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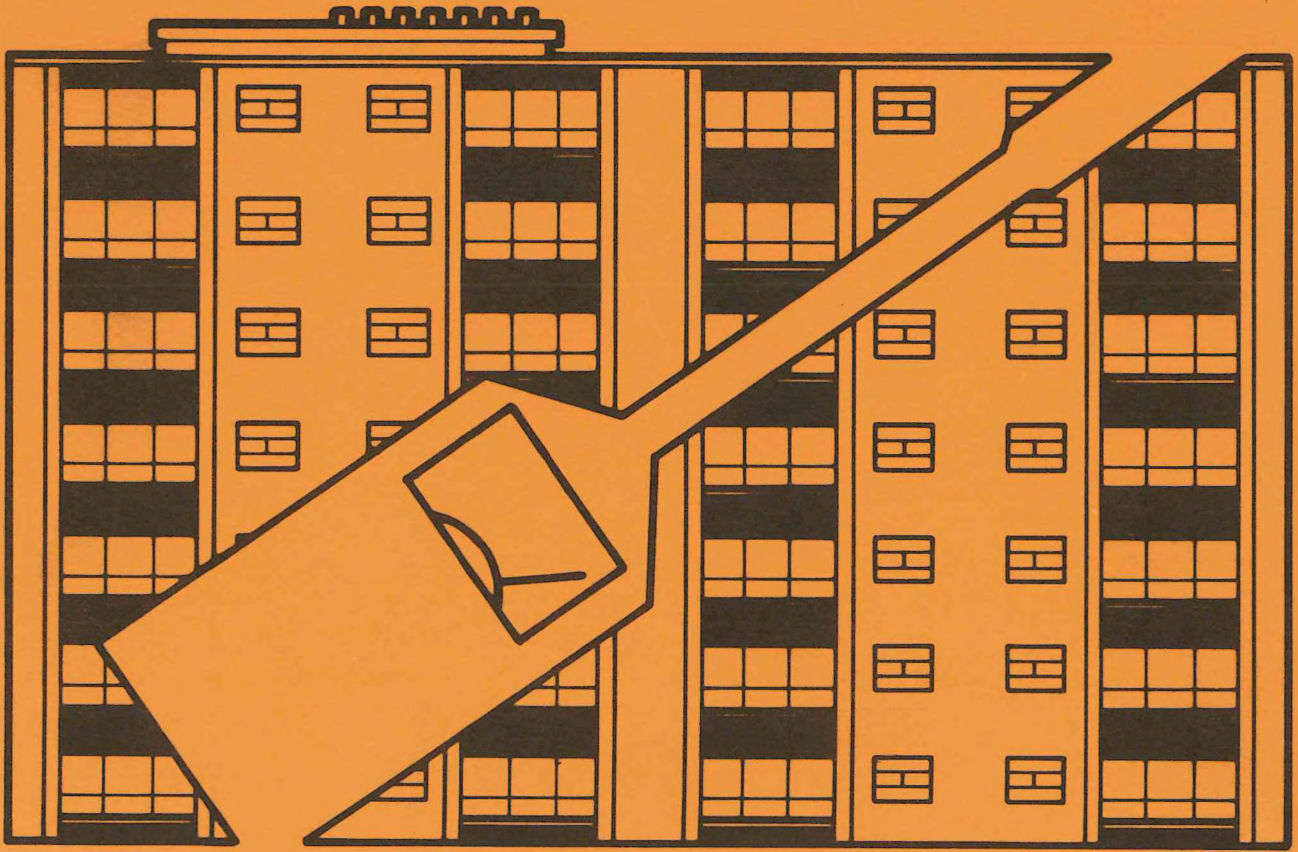

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canadian acoustics

The Canadian Acoustical Association
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EDITORIAL

Along with wishing you a traditional Happy New Year, we draw your attention to our new banner line - CANADIAN ACOUSTICS - and hope you too will wish us well!

To those of you exclusively in noise control, you can see from the contents in this issue that we are still very much interested in noise control as a subject. However, with the limited number of acousticians in Canada, we wish to appeal to all fields of acoustics, to develop and maintain as broad a link as possible. In this way we hope to enlarge our circulation, to give as much exposure as possible to our authors and advertisers.

"Acoustics and Noise Control in Canada" began in a modest way in January 1973 as a newsletter form of communication amongst members of the Canadian Committee on Acoustics (now the Canadian Acoustical Association). The first editor was Tony Embleton of National Research Council. The publication has gradually improved in style and contents over the last 9 years and is now internationally recognized and indexed. We hope, with your help, CANADIAN ACOUSTICS will continue this trend.

EDITORIAL

Bonne année à tous nos lecteurs. Si vous ne l'avez pas encore remarqué, la nouvelle année apporte un changement majeur à notre publication, un nouveau titre : ACOUSTIQUE CANADIENNE! Nous pensons qu'il réflète mieux la diversité et l'étendue du contenu de notre revue.

Ceux parmi vous qui travaillent exclusivement dans le domaine de contrôle du bruit peuvent constater que le contenu de ce numéro-ci témoigne de notre intérêt continu au contrôle du bruit. Cependant, étant donné que le nombre d'acousticiens au Canada est limité, nous voudrions englober tous les domaines de l'acoustique, développant et entretenant ainsi des liaisons globales. En faisant cela, nous espérons augmenter notre distribution, et par conséquent, faire connaître nos auteurs et annonces à un plus grand public.

"L'Acoustique et la Lutte Antibruit au Canada" a débuté modestement en janvier 1973, en tant que bulletin de liaison entre les membres du Comité Canadien sur l'Acoustique (maintenant L'Association Canadienne de L'Acoustique).

Le premier rédacteur a été Tony Embleton du Conseil National de Recherches. La publication a été considérablement amélioré en style et en contenu pendant les derniers neuf ans, et maintenant, elle est reconnue et indexée au niveau international. Nous souhaitons qu'avec vos contributions, ACOUSTIQUE CANADIENNE continuera dans cette voie de succès.

Nous avons le plaisir d'annoncer à nos lecteurs francophones qu'un séminaire sur le BRUIT et son CONTROLE se tiendra à l'Université de Sherbrooke le jeudi 18 mars 1982.

Organisée par la section d'acoustique du Département de génie mécanique, cette journée est parainée par la section regionale de l'Ordre des ingénieurs du Québec et la Société canadienne des ingénieurs.

Les thèmes abordés toucheront les normes, l'acoustique physiologique, la propagation sonore, les techniques classiques de réduction du bruit et des études de cas.

Pour plus d'information, s'adresser à Jean Nicolas ou N. Galanis au numéro (819) 565-4490.

NEWS

XI^e CONGRÈS INTERNATIONAL D'ACOUSTIQUE/11th INTERNATIONAL CONGRESS ON ACOUSTICS

Le Onzième Congrès International d'Acoustique se tiendra en France, à Paris, du 19 au 27 juillet 1983; il concernera tous les domaines de l'Acoustique. Il sera précédé de Symposiums satellites qui seront organisés:

- à Marseille, les 12 et 13 juillet, sur l'absorption acoustique active et les asservissements acoustiques;
- à Lyon, les 15 et 16 juillet, sur les vibrations des structures mécaniques;
- à Toulouse, les 15 et 16 juillet également, sur la communication parlée.

The 11th International Congress on Acoustics will be held in Paris, France, from July 19 to July 27, 1983. All fields of Acoustics will be covered. Satellite Symposia will be held before or after the Congress, as follows:

- in Marseille, on July 12 to 13 on Active Acoustic Absorption;
- in Lyon, on July 15 and 16 on Vibrations of Mechanical Structures;
- in Toulouse, on July 15 and 16 also on Speech Communication.

Pour tous renseignements s'addresser à/for further information write to: G.A.L.F. Secretariat, B.P. 40, 22301 Lannion-Cedex, France.

3rd MEETING OF THE WORLD FEDERATION FOR ULTRASOUND IN MEDICINE AND BIOLOGY

The Third Meeting of the World Federation for Ultrasound in Medicine and Biology/Fifth World Congress of Ultrasound in Medicine and Biology will take place in Brighton, England, 26-30 July, 1982. Abstracts should arrive before 1st December, 1981. For further information contact: Dr. Patricia Morley, Co-Chairman, 3 WFUMB Scientific Committee, Dept. of Diagnostic Radiology, Western Infirmary, Glasgow G11 6NT, Scotland, GB.

ACOUSTICAL IMAGING '82

The Twelfth International Symposium on Acoustical Imaging is to be held 12-22 July, 1982, in London, England. It is being arranged by the Institution of Electrical Engineers in association with the Sonics and Ultrasonics Group of the IEEE and other relevant learned societies. The symposium will cover all aspects of acoustical imaging and is being timed to coordinate with the 3rd meeting of the World Federation for Ultrasound in Medicine and Biology. All enquiries should be directed to: Acoustical Imaging '82, IEE, Savoy Place, London WC2R 0BL, England.

INTER-NOISE 82

INTER-NOISE 82, the eleventh International Conference on Noise Control Engineering, will be held at the Jack Tar Hotel in San Francisco, 17-19, 1982. For further information contact James G. Seebold, Standard Oil Co. of California, P.O. Box 3069, San Francisco, CA 94119, U.S.A., Telephone (415) 894-2484.

1982 CSHA CONVENTION

The 1982 Convention of the Canadian Speech and Hearing Association will be held in Vancouver, May 17-22, 1982. For further information contact Monica Brekelmans, 4230 Blenheim Street, Vancouver, B.C., V6L 2Z4.

NEW RESEARCH CONTRACTS

To Optech Incorporated, Downsview, Ont., $160,557 for "Development construction and testing of a system to assess noise levels associated with ocean roughness measurements", by the Department of National Defence.

To Tektrend International Incorporated, Lachute, Que., $142,217 for "Design and development of a correlation acoustic emission monitoring program". Awarded by the Department of National Defence.

To Asecor Ltd., Manotick, Ont., $38,404 for "Development of a computer code for the computation of the blast noise environment of recoilless rifles". Awarded by the Department of National Defence.

To Hermes Electronics Ltd., Dartmouth, N.S., $245,000 to "Investigate the designs for directional sonobuoy sensors with a view to achieving a small, cost effective, and viable design having appropriate frequency response characteristics". Awarded by the Department of National Defence.

To Woods-Gordon Management Consultants, Toronto, Ont., $175,000 for a "Study of the sound recording industry in Canada". Awarded by the Department of Communications.

To Dr. N. Georganis, Dept. of Electrical Engineering, University of Ottawa, Ottawa, Ont., $39,705 for a "Study of frequency spectrum management methods for mobile communications systems". Awarded by the Department of Communications.

To P. Kabal, Télécommunications, Institut national de la recherche scientifique, Verdun, Qué., $29,920 for "Coding by voice conversion". Awarded by the Department of Communications.

To Techno Scientific Inc., Downsview, Ont., $13,685 for "Ultrasonic monitoring of crack extension by corrosion fatigue in oil pipelines". Awarded by the Department of Energy, Mines and Resources.

To Tektrend International Ltd., Lachute, Que., $134,636 for "Development of an on-line acoustic emission monitoring system for welding thick-walled vessels". Awarded by the Department of Energy, Mines and Resources.

To Dr. W. Steenaart, Department of Electrical Engineering, University of Ottawa, Ottawa, Ont., $29,383 for "Development of a sonar signal injector". Awarded by the National Research Council.

To Acres Consulting Services Ltd., Niagara Falls, Ont., $62,624 for a "Study on radiation of sound by ships hull structure". Awarded by the Department of National Defence.

To Mesotech Systems Ltd., North Vancouver, B.C., $15,000 for "Further development and modifications to the model 440 acoustic navigations system". Awarded by the Department of Fisheries and Oceans.

NEXT CAA TORONTO CHAPTER MEETINGS

The next meeting of the CAA Toronto Chapter is scheduled for Monday, January 11, 1982 at 7:00 p.m. in the Ontario Hydro Auditorium, 700 University Avenue, Toronto. Topics for the meetings are: 1. Acoustics of the Ontario Hydro Building, and 2. Sound Re-enforcement. Contributors are A. Edwards (Ontario Hydro), and M.V. Merritt (Engineered Sound Systems Ltd.). The meeting convenors are Andy McKee and John Swallow. The following meeting is scheduled for sometime in April 1982 at the same location. The topic for the meeting will be Industrial Audiometry and the meeting convenors are S. Abel and W. Zydenborgh.

FUTURE MEETINGS

Spring 1982, Budapest, Hungary, 8th Colloquium on Acoustics. Details from: OPAKFI, Anker Köz 1, 1061 Budapest.

Spring 1982, Mexico City, Mexico, VI Latin American Meeting in Acoustics.

Details to be announced.

April 26-30, 1982, Chicago, USA, Meeting of the Acoustical Society of America. Chairman: Mahlon D. Burkhard, Industrial Research Products, Inc., 321 North Bond St., Elk Grove Village, Illinois U.S.A., 60007.

May 17-22, 1982, Vancouver, B.C., Convention of Canadian Speech and Hearing Association. See page 2 for details.

May 17-19, 1982, San Francisco, USA, INTER-NOISE 82. See page 2 for details.

July 12-22, 1982, London, U.K, Twelfth International Symposium on Acoustical Imaging. See page 2 for details.

July 26-30, 1982, Brighton, U.K., Third Meeting of the World Federation for Ultrasound in Medicine and Biology/Fifth World Congress of Ultrasound in Medicine and Biology. See page 2 for details.

July 19-27, 1982, Paris, France, The Eleventh International Congress on Acoustics. See page 2 for details.

September 13-17, 1982, Göttingen, Federal Republic of Germany, 3rd FASE CONGRESS jointly with DAGA '82. The Congress program will cover: Speech research, Architectural acoustics, structure borne sound; Aero acoustics, underwater sound, nonlinear acoustics. General Secretariat: FASE '82, c/o Physikalisch-Technische Bundesanstalt, Post Box 3345, D-3300 Braunschweig.

September 1982, Warsaw, Poland, Noise Control Conference. Details from: Prof. S. Czarnecki, Committee for Acoustics of the PAN, PKiN p.2321, 00-301 Warsaw.

October 1982, High Tatra, Czechoslovakia, 21st Acoustical Conference on Noise and Environment. Secretariat: House of Technology, Ing.L.Goralíková, Škultétyho Street, 881 30 Bratislava.

November 8-12, 1982, Orlando, Florida, USA, Meeting of the Acoustical Society of America. Chairman: Joseph E. Blue, Naval Research Laboratory, P.O. Box 8337, Orlando, Florida, U.S.A., 32856.

STUDY OF KILLER WHALE "TALK" MAY BENEFIT PACIFIC FISHERIES

Can the sounds made by the killer whales that range the British Columbia coastal waters in their tightly knit family groups or pods have a commercial application to the fisheries in that area?

The answer would seem to be "Yes".

This is the implication of a two-year study into the acoustic bebavior of the killer whale in the waters of eastern and southern Vancouver Island under a $21,792 contract negotiated and managed by the DSS Science Centre on behalf of the Department of Fisheries and Oceans.

The study was carried out by John K.B. Ford, a Ph.D. student at the University of British Columbia, working closely with the scientific authority for the project, Dr. Michael Bigg, program head, marine mammal unit, Pacific Biological Station, Nanaimo, B.C.

"Killer whales feed on salmon and other commercial fish and their vocal sounds do frighten their prey into fleeing for safety", says Dr. Bigg. "Such sounds could be usefully applied, for example, for herding the fish. Another practical application would be to turning on these underwater sounds in areas where seals and sea lions are marauding commercial fishermen's nets, causing considerable damage in addition to robbing the catch."

