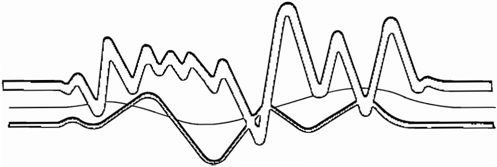
The Bulletin

OF THE AUSTRALIAN ACOUSTICAL SOCIETY

Volume 9, Number 2, August 1981



COUNCIL OF THE SOCIETY

R.A. Piesse (President), A.B. Lawrence (Vice President), D.A. Gray (General Secretary), K.R. Cook (Treasurer), R.W. Boyce, M.A. Burgess, B. Johnstone, G.A.B. Riley, T. Vass, M. Zockel (Councillors)

Standing Committee on Membership

P. Dubout, (Chairman)

Bulletin Editorial Committee

D.C. Gibson (Editor) G.E. Harding (Business Manager), J.L. Davy, E.J. Koop, J.A. Lambert (Members).

DIVISIONAL COMMITTEES

New South Wales

M.A. Burgess (Chairman), E.T. Weston (Vice Chairman), G.W. Patterson (Secretary), J.A. Whitlock (Treasurer), A. Gale (Registrar), M. Kateifides, P. Kotulski, A.B. Lawrence, K. Mott, R.A. Piesse, (Members).

South Australia

M. Zockel (Chairman), P.B. Swift (Vice Chairman), R.W. Boyce (Secretary), K.J. Martin (Treasurer & Registrar), D.A. Bies, H.S. Dean, P.R. Gardner, M.A.P. Lane, R.P. Williamson, G.R. Wild, (Members).

Victoria

K.R. Cook (Chairman), G. Chenco (Vice Chairman), W.J. Kirkhope (Secretary), G. Chenco (Treasurer & Registrar), G.A. Barnes, G.V. Coles, C.L. Fouvy, D.A. Gray, L. Koss, G.A.B. Riley (Members).

Western Australia

B.M. Johnstone (Chairman), F.R. Jamieson (Vice Chairman), V. Alder (Secretary), J. Spillman (Treasurer & Registrar), I. Bailey, D. Carruthers, N. Gabriels, P. Gunn, M.J. McCudden, T. Vass (Members).

Addresses for Correspondence

Correspondence to the Society on National matters should be addressed to:

The General Secretary, Australian Acoustical Society, Science Centre, 35 Clarence Street, Sydney, N.S.W., 2000.

Correspondence to the Society on regional matters should be addressed to the appropriate Division Secretary as set out below:

N.S.W. Division (includes Queensland & A.C.T.): Mr. G. Patterson, C/ Science Centre, 35-43 Clarence Street, Sydney, 2000.
S.A. Division (includes N.T.): Mr. R.W. Boyce, P.O. Box 87, Hindmarsh, S.A., 5007
Vic. Division (includes Tasmania): Mr. W.J. Kirkhope, P.O. Box 130, Kew, 3101.
W.A. Division: Dr. V. Alder, 10 Parkway, Nedlands, 6009

Address for Correspondence to The Bulletin

The Editor, Bulletin of The Australian Acoustical Society, c/o 240 Victoria Parade, East Melbourne, Victoria, 3002.

The Bulletin is available to non-members for an annual subscription of $15.00 (Australian). Address orders to the Editor. Advertising information may be obtained from Mr. J. Lambert (03) 651 4312

THE BULLETIN
OF THE
AUSTRALIAN ACOUSTICAL SOCIETY

Volume 9, Number 2, August 1981

CONTENTS

- The Bulletin is published by the Australian Acoustical Society, 35-43 Clarence St., Sydney, NSW, 2000.

EDITORIAL

Ten weeks ago Rob Law telephoned to tell me he would be leaving Australia early in July, and that we would therefore have to seek a stand-in Editor for the last six months of 1981. This, of course, was the thin edge of a wedge that eventually landed me with the job.

At the time I was busily preparing lectures for a four week visit to research centres in America. However, I planned to be back in Melbourne ten days before Rob departed, so things looked tight, but manageable. Whilst in America I visited Caltech, UCLA, Stanford, BBN and UC San Diego and several other centres where I talked about CSIRO's current work in fluid dynamics and noise control and learned about their work.

