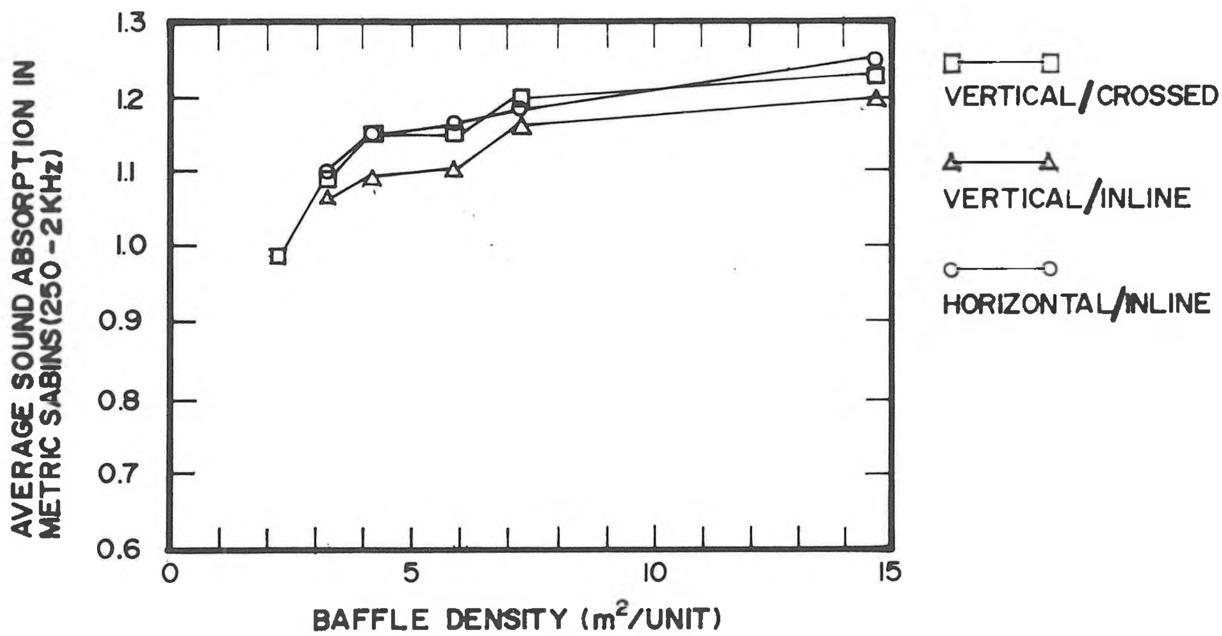

Figure 1. Average sound absorption of baffles for various placements and densities.

Both the VERTICAL/CROSSED and the HORIZONTAL/INLINE placements were similar in sound absorbing efficiency for all the densities measured. Although the differences were small, the VERTICAL/INLINE placement was the least efficient for sound absorption. For all baffle placements, the general trend was an increase in sound absorbing efficiency with a decrease in density. Similar results have been reported by others for baffle densities greater than 2 m^2/unit [5].

CONCLUSIONS

The sound absorbing efficiency of the tested baffles did not change significantly due to a change in placement. A notable increase of sound absorption (10 - 20%) was perceived as the baffle density decreased. It should be noted that these results apply to the baffle configuration tested and other shapes and/or sizes might produce different conclusions. Also, the results relate to acoustical conditions typical for a laboratory environment (diffuse). Tests under actual field conditions, such as those found in a large recreation facility, may provide further useful information.

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*NOISE-INDUCED HEARING LOSS AND HEARING PROTECTIVE DEVICES**

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Silverman Hearing Research Laboratory
Mount Sinai Hospital Research Institute
Toronto, Ontario

ABSTRACT

Longitudinal studies of hearing in workers in selected industries in Canada have shown that the effect of continuous high-level noise exposure is an increase in detection threshold of about 1 1/2 decibels per year. This is in contrast to 1/2 dB per year for non noise-exposed office workers in the same plants. Personal hearing protectors, in the form of ear plugs and muffs, have been chosen as an effective, inexpensive and easily implemented method of hearing conservation. However, behavioural experiments simulating the noise background in the industrial environment have shown that the use of these devices may give rise to difficulties in detecting warning signals and defects in the materials worked on, as well as in the perception of speech. This is particularly true in the case of individuals who have already sustained a moderate to severe sensorineural hearing loss, either through noise exposure or aging. To improve both hearing and comfort, many try to alter the device physically. This, of course, will result in a decrease in its sound attenuating capabilities. An experiment in progress is investigation the possibility of prescribing protectors on an individual basis, taking into account both hearing status and shape and size of the ear canal. Relatively little information is available on ear canal morphology. It appears that some types of widely used insert devices are less effective in reducing sound for women because of poor fit to their relatively smaller ear canals.

SOMMAIRE

Des études longitudinales sur l'ouïe de certains ouvriers canadiens ont indiqué que l'exposition continue à un niveau sonore élevé se traduit par une élévation du seuil de détection d'environ 1 1/2 décibel par an. Quant à eux, les employés de bureau des mêmes entreprises (non exposés au bruit) obtiennent un résultat de 1/2 dB par an. On a pu constater l'efficacité à cet égard des protecteurs d'oreilles et des protège-tympan, moyens peu onéreux et faciles à utiliser. Par contre, des expériences ont prouvé que le recours à ces protecteurs peut causer des problèmes lors de la détection des signaux avertisseurs et des défectuosités caractérisant des matériaux manipulés, ainsi que dans la perception de la parole. Ceci s'avère particulièrement dans le cas des personnes qui ont déjà subi une perte d'ouïe (moyenne à grave) du fait du vieillissement ou de l'exposition au bruit. Aussi, afin d'améliorer l'audition et le confort, nombre de personnes modifient les caractéristiques physiques des appareils. Bien sûr, ces derniers perdent alors une partie de leur efficacité sur le plan de la réduction du bruit. Une expérience est actuellement entreprise qui vise à

*First published in Canadian Journal of Public Health, Vol. 77, Supp. 1, May/June 1986.

déterminer la faisabilité de protecteurs personnalisés tenant compte de l'acuité auditive et de la forme du canal auditif de chacun. En ce qui concerne la morphologie de ce dernier, les informations disponibles sont relativement rares. Il semble que certains des appareils les plus fréquemment utilisés seraient moins efficaces dans le cas des femmes car ils s'insèrent moins bien dans la canal auditif de celles-ci.

Permanent hearing loss with continuous exposure to high-level noise has been well documented.[1-4] My work includes longitudinal studies of noise-induced hearing loss among workers in Canadian industry and evaluation of the effectiveness of hearing conservation programs. Experiments have measured the attenuation realistically provided by routinely used hearing protective devices and the drawbacks associated with their use. These drawbacks include interference with communication on the job and the perception of warning signals or changes in the material worked on. Work in progress focuses on difference in the success of hearing conservation programs based on personal hearing protection for males and females, and the relationship of these differences to ear canal morphology.

PROGRESSION OF NOISE-INDUCED HEARING LOSS

In order to study the progression of hearing loss, we enlisted the support of three Canadian industries, Ontario Hydro, Falconbridge Nickel Mines and DOFASCO, Inc.[5] Each industry provided us with the results of hearing tests routinely conducted on employees. The database for Ontario Hydro comprised one audiogram (a plot of the intensity required for detection of pure tones ranging from 500 Hz to 8 kHz) recorded in 1977 for each of 1191 workers in four different jobs. Falconbridge Nickel Mines contributed 2 to 13 audiograms measured at intervals of 1 to 2 years for each of 121 individuals employed in two job categories for a period of 4 to 11 years. DOFASCO provided 7 to 13 audiograms for 100 individuals employed in three job categories for a continuous period ranging up to 15 years. All, except for a control group of 343 office workers at Ontario Hydro, had been exposed to noise exceeding 85 dBA, a level considered injurious to hearing in the long-term.