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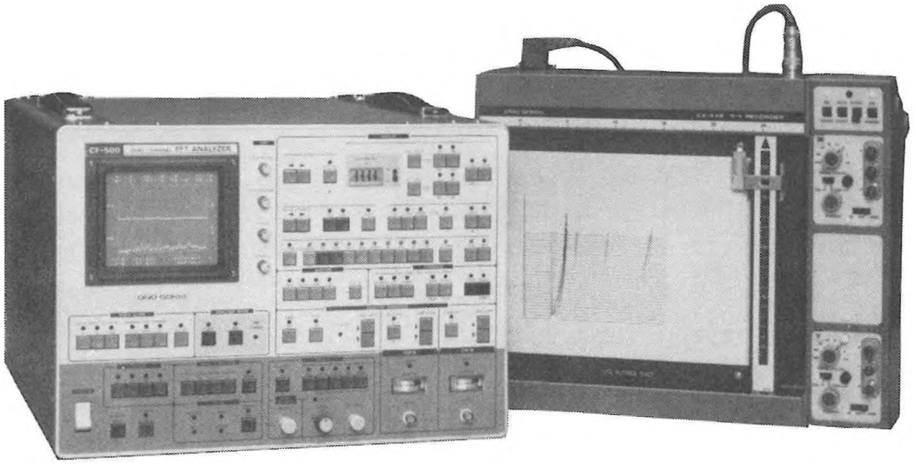

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1981 CANADIAN ACOUSTICAL ASSOCIATION CONVENTION REPORT

If you want a successful convention, just make sure you serve enough wine.

The Edmonton convention can, I believe, be evaluated as successful, but for other reasons besides wine.

The turnout was not as large as we had hoped, but it was at least above the minimum for which we had budgeted. As a result, we will show a very modest profit, in spite of some of the extra costs incurred by virtue of the postal strike.

The technical symposiums, with their keynote speakers and wide variety of papers presented, went off very well and very nearly as planned; a most remarkable achievement. The technical program committee under Gary Faulkner is to be congratulated.

The business sessions, under President Northwood, were well controlled and covered a lot of territory in a tight schedule.

The banquet speakers were interesting and kept within their time allotments.

All in all, a very successful convention, made more sucessful by the keen participation of the attendees.

The statistics:

Registration	-	74
Banquet	-	82
Technical Papers	-	34
Keynote Speakers	-	3

A more complete and somewhat more technical report is being prepared by the committee for use by other convention planners. It should be ready, along with the financial statements, before the end of November.

Coupled with the C.A.A. convention were two very good and well attended noise control courses, organized by the C.A.A., administered by the University of Alberta, Faculty of Extension. The first, Controlling Environmental Noise, was subsidized by the Province of Alberta. The second, Machinery Noise Control, was self supporting. The Environmental Noise course drew 31 registrants. The Machinery Noise course was attended by 27.

E.H. (EUGENE) BOLSTAD.

CAA ANNUAL MEETING - SECRETARY'S REPORT

Minutes of the Annual General Meeting of the Canadian Acoustical Association

Held at the Chateau Lacombe Hotel, Edmonton, on October 8, 1981

1. The meeting was called to order by President T. D. Northwood at 4:45 p.m.

2. The minutes of the previous annual meeting were read by the Executive Secretary, J. Manuel. On a motion by F. Hall seconded by J. Piercy the minutes were accepted as read.

3. The Treasurer, L. T. Russell, in presenting his report noted the CAA financial affairs were in an even better shape this year. The surplus at August 31, 1981 was $11,355.97 after repayment of a $2000 cash advance given to the CAA 1981 Edmonton organizing committee.

4. The auditor's report was presented by D. May who stated that the accounts accurately reflected the financial state of the Association affairs. On a motion by D. May and seconded by A. Behar the Treasurer's report was then accepted with thanks.

5. The Executive Secretary, J. Manuel, read the correspondence received during the past year. The most significant was the May 5, 1981 letter from R. T. Beyer, Chairman of the International Commission on Acoustics, advising that "The International Commission on Acoustics, at its meeting at Aachen, Germany, last week, voted to accept the kind invitation of the Canadian Acoustical (Society) to have the latter host the 12th International Congress on Acoustics in Toronto, Canada, in the summer of 1986".

6. The Editor, D. Benwell, in presenting her report noted that the CAA newsletter "Acoustics and Noise Control in Canada" was being indexed in at least six international abstracting journals. She stated that all papers submitted for publication were being reviewed. The french language content had increased and she called for more papers in both languages from the membership. The Editor noted that back copies of the newsletter were still available. Finally, special efforts were going to be made this year to increase the newsletter circulation and thereby increase advertising revenues. The Chairman accepted the report by thanking the editorial staff for the continuing improvement in the quality of the CAA newsletter.

7. The Chairman noted that H. W. Jones was representing the Association at the meeting of International INCE being held concurrently with the Noise-Con 1981 meeting in Amsterdam.

8. In presenting the report of the Nominating Committee, C. W. Bradley, noted that only one position on the executive had to be filled this year and he, therefore, proposed the following slate:

President:	T. D. Northwood	(continuing),
Executive Secretary:	J. Manuel	(continuing),
Treasurer:	J. Nicolas	(replacing L. T. Russell),
Editor:	D. Benwell	(continuing).

9. Election of the officers was moved by B. Dunn and seconded by A. Sydenborgh. Carried unanimously.

10. President T. D. Northwood, on behalf of the Officers, accepted the appointments and thanked the membership for their confidence in electing the Officers. He congratulated J. Nicolas on his appointment as Treasurer.

11. The Nominating Committee then nominated two members to fill vacant Directorships. Two additional nominations were, however, proposed from the floor and an election was held. As a result of the secret ballot by members in good standing, the Ballot Counting Committee, comprising S. H. Eaton and M. V. Merritt, reported that L. T. Russell and S. Abel had been elected. There were no spoilt ballots.

12. The Chairman confirmed the election results and congratulated the new Directors on their appointments. The 1981/82 slate of CAA Directors follows:

L. T. Russell	-	4 year term (Nova Scotia)
S. Abel	-	4 year term (Ontario)
S. Eaton	-	3 year term (British Columbia)
M. Osman	-	3 year term (Ontario)
R. Cyr	-	2 year term (Quebec)
J. Hemingway	-	2 year term (Ontario)
D. Whicker	-	1 year term (British Columbia)
J. Piercy	-	1 year term (Ontario)

13. The Chairman, in making the announcement that D. S. Kennedy had won the 1980 Director's Award, displayed the special scroll that had been produced to mark the occasion and noted that all the Directors had signed the scroll. The winner, D. S. Kennedy, was not present to accept the Award.

14. The Chairman then reported that the Ontario Ministry of the Environment on April 14, 1980 had invited the Canadian Acoustical Association to co-sponsor the 1982 acoustics technology training program to be held in Toronto. He indicated that this request had been discussed and approved at the Directors' meeting held on the previous day. He asked the membership to confirm the decision of the Directors.

15. A motion by D. Whicker seconded by G. Bolstad that "The Canadian Acoustical Association, at the invitation of the Ontario Ministry of the Environment, agrees to jointly sponsor the 1982 environmental acoustics technology training course session in Toronto subject to the Association and its membership being kept free and clear of all liability and expense" was approved.

16. In opening the discussion on the CAA planning for the 1986 ICA in Toronto, the Chairman recounted the initial actions in this regard approved by the membership at the 1979 annual general meeting in Windsor, Ontario, and the subsequent extraordinary meeting of the Directors held in Toronto in June 1980 prior to the 10th ICA in Sydney, Australia. He then called on E. A. G. Shaw, a former member of the International Commission on Acoustics, to make a short presentation on the nature and scope of an international congress. In his remarks Edgar Shaw noted that this international organization had its roots in the United Nations, Educational, Scientific and Cultural Organization. Of all the Commissions, the Acoustics Commission fits least easily into the International Union of Pure and Applied Physics (IUPAP) but acoustics was one of the most active and most appreciated Commissions in IUPAP. He said that our 1986 Congress would be the 12th Congress marking the 33rd year of co-operation in acoustics in a truly international forum. He noted that Congresses usually have between 1000 and 1500 participants at technical meetings and related activities. The benefits are many, mostly intangible, such as enabling graduate acoustics students to travel abroad and meet world leaders and their contemporaries.

    Chairman T. D. Northwood thanked Edgar Shaw for his remarks and concluded the discussion by summarizing the organizational work completed to date and the plans for broadening the organizational structure over the ensuing year. The Chairman noted that Canada must make a more detailed presentation to the International Commission on Acoustics in Paris in July, 1983.

17. A motion by J. Piercy seconded by J. Nicolas that "the 12th ICA task group established in 1979 be authorized to expand in order to represent the Canadian acoustical community both geographically and in terms of technical disciplines with the charge of preparing a detailed organizational plan by the time of the 1982 CAA meeting" was carried unanimously.

18. A further motion proposed by M. Osman and seconded by B. Dunn that "The Executive Secretary be authorized to confirm, on behalf of the Canadian Acoustical Association, accommodation reservations made in anticipation of the Toronto 1986 International Congress on Acoustics" was also carried unanimously.

19. To assist in the planning and organization of financial resources, E. A. G. Shaw proposed and A. Behar seconded a motion that "The 12th ICA organizing committee and the Treasurer of the CAA, to cover the organizational expenses connected with the 12th ICA, be authorized to accept and hold in trust voluntary contributions from members, subscribers and other interested parties. They are further authorized to solicit contributions from industry, governments and other institutions". Carried unanimously.

20. The membership and subscription fees are reviewed annually and confirmed. It was proposed by C. Sherry and seconded by D. Whicker that "The 1982 annual membership and the annual subscription fee shall be $15.00. The annual student membership fee shall remain at $0". After some discussion, an amending motion was voted on and defeated. The motion given above was then put to the vote and carried.

21. The Chairman then called on S. Eaton seconded by C. W. Bradley to propose a motion thanking members retiring from office.

> "In recognition and appreciation of the services rendered during their respective terms of office; the members, executive and directors thank the following members for their interest and support in furthering the interests of the Association:
>
> Les Russell - retiring Treasurer and New Director,
>
> Cameron Sherry - retiring Director,
>
> Gene Bolstad - retiring Director".

Carried by acclamation.

22. The Chairman noted that the 1982 CAA Meeting and Symposium would be held in Toronto. The Convenor of the 1982 meeting is J. Manuel.

23. The Association was invited by D. Whicker and S. Eaton to consider holding the 1983 CAA meeting in Vancouver.

24. On the motion of M. V. Merritt and carried with acclamation "The Association and its members thank the Edmonton organizing committee, and supporting organizations for the excellent 1981 CAA meeting program and arrangements".

25. There being no further business, the Chairman adjourned the meeting at 6:45 p.m.

John Manuel
Executive Secretary

CAA ANNUAL MEETING - TREASURER'S REPORT

The Treasurer's report consists of the following parts:(a) Statement of Cash Receipts and Expenditures for the Period of September 1, 1980 to August 31, 1981 and (b) a breakdown of these figures reflecting the major income and expenses up to August 31, 1981.

Leslie T. Russell,
Treasurer.

STATEMENT OF CAST RECEIPTS AND DISBURSEMENTS FOR PERIOD SEPT. 1, 1980, TO AUG. 31, 1981.

Receipts

Newsletter, advertising, membership and contributions.		$5,679.49	
Interest		456.60	
1979 Annual Meeting		1,494.85	
1980 Annual Meeting		1,548.67	
NRC Measurements Seminar		520.00	
	TOTAL =	$9,699.61	$9,699.61

Disbursements

I/INCE fees		$ 189.93	
Receiver General of Canada		30.00	
Printing of Newsletter		3,056.03	
Miscellaneous		10.06	
Petty cash advance to D. Benwell & M. Osman		200.00	
Advance for 1981 CAA Annual Meeting		2,000.00	
	TOTAL =	$5,486.02	$5,486.02

Excess Receipts Over Disbursements = $4,213.59

BALANCE SHEET

AUG. 31, 1981

Assets

Cash on hand	$4,355.97
Bank of Montreal Term Deposit	5,000.00
	$9,355.97

Liabilities

Surplus Balance Forward, Aug. 31, 1980	$5,142.38
Add: Excess Receipts over Disbursements	4,213.59
	$9,355.97

BANK RECONCILLATION

Bank Statement, August 31, 1981	$4,355.97
Outstanding cheques	0.00
Balances as of August 31, 1981 =	$4,355.97

In agreement with books.

CSA ACOUSTICS AND NOISE CONTROL COMMITTEE REPORT

The Technical Committee Z107 on Acoustics and Noise Control of the Canadian Standards Association held its Annual Meeting at the Chateau Lacombe Hotel, Edmonton on October 7, 1981. Some 20 members of the committee and about 4 guests attended.

During the year the work of the committee is advanced through the activities of its several subcommittees and task forces. A major part of the Annual Meeting of Z107 is taken up with reports from these groups. For the benefit of readers who may be interested in standards work in specific subfields of acoustics, the following is a list of the subcommittees and their current chairmen:

SC on Noise in Industry - C.W. Sherry
SC on Consumer Appliances - J. Manuel
SC on Powered Machines - E.O. Nyborg
SC on Instrumentation - J. Coulter
SC on Transport Vehicles - L.G. Kende
SC on Hearing Measurement - R.B. Johnston
SC on Transmission of Noise Through Buildings - T.D. Northwood
SC for Editorial Review - C.W. Sherry
SC on Bioacoustics - A.J. Brammer
CAC/ISO/TC43 - T.D. Northwood
Task Force on Community Noise - J. Manuel (pro-tem)
Task Force on Occupational Noise - D. Benwell.

The subcommittees are primarily responsible for the development of standards; the task forces identify the need for new or modified standards.

CSA Standard Z107.71-M1981 "Measurement and Rating of the Noise Output of Consumer Appliances "is now available from CSA (178 Rexdale Boulevard, Rexdale, Ontario M9W 1R3) at a price of $20. Earlier standards on other acoustical topics are also available from the same address. Several draft standards on site-noise surveys and in-plant prediction procedures, sound level meters and various types of self-powered machines will be balloted and/or printed within the next year.

T.F.W. Embleton

POSITION WANTED

NAME:	Khalid Masood Hafeez
AGE:	30 Years
MARITAL STATUS:	Married
CITIZENSHIP:	Canadian Landed Immigrant
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SOUND LEVELS AROUND BUILDINGS NEAR ROADWAYS

by

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ABSTRACT

This paper presents the results of preliminary measurements of the difference between the incident sound levels at the front and rear facades of suburban detached and semi-detached houses adjacent to major roadways. The measurements also yielded data on sound transmission through open windows and comparisons between the sound levels measured in open windows, at the surface of the building facade, and 2 m from the facade.

A preliminary series of measurements, now reported, is part of an ongoing effort to provide accurate prediction of the indoor sound levels in buildings affected by major transportation noise sources, in this case, highway traffic. The study involved three specific aspects of the problem:

1) the effect of reflections on the sound field near the exposed facade of a building;

2) the difference in the incident sound levels at exposed and sheltered facades of detached housing in the first row of buildings near a major highway;

3) the noise reduction characteristic of open windows.

As anticipated, the results demonstrated that simple, well-established approaches to these problems provide reasonable predictions.

Figure 1 illustrates the typical microphone positions used in taking simultaneous measurements at a number of positions inside and outside a building, including 2 m from the exposed facade, immediately adjacent (within 10 mm) to it, and inside and at the open windows of rooms on both the exposed and sheltered sides of the house. Metrosonics dB-301 logger units were used to measure the A-weighted equivalent sound level for 1-min intervals and store the data for up to 480 such intervals. By synchronizing the starting time of the six (or more) dB-301 units used at each site the difference in sound levels for any time interval could be readily obtained. Typically, data were logged for 80 to 100 min at each building, the indoor microphones being moved every 15 to 20 min to provide data for at least five positions and permit calculation of average room response.

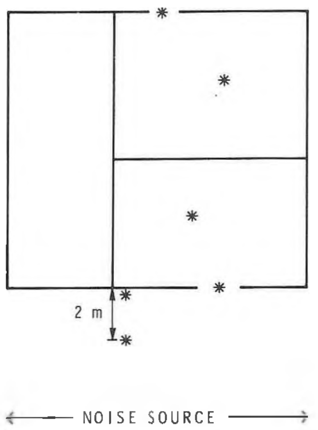

FIGURE 1

Schematic indication of typical microphone positions (indicated by asterisks) in window openings and adjacent to the exposed facade

The 1-min intervals provide sufficient temporal smearing to average out most of the fluctuation associated with the passing of an individual noisy vehicle. On the other hand, the intervals are short enough to permit discarding data from any intervals during which specific extraneous noises contaminated the traffic noise data. For room characterization the room and window dimensions and reverberation time were also measured.