At Caltech I attended a meeting on "The Physics of Bubbles in Liquids" which, as some of you know, has been an interest of mine for years. At the meeting I heard an erudite and entertaining lecture on the use of Catastrophe Theory in Engineering Physics. It appears that in any physical process there may be several controlling parameters that can be regarded as co-ordinates defining the surface shape of the process in some way. A fan performance curve, and a load resistance curve, both relating pressure drop to flow, is a simple example. Catastrophe theory tells us that all our problems will occur when there are folds in the surface, because then the process will change markedly and suddenly when there is a small change in one of the controlling parameters; i.e. the fan will stall.

What, you may say, is the point of all this. The point is I returned to Australia to find myself smack in the middle of a fold. It was announced some days before my return that the CSIRO Division of Mechanical Engineering is to close on 31st August, and its research groups are to be dispersed to other Divisions. Instead of settling down to some quiet and productive research, I found myself immersed in a sea of rumour and uncertainty. Where will we end up? When will the process stabilize again? These were and are questions on all our lips. Doubtless our gossip columnist will have something to say about that; I must talk about other things.

The CSIRO Division of Mechanical Engineering has been the production centre for the Bulletin since it moved to Victoria in January 1979. Jacinta Andrews, the Division's receptionist, has, in her lunch breaks, typed and corrected column-width copy on the Division's word processor; Liz Manton, the editor of EngEvents in 1979, introduced John Davy and me to the mysteries of pasting-up copy; my research group has endured the smell of rubber cement and thinner, and given up valuable bench space at lay-up time; and all of these things happened because the Division was pleased to help the Society.

As Editor, I shall take this opportunity to express our gratitude to Dr. Rawlings and his staff, and to thank them for their support. On behalf of the Bulletin and the Society I wish them well for the future.

Donald Gibson

NEWS & NOTES

ENVIRONMENTAL NOISE CONTROL COMMITTEE'S REPORT

Since the previous Chairman, Garry Stafford, reported in The Bulletin of April 1979, the Environmental Noise Control Committee (ENCC) has met three times and has continued to play a major co-ordinating role in the development and implementation of each state's and territory's environmental noise legislation. It is also involved in the acoustics work of the Standards Association of Australia, through its membership of the Acoustics Standards Committee.

The present membership is: Dr. Carolyn Mather (Chairman, Environment Protection Authority of Victoria), Mr. Garry Stafford (Department of the Environment, South Australia), Mr. Richard Langford (Department of the Environment, Tasmania), Mr. George Kwasigroch (Department of the Capital Territory, ACT), Mr. Jeffrey Wright (State Pollution Control Commission, NSW), Mr. Ian Badham (Division of Noise Abatement, Queensland), Ms. Barbara Singer (Conservation Commission, Northern Territory), Mr. Terry O'Brien (Department of Home Affairs and Environment, ACT) and Mr. Cedric Roberts (Department of Public Health, Western Australia). The secretary to the Committee is Mr. Richard Proctor, (AEC Secretariat).

Since April 1979, the ENCC has had three technical documents approved and issued by the Australian Environment Council (AEC). The first of these was the revision of "Environmental Noise Control Legislation in Australia", which provides an outline of each state's and the ACT's environmental noise controls. The second was "Technical Basis for a Regulation to Control Noise from New Chainsaws in Australia" and the third was "Technical Basis for the Noise Labelling of New Air Conditioners in Australia". The latter two documents given standard test methods for determining the equipment's noise emissions, and the one on chainsaws has been adopted by New South Wales as a regulation under its Noise Control Act, 1975. A further technical basis on controlling noise from lawnmowers and edgecutters has been drafted and will be forwarded shortly to the AEC for approval.

In May 1980, Garry Stafford represented the AEC at a conference on noise abatement policies, arranged by the Organisation for Economic Co-operation and Development (OECD). The venue was OECD's headquarters in Paris and 24 countries were represented, together with a number of international organisations. Some important conclucions were reached in such areas as traffic noise, urban planning and land-use management and international co-operation in approaches to noise abatement.