Where only a single audiogram was available, cross-sectional analyses were carried out to assess the effects of job type, number of years of exposure and age on noise-induced hearing loss. Within-subject comparisons were made of hearing loss for the various test frequencies. The availability of several successive audiograms for individual workers allowed an investigation of the rate of hearing loss with time on the job.

The results for a group of 63 Falconbridge drillers employed in the mining industry since the age of 21 or younger are typical of the overall findings. A comparison was made of the most recent audiogram measured (1977-80) and the earliest on record, taken on average 6 years earlier. We looked first at risk of impairment, i.e., the number of individuals whose hearing thresholds exceeded a defined critical value of 25 dB relative to normal. For the earliest test the results of only 4 of 26 individuals, 35 years of age or younger, exceeded the fence for risk at 1 kHz and 10 of the 26 exceeded the fence at 4 kHz. Six years later the figures were 4 and 15 respectively for these two frequencies. No changes in risk had occurred for the lower frequency. At the higher frequency, 5 more individuals had crossed the line. Seven of the 15 had a moderate to severe loss of 50 dB HL or greater. An analysis of the slope of the hearing loss over time within individuals indicated that the rate of change at 4 kHz was about 1.5 dB per year. This was in contrast to a rate of 0.5 dB per year for non-noise exposed office workers employed at Ontario Hydro.

Each of the industries included in the survey had had a hearing conservation program based on the use of personal hearing protection in effect at the time the measurements were made. Yet noise-induced hearing loss was evident in even the youngest workers sampled, i.e., those for whom the wearing of protectors had been mandatory since the onset of employment. In order to better understand this negative effect we surveyed a sample of 57 individuals at one Ontario Hydro work site. For these there had been no change in exposure over the total period of employment and no known noise exposure outside of the work environment.

Responses to the survey questionnaire indicated that 20 subjects in the sample under age 25 had all been provided with protectors on starting employment. Of these, 16 (80%) admitted to wearing the muffs or plugs less than 50% of the time on the job. In a second subgroup of 25 workers aged 25 to 34 years only 11 had first worn protection at the start of employment. Again, we found that virtually the entire subgroup (70%) wore protection less than 50% of the time. Looking at the benefits for those who consistently wore protection more than 50% of the time (about 8 of the 57 or 14%), we found no clear trend in the direction of less risk for hearing impairment.

WHY HEARING PROTECTORS FAIL

One of the reasons why hearing protectors may fail to protect against the harmful effects of high-level noise is that the actually achieved attenuation may fall short of the manufactuer's specification. In order to test this hypothesis, we measured the attenuation provided by ten commonly used plugs and muffs in 350 workmen who had been referred for clinical assessment of noise-induced hearing loss by the Workmen's Compensation Board of Ontario.[6] Most were miners and steelmakers aged 35-65. Each was asked to bring the protectors he normally used and to fit them personally. The number of individuals tested for the various devices ranged from 15 to 58.

Thresholds for hearing were measured free-field with and without the protector worn at eight narrowband frequencies ranging from 125 Hz to 8 kHz. The difference between the protected and unprotected scores gave the attenuation for each frequency. Regardless of the protector type (i.e., muffs or plugs) the model (e.g., expandable foam or pre-molded vinyl) or the frequency tested, the achieved attenuation varied by as much as 45 dB across individuals. To take an example, for one plug, purported to provide 40 dB of attenuation at 4 kHz, 84% of the 49 individuals tested achieved less than 35 dB.

An examination of the devices used by the workers[7] indicated that these had often been modified for greater comfort. Many individuals had difficulty fitting the device correctly. A later study[8] indicated that if the protectors were fitted by an audiologist rather than by the subjects the standard deviation in attenuation scores associated with a particular protector and test frequency decreased by about 5 dB. Achieved attenuation was not related to the amount of hearing loss or age of subjects.

COMMUNICATION AND SIGNAL DETECTION IN NOISE

Misuse and deliberate abuse of the protector in many cases reflects concern by the worker that attenuation of sound will interfere with the perception of speech, warning signals, machinery malfunctions and defects in the material worked on. In the first experiment of a series to study this problem[8] we compared speech intelligibility in noise with and without protectors worn in three groups of subjects with screened normal hearing, bilateral noise-induced high-frequency hearing loss, (i.e., normal hearing at 500 Hz), and bilateral flat loss (i.e., hearing loss throughout the range of audible frequencies).

At the time of the study census data indicated that at least 1/4 of the workforce in Ontario had acquired English as a second language. We wondered whether poor comprehension and a hearing loss would act orthogonally in determining speech perception in noise with ear protectors. Thus, half the subjects recruited for each of the three groups were fluent in English and half were poorly conversant. Each of the subgroup with high-frequency loss were further subdivided into two age categories, 35 to 50 years and 51 to 65 years. Aging apart from hearing loss has been shown to affect central neural processing.

Intelligibility of word lists was assessed in quiet and in background of white noise and crowd noise of 85 dBA for speech level of 80 and 90 dBA. The results showed that intelligibility decreased with signal to noise ratio and was poorer in speech-like crowd noise than in steady-state white noise. The wearing of protectos had no effect for the normal listener but caused a substantial decrement in individuals with hearing loss. For all three major groups, non-fluency contributed an additional loss of 10% to 20%. Age of subjects was not a significant factor. Significant differences were found for different plug and muff types used.

In order to simulate the detection in noise problem in the laboratory, we taped samples of mill house and drilling noise at Falconbridge Nickel Mines, and subsequently measured detection thresholds for narrowband signals centred at 1 kHz and 3 kHz in quiet and superimposed on each of these noise backgrounds set at levels of 85 dBA.[9] Signals and noise were presented using headphones. Thresholds were measured both with and without insert protectors worn.

Subjects with three configurations of audiogram were tested: normal hearing; bilateral high frequency loss of at least 35 to 85 dB HL at 3 kHz and normal hearing at 1 kHz; and bilateral hearing loss of 35 to 85 dB HL at both 1 kHz and 3 kHz. Within each of the groups with noise-induced hearing loss we studied two subgroups: workers who had been exposed mainly to steady-state noise (e.g., machinists and millers employed in pulp and paper mills) and workers exposed mainly to impulsive or intermittent noise, (e.g., riveters and rock drillers).

For unprotected listening, all subjects regardless of hearing status showed a detection threshold of about 80 dBA when listening for a 3 kHz narrowband signal superimposed on noise of 85 dBA. Detection in quiet was well predicted by the audiogram. Using insert protectors in noise, normal subjects showed an advantage of 3 dB. Those with moderate to severe hearing loss at 3 kHz were virtually totally deafened by the use of the protector when listening in quiet or in noise. Analysis of the results for detection of 1 kHz indicated that the deleterious effets of wearing hearing protection was confined to the frequency of hearing loss. Impaired listeners with near-normal hearing at 1 kHz performed like subjects who had normal hearing throughout the range of audible frequencies. For neither of the hearing-impaired groups was noise exposure history a significant factor.

The results of the detection study were conclusive in showing that individuals with a moderate to severe hearing loss are at risk when wearing protectors. A model of the detection process was described for choosing a level of attenuation that would optimize detection while at the same time affording the listeners reasonable protection. The recommendation made was that noise reduction to a standard of 85 dBA through the use of attenuating devices was not necessarily suitable for all workers. For those who already have a moderate to severe impairment, Class B or C protectors, as described by the new Canadian Standard[10] would likely be far more appropriate.