The incident Sound Pressure Level (SPL) at the facade was generally used as the reference level. It was chosen because it is the incident SPL predicted by most traffic and aircraft noise models or measured on a site before buildings are constructed. It is important to remember that in the presence of reflecting surfaces such as building facades the measured SPL depends on the combination of incident and reflected sound fields. Before discussing the data, some of the basic features of the sound field near a reflecting surface should be reviewed.

The problem was treated particularly clearly by Waterhouse in the context of sound fields near the surfaces of a reverberation room.[1] Figure 2(a) shows his results for random incidence. At the surface the SPL is increased by 6 dB relative to the incident level because the combination of incident and reflected waves of the same amplitude and phase simply doubles the pressure. Interference between the incident and reflected waves causes standing waves near the surface, but because the location of their extrema depends on the angle of incidence, combining the incoherent contributions from different angles causes these fluctuations to average out; for distances $\sim$1 or 2 wavelengths from the wall the SPL increase tends to the 3 dB associated with doubling the energy. The second curve in Fig. 2(a) shows the similar results expected for a line source (note that the variations in SPL

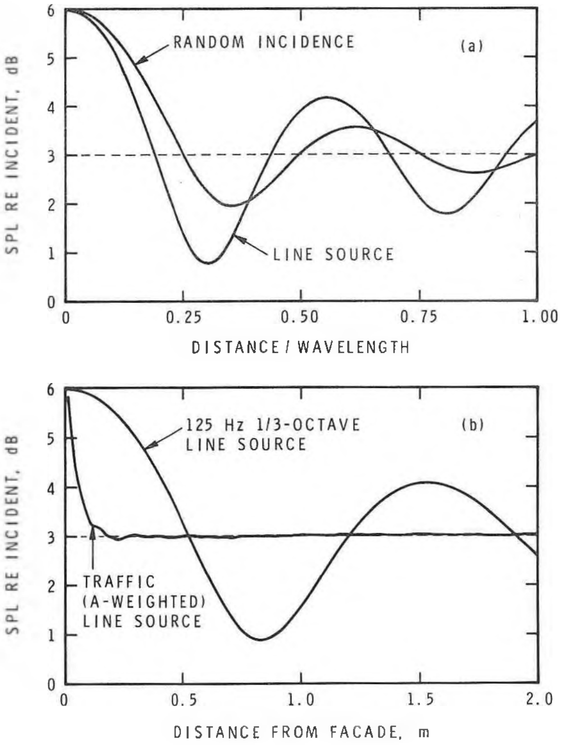

FIGURE 2

Sound pressure level near a reflecting surface for various source geometries and spectra with distance from the surface are larger). The curves shown in Fig. 2(a) are for a pure tone, but virtually identical results apply for a 1/3-octave band; with increasing band width the maxima and minima are reduced because the extrema are located at different positions for each frequency.

In Fig. 2(b) the calculated SPL for a line source parallel to a reflecting plane is shown as a function of distance from the surface (in metres). For individual third octave bands the SPL 2 m from the facade may deviate appreciably from 3 dB above the incident level (especially at low frequencies), but for A-weighted traffic noise the observed SPL should be very close to 3 dB above the incident level for distances of more than about 0.2 m. For distances up to ∿10 mm from the surface the SPL increase should be within 0.1 dB of the 6 dB pressure doubling. These predicted increases of 6 dB and 3 dB are appropriate for a rigid, perfectly reflecting surface; sound absorption by materials such as window glass or wood siding could reduce the increase by as much as half a decibel.

Although the incident SPL seems to be the appropriate reference level for this sort of study, there is no convenient way to measure it directly; directional microphones would distort the relative contributions from different parts of the line source and absorptive treatment of each facade to eliminate reflections over the relevant frequency range (60 - 5000 Hz) is not really practical. Measurements in a room with an open window can be used, however, to obtain a reasonable estimate. If the room's absorption (including the window opening) is not too large, the sound field in the room can be described fairly accurately as the combination of a reverberant field plus a direct field from the sound incident on the window opening. In the window opening the measured sound level (L_{WINDOW}) is dominated by the incident sound (L_{INC}), but the reverberant sound field (L_{ROOM}) is not insignificant. Using the equation

$$L_{INC} = 10 \log [\text{antilog} (L_{WINDOW}/10) - 0.5 \text{ antilog} (L_{ROOM}/10)] \qquad (1)$$

the incident SPL can readily be calculated. To the extent that one may ignore diffraction at the window opening and treat the incident and reverberant fields as uncorrelated, this should provide a reasonable measure of the incident sound level.

The data obtained in the window openings and the central area of the rooms were processed in this way to obtain the incident SPL. These values were then compared with the corresponding data for microphones immediately adjacent to the facade (Fig. 3). The mean difference of 5.6 dB is in quite good agreement with the expected increase of 6 dB. There is some scatter, but it is to be expected for several reasons:

1) the 1 dB resolution limit of the measuring units and the comparable calibration uncertainty would be expected to introduce scatter ∿ ±1 dB;

2) synchronization of the time intervals was imperfect (up to ∿ 5 s in some cases) and the effect of brief, loud events could fall in nominally different time intervals for the two units being compared;

3) interference effects associated with the finite, somewhat irregular facades and diffraction at the window opening could cause real deviations from the simple model used;

4) occasional extraneous noises.

Obviously this is not a precise test of the predicted pressure doubling, but it

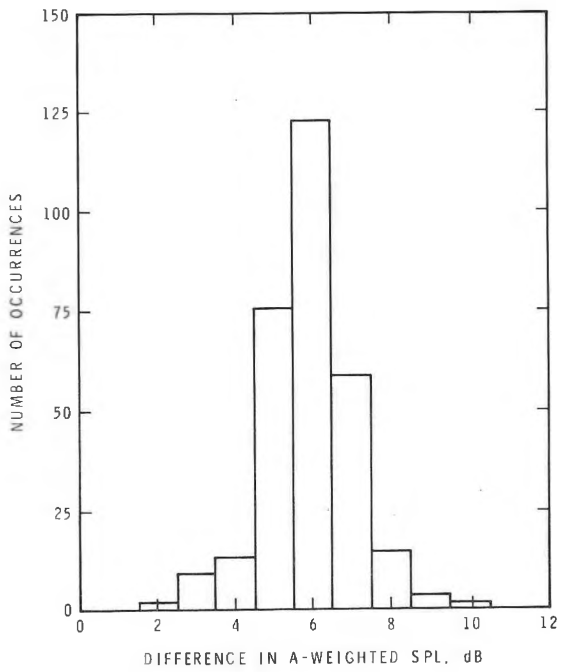

FIGURE 3

Difference between the measured sound level at the surface of the exposed facade and the incident sound level

does provide a fairly clear indication that the sound fields are basically consistent with simple physical expectations. The deviation from 6 dB is consistent with the expected effect of sound absorption by the window glass on which the microphones were mounted.

Similar agreement is found when the incident SPL is compared with the level 2 m from the facade (Fig. 4). The mean increase in the SPL relative to the incident level is 2.5 dB, in reasonable agreement with the expected value of 3 dB. Again, there is appreciable scatter, much of it presumably due to limited measurement accuracy and the effect of extraneous noises.

As already indicated, the procedure to measure the incident sound level required measurement of the sound level inside rooms with open windows and thus provided the data needed to assess sound transmission through open windows. Previous studies[2] indicated a wide range in the noise reduction associated with open windows; it seemed useful to assess the cause of these variations. Before examining the data, the expectations from a simple extension of the Transmission Loss (TL) measurement between two reverberant rooms[3] should be considered. In laboratory measurements the TL is determined from the difference between the reverberant sound levels in the source and receiving rooms (L_{SOURCE} and L_{REC} respectively) normalized to allow for the absorption (A) in the receiving room and the surface area (S) of the element transmitting the sound:

$$TL = L_{SOURCE} - L_{REC} + 10 \log [S/A]. \qquad (2)$$

With this definition the TL corresponds to 10 log $(1/\tau)$, where τ is the ratio of transmitted to incident sound power. For an open window one expects all the sound power to pass through (i.e., $\tau = 1$ and $TL = 0$); experimental results generally agree with this for frequencies where the wavelength is appreciably less than the dimensions of the opening and diffraction can be ignored. For applications relating to exterior facades it is appropriate to consider the noise reduction relative to incident SPL at the test specimen rather than the reverberant level in the source room (L_{SOURCE}). For the reverberant source room $L_{INC} = L_{SOURCE} - 3$ dB, as shown by Waterhouse[1] and illustrated in Fig. 2a. Thus, the noise reduction relative to incident SPL when normalized like TL to allow for component area and receiving room absorption ($L_{INC} - L_{REC} + 10 \log [S/A]$) should correspond to TL - 3 dB; i.e., to -3 dB for an open window.

The actual measured noise reduction relative to the incident SPL (when normalized like laboratory TL data) is shown in Fig. 5. The mean value is -3.4 dB with a standard deviation of slightly less than 1 dB, in rather good agreement

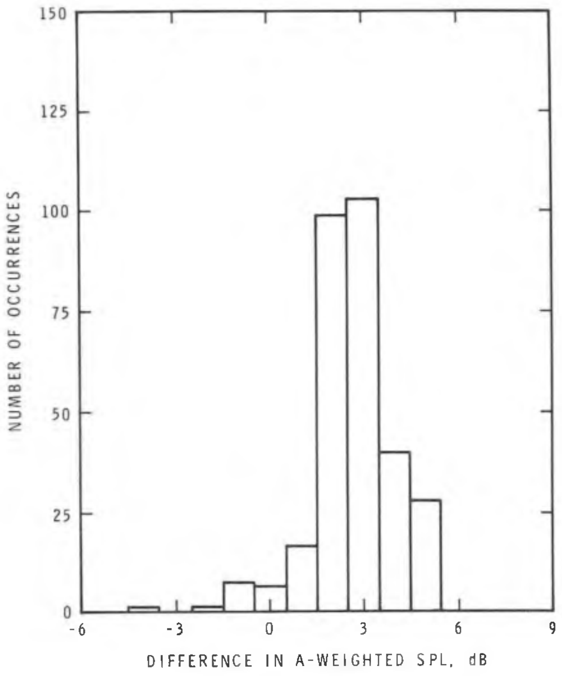

FIGURE 4

Difference between the measured sound level at 2 m from the exposed facade and the incident sound level

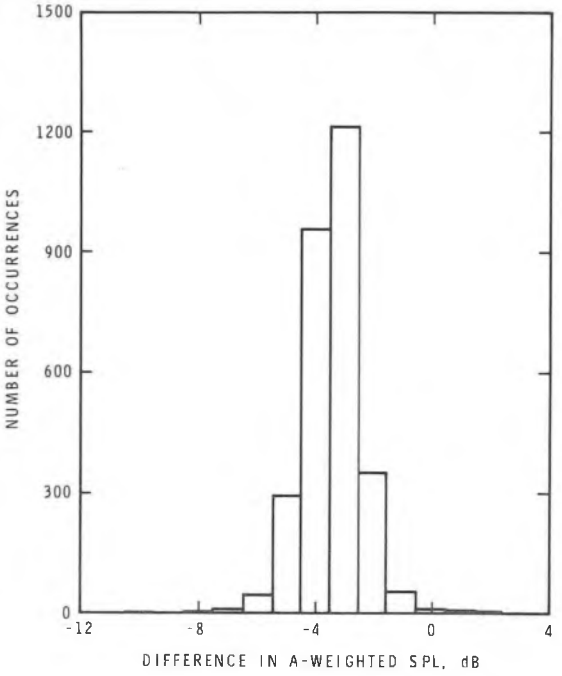

FIGURE 5

Noise reduction for open windows (relative to the incident sound level), normalized to the case where absorption (A) = open area (S)

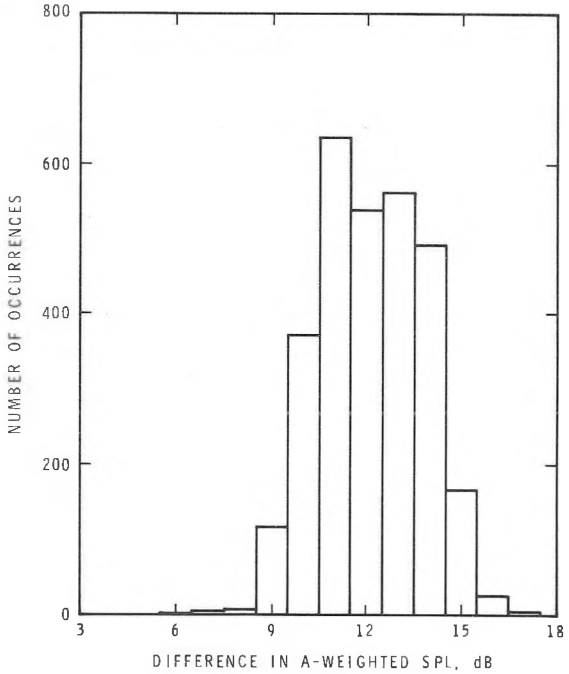

FIGURE 6

Noise reduction for open windows (relative to the incident sound level) when normalized to typical room conditions, as discussed in text

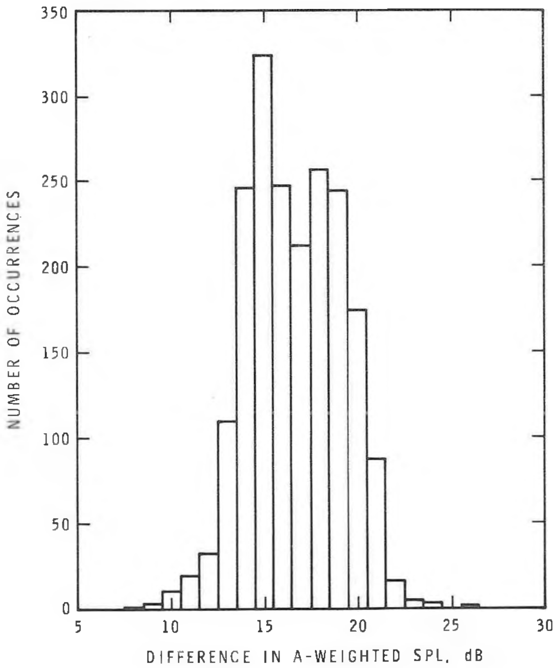

FIGURE 7

Difference between the incident sound levels measured at the exposed and sheltered facades of the houses with the expected value. Because of the rather large number of measurements ($\sim$ 50 rooms) it is tempting to interpret this deviation from -3 dB as systematic. This is not unreasonable, as the increased sound transmission associated with diffraction at the lower frequencies[4] would tend to introduce this sort of shift in the results. The essential features, however, are the quite small scatter in data and the good agreement with the expected value of -3 dB. It should be noted that this shift of -3 dB (as well as corrections to allow for the difference between random incidence and a line source) must be allowed for in applying the laboratory data for any building element to predict indoor noise from an incident outdoor sound level.

Having established the sound transmission characteristics of the windows themselves, it is useful to examine their implications for typical indoor sound levels relative to the incident level. Figure 6 shows the same data re-normalized to assumed "typical" conditions: room reverberation time of 0.5 s and window opening of 3 ft^2. The latter was chosen because it is the required minimum opening for natural ventilation in Canada's National Building Code. The data in Fig. 6 show much more scatter than the data in Fig. 5 owing to the range of room size. Although the assumed window opening is a reasonable compromise between the discomforts of noise and heat, different occupants would obviously choose a range of openings and might furnish the room to give shorter or longer decay times. These individual variations would further broaden the range of expected noise reductions beyond that indicated in Fig. 6. It should be stressed, however, that for a given room and window a much smaller range (which can be readily calculated) would be expected.