FORMAL EDUCATION REQUIREMENTS FOR MEMBERS OF THE AUSTRALIAN ACOUSTICAL SOCIETY

The Articles of the Society (in particular, Articles 16 (a) and 16 (b) provide that candidates for election to the grade of Member shall have "recognized educational qualifications". Article 16 (c) covers the case of admission following exemption from subjects of a Membership Examination of the Society and 16 (d) deals with applicants who have no recognized educational qualifications but may be elected by reason of verified practical or theoretical experience in the field of Acoustics.

Until this year the Society had not made a formal decision on what were "recognized educational qualifications"; however the 26th meeting of Council on 4th April, 1981 laid down the educational qualifications to be recognized both for the grade of Member and for all other grades, as set out below.

Member grade: A degree or equivalent tertiary qualification in a field of Acoustics

or

a degree or equivalent tertiary qualification in any discipline which includes approved undergraduate or postgraduate study in Acoustics

or

a degree or equivalent in any discipline plus undergraduate or postgraduate study in Acoustics

or, in exceptional circumstances,

successful completion of an approved course of study in Acoustics.

Graduate: As for Member grade, except for the examination alternative.

Fellow: As for member grade.

Affiliate: Appropriate technical qualification, at least at Certificate level.

Student:

(a) Qualifications such as to admit a person to an appropriate degree or equivalent course. This person would then progress through Graduate grade to Member.

(b) Qualifications allowing a person to achieve technical competence, e.g., suitable for admission to an appropriate certificate or diploma course. This person would then progress to Affiliate.

Subscriber: No formal qualifications required.

Sustaining Member: No formal qualifications required.

EPA CONTROLS ON NOISE FROM INDUSTRY

INTRODUCTION

On Tuesday the 13th of January the Victorian Government approved the State Environment Protection Policy No. N-1 "Control of Noise from Commercial, Industrial and Trade Premises within the Melbourne Metropolitan Area" and announced that it would take effect on 4th May 1981. At the same time the Government announced that amending legislation, the Environment Protection (Noise Control) Act 1978 would come into operation on the same date.

The Act and the Policy are linked not only by the date on which they take effect, but also in operation. Because of this, any discussion on the control of environmental noise from industry in Victoria requires careful consideration being given to both the Act and the Policy. (Occupational noise is covered by a separate Act and is the responsibility of the Health Commission.)

NOISE CONTROL NOTICES

Under the Act, the Authority may serve a Noise Control Notice on the occupier of premises other than those used exclusively for domestic purposes or primary production. The Noise Control Notice is a legal document specifying the noise requirements to be met. However, before a Noise Control Notice can be issued a series of steps has to be followed. (See figure). When the Authority receives a complaint from someone affected by noise from industrial or commercial premises, the Authority may, after investigation, serve a Preliminary Noise Control Notice on the occupier. The recipient has 30 days to request a conference with the Authority to discuss the contents of the Notice or offer objections. In convening the conference the Authority may also invite other parties to participate if it considers others may help in the resolution of the situation. After the conference is held, the Noise Control Notice may be confirmed with or without changes, or possibly cancelled altogether. The recipient of the Noise Control Notice may lodge an appeal with the Environment Protection Appeal Board within 30 days of receiving it and may appeal against any of the requirements specified. The Board may take into consideration for example, non-conforming land use rights of the industry under the Town and Country Planning Act 1961. The Act also allows for the Authority to vary the Notice. Any variation of the Notice may also be subject to appeal.

Under the Act, the Noise Control Notice may:-

(a) specify maximum noise levels to be observed outside the premises using limits prescribed in Regulations or by State Environment Protection Policy.

(b) impose conditions on the use of certain plant, machinery, equipment, vehicle or process in relation to the emission of noise, and,

(c) in relation to (a) and (b), impose conditions to be fulfilled according to time or other circumstances and thereby, for example, allow either staged or single step reductions in level. The Authority shall have regard to the nature, extent, difficulty or complexity of complying with the requirements when fixing the time for compliance.

NOISE POLICY N-1

In setting maximum noise levels it was decided that, for most situations, control by State Environment Protection Policy was more appropriate than by Regulation. For this purpose the draft State Environment Protection Policy No. 59/78 "Control of Noise from Commercial, Industrial or Trade Premises within the Melbourne Metropolitan Area" was published and made available for public comment in March 1979. The period for comment was extended to July 31 1979 in response to public request and over 100 submissions were received. All comments were reviewed and additional technical work carried out by the Noise Control Branch of the Authority. The final Policy contains several changes as a result of this

The aim of the Policy is to set out environmental noise level requirements for industrial, trade or business premises within the Melbourne Metropolitan Area. The assessment criteria have been developed for the general range of noises emitted by industry but may not be applicable to other types of noise such as music and noise from firearms which, are exempted from the Policy and, after further studies, may be covered by further documents.