MORPHOLOGY OF THE EAR CANAL

An experiment in progress is investigating the possibility of prescribing ear protectors on an individual basis, taking into account both hearing status and shape and size of the ear canal. The attenuation of three commonly used insert protectors having different physical characteristics is being measured in one hundred and twenty young males and females with normal hearing. The protectors include the EAR expandable foam, the Willson premolded vinyl and Bilsom polyethylene encapsulated glass fiber. All have similarly high noise reduction ratings. Headphone detection thresholds are being measured with and without the protectors worn for five one-third octave bands centred at 250, 500, 1000, 3150 and 6300 Hz.

The question of interest is whether the achieved attenuation found for each type of protector is related to the size and shape of the ear canal. To this end bilateral full ear canal molds are being made in the same subjects. Various parameters characterizing size and shape will be correlated with the attenuation data within individuals for each protector in order to establish whether particular types of devices may be inappropriate for certain individuals. Few objective data are available regarding human ear canal morphology. This aspect of the study is designed to provide new basic information.

A concern which is often raised with regard to the use of hearing protective devices is the effect of wearing time on attenuation. Workers often report that insert protectors may work their way out of the ear canal, requiring frequent re-fitting. In order to study this problem in the laboratory, we have begun an investigation in which attenuation is measured in young normal subjects before and after they eat lunch. The protectors are not re-fitted prior to the second measurement, thereby allowing us to assess the affect of head and jaw movement on attenuation.

Twelve subjects will be tested at each of two narrowband stimuli with centre frequencies of 500 Hz and 3150 Hz. Each subject will be required to participate on three separate days for testing of the three protectors used in Experiment I, i.e., the EAR expandable foam plug, the Willson sound silencer premolded vinyl plug and Bilsom encapsulated glass fiber. Order of presentation of protectors (across days) and test frequency (within days) will be counterbalanced across subjects so that we may assess possible practice effects.

CONCLUSION

The results of these investigations indicate that noise-induced hearing loss continues to be an important problem for occupational health. Every province has a regulation for safe levels of noise exposure, and large industries have viable hearing conservation programs, yet claims for compensation for hearing loss continue to rise. Part of the problem is nonoccupational noise exposure associated with leisure activities. On the worksite, failure of personal hearing protectors appears strongly related to poor fitting techniques, maintenance, and inadequate monitoring of usage. If protectors continue to be the method of choice for noise reduction, then our experiments strongly point to the need for prescription on an individual basis with special attention paid to such variables as hearing loss, ear canal morphology and characteristics of the noise background in which the devices are used.

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NON-ACOUSTIC ENVIRONMENTAL FACTOR INFLUENCES ON OCCUPATIONAL HEARING IMPAIRMENT: A PRELIMINARY DISCUSSION PAPER*

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ABSTRACT

Recently, several review papers have been published on environmental factors affecting hearing. But no mention was made of the ototoxic substances or agents to which industrial workers may be exposed apart from noise. This paper is a preliminary discussion of data on the numerous agents which ototoxicity is suspected or demonstrated on animals and on humans and on their probable site of disorder. These include carbon monoxide, heavy metals such as lead, arsenic and mercury, organic solvents such as toluene, xylene and stryrene. Allergenic chemicals and climatic conditions are also considered as being possibly associated with occupational middle ear dysfunction. Effects of vibration on hearing and synergistic interactions between noise and vibration are also examined. Research priorities are discussed in terms of the likelyhood of exposure and suspected toxicity. Based on known mechanisms of ototoxicity, it is suggested that potent nephrotoxic substances are also strong toxic agents to the inner ear. The risk of damage to the ear of the foetus from noise exposure of the pregnant woman is also considered. It is concluded that systematic investigation of potential ototoxic chemicals from the workplace should be conducted as it was done for drugs for which case studies showed damage to hearing.

SOMMAIRE

L'analyse des données disponibles concernant les facteurs de l'environnement pouvant affecter l'audition a récemment fait l'objet de plusieurs publications. Toutefois, mis à part le bruit, on n'y fait pratiquement aucune mention des substances ou agents ototoxiques auxquels les travailleurs industriels peuvent être exposés. Cet article constitue une analyse préliminaire

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des données sur l'ototoxicité présumée ou confirmée de plusieurs de ces substances ou agents ainsi que du site probable de lésion. Il est question du monoxide de carbone, des métaux lourds tels que le plomb, l'arsenic et le mercure, de solvents organiques tels que le toluène, le xylène et le styrène. Des substances allergènes ainsi que des conditions bio-climatiques sont mis en cause en regard des troubles de l'oreille moyenne d'origine professionnelle. Les effets des vibrations sur l'audition de même que leur action synergique avec le bruit sont également abordés. La probabilité d'exposition et le degré présumé de toxicité ont servi de base à la discussion de priorités de recherche. Des mécanismes connus d'ototoxicité permettent de poser l'hypothèse à l'effet que des substances fortement néphrotoxiques sont également de puissants agents toxiques pour l'oreille interne. L'analyse des données disponibles conduit à la conclusion qu'une étude systématique des produits chimiques potentiellement ototoxiques du milieu de travail mérite d'être entreprise comme ce fut le cas pour les médicaments pour lesquels des études de cas avaient révélé des atteintes auditives.

INTRODUCTION

Occupational hearing loss (OHL) has been studied for more than a century. One hundred years ago, Barr published an occupationnaly based comparative study of hearing loss (Barr, 1886). He considered excessive noise as the major toxic agent to the ear; but he noted that exposure to dust and fumes were also associated with hearing loss. Most contemporary studies of OHL have focused on the influence of noise exposure, ignoring or excluding other environmental causes of hearing impairment. The resulting bulk of data gives the impression that noise is the only possible ototoxic agent in the workplace. This view, shared by acousticians, otologists and audiologists, is clearly expressed in recent review papers on environmental factors affecting hearing (Mills and Going, 1982; Mills, 1985). Reviews of interactions between noise and other agents are somewhat limited to exposure to drugs that independantly affect hearing (Humes, 1984). Such an approach is restrictive; for example, in a well controlled epidemiological study of OHL in heavy industry, age and noise exposure accounted for only 40% of the variance of hearing levels (Phaneuf, 1982).

This paper presents a case for the necessity of consideration the effects of non-acoustic environmental factor influences on hearing loss in addition to that of noise exposure. The theoretical relationship of joint exposures has been described elsewhere (Phaneuf and Hétu, 1986). These contributions to the occurence of OHL can be additive or interactive, depending on the nature of the ototoxicity. The determinants to OHL other than noise are reviewed below. Recommendations are made for further research.

The term ototoxicity in this paper refers to an adverse structural or functional effect of an agent on the auditory system, including the middle and the inner ear, the auditory pathways and the cortex. To affirm that occupational exposure to a substance or to an agent is ototoxic, two conditions are required: (a) it must induce a consistent acute and/or chronic response on the human auditory system and (b) this response can be reproduced experimentally in animals and observed in humans. Few agents actually meet these conditions but several can be seriously considered as possibly toxic to hearing in the context of occupational exposure.