Figure 7 presents the data pertinent to the original motivation for the study, the difference between the incident SPL at the exposed and sheltered facades of these houses. Clearly the data are of great concern in deciding on the noise control measures necessary to provide an acceptable indoor noise environment, particularly since bedrooms (where noise sensitivity tends to be greatest) are more likely to be on the sheltered side. For most of the cases studied here the noise level was 15 to 20 dB lower on the sheltered side. Because these houses were fairly large and closely spaced, however, and in most cases the buildings in the second row were smaller and more widely spaced, there are reasons to believe that the reflected sound power was somewhat less than would be encountered with a broader sample. Subsequent stages of the measurement program will try to establish data for a broader range of conditions. It is hoped that they will provide the basis for a simple empirical procedure for estimating noise at the sheltered wall, given simple data on size and spacing of nearby buildings. In the meanwhile, a reduction of 10 to 15 dB appears to give a fairly conservative estimate of the noise reaching the sheltered facade.

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ACOUSTICAL ENGINEERING WORK IN PREVENTION SERVICES

by

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ABSTRACT

This is the second of three articles on acoustical activities in the Workers' Compensation Board of British Columbia. In this article, R. Griffioen, P. Eng., group leader for Acoustics for the Engineering and Research Section of Prevention Services covers the activities of his group.

SOMMAIRE

Cet article est le deuxième dans une série de trois articles sur les activités réalisées par la Commission de Compensation des Travailleurs en Colombie Britannique dans le domaine de l'acoustique. Dans cet article-ci, R. Griffioen Ing.P., Chef de Groupe de l'Acoustique, Section Génie et Recherches , Service de la Prévention, traite les activités de son groupe.

There are two acoustical engineers on the staff of the Engineering and Research Section of the Prevention Services Division. Their principal role is to provide technical support to staff conducting field inspections. They also assist industry to achieve compliance with the Board's Industrial Health and Safety Regulations regarding control of noise.

In 1979, as soon as the acoustical engineers joined the Engineering and Research Section, a detailed six month study was conducted to determine the extent of the problem of industrial noise in B.C. A review was made of the non-traumatic hearing loss claims paid by the Board since the Workers' Compensation Act of B.C. recognized noise induced hearing loss as a compensable industrial disease in 1975. The claims review revealed that eighty-four percent (84%) of the claims were generated by the lumber and paper products, the foundry and steel fabrication, and the primary metals' industries. These industries account for only twenty-two percent (22%) of the total provincial workforce. A statistical review was carried out of the noise surveys made in these industries and typical noise profiles were developed and compared to European and American studies. A projected cost estimate to determine the economic impact of the noise control regulations on these industries was developed using Bolt Beranek & Newman's "Economic Impact Analysis of the Proposed Noise Control Regulations".[1] Individual industrial sub-classes of the industries listed above were then ranked using the claims information, noise exposure profiles, worker populations and expected compliance costs to determine a priority listing.

Even though it ranked second behind steel fabrication and foundries the B.C. Sawmill Industry was given first priority for noise control action by WCB. This was due to present knowledge of noise control techniques available in this industry. In British Columbia there are over eight hundred and fifty sawmills in operation. There is a marked difference between coastal and interior operations owing to the harvested tree sizes but the sawmill operating principles and machinery are essentially the same. In a sawmill the principal noise sources are the band saws, edgers, trimmers, chippers, lumber conveying systems and planers. A detailed study was conducted of these machines to determine the feasibility and costs of achieving the 90 dBA exposure criteria required by B.C. Regulations. Numerous on-site noise measurements were made of the machinery during normal operation to obtain operator Leq_8's, machinery octave band sound pressure data and estimates of machinery sound power levels. An extensive literature review was made of noise control work done in European and North American sawmills by utilizing our own library search facilities. Site visits were made to U.S. sawmills in the Pacific Northwest noted for the work which they have done in noise control. Technical pamphlets were written detailing proven methods of reducing noise levels for the machines causing the major noise problems in sawmills. These were designed to provide sawmill maintenance superintendents with enough information to implement noise control in their own mills. The pamphlets were reviewed before release by a group of experts from the sawmill industry with a strong background in acoustics.

Presently, the Engineering Section's two acoustical engineers are developing noise control solutions for the British Columbia metal fabrication industries. Because of the diverse nature of these industries, each firm is being treated on an individual basis and comprehensive noise surveys are conducted at each site. This includes noise dosimetry of operators and measurement of machinery noise spectra and sound power levels. A computer simulated noise mapping technique is used to rank noise problems and evaluate the benefits of proposed noise control techniques. Cost estimates are developed for each of the proposed noise control solutions and a noise control case history for each plant is written. These are reviewed with the plant managers to obtain their input. The case histories are kept in the inspection firm files to act as a source of reference material for enforcement procedures.

To assist in noise problem evaluation, the section has a Hewlett-Packard 3582A dual channel real time analyzer controlled by a HP 85 computer. This system allows for rapid third octave band frequency analysis, measurement of room reverberation times and identification of noise sources utilizing cross-correlation coefficients. For field work, a Bruel and Kjaer 7003 tape recorder is used to record machinery noise. Spectra analysis and sound power calculations are made in the office from these recordings.

REFERENCE

1. "Economic Impact Analysis of Proposed Noise Control Regulation", by Bolt Beranek & Newman Inc., Report No. 3246, April 21, 1976.

HEARING CONSERVATION IN BRITISH COLUMBIA

by

Dr. Pat Gannon
Hearing Branch
Workers' Compensation Board
of British Columbia

ABSTRACT

This is the third of three articles on acoustical activities of the Workers' Compensation Board of British Columbia. Dr. Pat Gannon describes the work of the Hearing Branch on hearing conservation.

SOMMAIRE

Cet article est le dernier dans une série de trois articles sur les activités réalisées par la Commission de Compensation des Travailleurs en Colombie Britannique. Dr. Pat Gannon décrit le travail de la Branche de l'Audition sur la préservation de l'audition.

In the early 1970's an impending change in the Workers' Compensation Act led to a dramatic increase in the involvement of the Workers' Compensation Board (WCB) in hearing conservation. In the Province of British Columbia the WCB is charged not only with the responsibility for the compensation of workers with existing occupational hearing loss but also with the prevention of this, the most widespread of all industrial diseases.

Accordingly, to meet the demands of this impending change, a graduate audiologist from the Speech and Hearing Division at the University of British Columbia was hired to work in the Industrial Hygiene Department. At the same time, plans were laid for a centre operated by the WCB to deal solely with compensation for and the prevention of occupational hearing loss. This later became known as the Hearing Branch of the Workers' Compensation Board and it was opened in September 1975.

From the outset, Industrial Audiometry was seen as a keystone to a conservation program. Only in this way could the magnitude and seriousness of the problem be evaluated and subsequent remedial efforts monitored. Accordingly, a program for the training of industrial audiometric technicians was evolved and classes started. At the outset it was decided that all industrial audiometric technicians trained in the program would be employees of industry and not of the Workers' Compensation Board. Industry was invited to nominate participants in these courses to be trained to do industrial audiometry at their place of work. Since September 1975, almost twelve hundred technicians have been trained, although only about six hundred are actively engaged in audiometric testing at this time.

The training course is a very intensive two and a half day course. Emphasis is placed on the practical techniques of hearing testing, counselling and the accurate recording of results. The Industrial Audiometric Program is based on obtaining reliable thresholds down to 0 dBHL at 500, 1000, 2000, 3000, 4000, 6000 and 8000 Hz, although with the advent of a number of audiometers on the market which do not have the 8000 Hz frequency, thresholds at this frequency are not always obtainable.

The vital importance of counselling the worker about the results of his hearing test and the importance of wearing hearing protection regularly where it is required are also very strongly stressed, with the result that there has been a very widespread acceptance of the wearing of personal hearing protection by workers in industry in B.C.

While the wearing of personal hearing protection ought not to be and is not regarded by the WCB as a permanent solution to the prevention of occupational hearing loss, there can be no doubt that at the present time it is the first and may be the only line of defence against hazardous noise. Noise control is the ideal solution and much effort is being expended by the Prevention Services Department of the Board in providing industry with the necessary information to apply this solution. However, personal hearing protection will be with us for a long time as it provides immediate protection to the worker. An important point to be realized is that occupational hearing loss ceases as soon as excessive noise is prevented from reaching the ear. Properly selected and faithfully worn hearing protection will provide adequate protection in almost any situation in any industry. Meanwhile, noise control efforts can continue, knowing that the worker is not suffering any further hearing loss.

From the outset of the Industrial Audiometric Program, it was envisaged that the Hearing Branch would function as a data centre and clearing house for industrial audiometric information. To fill this requirement and bearing in mind that there may be as many as 250,000 workers exposed to hazardous noise in the Province being tested annually, it was decided, with the co-operation of the Data Processing Department of the WCB, to embark upon a program of computer storage of industrial audiometric data.

In view of the large amount of data to be collected annually, a pilot study to test the feasibility of optical scan entry of data into the computer was carried out. This was completed successfully using a prototype optically readable industrial audiometric form which also retained a strong similarity to the customary graphic representation of the audiogram. It was thought to be important for the technicians to be able to counsel their workers with regards to the results of their tests in a graphic presentation which at the same time would be compatible with the optical scanner. The ultimate aim being to avoid the transfer of information from one document to another either by technicians or by keypunch operators. The evolution of this form is now completed and, besides the graphic representation of the audiogram, it also includes medical history questions, noise exposure questions, and hearing protection information. All of the information on the form can be read by an optical scanner and entered into the computer data bank. Periodic summaries of this information are sent out to industry for them to monitor the effectiveness of their hearing conservation programs, but no personal medical history information is ever divulged to a worker's employer.

Education of workers and employers to the hazards of noise is an essential ingredient of any hearing conservation program. As previously indicated, while we regard the counselling of the worker about his audiometric results as being the most potent and effective tool in alerting the worker to the deleterious effect of noise on his hearing and to the need for the wearing of personal protection, nevertheless a good deal of time and effort has also been put into the education of the worker and his employer through formal presentations.

It began with a seminar sponsored jointly by the Workers' Compensation Board and the British Columbia Medical Association under the title "Noise Abatement in the 70's" held in September 1971. This two day seminar dealt with problems arising from industrial noise exposure. Since that time there have been several series of smaller seminars for industry, unions and other organizations requiring information on this problem. A follow-up to the initial seminar was held in November 1980 under the title "Challenge of the 80's". Among other things, this summarized the present status of occupational hearing loss in the Province and dealt in detail with noise control.

The staff of the Hearing Branch consists of two physicians, seven audiologists, a research associate, two noise assessors, two claims adjudicators, and last but by no means least, technical and clerical staff necessary to assist in the activities of the Hearing Branch. Altogether, thirty five people deal with all of the problems related to hearing conservation and claims for occupational hearing loss for the whole of the Province. The centre is located at 10551 Shellbridge Way, Richmond, B.C., V6X 2X1, telephone number 273-3878. A series of publications are also available including a booklet "Hear Today, Hear Tomorrow" which contains information on hearing protection, written in a non-technical style. A new listing of all the types of hearing protection available in the Province together with attenuation data, CSA rating, and a listing of suppliers and the lines they carry has just been published. Two brochures dealing specifically with industrial audiometry are "Industrial Audiometry How and Why" and "Requirements for Industrial Audiometry". The former is an explanation to the worker of the reasons for having his hearing tested as part of the Industrial Audiometric Program. It also explains the questions asked in relation to the medical history. The latter publication cites technical information required for setting up an industrial audiometric facility. These publications are supported by a series of slide/tape presentations and brochures which are always available to any interested party.

Little has been said about the activities of the Hearing Branch in relation to claims for occupational hearing loss. While the rehabilitation and compensation of the worker with a hearing loss caused by noise at work is a very important function of the Hearing Branch, it is hoped that in the long-term the Board's Hearing Conservation Program will result in a steady diminution in the amount of effort required to help these individuals. Since the Hearing Branch opened in 1975, over 7,600 claims have been received and dealt with. Over 5,300 of these workers have been fitted with hearing aids and a lesser number have received financial compensation for loss of hearing. The extent of the effort required to assess, adjudicate and rehabilitate these claimants and the importance of the work is in no way related to the space devoted to it in this article. However, it is regarded by all concerned as a subsidiary but very necessary effort in relation to our hearing conservation activities. It is interesting to note that, despite the increase in the workforce in British Columbia and despite the increasing number of workers who are being tested annually at work, the number of claims received continues to decrease slowly but surely. In the first month of operations, September 1975, sixty five claims were received. By March of 1977, it rose to one hundred and eighty six in that month. In June 1981 ninety four new claims were received. An analysis of the last three years data indicates a consistent decline in the number of new claims over that period. We dare to hope that this is an indication of a genuine decline in the incidence of occupational hearing loss!

REVIEW OF SOUND PROPAGATION IN THE ATMOSPHERE*

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SUMMARY

Advances in our understanding of the mechanisms of outdoor sound propagation during the last five years which are relevant to community noise problems are discussed, and an attempt made to fit them into a consistent overall picture. One aspect is studies of ground impedance and the relevance of modelling the ground plane by a semi-infinite porous medium. Another is the contribution of theoretical papers on propagation from a point source through a homogeneous atmosphere over a plane of finite impedance. A third is the effect of atmospheric inhomogeneity - most notably scattering by turbulence and refraction by the thin (~10cm) thermal boundary layer close to the ground. The attenuation of barriers will also be discussed including the application of modern theory to diffraction over the top, interference effects produced by reflection from the ground, and scattering down into the diffractive shadow zone by turbulence.

SOMMAIRE

On présente une synthèse des connaissances acquises durant les cinq dernières années sur les mécanismes de propagation qui sont pertinents au bruit urbain. Premièrement on discute les travaux sur l'impédance du sol et en particulier la validité du modèle qui considère celui-ci comme milieu poreux. Ensuite on résume les études théoriques sur la propagation du son d'une source ponctuelle dans une atmosphère homogène au-dessus d'un dioptre plan. Troisièmement on considère l'effet d'une atmosphère inhomogène; notamment la diffusion par la turbulence et la réfraction par un mince (~ 10 cm) gradient thermique près du sol. On traite en plus l'efficacité des écrans sonores en considérant les théories modernes de diffraction, les effets d'interférences dus aux réflections au sol et la diffusion dans l'ombrage acoustique de l'écran par la turbulence.

It is proposed to review briefly recent advances in the understanding of outdoor sound propagation which are relevant to community noise problems. Only advances since the review[1] which appeared in JASA in June 1977 will be considered.

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* Text of an oral paper presented at the 101st meeting of the Acoustical Society of America, Ottawa, Ontario, May 19-22, 1981.

I. GROUND IMPEDANCE

Figure 1 shows measurements[2] of the real and imaginary parts R and X of the acoustic impedance of grass-covered soil outside our laboratory. The measurements were laboriously carried out over one summer using two different techniques, as shown, for various grazing angles in the range 20° to 90°. We drew the solid curves as an approximate fit to our data, and found within experimental scatter there was no dependence on angle, meaning that the surface could be regarded as locally reacting.

Ian Chessell[3] then fitted this data by Delany and Bazley's[4] simplified equations for the characteristic impedance of a fibrous material. In these equations there is only one adjustable parameter, the flow resistivity σ, and he obtained the dashed curves for a value of 300 C.G.S. units which fit the data remarkably well, - as well in fact as our empirical curves. Thus a semi-infinite porous medium is a good model for the sound reflective properties of this grassy surface.