The basic principles behind the policy are that noise from industry should not greatly exceed typical background levels and that emission levels are to relate to an individual's expectations of the neighbourhood. The levels set are on a sliding scale and are based on a major study carried out by the Authority which was published in 1978 under the title "Melbourne Noise Survey". The sliding scale allows industry in a fairly industrialised area to make higher noise levels than an industry in a predominantly residential area. The Zoning Permissible Noise Level (the maximum level allowed for established industries in most instances), is determined from the "Influencing Factor" which is an objective measure of the industrial land use in proximity to the measurement point. A low value indicates a fairly residential area while a high value indicates an industrialized area. To determine the Influencing Factor two circles of 400 m and 140 m diameter are drawn to scale on the Melbourne Metropolitan Planning Scheme Map and centred at the measurement point. The planning use specified by the Map within the circles are categorized as Type 1, Type 2 and Type 3, which are typically residential, commercial and light industrial, and general industrial use respectively. The relative areas of Type 1, Type 2 and Type 3 are used to calculate the Influencing Factor using a simple formula. Adoption of objective criteria based upon a recognized planning scheme ensures that the Policy will not be in conflict with the Melbourne Metropolitan Board of Works planning requirements and in practice the Policy will reinforce the intentions of the subjective conditions contained in the Ordinance.

Specific recommendations are also contained in the Policy for industrial premises which commence operations 12 months or more after the Policy is declared. These levels are lower than the levels for existing premises as it is considered in planning situations all residents should be entitled to the same degree of protection regardless of the proximity of industry. Although the planning levels are only advisory Local Councils and other planning authorities will be encouraged to give consideration to this section of the Policy in the development of both industrial and residential estates.

The Policy accepts that in some cases unusually high or low background sound levels can occur. High ambient levels usually occur where residential premises are affected by traffic noise from nearby highways or main roads, or by non-intrusive noise from distant industries. For these situations the background noise masks the noise from a particular industry, reducing the potential for annoyance. The Policy allows higher levels based upon the background level, plus a margin. On the other hand, where unusually low backgrounds occur, industrial noise may cause annoyance due to its prominence and levels below the Zoning Permissible Noise Levels will be required.

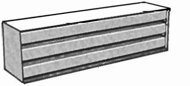
The notices will usually only specify levels to be met at points in residential areas. However, where two or more industries contribute to the level at the measurement point it is, of course, difficult to determine the relative contributions. To overcome this difficulty the Authority may set boundary levels around the industries, the boundary levels being determined such that the resultant level shall not exceed the Permissible Noise Level for the measurement point.

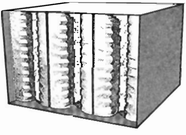
J. Fowler

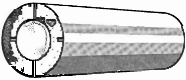
INTRODUCING

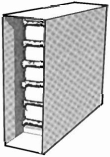
Silentone Series 3000 Acoustic Products

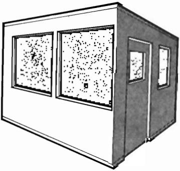
- AUDIOMETRIC TESTING ROOMS
- ARCHITECTURAL ACOUSTIC PRODUCTS
- DUCT SILENCERS
- MACHINERY ENCLOSURES
- ACOUSTIC ABSORBERS
- ACOUSTIC PHONE BOOTHS











TP6102

DVANCED COUSTIC PRODUCTS USTRALIA PTY. LTD.
30–36 Lawson Crescent, Thomastown, Victoria 3074.
Telephone: **(03) 460 9055**. Telex: AA37436.

Silentone
Series 3000

DIVISION REPORTS

NSW DIVISION REPORT

The 1981 activities for the NSW Division commenced in March with a talk and demonstration by Mr. Peter Vogel on the "Fairlight Computer Musical Instrument". This well attended meeting gave encouragement to the Technical Programme Sub-committee in their plans for the remainder of the year. A panel discussion on "Rock Music and Young Peoples Hearing" in April provided an opportunity for a stimulating discussion. It was surprising to learn that although the noise dosage for attendees and workers at rock music venues is extremely high there is little evidence yet to show definite hearing damage.