Carbon monoxide

Several case reports have been published on acute and chronic effects of carbon monoxide on hearing (Lumio, 1948a, b; Wagemann, 1960; Kawata et al., 1964; Taniewski and Kugler, 1964; Zenk, 1965; Baker and Lilly, 1977). The hearing loss appears to be reversible in most cases and is associated with a central nervous system toxicity. In an extensive epidemiological investigation, CO was reported as a frequent cause of "industrial toxicosis" (Surgen et al., 1973). Laboratory exposure to 200 ppm during 4 hours failed to show any effect on the temporary threshold shift (TTS) induced by a loud tone exposure (Haider, 1973). However, auditory perception tasks appeared consistently sensitive to acute effects of exposure levels between 0.50 to 250 ppm during 2 to 5 hours (Beard and Wertheim, 1967, 1969; Groll-Knapp et al., 1972; Fodor and Winneke, 1972). Acute CO poisoning of guinea pigs demonstrated severe but reversible loss of auditory sensitivity which was clearly associated with cortical and to a lesser extent subcortical dysfunction (Makishima et al., 1977).

The possibility of a permanent damage to hearing should be tested on animals using low level chronic exposures to CO. A retrospective epidemiological study of workers exposed to carbon monoxide, after adjusting for noise exposure and age, may confirm laboratory experimentation. Several occupations involve low level chronic exposure to CO and high noise levels, including welders, foundry workers and diesel operators.

Heavy metals

Heavy metals are traditionally mentioned as possible ototoxic agents (see Quick, 1982) but very few studies have verified this possibility.

Hearing disability has been reported as a symptom associated with lead-poisoning (Ciurlo and Ottoboni, 1956). Two studies conducted on guinea pigs confirmed this contention, showing VIII nerve axonopathy, the inner ear appearing otherwise intact (Gozdzik-Zolnierkiewicz and Moszinski, 1969; Yamamura et al., 1984).

Inner ear disorders have been repeatedly observed following arsenical intoxication of animal subjects (Ruedi, 1951; Leonard et al., 1971; Anniko and Wersall, 1975). The damage seems to appear in the stria vascularis followed by disorders in the various components of the organ of Corti. Sensorineural hearing loss (more pronounced in the low frequencies) has been measured in a significantly higher proportion of children exposed to environmental arsenic than in a group of controls. No comparable study have been conducted among the various groups of workers chronically exposed to arsenic (see Landrigan et al., 1982).

Mercury is considered as ototoxic from the results of the study on the people from the Minamata Bay in Japan who showed hearing losses in a large majority (Kurland e al., 1960). Results from a study on guinea pigs intoxicated with methyl mercury demonstrated considerable sensory cell destruction in the inner ear (Falk et al., 1974). A study of hearing loss among industrial workers has suggested a combined effect of noise and mercury exposure (Eggemann et al., 1977). Data on the effects of chronic exposure to other suspected toxic metals such as gold, zinc or manganese have not been found in this preliminary review of litterature.

Organic solvents

Case reports of organic solvent ototoxicity among industrial workers were published more than 30 years ago (Lehnardt, 1965) but experimental studies were initiated only recently. They originated from an extensive investigation of the possible damage resulting from solvent abuse among volunteer inhalers (Rebert et al., 1983). This led to a demonstration of the toxicity of toluene (1200 ppm, 14hr/day, 7 days/week for 5 weeks) on the sensory cells of the inner ear of new born and adult rats (Pryor et al., 1984). Comparable tests on xylene and styrene showed much higher toxicity of these two substances (Pryor and Rebert, 1984). Yet no epidemiological study on workers chronically exposed to these chemicals has been undertaken to assess their ototoxicity. Vestibular disorders have been reported among painters exposed to white spirit (Arlien-Soborg et al., 1981), but no data on hearing assessment is given. Results from cross-sectional studies on relatively small samples of workers suggest that carbon disulfide, carbon tetrachloride, trichlorethylene, and n-butanol induce sensorineural hearing loss (see Barregard and Axelsson, 1984).

Reviews of published data on the neurotoxicity of organic solvents suggest that sensorineural hearing loss can likely be an early indicator of organic solvents neuropathies (Chong, 1982; Spencer and Schaumburg, 1985).

Proved neurotoxicants such as trichlorethylene and carbon disulfide (Spencer and Schaumberg, 1985) may also interact with the effect of noise by acting on the VIIth cranial nerve, involved in the activation of the acoustic reflex. Noise would have more deleterious effects in the absence of the protection normally afforded by this reflex (Bobbin and Kiniel, 1980). Thus on physiological grounds, noise and solvents should produce synergistic interactions.

Allergenic chemicals

A number of substances, though not directly toxic to auditory system, may cause allergic reactions in the upper respiratory tract.

This may contribute to middle ear disorders such as chronic otitis media causing conductive hearing loss. Families of chemicals that are more frequently associated with these allergic reactions include formaldehyde, alcohols and phenols (Boyles, 1985). These substances are frequently found in the workplace. Formaldehyde is also suspected to be toxic to the inner ear (Quick, 1982).

No data are available to quantify the prevalence of OHL associated with respiratory allergies from exposure to chemical substances in the workplace. Nevertheless, this could account for the increased prevalence of conductive hearing loss among coal miners (NIOSH, 1976) as well as among foundry workers (Burns et al., 1977) exposed to dust particules and to vapors of metal scouring solutions. In a Quebec foundry, we have found 9 out 12 (75%) workers exposed to such vapors with middle ear disorders, whereas the proportion of the 212 workers not exposed to these irritants was 19%. Although it is not a conclusive proof as the cause of occupational middle ear disorder, this suggests its plausibility.

Bio-climatic conditions

In the same way as for allergic reactions, exposure to very humid and to cold temperature (as in refrigerated areas of the food industry) as well as contaminated recirculated air in buildings could result in occupational middle ear dysfunction or disease and conductive hearing loss. This is again an undocumented possibility, but we have received several reports of symptoms related to middle ear diseases from people employed in slaughterhouses exposed to cold, humid and possibly contaminated air.

Vibrations

Exposure to whole body vibrations appears to induce, at least in some conditions, a measurable TTS though of small magnitude (Kile and Wurzbach, 1980). Combined with noise, it has consistently been associated with increases in TTS (Okada et al., 1972; Yokoyama et al., 1974; Okada et al., 1984; Manninen, 1986).

A synergistic effect on permanent threshold shift was also observed in animals exposed to high levels of impulse noise (Hamernick et al., 1980) or to low levels of impact noise over several consecutive days (Hamernick et al., 1981). Considerable permanent damage to the middle and the inner ear have been observed in animals exposed to high intensity infrasound (Lim et al., 1982).

Few field studies have been conducted on the possible contribution of occupational vibration exposure to hearing impairment. Vestibular dysfunction has been reported in almost one out of two among a group of workers testing diesel engines and being exposed to 10 Hz vibrations (Aantaa et al., 1977) but no data on hearing was presented. The combined noise and vibration exposure appears to induce hearing losses that are more pronounced in the low frequencies than is the case for noise exposure alone (Sulkowski, 1980). In two well controlled studies in the lumbering industry, workers suffering from vibration induced white fingers had more hearing loss than

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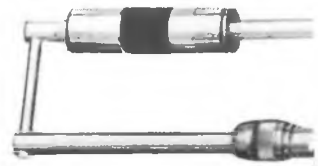