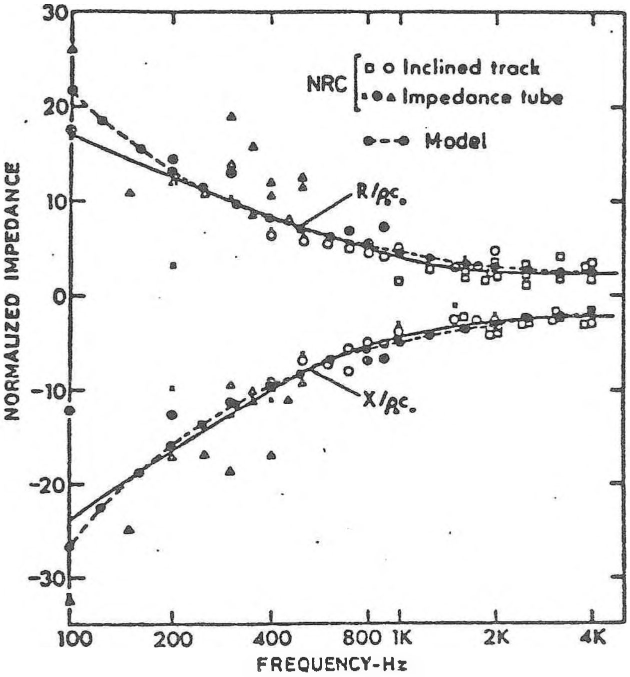

Fig. 1

Since then the measured impedances for a number of ground surfaces have appeared which show similar agreement with Chessell's model. Figure 2 shows the acoustical measurements of Bolen and Bass[5], and theoretical curves from the model for two values of the flow resistivity σ. The best fit to their acoustic data is the dashed curve for σ = 40 C.G.S. units. They also measured the flow resistivity of the soil by an non-acoustical technique and obtained σ = 60 C.G.S.

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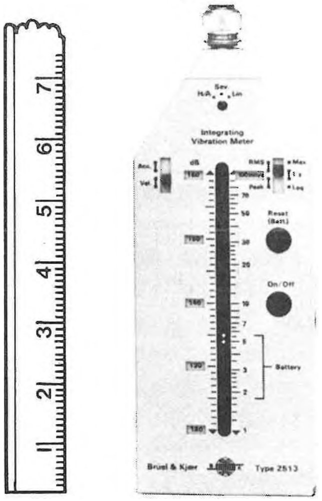

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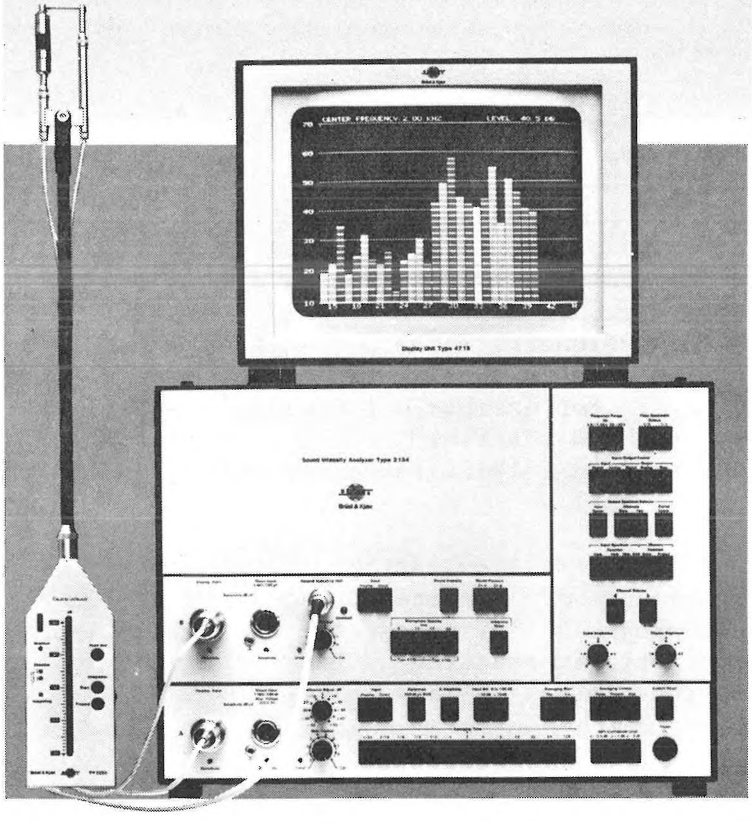

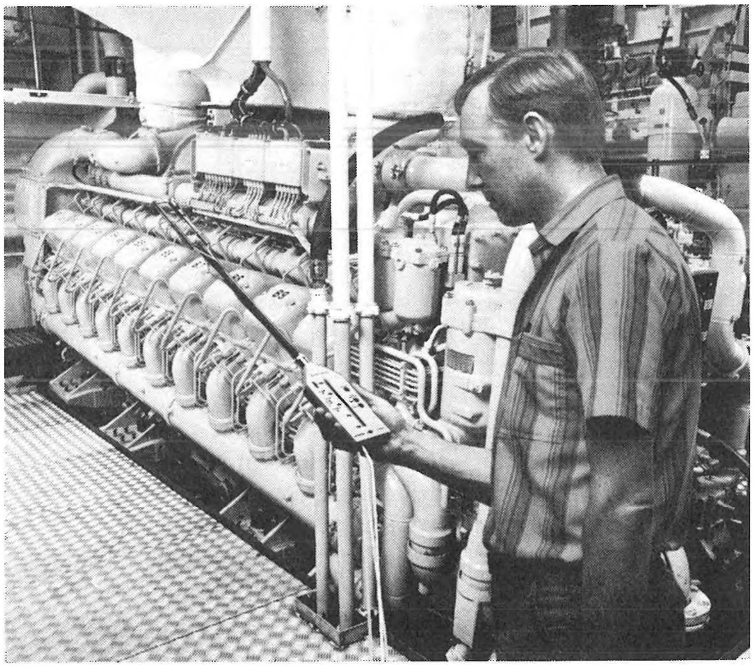

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units. The solid curve therefore represents an independent prediction. We take the closeness of predicted and experimental curves to be further verification of the model.

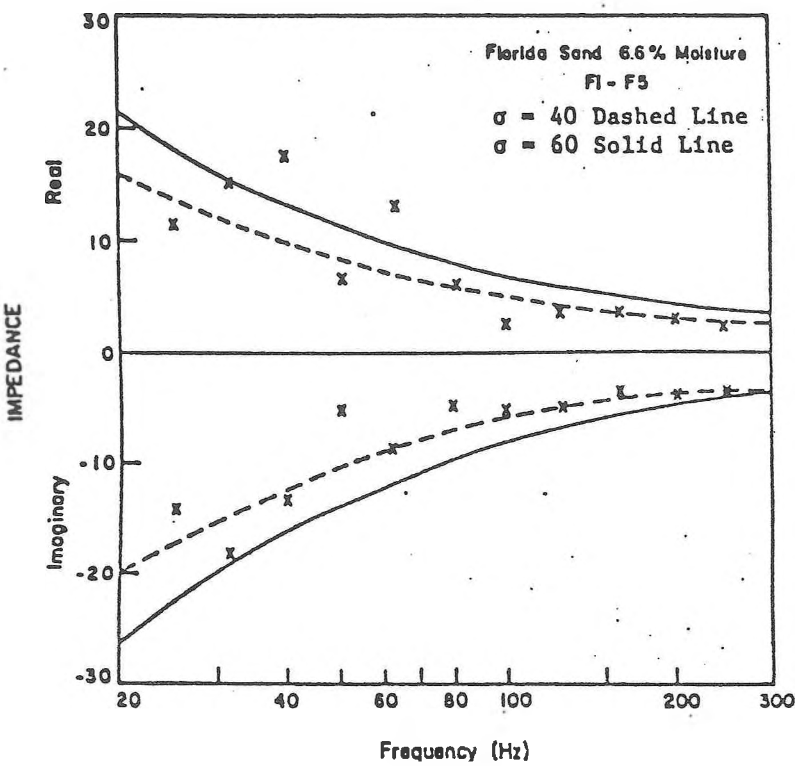

Fig. 2

A factor which needs understanding is the effect of pore size. For the impedance to go up at low frequencies, as shown here, the pore size needs to be smaller than the thickness of the acoustic boundary layer (which is in turn proportional to $f^{-\frac{1}{2}}$ and has a value of 0.1 mm at 300 Hz). Thus the wave in the pores at low frequencies is a viscous wave, which is a very slow and very highly damped wave. It is for this reason that a porous layer of soil at the surface, whose thickness may be small compared to the free space acoustic wavelength, may in practice be modelled by a porous medium of infinite thickness. There has been some work on the limits to this model: for example a 1 inch layer of new snow, where the pore size is large and the flow resistivity hence very low, has been found[6] to need a layer representation.

Nevertheless there are now values of effective flow resistivity available[7] from acoustic reflectivity measurements for a number of common surfaces outdoors, some of which are shown in Fig. 3, and the one parameter model of Chessell is a suitable fit in practice, given the low state of present knowledge and the rough needs of many practical applications.

Fig. 3: Flow resistivities of various ground surfaces. Values give best fit between measured sound spectrum and that predicted by a one-parameter model.

Description of Surface	Flow Resistivity in rayls (CGS units)
Dry snow, new fallen 7.5 cm on a 40 cm base	15 to 30
Sugar snow	25 to 50
In forest, pine or hemlock	20 to 80
Grass: rough pasture, airport, public buildings, etc.	150 to 300
Roadside dirt, ill-defined, small rocks up to 4"	300 to 800
Sandy silt, hard packed by vehicles	800 to 2500
"Clean" limestone chips, thick layer (1/2 to 1 inch mesh)	1500 to 4000
Old dirt roadway, fine stones (1/4" mesh) interstices filled	2000 to 4000
Earth, exposed and rain-packed	4000 to 8000
Quarry dust, fine, very hard-packed by vehicles	5000 to 20,000
Asphalt, sealed by dust and use	> 20,000

II. PROPAGATION OVER A PLANE WITH FINITE IMPEDANCE

Figure 4 shows the attenuation in excess of that from molecular absorption and spherical spreading from a point source to a receiver 600 m away, both approx. 2 m above a grass-covered ground surface having an impedance shown by the measurements in Figure 1. The different curves give the contributions calculated for the different wave components by Donato[1]. The lower dashed curve gives the contribution D from direct and R from reflected waves as known classically, say by Rayleigh. Contribution G from the ground wave was introduced to acoustics by Rudnick[8], and Ingard[9] and their colleagues about 1950 from radio wave propagation. Contribution S from the surface wave was introduced by Wentzel[10] in 1974 also from electromagnetic propagation. The points are measurements by Parkin and Scholes[11] of the propagation of jet noise across an airport. Note that all of these wave components are needed to get agreement within 10 dB for frequencies less than 300 Hz, and for f > 300 Hz an additional phenomenon is needed which will be discussed later. A number of different methods of calculation have been proposed recently by people such as Thomasson[12], Donato[13], Soroka[14], Filippi[15] and their various colleagues for propagation close to the ground from a point source. To assess these methods we recommend two recent critical reviews, by Attenborough[16], and Filippi[17] and their colleagues.

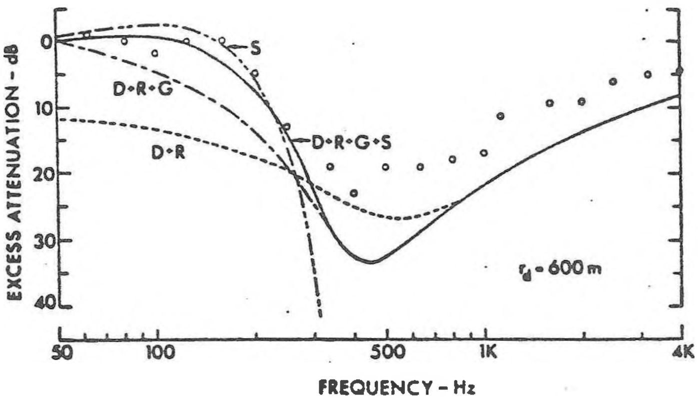

Fig. 4

III. REFRACTION

It has been known for some time that for distances greater than about 100 m over very flat open terrain, such as a large airport, the effect of curved ray paths (refraction) needs to be considered[18]. The principal effects are shown in Fig. 5. For propagation downwind, or under temperature inversions the refraction is downward, as shown at "a". The effects is usually to reduce attenuation due to the ground effect. For propagation upwind, or under temperature lapse conditions, the sound refracts upwards, as shown at "b" in the figure.

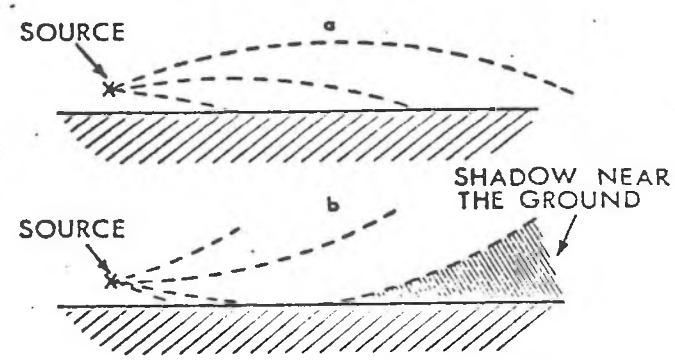

Fig. 5

The main effect here is the creation of shadow zones as shown also in Fig. 5. In both cases there exists a gradient of sound velocity in the atmosphere which extends well up from the ground (10 m or more).

One is often interested in the propagation of noise over less open terrain, such as near a highway, in a built up area, or around a small airport. Figure 6 shows typical profiles[7] of temperature that we find close to the ground for these sites, on the left for a sunny summer afternoon where there is a constant wind velocity (here ~ 6 m/sec), and on the right for comparison on a calm cool evening. The error bars give a rough indication of the variation in temperature with time. Note the existence of a thermal boundary layer during the daytime which is confined in thickness to about 30 cm by the wind. Above this layer the gradient virtually disappears due presumably to mixing by air flow around obstacles such as trees. To find whether the steep gradient close to the ground, which is responsible for optical mirages, could influence noise measurements on vehicle test sites an acoustical point source was placed right on the surface of a flat asphalt roadway.

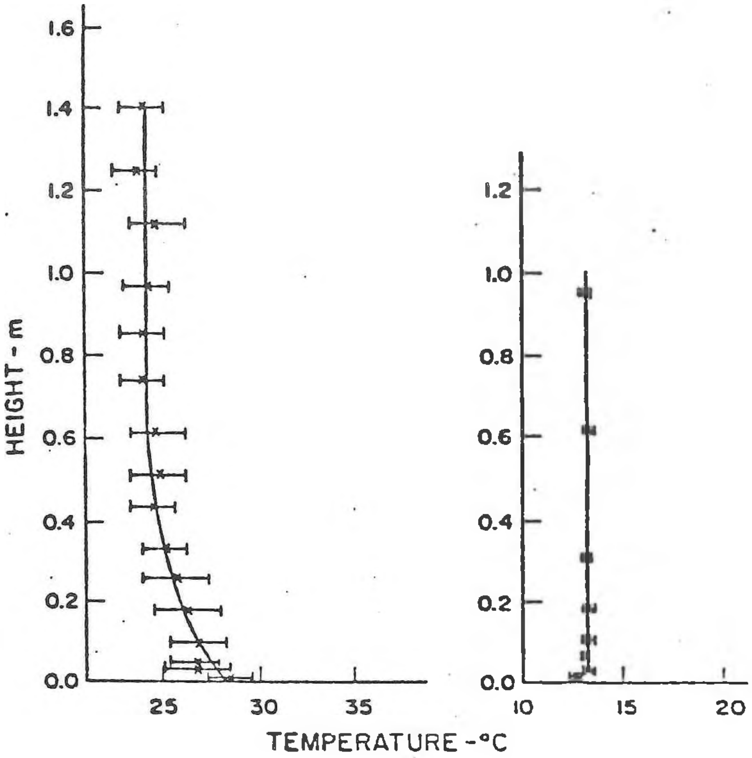

Fig. 6

The dashed lines in Fig.7 show measurements[7] of sound level at a distance of 15 m and a height of 1.0 m for propagation both upwind (the O's) and downwind (the X's) and the solid lines the same for a microphone on the ground. Note that at a height of 1.0 m there is no significant excess attenuation of sound due to the thermal boundary layer, but at ground level there is a well formed shadow zone even when propagating downwind - and that at a range of only 15 m which is common for vehicle tests.