The Annual General Meeting was held in May and the guest speaker was to be the Honourable E.L. Bedford, Minister for Planning and Environment, NSW Government. Unfortunately, Mr. Bedford contracted influenza and was unable to attend however he arranged, at very short notice, for Mr. Tony Hewett, Principal Engineer, Noise, at the State Pollution Control Commission to present his prepared speech.

One of the important items of business at the A.G.M. was the election of committee members for the next two years. Four of the retiring five members were unwilling to accept renomination and there were six nominations for the four vacant positions, as representatives of Members. Following the Committee Meeting in June the office bearers are:

John Dunlop - Chairman,
Michael Katefides - Vice Chairman,
George Pattison - Secretary,
John Whitlock - Treasurer/Registrar,
Bert Gale - Committee Secretary.

Ray Piesse is Convenor of the Membership Sub-committee and John Dunlop and Les Johnson will look after the Technical Programme. The other members of the Committee are Anita Lawrence, Leigh Kenna. (Sydney Hall has resigned due to an inability to attend meetings).

The retiring committee members have all worked hard in their various duties and I have been fortunate to be the Chairman of such an enthusiastic and supportive committee. I forward best wishes to the incoming committee and am sure they will continue to work hard for the Society and its members.

One additional responsibility for the NSW Division is that of production of the Bulletin. Professor Howard Pollard has accepted the position as Convenor of an Editorial Sub-committee which is preparing proposals for production of the Bulletin in 1981. The Sub-committee is to include Editors for the range of aspects of Acoustics which are of interest to all members of the Society.

Marion Burgess
Retiring Chairman

VICTORIA DIVISION DIARY

Our year commenced with a very informative visit to the Bradford Insulation Plant in Clayton to observe the manufacturing process of rockwool insulation. We thank Bradford Insulation for making our visit possible.

The rockwool manufacturing process involved the addition of limestone, bassalt and coke at specific ratios for product characteristics. The molten mix passed out of the furnace over a set of spinning drums and into a collection chamber as fibration occurred. An atomised thermo-setting binder was simultaneously released into the chamber which combined with the fibres before they were collected on a conveyor system and passed through a curing oven.

The density of the insulation blanket was determined by the speed of collection by the conveyor system, and the thickness was varied by the height setting of the curing oven. On curing, the blanket was trimmed, and the waste off-cut material was granulated for thermal insulation products. Finally the rockwool blanket was cut on-line to client's requirements.

At the conclusion of our visit, members were shown a range of products manufactured with rockwool, including high temperature pipe cladding and then provided with sumptuous refreshments.

The Victoria Division Annual General Meeting was held on June 10, at the Environment Protection Authority Headquarters, and was combined with a Technical Meeting. Mr. J. Fowler, Senior Noise Control Officer with the E.P.A., spoke on the recent legislation for Control of Noise from Commercial, Industrial or Trade Premises within the Melbourne Metropolitan Area, and an inspection of the E.P.A. Noise Laboratory followed by those interested members.

In discussion of the legislation and policy, Mr. Fowler emphasised that both should be dove-tailed and considered together. The area of application is the Melbourne Metropolitan area as covered by the Melbourne Metropolitan Planning Scheme.

On receiving a complaint from a person affected by noise from a Commercial, Industrial or Trade Premises, the E.P.A. is authorised by the Act to serve a Preliminary Noise Control Notice on the occupier of the premises if it is found that the noise emanating from the premises exceeds the specified E.P.A. Policy

limits. Following receipt of the notice the occupier has 30 days to request a conference with the E.P.A. to discuss the problem. If he fails to do this, or the outcome of the conference necessitates action, then a Noise Control Notice will be served on him. The offender then as a further 30 days to lodge an Appeal if he so desires.

An area of confusion and debate is the establishment of a background sound level. In terms of the Policy, background sound level means the arithmetic average of the L90 level for each hour of that period for which the premises under investigation normally operates. The background sound level includes all noise sources except the noise from the offending premises which is considered by a Noise Control Officer to be intrusive at the point where the background sound level is measured.