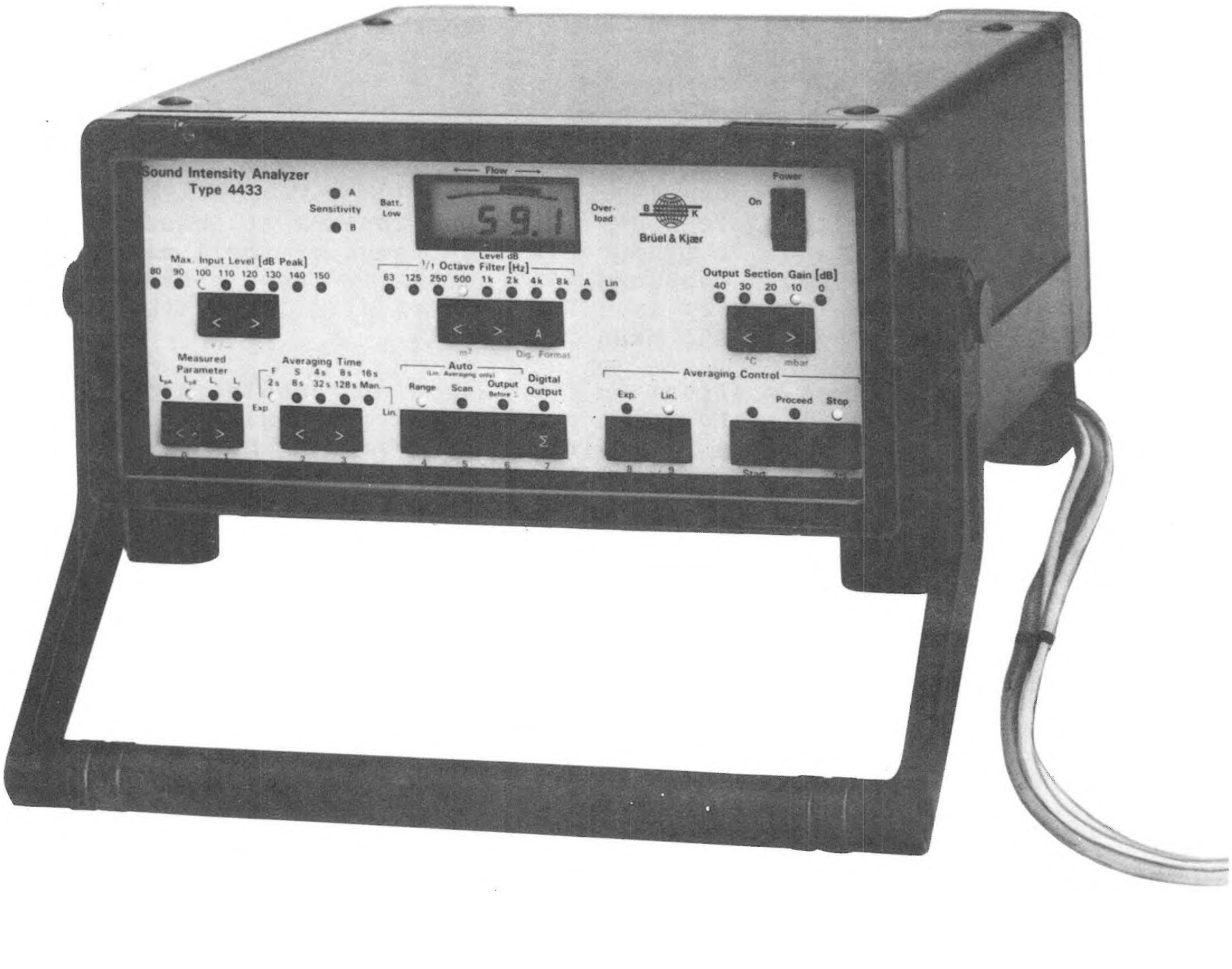

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controls exposed to the same cumulative amount of noise (Pyyko et al., 1981; Iki et al., 1985).

As vibration exposure is frequently associated with noise exposure in industry, it could account for a significant portion of the variance of hearing loss measured in cross-sectional studies.

The above review, summarized in Table 1, confirms the need to consider other agents than noise as environmental factors that may have adverse effects on hearing in the workplace. It also stresses the need for a systematic investigation of the various suspected ototoxic agents.

Table 1. Agents which ototoxicity is suspected (?), demonstrated on animals (*) and for humans (x) and their probable site of disorder.

Suspected agent	Probable site of disorder: middle ear	inner ear	auditory pathway	auditory cortex
<u>Gases</u>				
Carbon monoxide				x *
<u>Heavy metals</u>				
Lead			*	
Arsenic		x *		
Mercury		x *	?	?
<u>Organic solvents</u>				
Toluene		*		
Styrene		*		
Xylene		*		
White spirit (mixed solvents)		?		
Carbon disulfide		?		
Carbon tetrachloride		?		
Trichlorethylene		?		
n-butanol		?		
<u>Allergenic chemicals</u>				
Formaldehyde	?	?		
Alcohols	?			
Phenols	?			
Strong acids	x			
<u>Climatic conditions</u>				
Temperature variations	?			
cold damp air	?			
contaminated air	?			
<u>Vibrations</u>				
Whole body		x *		
hand/arm		x		

RESEARCH PRIORITIES AND STRATEGIES

In view of the number and the diversity of the agents that need to be investigated in order to confirm and characterize their potential ototoxicity, priorities should be defined. These could be based on the following two principles: (a) the substances or agents most widespread in the working environment should be considered first; (b) those for which presumed toxicity is more potent should receive priority.

The first principle calls upon knowledge of the industrial processes and statistics on exposures to the different agents considered. Industrial hygiene measurements may be helpful for determining the priorities. Stated in broad terms, substances such as organic solvents and heavy metals are sufficiently widespread to deserve consideration.

The second principle put forward raises more difficulties as it implies making assumptions on the damaging mechanism of the different agents suspected to be ototoxic. One assumption that we wish to propose is that substances that are potent nephrotoxics are also strong toxic agents for the inner ear. This is based on four line of reasoning:

1) Several substances that act upon the renal function also affect the inner ear and vice versa. It is the case for diuretic drugs (e.g. ethacrynic acid) that inhibit reabsorption in the loop of Henle; their effects are observed in the stria vascularis of the inner ear (Prazma, 1981a), causing temporary and, in some instances, permanent hearing losses. Mercurial diuretics also fall in this category. In addition, aminoglycosides, which are powerful toxicants to the inner ear, are also nephrotoxic (Prazma, 1981b).

2) The damaging power of proven ototoxic substances, such as aminoglycoside antibiotics and loop diuretics, strongly interact with renal dysfunction (Prazma, 1981a, b; Quick, 1982). Moreover, it is generally considered that loop diuretics can induce permanent damage to the inner ear only among those patients suffering from renal insufficiency.

3) Several of the suspected or confirmed ototoxic substances found in the workplace are nephrotoxic. It is the case for heavy metals such as lead and mercury (Buchet et al., 1980), and for organic solvents such as toluene, xylene and styrene (Askergen, 1984; Lauwerys et al., 1985). It is noteworthy that exposure in the workplace to such substances, which share the same sites of damage, are often combined (Orbaek et al., 2985; Winchester, 1985). This implies that they could be toxic even though each is present in concentrations below the permissible level.

4) Drug ototoxicity is a direct function of their renal clearance (Quick, 1982), which in turn depends on the integrity of the renal function. The same could be true for ototoxic chemicals from the workplace; moreover if the serum half-life of the substance is long enough, it could prevent complete elimination during the hours separating two work-days. This appears to be the case for toluene even under low levels of exposure (Brugnone et al., 1985). Accumulation in the blood could take place and a threshold of

ototoxicity could be reached when the renal clearance is insufficient.

One particular condition of possible ototoxicity of the working environment has been overlooked; it is the possible damage to the ear of the foetus from exposure of the pregnant mother at work (Lalande et al., 1986; Marien, 1986). Arsenic, lead, mercury and cadmium have been shown to cross, by passive diffusion, the placental barrier; it is also the case for liposoluble substances such as organic solvents (Barlow and Sullivan, 1982). The immaturity of the renal function probably accounts for the greater susceptibility of the foetus to ototoxic antibiotics (Henry, 1983). Consequently, it is urgent to undertake the investigation of the toxicity of the nephrotoxic agents of the working environment on the developing ear of the foetus.