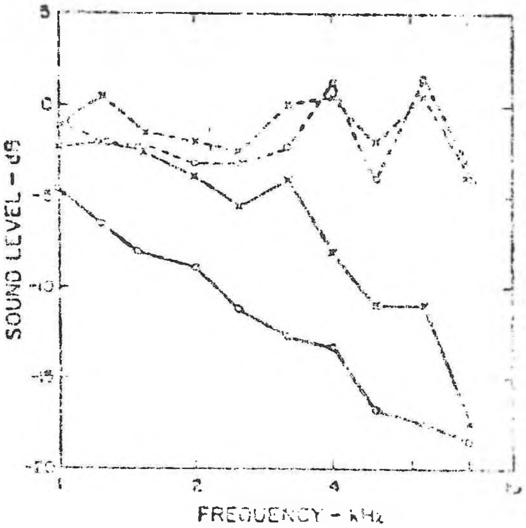

Fig. 7

The effects of refraction are probably the most difficult to quantify in noise prediction schemes at present, particularly those due to thermal gradients, as shown recently by the measurements of René Foss[19].

IV. TURBULENCE

The inhomogeneity of the atmosphere during the daytime is normally much larger than is generally appreciated. Figure 8 shows typical records of wind velocity and temperature 1 m above a flat

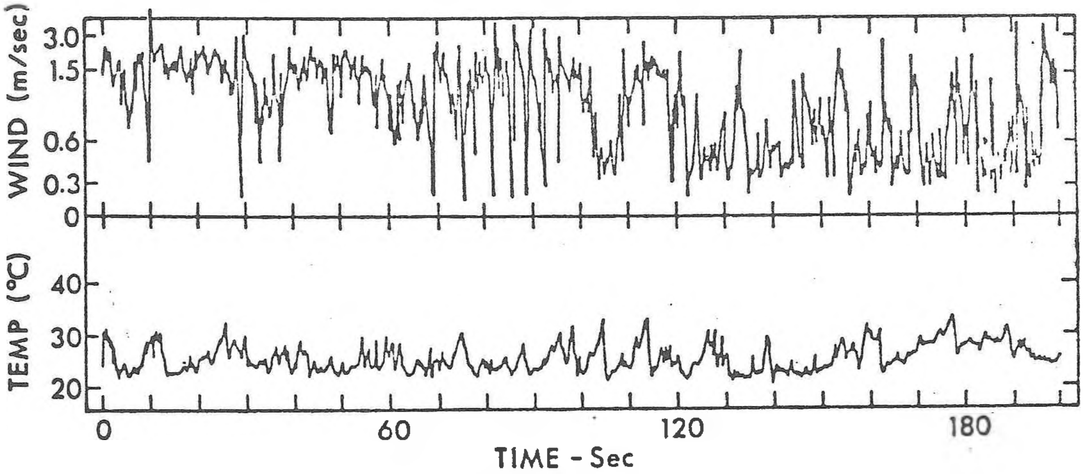

Fig. 8

ground surface on a sunny day. Note from the bottom record that fluctuations in temperature of 5°C which last several seconds are common and 10°C not uncommon. These are bubbles of hot air plucked by the wind from the thermal boundary layer at the ground shown previously. From the top record we can also see that there is really no such thing as a "steady wind", the standard deviation in velocity being commonly 1/3 of the average. The local sound velocity therefore also fluctuates rapidly. Recent work on the propagation of sound in a fluctuating atmosphere, mainly in the area of remote sensing[20], enables us to evaluate the consequences for noise propagation.

Measurements by Daigle[21] are shown in Fig. 9 for the sound propagation between a point source and microphone placed 50 m apart, each of them 1.2 m above a plane asphalt surface on a sunny afternoon. The measurements are 2 minute averages $\left(L_{eq}(2\ \text{min})\right)$. The dashed curve is the interference pattern between direct and reflected waves calculated by coherent acoustical theory. The solid curve was calculated using the theory of propagation in a turbulent atmosphere, which required simultaneous measurements of the fluctuations of temperature and wind velocity. The incoherence introduced by normal daytime turbulence can clearly destroy interference phenomena, at least for high acoustic frequencies.

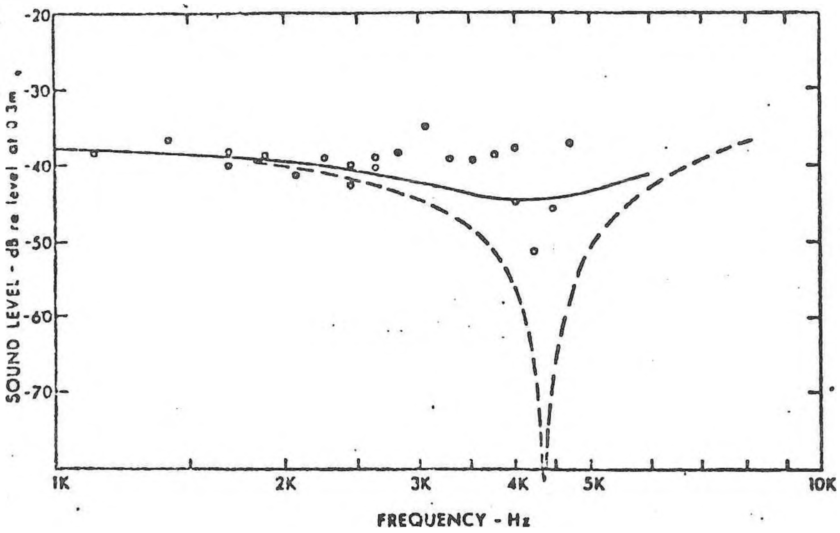

Fig. 9

Probably the most important interference phenomenon in noise propagation is the excess attenuation for frequencies of several hundred Hertz which is usually called the ground effect[1], but is really the zero frequency interference fringe for propagation over an acoustically soft boundary. Figure 10 shows measurements by Parkin and Scholes[11] of the ground effect for various distances of propagation of jet noise across an airport. The dashed curves were calculated using coherent acoustical theory as described earlier. The solid curves, which were calculated by Daigle[22], include the effect of typical daytime fluctuations of atmospheric temperature and wind velocity. The difference between the solid and dashed curves indicates that the incoherence produced by atmospheric turbulence reduces but does not eliminate the ground effect for horizontal ranges of hundreds of meters.

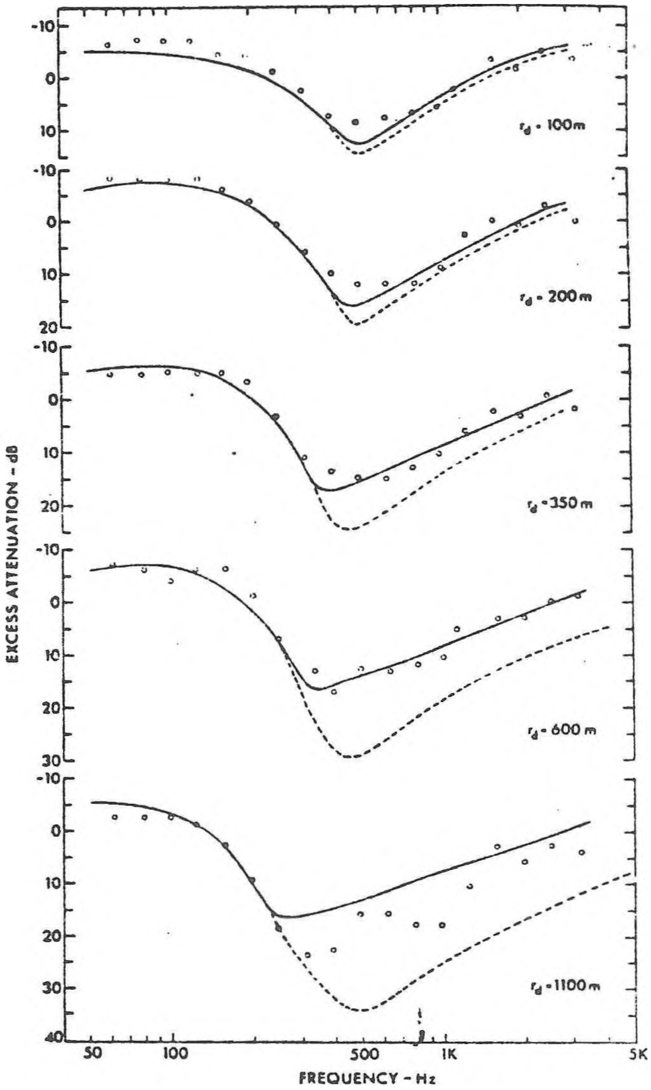

Fig. 10

Another role for atmospheric turbulence in noise propagation is the scattering of sound energy down into shadow zones[1]. Shown in Fig. 11 are a set of carefully controlled measurements of the sound level behind an experimental noise barrier again by Daigle[23] and his colleagues. The barrier was a long thin screen 2.5 m high, a point source of sound was 10 m in front of it and the microphone 30 m behind

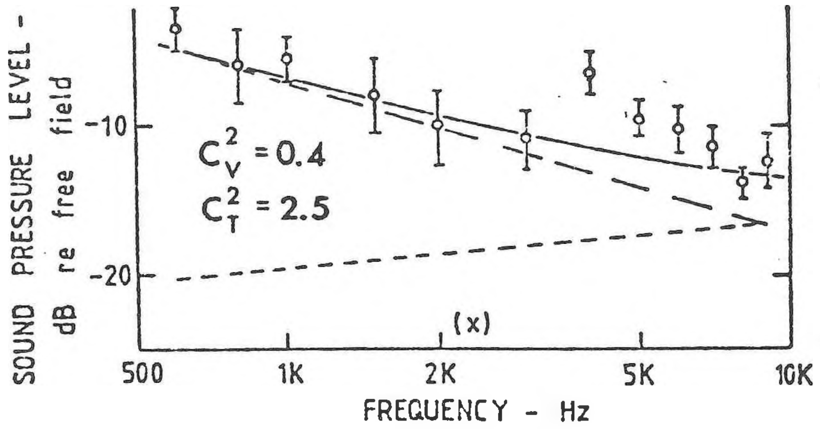

Fig. 11

it. The circles with error bars show the measured levels. The dashed line sloping down to the right gives the expected level due to diffraction over the top of the barrier. The dotted line near the bottom gives the level of scattered energy calculated from simultaneous measurements of the strength of atmospheric turbulence shown also on the figure. The sum of the two calculated contributions is the solid curve, and it agrees well with the measurements. The indication here is that typical daytime turbulence will probably reduce the attenuation by highway barriers only at very high frequencies in situations for which they are often designed - namely to protect the first one or two rows of housing by a diffracted angle (and hence also a minimum scattering angle) of 20° or more. Here only single scattering is important. For larger distances from the barrier, and hence smaller angles, multiple scattering becomes important, which makes the effect probably much larger, but also much more difficult to calculate. This case has not yet been examined.

V. BARRIERS

Although highway barriers have become much more widely used recently, they are still designed using Kirchhoff-Fresnel diffraction theory from the last century for an ideal screen via the curves of Maekawa[24] and Kurze and Anderson[25]. Recent measurements, however, show this theory to be a poor approximation at close range, even for the ideal case.[26-27] Fortunately there has also been work on more precise diffraction theory by Jebsen et al[28], and Hayek et al[29-30].

The dashed line for diffraction in Fig. 11 is only straight because the point source and microphone were both placed at the hard asphalt ground surface to avoid interference effects.

In practice we usually have a situation such as that shown at the top of Fig. 12, where there are complicated interference effects due to refraction from the ground surface, as well as diffraction over the top of the barrier. Shown below are calculations of the insertion loss I and attenuation A for this case by Isei[31] and colleagues for 1,

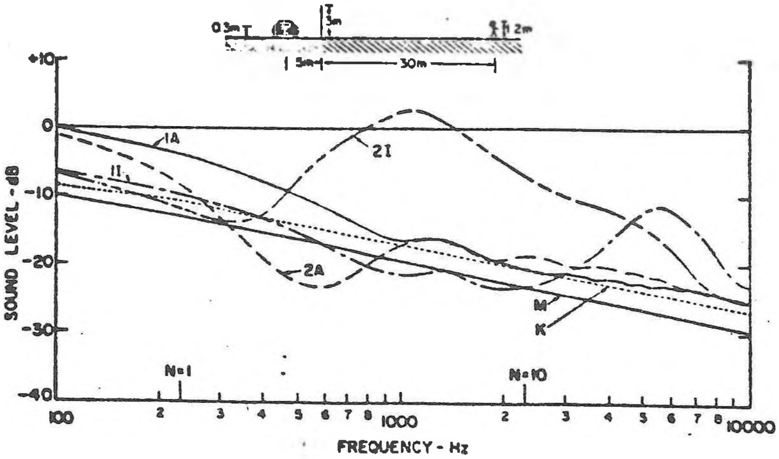

Fig. 12

a hard ground surface, and 2, a grassy surface. These predictions are obviously far from lines M of Maekawa and K by Kurze and Anderson which do not consider interference effects. Practical aspects of this matter are reported by Lawther et al[32].

Finally we must emphasize that the phenomena of outdoor propagation usually do not appear well separated, as described here, but together. They have been carefully separated here only for purposes of description. How to cope with them altogether for various uses, has been described by Soom[33], Marsh[34] and Miller[35].

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

SEPTEMBER 21, 1981 - 7:00 P.M.

AUDITORIUM OF ONTARIO HYDRO, 700 UNIVERSITY AVENUE, TORONTO

CHAIRPERSON: CHRIS A. KRAJEWSKI

TOPIC: IMPULSE NOISE

FIRST SPEAKER: ALBERTO BEHAR

As an introduction, the speaker gave a short historical overview of impulsive sound perception and the effect of this type of noise on hearing (references were made to the use of gunpowder and to the industrial revolution in Europe). A comparison between steady and impulsive noise and a summary of the existing and proposed descriptors followed the introduction. The complex nature of the impulsive sound signal was emphasized; peak value, time duration, rate at which impulses occur and spectral characteristics. In his presentation, the speaker also talked about the assessment of impulsive noise and the potential for hearing damage resulting from exposure to impulsive noise.

A review of Ontario Ministry of Labour evaluation criteria and difficulties in characterization of various types of impulsive noise concluded his talk. Excellent slides supported his oral explanation.

SECOND SPEAKER: ANDY MCKEE

This speaker also started with a historical overview of impulse noise measurements. He described how the advent of acoustical instrumentation designed in the early 30's brought about sound level meters capable of measuring sound with 125 ms time constant. However, difficulties in following rapid needle fluctuations by the observer resulted in standardization of "slow response" with 1 second integration time. Later on, developments in psychoacoustic research led to a discovery that 35 ms time constant represents a limit on the time period of human brain reaction to short duration sounds. This integration time was generally accepted as a standard for impulsive noise measurements.

In the following part of his presentation, the speaker showed the acoustical model of the human ear and explained the possible reason for commonly experienced hearing loss in the 3-4 kHz frequency region.

The perception of impulsive noise by the human ear and analogies in the acoustic instrumentation were discussed, followed by a short summary of new methods for analysis of transient and impulsive noise using the Fast Fourier Transform technique.

A lively discussion ensued with questions referring to both preceding presentations.

THIRD SPEAKER: STAN FORSHAW

In this presentation, the speaker focused on the effect of impulsive noise on armed forces personnel and various aspects of hearing protection. Using excellent slides, he showed an audiometric comparison of hearing loss suffered by 3 major groups of military units, over an extended period of time. It was pointed out that some army personnel operating recoilless-rifles or anti-tank weapons are frequently exposed to peak SPL values over 180 dB, and that special types of hearing protectors are required for such applications.

The effectiveness of various types of hearing protectors and new developments in the field of ear plug technology were discussed. A type of ear plug was shown with a minute opening at the centre. This plug offers little attentuation at the low range of sound levels, allowing for verbal communication, but high attentuation is achieved when the laminar flow through the opening changes into a turbulent flow at high sound levels. Another example of innovative design shown during the presentation was a set of specialized ear muffs (head-set protectors), containing electronic circuitry to allow for amplification of low intensity sound (to retain ability for verbal communication), while high noise levels are effectively attenuated. Both devices were demonstrated and circulated among the audience.