From the above proposed priorities of research, strategies of investigation must be considered. Experimental studies on animal models should be developed as has been profitable with ototoxic drugs. This would allow one to confirm the ototoxicity, to obtain a dose-response curve, to estimate the relative potency and to understand the damaging mechanism of the suspected substances. This approach is essential knowing the relative insensitivity of epidemiological procedures to identify a more or less small excess of disease in the presence of many confounding factors. However, epidemiological data are necessary to validate the risk factors and the exposure limits and to explore the possible interactions with noise exposure. In a context where the neurotoxicity of substances such as solvents is of increasing concern, thus making it the object of numerous epidemiological studies, it is tempting to include hearing assessment in such studies. But the confounding variables involved differ with the outcome considered. The association between hearing loss and organic solvents exposure should be the object of specific study designs.

CONCLUSION

In conclusion, the above preliminary review of evidence provide sufficient grounds to contemplate occupational hearing loss in a different perspective. Noise is certainly a preponderant cause of OHL; but several other agents of the working environment can affect hearing in isolation or in conjunction with noise. Such a perspective calls for a new research effort in the field of occupational toxicology and epidemiology.

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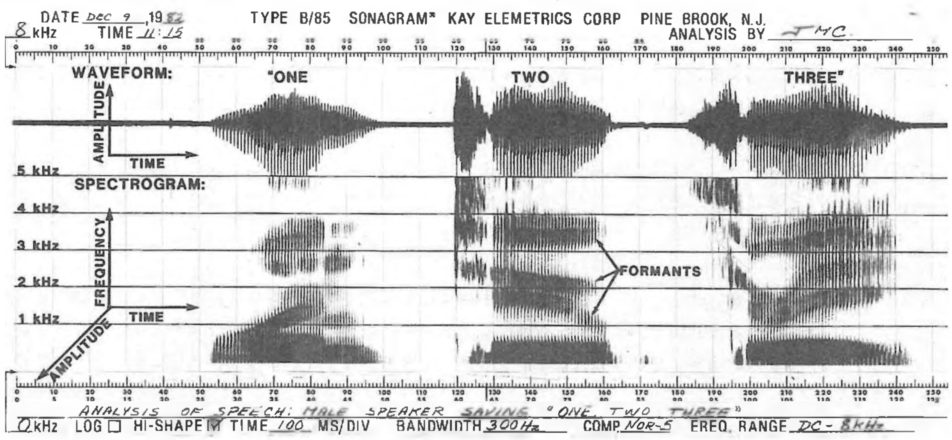

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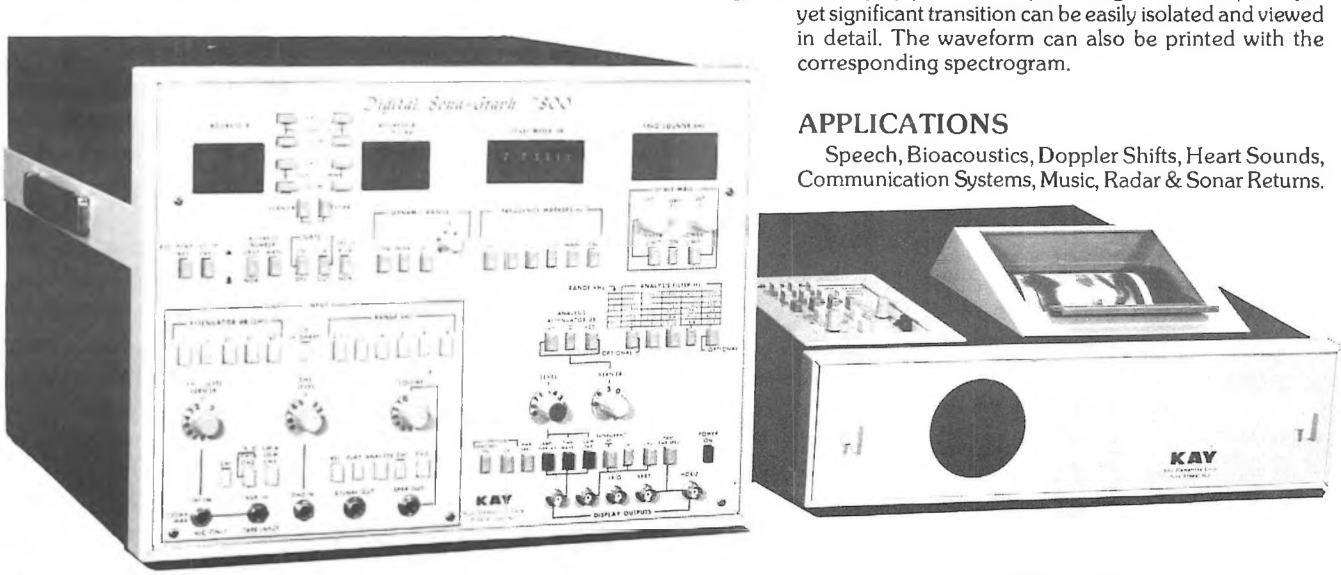

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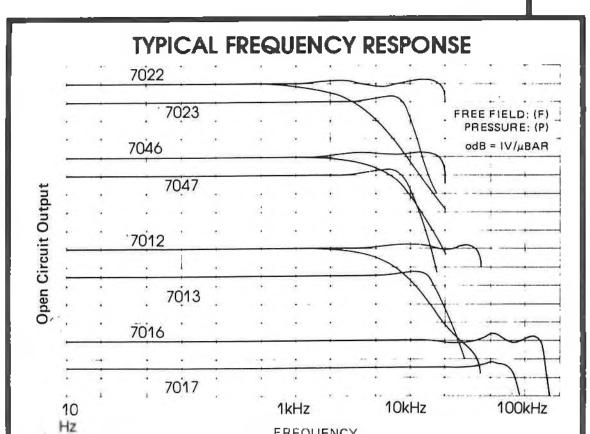

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7022	4145	—	—
7023	4144	—	—
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LETTER TO THE EDITOR

On 23 January, for the first time, I met and spoke with Alan Toon, P.Eng., Industrial Research Assistance Program, NRC, 2650 Westbrook Mall, Vancouver, B.C. His appointment followed the retirement of Max Baker, former Director Pacific Regional Station, DBR, NRC and the renaming of the DBR (Division of Building Research) as the IRC (Institute for Research in Construction). This, to reflect its mandate of serving the construction industry in general and not just the building industry.

During our discussions, he mentioned that a large number of submissions had been received by the ACNBC (Associate Committee of the National Building Code), concerning proposed changes to the 1985 editions of the National Building Code, National Fire Code, and the Canadian Plumbing Code. Subsequently, the proposed changes were compiled/segregated and then distributed across Canada for "Public Review" and comment. Reasons for "supporting" or "not supporting" the proposed changes, were to be detailed on an enclosed "Public Comment Form" and returned to the Codes & Standards Group of the IRC by 15 April, 1987.

The above documents, together with a covering letter of 15 January, 1987 (file reference: M4-86-P1-3), issued by Robert A. Hewett, P.Eng., Principal Secretary, National Codes Secretariat, were personally examined. They did NOT include any proposed changes in Section 9.11 Sound Control, or in its subsections, nor in Tables 9.10.3.A and B.

It was also noted that "FORUMS ON CODE CHANGES" will be held in 7 cities in 6 Provinces during March, 1987, and that "anyone who intends to comment on the proposed changes is particularly invited to attend". However, since there are NO proposals for sound control changes, then obviously, there will be nothing to comment about in these respects.

This 'absence of inpurt' by Consulting Engineers is regrettable, especially since they are particularly aware of the existing deficiences, inadequacies and ommissions, in the Sound Control Section of the NBC.

The recommendations of H.W. Jones, Professor, Engineering Physics, Technical University of Nova Scotia, published in CANADIAN ACOUSTICS, April 1984, Volume 12, Number 2 (see page 19 & 20), confirm the accuracy and relevancy of the above statements. Furthermore, his comments that:

> "It is essential that a determined effort should be made as quickly as possible, by resorting to interim recommendations if necessary."

> "There is a crying need for some form of effective action to meet the needs of the public."

have seemingly fallen on 'deaf ears'.

Then, there is the exhaustive and detailed technical paper by Michel Morin, published in CANADIAN ACOUSTICS, January 1986, Volume 14, Number 4, and where on page 5, it states:

"After realizing the inadequacy of the inter-dwelling noise isolation criteria set forth in Section 9.11 of the NBC, the Canada Mortgage & Housing Corporation (to be more precise, the CMHC offices in the Province of Quebec) has set its own noise isolation criteria in an attempt to improve the quality of the condominium projects in which it is involved."

Briefly, the above refers to an airborne sound isolation of at least STC 55 for walls and floors and an impact isolation of at least IIC 65 for ceiling/floor assemblies. CMHC Vancouver, requires an STC of 55 for cooperative housing in which they are involved. They have also advised, that some form of "Acoustical Certification" is issued by CMHC Quebec offices and that details and particulars may be obtained from:

Jacques Soucy,
Regional Engineer CMHC Technical Service
1010 - Lagaucheterie, 1.W.
Montreal, Quebec, H3B 2N2

To a lesser degree, the Sound Control Section of the 1987 Provincial Building Code of B.C., has raised the minimum STC rating of 45 to 50, but does not deal with an impact isolation rating.

Enclosed, is a copy of a highly informative letter from R.H. Dunn, A/Secretary ACNBC (File reference: M4-86-S9) 23 December, 1986, which should be scrutinized by the CAA Executative, if any positive actions whatsoever are contemplated, concerning the suggestions in my letter of 20 November, 1986.

Yours sincerely,
H. Gordon Pollard

(To all you complacent 'deaf ears' the time to act is obviously now! These proposed changes are for the 1990 NBC; if you miss these, you won't get another chance until the 1995 code. If you wait long enough, it will be the 2000 code! Virtually all people knowledgeable about this topic agree that STC 45 is inadequate. Many European countries have had much higher standards for many years. As Mr. Pollard points out, in a number of parts of the Canadian construction industry higher standards are already in use. The CAA membership passed a resolution at its annual meeting several years ago in Vancouver that these particular provisions of the NBC should be increased to at least STC 50. To change your National Building Code would require a definite effort from consultants, architects, and builders. It's now or never. (...or maybe 2010 ?)) Editor.

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TORONTO CHAPTER NEWS

The Toronto chapter held its first meeting of the year at the new Toronto location of Bruel and Kjaer Canada Ltd. Mr. Bob Pemberton gave a talk titled, "Measurement techniques for the nineties: a topical discussion of present instrumentation and future trends". Bob Pemberton was born in England, served an engineering apprenticeship with DeHavilland Aircraft Co. and qualified as a Graduate of the Institute of Electronic and Radio Engineers. His specialization was in vibration test and structural fatigue investigations. He emigrated to Canada in 1964 and for seven years managed the Environmental Test Laboratory in the Aerospace Division of RCA Ltd. in Montreal. He joined Bruel and Kjaer with an initial assignment to design and set up the Vibration Test Laboratory for the Communications Research Centre in Ottawa. He has subsequently engineered a range of systems for Government and Industry across Canada and is now Regional Manager, Central Canada for Bruel and Kjaer.

The meeting included a technical visit to Bruel and Kjaer's new premisses as well as coffee and doughnuts provided by H. L. Blachford and Bruel and Kjaer.

TORONTO CHAPTER AES MEETINGS

Three meetings of the Toronto chapter of the Audio Engineering Chapter have been held since our last issue. The November 19th meeting was held at George Brown College, and included discussions of "Synchronizers". Allen Lambshead of Evertz Microsytems, a Canadian manufacturer of synchronizers, gave an in-depth overview of synchronizers, how they work, and how they interact with various tape machine transports. A panel of experienced synchronixer users answered questions and discussed problems with synchronizers.

The December 16th meeting was a report to local members from the Los Angeles 81st Convention of the Audio Engineering Society. During the first part of the meeting highlights of some of the more notable papers presented during the technical sessions were given along with recaps of interesting workshops. The latter half of the meeting consisted of a slide presentation, giving members a tour of the Los Angeles convention facilities and some of the displays.

The January 20th meeting consisted of a tour of Master's Workshop. Master's Workshop is involved in post audio for feature films, IMAX films, and episodic television. Doug McKenzie, Bob Predovich, and Paul Massey were hosts for the interesting and informative evening tour. The facility featured a full miximg theatre including 3 digital multi-tracks and a 64 channel board. Along with the main production theatre, the tour also involved a look at the ADR rooms as well as special effects facilities.

The next meeting of the Toronto Chapter of the AES will be held at George Brown College at 8:00 PM, February 17, 1987. Mr.Errol Brooks of SONY Canada will discuss the use of VTR's (video tape recorsders) in professional audio.

Sound Intensity Round-Robin

Working Group S12-21 of the Acoustical Society of America, chaired by M.J. Crocker, has developed a draft standard that provides guidelines for the determination of sound power from sound intensity. In order to evaluate the new standard, the Working Group is organizing a round-robin.

The objective of the round-robin test is to investigate the bias and the precision of the measurements made in accordance with the technique outlined in the standard incorporating the effects of a large number of users, a variety of instruments, and many different acoustical environments. We strongly encourage participation by potential users of the standard and especially solicit participants who have had some experience with sound intensity measurements but who are unfamiliar with the draft standards being discussed in ASA, ISO, and ANSI.

We anticipate starting the round-robin in the Spring of 1987 and will provide details of the test protocol to those interested in joining the test.

For further information write or call either of the following persons. Your response is needed before 1 April 1987.

Richard J. Peppin, Scantek Inc./Norwegian Electronics, 1559 Rockville Pike, Rockville, MD USA 20852, (301) 468-3502.

Jean Nicolas, Genie mechanique, Universite de Sherbrooke, Sherbrooke, Quebec, J1K2R1 (819) 821-7157.

ASTM NEWS

ASTM Committee E-33 on Environmental Acoustics is looking for people to join a Task Group researching dry type transformers used in buildings. Participants will write a method of test and an application document for these transformers. Anyone interested in joining this group or wanting additional information, should contact Howard F. Kingsbury, Pennsylvania State University, 204 Engineering A, University Park, PA, 16802, U.S.A., (814) 863-2076.

A new Task Group on Sound Absorption Ratings will investigate the need for a new single number rating for sound absorptive materials to replace the noise reduction coefficient (NRC). Confusion now exist between the NRC and the noise reduction (NR) which is unrelated to sound absorption. The task group seeks comments from users, manuafacturers, and distributors of sound absorptive materials.

The Task Group on Practices and Criteria for Audiometric Enclosures will develop a guide for selecting audiometric and personnel enclosures. This task group seeks participation by people interested in the proposed guide. The Task Group on Manufactured Enclosures will prepare a test method for evaluating printer enclosures.

The following new ASTM standards have now been approved: Classification E 1110 for Determination of Articulation Class, Test Method E 1111 for Measuring Interzone Attenuation of Ceiling Systems, Practice E 1123 for Mounting Specimens for Sound Transmission Loss Testing of Naval and Marine Bulkhead Treatment Materials, Test Method E 1129 for field Measurement of Sound Power Level by the Two Surface Method, and Test Method E 1130 for the objective Measurement of Speech Privacy in Open Offices using the Articulation Index.