Coffee in the intermission was courtesy of Ontario Hydro, while B & K provided refreshments during the coffee break.

Chris Krajewski closed the meeting expressing thanks to the speakers and all participants in the discussion. Announcement was made of the forthcoming acoustic events and copies of the Toronto Chapter's future program were distributed.

C. A. Krajewski

LA LUTTE CONTRE LE BRUIT, DANS L'HABITATION, EN FRANCE*,**

Robert Josse
Chef de l'Etablissement de Grenoble
du Centre Scientifique et Technique de Bâtiment,
Grenoble, France

SOMMAIRE

Les autorités françaises s'efforcent depuis plusieurs années, d'assurer une bonne insonorisation des nouveaux logements afin de soustraire les habitants aux bruits de leurs voisins et de l'extérieur. Les efforts ont été déployés dans les domaines suivants : règlements, étiquetage, contrôles et sanctions, recherches scientifiques et techniques et publication d'exemples de solutions. Les divers aspects de cette lutte contre le bruit seront examinés en détail.

ABSTRACT

For several years a considerable effort has been made in France to ensure good sound isolation between new dwellings, as well as against the intrusion of outdoor noises. The effort has been carried out in the following areas: regulations, labelling, controls and sanctions, scientific and technical research, and the publication of examples of solutions. The different aspects of this effort against noise will be examined in detail.

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* Le même thème a été exposé à TURIN en Juin 1979 et a fait l'objet de la publication suivante : "Les différents aspects de la lutte contre le bruit dans les habitations, en France". par R. Josse. dans L'Acustica Nell'Edilizia Collana degli atti della rivista italiana di acustica Vol III 1979 Edizioni Scientifiche Associate ROMA.

** Le texte de l'exposé invité pour le 101ème Réunion de L'ASA, Ottawa, Mai 1981.

LA SITUATION ACTUELLE

Une enquête menée en 1976 par l'Institut de Recherche des Transports auprès d'un millier de personnes choisies au hasard dans des villes de plus de 50.000 habitants a montré que parmi les nuisances ressenties par les Français, le bruit arrive largement en tête et, parmi les divers bruits perçus, c'est le bruit de trafic automobile qui est le plus gênant (47%), suivi d'assez près par les bruits de voisinage (32%).

Pour lutter avec le maximum d'efficacité contre le bruit, une loi générale est en cours de préparation. Elle devrait être discutée par le Parlement à la prochaine session parlementaire. Quoi qu'il en soit, la lutte contre le bruit a déjà été entreprise d'une manière efficace, depuis une dizaine d'années, dans les immeubles d'habitation.

LES BRUITS EN PROVENANCE DE L'EXTERIEUR

Comme nous venons de le voir, c'est le trafic terrestre qui est la source principale de bruit extérieur (50%, si l'on compte les trains). Le trafic aérien n'intervient que pour 5% des cas.

L'objectif actuel de l'administration est de faire en sorte que les zones touchées plus ou moins gravement par ces bruits, ou qu'il est prévu qu'elles le soient à plus ou moins longue échéance, soient délimitées sur les plans d'occupation des sols (P.O.S.) des communes ou sur les documents d'urbanisme en tenant lieu, ceci afin qu'il en soit tenu compte au moment de la délivrance des permis de construire. La tendance actuelle est de représenter une situation de bruit par le niveau Leq d'un bruit stable énergétiquement équivalent au bruit considéré.

LA CONSTRUCTION EN ZONE DE BRUIT

Depuis peu (arrêté du 6 Octobre 1978), la construction en zone de bruit est sévèrement réglementée au niveau de la délivrance du permis de construire. Pour les bâtiments d'habitation construits dans ces zones, les pièces principales (chambres et séjours) et les cuisines doivent présenter un isolement vis à vis de l'extérieur précisé par la réglementation.

Leq façade en dB(A)	Isolement de façade en dB(A)	Confort thermique et Pureté d'air exigés	
		Pièces principales	Cuisines
80	50 (dissuasif)	X	X
73	42	X	X
68	35	X	
63	30	Chambres	
	Isolement usuel 20 à 25		

Isolement des habitations en zone de bruit
Principe de la réglementation du 6 Octobre 1978

La zone de bruit, ainsi que l'isolement requis sont précisés par l'Administration, au demandeur du permis de construire. Etant donné que la protection vis à vis de l'extérieur impose une fermeture des fenêtres, la réglementation prévoit que les habitations isolées doivent posséder un système assurant la pureté de l'air et le confort thermique en saison chaude pour les locaux les plus exposés.

La réglementation citée s'applique aussi au cas des zones situées près des aérodromes. Toutefois, ce cas ayant été traité antérieurement à l'arrêté du 6 Octobre 1978, les zones de bruit ne sont pas définies par Leq mais par un indice dit psophique

$$N = L + 10 \log (N_j + 10 N_n) - 34$$

L étant le niveau de crête quadratique moyen pour l'ensemble des passages d'avions, exprimé en DNdB

N_j et N_n sont respectivement le nombre de vols de jour et de nuit.

Dans bien des cas on a :

$$N \simeq \mathrm{Leq} + 19$$

Lorsque N est supérieur à 89, c'est-à-dire Leq 70 dB(A), la construction d'habitations est interdite. Pour les habitations existant dans ces zones, une aide financière à l'insonorisation peut être fournie grâce à la recette d'une taxe principale imposée aux passagers des avions.

Lorsque N est compris entre 84 et 89, c'est-à-dire Leq entre 65 et 70 dB(A), la construction de lotissements est interdite. Les constructions individuelles sont admises sous réserve d'insonorisation (arrêté du 6 Octobre 1978).

Pour l'application de l'arrêté du 6 Octobre 1978, en ce qui concerne les voies de transport terrestre, il a été nécessaire d'élaborer une méthode de prévision des zones de bruit n'utilisant aucun moyen de calcul, mais basée uniquement sur l'observation de la position relative des voies et des bâtiments, sur la nature des voies et le nombre de leurs files de circulation. Naturellement, une telle méthode est forcément imprécise et pour les cas importants (aménagements de zones à action concertée, par exemple), il est préférable d'utiliser des méthodes scientifiques telles que celles basées sur l'utilisation de programmes de calcul ou sur l'utilisation de modèles réduits. Ces moyens ont été particulièrement développés en France. En particulier un laboratoire d'étude sur modèles réduits (échelle 1/100) unique en son genre a été construit au CSTB à Grenoble. Grâce à son automatisation, il permet de déterminer, très rapidement, aux points choisis, le niveau sonore recherché, dans des conditions de similitude excellentes.

Une étude préalable permet de modeler les zones de bruit par utilisation d'écrans constitués soit de murs, buttes de terre ou immeubles. En effet, dans toute la mesure du possible, il est préférable de reporter la protection près des voies incriminées plutôt que sur les bâtiments eux-mêmes puisque, dans ce dernier cas, une telle protection impose de laisser les fenêtres fermées. La maquette à échelle réduite rend facile ce genre d'étude.

La plupart du temps le point faible des façades est constitué par les fenêtres, même lorsqu'elles sont fermées et, pour cette raison, il est apparu important à l'Administration française d'attirer l'attenuation des fabricants sur ce point. A cet effet, l'Administration a inventé un système de label permettant d'apprécier, à la fois la qualité thermique et la qualité acoustique des fenêtres. Ce label est appelé "Label Acotherm".

Ce label est attribué aux gammes de fenêtres présentant de bonnes caractéristiques acoustiques et thermiques.

Chaque gamme comprend des types de fenêtres assurant un indice d'affaiblissement acoustique d'au moins :

30 dB(A)
35 dB(A)
45 dB(A)

Cet affaiblissement est celui que l'on mesure en laboratoire entre deux salles réverbérantes lorsque dans l'une de ces salles règne un champ diffus ayant un spectre de bruit de route.

Entre autres propriétés, les fenêtres doivent avoir une étanchéité à l'air améliorée.

La liste des fabrications ayant obtenu le label est mise à jour par le Ministère de l'Environnement et du Cadre de Vie et publiée tous les six mois.

D'après l'examen des premiers catalogues de fabrication ayant reçu le label, il semble que le fait de passer de 30 à 35 dB(A) accroisse le prix d'une fenêtre à la française (sans volet roulant) d'environ 20%, tandis que le passage de 30 à 45 dB(A) double le prix. Ce label permet donc aux constructeurs un choix relativement facile de fenêtres dont ils ont l'assurance que la qualité acoustique et thermique seront satisfaisantes.

LES INFRASTRUCTURES NOUVELLES

La loi relative à la protection de la nature (10.7.1976) impose que les travaux et projets d'aménagements qui sont entrepris par une collectivité publique doivent respecter les préoccupations d'environnement. Les études préalables de ces travaux et projets doivent comporter une étude d'impact. Cette étude doit comporter, en particulier, une analyse de l'état initial du site, une analyse de l'effet des travaux prévus et les mesures envisagées pour réduire les nuisances. Ces analyses s'appliquent, en particulier, au cas du bruit.

Pour la création de voies nouvelles et la transformation de voies existantes, une circulaire du 7.3.78 précise que, dans les cas courants, cette création ne doit pas engendrer un bruit supérieur à 65 dB(A) (Leq de 8h à 20h). Toutefois, dans les zones résidentielles calmes, c'est 60 dB(A) qu'il faut prendre comme limite. A l'inverse, un niveau de bruit supérieur pouvant atteindre 70 dB(A) sera toléré si le respect de l'objectif de 65 dB(A) conduit à des dépenses prohibitives. Un accroissement de l'isolement de façade par rapport à la valeur usuelle de 22 dB(A) pourra être pris en compte comme une réduction d'autant du niveau de bruit en façade.

Pour atteindre ces objectifs, l'ingénieur routier français a à sa disposition le guide du bruit établi par le Ministère de l'Environnement et de la Qualité de la Vie. Dans les cas difficiles, il doit s'en remettre aux programmes de calcul ou aux études sur modèles réduits cités plus haut.

Ses moyens d'action sont :

- l'emplacement de la voie, pour une voie nouvelle,
- l'adaptation du profil en travers (écrans),
- l'action sur les façades des immeubles riverains.

Des tentatives d'action sur la régulation du trafic, pour réduire le bruit, se sont soldées par des échecs.

Bien des implantations de voies ou de bâtiments d'habitation se sont faites dans des conditions fâcheuses avant que cette réglementation récente n'existe. On assiste, actuellement, dans les cas les plus critiques, à des opérations de réhabilitation. Ainsi, à BRON-PARILLY, près de LYON, 2600 logements répartis dans 12 bâtiments situés près de voies rapides vont être insonorisés par renforcement des façades. Le coût de l'opération sera d'environ 20.000 Frs/logement, 90% étant payés par l'Administration.

Un calcul sommaire montre que si l'on voulait appliquer cette méthode à l'ensemble des logements français trop exposés au bruit, la dépense à prévoir serait de l'ordre de 30 Milliards de Francs.

Pour l'instant, aucune procédure d'indemnisation des riverains qui se trouvaient, du fait de la construction d'ouvrages publics, soumis à un bruit gênant, n'existe en France.

LES BRUITS EN PROVENANCE DE L'INTERIEUR

Il est d'usage de répartir ces bruits en trois classes : bruits aériens, bruits d'impact, bruits des équipements.

Voyons quelle est la réglementation actuelle (Arrêté du 14 Juin 1969).

La réglementation

Tout d'abord examinons le cas de la protection contre les bruits aériens, c'est-à-dire contre les bruits émis directement sous forme aérienne et qui, ensuite, se transmettent à la fois par l'air et par les structures. Pour ces bruits, le niveau de pression acoustique ne doit pas dépasser 35 dB(A) dans les pièces principales; 38 dB(A) dans les cuisines, salles d'eau et cabinets d'aisance, lorsque le niveau de pression acoustique du bruit régnant à l'intérieur des autres locaux du bâtiment, pris séparément ne dépasse pas par bande d'octave :

- 80 dB si ce local est un logement,
- 85 dB si ce local est à usage commercial, artisanal ou industriel,
- 70 dB s'il s'agit d'une circulation intérieure au Bâtiment mais commune.

Ces bruits sont supposés avoir un spectre continu couvrant les octaves centrées sur 125-250-500-1.000-2.000 et 4.000 Hz.

On a pris l'habitude d'exprimer ces exigences sous une forme différente qui est la suivante :

Par exemple, lorsque l'on considère un local d'habitation comme étant le local d'émission et un local d'habitation en réception, on dit que l'isolement aux bruits aériens d'un local vis-à-vis de l'autre doit être d'au moins 51 dB(A). Ce nombre correspond à la différence existant entre le niveau du bruit à l'émission exprimée d'une manière globale en dB(A), bruit ayant le spectre indiqué plus haut et le niveau du bruit en réception exprimé lui aussi en dB(A).

Cet isolement est porté à 56 dB(A) dans le cas des locaux à usage commercial, artisanal ou industriel et ramené à 41 dB(A) dans le cas des circulations intérieures communes.

Les valeurs indiquées ci-dessus s'entendent pour des locaux normalement meublés, c'est-à-dire ayant une durée de réverbération de 0,5 seconde à toutes les fréquences et pour des points de réception situés au voisinage du centre des locaux. De plus, on suppose que toutes les portes et fenêtres sont fermées.

Cette manière de présenter les exigences en ce qui concerne la qualité de l'isolation vis-à-vis des bruits aériens est, dans sa forme assez différente de ce qui se pratique à l'étranger et, en particulier, de ce qui est recommandé par l'Association Internationale de Normalisation (I.S.O.).

En effet, en général, dans les réglementations étrangères, les spécifications sont données sous forme d'une courbe d'isolement limite au-dessus de laquelle l'isolement réel des logements doit se trouver. Pour-quoi avons-nous procédé ainsi en France ? Et bien, c'est essentiellement par souci d'avoir des textes aussi simples que possible, en particulier, sans courbe de référence, l'autre raison étant que la validité scientifique des courbes de référence est loin d'être prouvée puisque l'on sait qu'elles dérivent plus ou moins de la norme allemande qui, elle-même, concrétise le fait qu'un mur en briques pleines de 22 cm d'épaisseur donne satisfaction.

Dans le règlement français, il est précisé que, pour tenir compte des incertitudes liées aux mesures lors des contrôles, une tolérance de 3 dB(A) sur les limites indiquées plus haut est admise. Autrement dit, lorsque l'on procède à des mesures de contrôle, si entre deux pièces principales de logements on trouve 48 dB(A), on considère que, compte tenu de la tolérance admise, l'isolation acoustique est satisfaisante.

Le nombre de 51 dB(A) choisi par la réglementation en ce qui concerne l'isolement entre pièces principales, ne l'a pas été au hasard. C'est un compromis entre les exigences de confort et les possibilités ainsi que le coût de la construction. Une enquête de satisfaction effectuée en France à partir d'une comparaison entre résultats de mesure et avis des occupants des logements a montré que l'isolement réglementaire donne satisfaction à la majorité des occupants des logements lorsqu'il s'agit d'immeubles collectifis situés dans des zones qui ne sont pas excessivement calmes.

Par contre, si l'on considère des logements situés dans des pavillons en bandes, c'est-à-dire des maisons individuelles accolées les unes aux autres, on a constaté que les occupants sont bien plus exigeants que dans les immeubles collectifs et qu'alors le simple respect de la réglementation est loin de donner satisfaction.

Une étude est en cours en France pour essayer de déterminer quelle serait l'incidence économique d'une majoration de cette exigence.

Voyons maintenant la protection contre les bruits de chocs, c'est-à-dire les bruits produits, soit par la marche des personnes, soit résultant du déplacement de mobilier, de jeux d'enfants, etc.

L'arrêté du 14 Juin 1969 précise que l'isolation des planchers, y compris les revêtements de sol doit être telle que le niveau de pression acoustique du bruit perçu dans chaque pièce principale ne dépasse pas 70 dB(A) lorsque la machine à chocs normalisée fonctionne dans toute autre local du bâtiment. Là, encore, au moment des contrôles, il est admis une tolérance de 3 dB(A) et le niveau sonore est mesuré au centre des locaux.

Il est bien connu que l'utilisation de la machine à chocs normalisée est très critiquée. En effet, beaucoup de spécialistes considèrent que cette machine n'est pas représentative des chocs résultant de la marche de personnes, en particulier, des femmes munies de chaussures à talons. Quoi qu'il en soit, les études en cours destinées à la modification de cette machine ou à son remplacement par une machine totalement différante n'ont pas encore permis de proposer une méthode très valable et l'on est bien réduit à continuer, pour l'instant, à utiliser la machine normalisée dont l'utilisation, du reste, est relativement facile.

En ce qui concerne les bruits d'équipements, le règlement est, aussi, relativement simple. Il prescrit que le niveau de pression acoustique du bruit engendré dans les pièces principales d'un logement par un équipement quelconque du bâtiment ne doit pas dépasser 35 dB(A) en général et 30 dB(A) s'il s'agit d'équipements collectifs, tel qu'ascenseur, chaufferie ou sous-station de chauffage, transformateur surpresseur d'eau, vide-ordures et installation de ventilation mécanique contrôlée, bouches d'extraction comprises.

Par ailleurs, le niveau de pression acoustique du bruit engendré dans les cuisines par un équipement quelconque du bâtiment ne doit pas dépasser 38 dB(A) et 35 dB(A) pour les installations de ventilation mécanique lorsque toutes les bouches de ventilation de l'immeuble d'habitation sont à leur débit minimum. La seule difficulté qui réside lors du contrôle du respect de ces spécifications concernant les bruits d'équipement est le fait que ces bruits sont relativement faibles et que, par conséquent, il est nécessaire de les mesurer lorsque le bruit ambiant est aussi bas que possible, ce qui veut dire qu'en général, ces mesures doivent être effectuées la nuit.

Les contrôles

La réglementation, dans la mesure où elle repose sur la confiance faite au constructeur, et affirme, par conséquent, ses responsabilités, dispense l'Administration de l'obligation de procéder à des contrôles à priori sur plans. En revanche, les pouvoirs publics conservent la pleine liberté de s'assurer, à tout moment, que les dispositions réglementaires ont bien été respectées.

Ces contrôles se font par sondages, car, actuellement, il n'est pas question de mesurer systématiquement tous les logements de toutes les opérations qui se construisent, cela nécessiterait des moyens de mesure considérables et conduirait à un coût de contrôle qui serait loin d'être négligeable devant le coût de la construction. Donc, pour l'instant, l'Administration se contente de sondages, c'est-à-dire qu'elle ne vérifie que certaines opérations et dans ces opérations, seulement quelques logements sont testés.

Le délai d'intervention de l'Administration pour faire effectuer des contrôles est de deux ans à partir de la date de déclaration d'achèvement des travaux. Pour ces contrôles, l'Administration possède un certain nombre de Centres d'Etudes Techniques de l'Equipement (C.E.T.E.) et elle peut faire appel à certains laboratoires ou bureaux de contrôle qu'elle a agréés. Ces organismes doivent appliquer un code d'essai qui leur a été communiqué par l'Administration.

Lorsque les mesures sont achevées, l'Administration envoit le procès verbal des mesures au maître de l'ouvrage et, si certains résultats ne sont pas conformes à la réglementation, la lettre d'accompagnement signale les dépassements abusifs et réclame une mise en conformité dans un délai donné, généralement 6 mois aux termes duquel un nouveau contrôle pourra être effectué.

Des méthodes de contrôle plus rapides que celles actuellement utilisées sont en course d'étude dans plusieurs laboratoires.

Le Label Confort Acoustique

Pour les raisons indiquées, plus haut, le strict respect de la réglementation de la construction en matière d'acoustique n'est pas toujours le gage d'une satisfaction totale des habitants vis-à-vis de l'isolement de leur logement. Pour cette raison, il a paru nécessaire au Ministère de l'Environnement et du Cadre de Vie d'encourager la construction d'habitations dont les niveaux d'isolation acoustique dépassent ceux fixés par le règlement.

Pour celà, il a été créé le Label Confort Acoustique qui peut être attribué à toute opération s'il s'avère après des mesures acoustiques de contrôle, que celle-ci offre un confort acoustique supérieur à celui exigé par le règlement.

Dans le cas des opérations à loyer modéré, l'obtention du label entraine l'attribution d'un prêt financier complémentaire. Un arrêté et une circulaire précisent les conditions d'attribution du Label Confort Acoustique, du prêt complémentaire, et donnent les instructions nécessaires à l'application de ces dispositions.

Le Label comporte trois degrés correspondant à des niveaux croissants de qualité acoustique notés 1 étoile, 2 étoiles, 3 étoiles, suivant que l'opération considérée obtient, après mesure de contrôle, un nombre de points : supérieur à 40% et inférieur à 70% du maximum de points susceptibles d'être attribués à l'opération considérée - supérieur ou égal à 70% - égal à 100%.

Pour un nombre de points inférieur à 40%, aucun Label ne peut être accordé.

Les performances à réaliser et le nombre de points correspondant sont précisées dans un arrêté.

Les mesures de contrôle sont effectuées soit directement par l'Administration, soit par des organismes agréés, comme dans le cas du contrôle du respect du règlement. Là aussi, une tolérance de 3 dB(A) est admise.

LA QUALITE DES CONSTRUCTIONS RECENTES

Les premiers sondages ayant eu lieu en 1972 et se déroulant maintenant régulièrement au fil des années, il est possible d'observer la variation de la qualité des nouvelles constructions.

Ainsi, pour les isolements aux bruits aériens, en 1972, seulement 45% des isolements mesurés étaient satisfaisants sans la tolérance de 3 dB alors que 70% l'étaient en tenant compte de la tolérance.

En 1976, on constate une légère amélioration, puisque ces valeurs sont passées respectivement à 52 et 78%.

Pour les impacts, l'amélioration a été plus spectaculaire :

En 1972, 26% des isolements mesurés étaient satisfaisants sans tolérance et 46% avec tolérance,

En 1976, ces valeurs sont passées respectivement à 80 et 90%.

Pour les équipements, la situation est restée stable :

60% sans tolérance de 3 dB - 76% avec la tolérance.

LES SOLUTIONS POUR OBTENIR UN BON ISOLEMENT

Lorsque l'on utilise des procédés de construction traditionnels, la satisfaction des exigences concernant les bruits aériens n'est pas très difficile à satisfaire puisque, en général, après avoir conçu des plans de logement qui ne rendent pas les problèmes à résoudre trop ardus, il suffit d'assurer aux parois de séparation des masses suffisantes (350 à 400 kg au m2), tout en évitant un certain nombre de court-circuits acoustiques, tels que ceux qui peuvent être créés par des conduites de chauffage central, etc.

Naturellement, étant donné que le règlement est exigentiel et qu'il n'impose pas de procédé de construction, chaque maître d'ouvrage est libre de choisir la solution qui lui convient. S'il choisit un procédé de construction tout à fait nouveau, il est fondamental qu'il s'entoure de tous les conseils d'un ingénieur acousticien et que, de plus, il procède à des essais préliminaires sur un bâtiment prototype.

Pour faciliter le travail des constructeurs, le Centre Scientifique et Technique du Bâtiment a édité un petit recueil qui contient des exemples de solutions pouvant satisfaire au règlement de la construction ainsi qu'aux définitions du Label Confort Acoustique. On trouve dans ce recueil tous les conseils classiques qui permettent d'assurer, avec une très forte probabilité, une bonne isolation acoustique aux constructions projetées. Ainsi qu'il est dit plus haut la satisfaction concernant les bruits aériens est obtenue essentiellement par des parois lourdes. Toutefois, dans certains cas, on peut envisager des parois plus légères doublées par d'autres parois légères.

Pour la satisfaction concernant les bruits de chocs, le problème est aussi relativement facile car, bien souvent, tout réside dans le choix d'un revêtement de sol convenable.

Pour les pièces principales, ce choix ne rencontre pas de difficulté car il existe un grand nombre de revêtements de sol donnant satisfaction. Par contre, pour les pièces humides, telles que salles d'eau et cuisines, il est plus délicat de trouver des revêtements de sol qui aient, à la fois, les propriétés requises pour être dans ces pièces, et qui soient, sur le plan acoustique, un isolant convenable des bruits de chocs.

Pour faciliter le choix des constructeurs, on a développé depuis longtemps, en France, bien avant la réglementation, un système de cotation de qualité acoustique des revêtements de sols. Ce système attribue à chaque revêtement de sol, un indice de qualité que l'on appelle "Indice Alfa", qu'il ne faut pas confondre avec le facteur d'absorption "Sabine". Grosso modo, l'indice Alfa est la différence qui existe sous un plancher normalisé entre le niveau de bruit lorsque le plancher est ne et le niveau de bruit lorsque le plancher est nu recouvert du revêtement de sol. Autrement dit, un indice Alfa de 0 correspond à un revêtement totalement inefficace au point de vue acoustique, tandis qu'un indice Alfa de 25-30 ou 35 correspond à un bon revêtement de sol.

Pratiquement, la réglementation en matière de chocs peut être satisfaite si on associe une dalle pleine en béton de 16 cm d'épaisseur, par example, à un revêtement d'indice Alfa d'environ 21.

La plupart des revêtements de sols utilisés en France font l'objet de mesures acoustiques en laboratoire de manière à déterminer leur indice Alfa et les résultats correspondants sont donnés, à la fois, par le fabricant et par des recueil de résultats publiés régulièrement, par le CSTB en particulier. Signalons, au passage, que les revêtements de sol les plus fréquents sont des revêtements en plastique avec souscouche ainsi que des moquettes. Par contre, les dalles flottantes qui, pourtant, constituent un moyen très efficace de se protéger contre les bruits de chocs, sont relativement peu utilisées en France, ceci d'une part à cause de leur prix, d'autre part, à cause de leur très fort pourcentage de non réussite en matière acoustique.

Pour ce qui concerne les bruits d'équipements, les choses sont bien avancées lorsqu'il s'agit des équipements sanitaires, en particulier, des robinets. En effet, il existe maintenant, en France, une méthode de mesure normalisée qui permet d'attribuer un indice de qualité acoustique aux robinets. Comme pour les revêtements de sols, cet indice est déterminé en laboratoire à partir de mesures acoustiques. Ces mesures sont conformes à une norme ISO relativement récente.

Les robinets ayant le meilleur indice de qualité sont classés dans un groupe que l'on appelle "groupe 1", ceux ayant une qualité un peu inférieure à celle-ci sont classés dans un "groupe 2" et ceux qui n'ont pas de propriété acoustique particulière ne sont pas classés. Ce système de classement des robinets en fonction de leurs caractéristiques acoustiques est intégré dans le système de marque AFNOR des robinets. C'est ainsi que les robinets, lorsqu'ils reçoivent la marque NF, portent sur leur corps, l'indication du groupe acoustique auquel ils appartiennent.

Pour les autres équipements, il reste encore beaucoup de choses à faire car les travaux ne sont pas aussi avancés que ce qu'on vient de voir à propos des robinets.

Actuellement, il existe un travail de recherche important sur le problème des équipements de ventilation, de manière à pouvoir caractériser tous les composants qui interviennent dans les installations de ventilation et à utiliser ces caractéristiques pour pouvoir prévoir la qualité d'installations complètes.

On peut estimer que dans trois ou quatre années, ce problème sera résolu en France.

En ce qui concerne les équipements de chauffage central, là, pratiquement, tout reste à faire pour caractériser à la fois la puissance acoustique des différents composants que l'on trouve dans les chaufferies, en particulier, et pour pouvoir prévoir, à partir de ces caractéristiques, les niveaux de bruit qui risquent de résulter dans les bâtiments d'habitation.

Pour ce qui est d'assurer une acoustique satisfaisante des locaux de grande dimension, de manière à ce que, par example, la parole y soit bien perçue, ou que le bruit n'y soit pas trop fort, on dispose de toute la panoplie des matériaux absorbants. En France, les fabricants de ces matériaux indiquent avec précision dans leur documentation quelles sont les caractéristiques acoustiques de ces matériaux. Il est bien connu que c'est là un domaine assez difficile car la forme des locaux, les emplacements où sont installés ces matériaux, peuvent conduire à des résultats divers en ce qui concerne par example, la durée de réverbération. Il existe donc toujours une certaine incertitude quant aux résultats que l'on peut obtenir lorsque l'on a décidé d'utiliser ce genre de matériaux.

Pour terminer, signalons que le CSTB publie régulièrement les caractéristiques acoustiques des matériaux et équipements qu'il a testés dans son laboratoire. Naturellement, ces caractéristiques ne sont publiées qu'avec l'accord du fabricant. On trouve dans ce recueil des caractéristiques à la fois de parois plus ou moins légères, de fenêtres telles que les fenêtres Acotherm, de portes, de porte-fenêtres, de planchers et plafond, revêtements de sols et équipements divers tels que les robinetteries. Ce genre de catalogue est d'un très grand intérêt pour le constructeur qui recherche les éléments propres à assurer un confort acoustique satisfaisant.

CONCLUSION

Au cours des dix dernières années, l'administration, en France, a fait un effort important pour réglementer les problèmes d'isolation acoustique des logements et pour chercher à améliorer la qualité de cette isolation par divers moyens. De leur côté, les laboratoires ont fourni un effort important pour normaliser le maximum de méthodes de mesure, pour étudier les phénomènes et pour mettre à la disposition du public les éléments permettant de concevoir les bâtiments en vue d'une isolation acoustique satisfaisante. Malgré tout, il reste un effort important à fournir, à la fois du côté réglementaire et du côté recherche pour que l'ensemble des problèmes acoustiques que l'on rencontre dans la construction trouve une solution d'une manière rationelle. Bien qu'un léger frein ait été donné aux travaux concernant des problèmes, par suite de la primauté de problèmes liés aux économies d'énergie, on peut imaginer que dans les dix années à venir une grande partie des problèmes auront été résolus sur le plan acoustique, tout au moins au niveau de l'administration et des laboratoires mais qu'il restera probablement encore le problème que constitute le passage des connaissances à l'ensemble du public participant à l'acte de bâtir.

REPORT OF ASTM COMMITTEE E-33 "ENVIRONMENTAL ACOUSTICS" MEETING

Experts on the design and testing of open offices and components for open offices are sought by American Society for Testing and Materials (ASTM) Committee E-33 on Environmental Acoustics the Committee announced at its meetings, October 19-21, at the Hyatt Regency Hotel in Dearborn, Michigan. E-33 Task Groups on office screens, ceilings, and background sound systems are responsible for standards on the evaluation of these components. The Committee wants to set up a new task group to draft standard methods to evaluate open offices as complete systems. Of special interest are methods to evaluate whether speech isolation is adequate and comments from users about the acceptability of open offices.

The E-33 Task Group on Pneumatic Exhaust Silencers also asked for comments and information about testing silencers for air exhausted from pneumatic systems. The task group is studying various ways to test and evaluate the silencers.

The Task Group on Close Fitting Pipe Enclosures is preparing a draft laboratory method to measure the insertion loss of pipe lagging. When the draft has been prepared, the proposed method will be evaluated in several laboratories. The task group welcomes comments and offers to evaluate the test method.

A new task group was established to convert Federal Specification SS-S-111B on trowel and spray sound absorption materials to an ASTM Standard. This activity was requested by the Federal Agency that uses it. The request was made under a program to convert Federal standards and specifications to consensus standards whenever possible.

A new standard, ASTM Designation E 795-81, "Standard Practices for Mounting Test Specimens during Sound Absorption Tests," was announced at the meetings. The mountings described in E 795 replace and update those devised by the Acoustical Materials Association (AMA) about thirty years ago.

The next meeting of Committee E-33 will be held in Philadelphia, PA, April 5-7, 1982. Visitors are welcome at all E-33 meetings. For further information contact David R. Bradley, ASTM, 1916 Race Street, Philadelphia, Pennsylvania 19103, Telephone: 215/299-5560.

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