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13-16 April
IEEE International Conference on Acoustics, Speech, and Signal Processing
Dallas, USA

11-15 May
Acoustical Society of America
Indianapolis, USA

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AIHA Annual Conference
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22-24 June
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Lisbon, Portugal

22-26 June International Symposium on Fisheries Acoustics
Seattle, USA

24-26 June
Symposium on Echocardiology
Rotterdam, The Netherlands

6-9 July
Ultrasonic International
London, UK

15-17 July
Inter-Noise 87
Beijing, China

26-30 July
16th International Symposium on Shock Tubes and Waves
Aachen, West Germany

16-19 October
83rd Audio Engineering Society Convention
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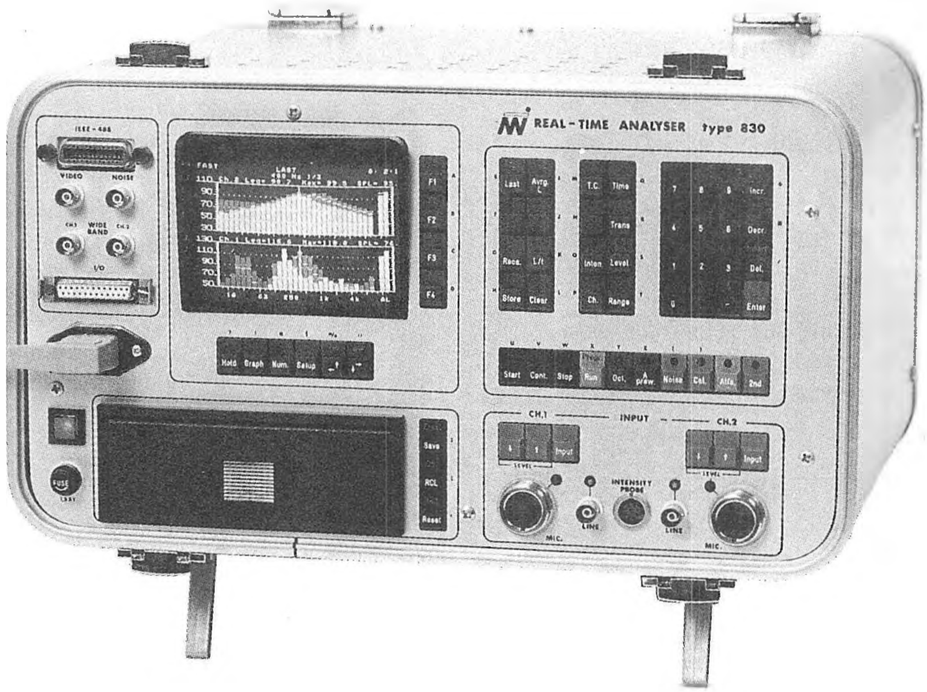

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CAN3-Z107.4	Pure Tone Air Conduction Audiometers for Hearing Conservation and for Screening	Issued 1986 New edition	($19.75)
Z107.21	Procedure for Measurement of the Maximum Exterior Sound Level of Pleasure Motor Boats	Issued 1977 Subcommittee review	($12.50)
Z107.22	Procedure for Measurement of the Maximum Exterior Sound Level of Stationary trucks with Governed Diesel Engines	Issued 1977 Subcommittee review	($12.50)
Z107.23	Procedure for Measurement of the Maximum Interior Sound Level in Trucks with Governed Diesel Engines	Issued 1977 Subcommittee review	($12.25)
Z107.24	Procedure for Measurement of the Exterior Sound Level of Railbound Vehicles	Approved by CSA Z107 committee Publication postponed	
Z107.25	Procedure for Measurement of the Exhaust Sound Level of Stationary Motorcycles	Issued 1983	($13.25)
CAN/CSA-Z107.31	Test Procedures for Measurement of Sound Levels from Agricultural Machines	Issued 1986	($25.00)
CAN/CSA-Z107.32	Test Procedure for Measurement of Sound Emitted from Construction, Forrestry and Mining Machines to the Operator Station and Exterior of the Machine	Issued 1986	($25.00)
Z107.51	Procedure for In-Situ Measurement of Noise from Industrial Equipment	Issued 1980 Reaffirmed 1986	($12.50)

Z107.52	Recommended Practice for the Prediction of Sound Pressure Levels in Large Rooms Containing Sound Sources	Issued 1983	($18.50)
Z107.53	Procedure for Performing a Survey of Sound due to Industrial, Institutional or Commercial Activities Sources	Issued 1982	($11.25)
CAN3-Z107.54	Procedure for Measurement of Sound and Vibration due to Blasting Operations	Issued 1985	($21.00)
CAN/CSA-Z107.55	Recommended Practice for the Prediction of Sound Levels Received at a Distance from an Industrial Plant	Issued 1986	($23.00)
CAN/CSA-Z107.56	Procedures for the Measurement of Occupational Noise Exposure	Issued 1986	($28.00)
Z107.71	Measurement and Rating of Noise Output of Consumer Appliances	Issued 1981 Subcommittee review	($22.00)

Handling and mailing charges are additional. Copies may be ordered or obtained from CSA offices in Moncton (855-5596), Montreal (694-8110), Toronto (747-4044), Winnipeg (632-6633), Edmonton (450-2111), or Vancouver (273-4581). The mailing address for CSA Head Office is 178 Rexdale Blvd., Toronto, Ontario, M9W 1R3. Technical enquiries concerning standards in the Z107 series may be addressed to J.D. Quirt, Institute for Research in Construction, National Research Council of Canada, Ottawa, K1A 0R6 (telephone: (613)-993-2305).

Other CSA Standards with Acoustical Content

CAN3-Z62.1-R1984	Chain Saws (National Standard for Product Certification)
Z94.2-R1983	Hearing Protectors
C22.2 No. 0.7-M1984	Equipment Electrically Connected to a Telecommunication Network (Specifies maximum sound from telephones)

Foreign Standards Endorsed by CSA Committee Z107 for Use in Canada

(Some revision of this list is anticipated in 1987)

ANSI S1.4-1983	Specification for Sound Level Meters
ANSI S1.11-1966(R1976)	Octave, Half-Octave, and Third-Octave Band Filter Sets Sound Level Meters
ANSI S1.13-1971(R1976)	Methods for the Measurement of Sound Pressure Levels
ANSI S1.31-1980	Precision Methods for the Determination of Sound Power Levels of Broad-Band Noise Sources in Reverberation Rooms
ANSI S1.32-1980	Precision Methods for the Determination of Sound Power Levels of Discrete Frequency and Narrow-Band Noise Sources in Reverberation Rooms
ASTM C384-77	Impedance and Absorption of Acoustical Materials by the Impedance Tube Method
ANSI/ASTM C423-1977	Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM E90-1981	Laboratory Measurements of Airborne Sound Transmission Loss of Building Partitions
ANSI/ASTM E336-1977	Measurement of Airborne Sound Insulation in Buildings
ANSI/ASTM E492-1977	Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine
IEC 651-1979	Sound Level Meters
SAE J919-Jun86	Sound measurement - Earthmoving Machinery - Operator Singular Type

New CSA Standards Under Development by Committee Z107

P9.2.18	Noise Monitoring around Industrial Complexes	Draft in preparation
Z107.6 (tentative)	Pure Tone Air Conduction Threshold Audiometry for Hearing Conservation Purposes	Ready for Main Committee ballot

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