Corrections are made to the Permissible Noise Level for exceptionally high or low background sound environments. Other corrections are made to the Permissible Noise level for such items as standby generators.

The Policy is aimed at protecting Noise Sensitive Areas from intruding noise emitted from Commercial, Industrial or Trade Premises, and excludes, at present, music, noise from crowds, firearms, noise from construction or demolition activity on building sites and noise from sporting events.

Our next technical meeting will be a visit to the recently commissioned Newport Power Station on July 29, and promises to be a most informative evening.

The Victoria Division is looking forward with great expectation to hosting the Australian Acoustical Society 1981 Conference in September. The theme 'Acoustics and Society' and the venue, the Continental Resort and Conference Centre at Cowes, on Phillip Island have both contributed to the interest shown thus far, both in the large number of contributors of papers on a wide range of topics, and early application responses.

A feature of the conference is the attractive tour program which has been arranged for accompanying persons and delegates, to visit the wildlife penguin parade, and see some of the beauty of both Phillip Island and Westernport Bay.

Following the 1981 Conference, we plan a Technical Meeting on October 6, at the National Science Centre. This will be a joint meeting with the Institution of Engineers (Mechanical Branch), and the speaker will be Dr. D. Rennison, Senior Consultant for Vipac & Partners, speaking on the subject of 'Some Vibro-acoustic Aspects of the N.A.S.A. Aerospace Program'.

Geoffrey A. Barnes,

S.A. DIVISION REPORT

Technical Meeting February 1981

A panel of local Audiologists presented an overview of the general condition of the hearing of the population at large with emphasis on non noise induced problems. This was treated as follows:-

Child Problems - Sharon Gibki, Adelaide Childrens Hospital;
Adult Problems - Tim Klar, Royal Adelaide Hospital;
Aged Problems - Sue Bodossian, National Acoustics Laboratory.

A lively discussion followed.

Technical Meeting April 1981

Mr. Soetratma, who is Investigation and Test Engineer for the Electricity Trust of South Australia, presented a most interesting and informative talk on the major noise problem with ETSA. He began with some hearing loss information, showing that hearing losses have been decreasing since hearing protectors were made compulsory and noise specifications for new equipment have become effective.

Mr. Soetratma then spoke about specific noise sources; for example, during steam blow off and steam discharges while the plant is being commissioned the noise level over a considerable area exceeds 100 dB. However, as these conditions only occur infrequently and for very short periods the solution has been mainly one warning the surrounding residents. Another noise problem is the tonal noise from transformers which is mainly low level but continuous. The experience of the Trust has been that the severity of complaints generally agree with the levels recommended by A.S. 1055 and by the S.A. Noise Control Act. It was interesting to hear that the late Bruce King suggested the use of barriers made of hollow blocks acting as Helmholz resonators long before they became commercially available, and this method is still in use today.

Finally Mr. Soetratma discussed the low frequency noise problem associated with gas turbine power stations. This problem is still under investigation and a discussion developed on whether the source is the combustion instability or whether it is associated with the duct work.

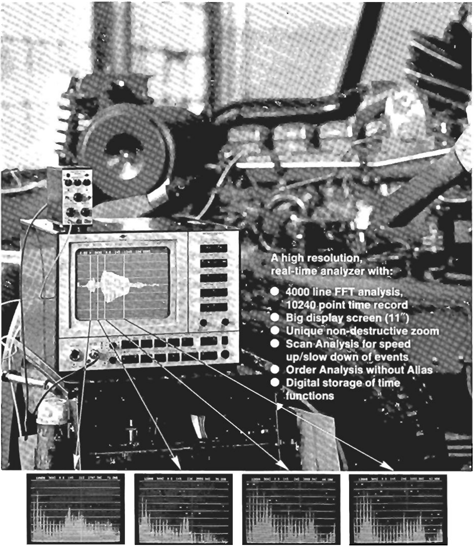
Proposed Future Program

September 24th, 1981

Combined meeting with Chemical Engineering Branch, I.E. Aust. and I. Chem. Eng.

"Techniques used in predicting and controlling noise emissions from a chemical plant."

The Unique High Resolution Signal Analyzer 2033



Brüel & Kjær *....leading in Acoustic Measuring Equipment*

Brüel & Kjaer Australia PTY. LTD.

HEAD OFFICE:
33 Majors Bay Road, Concord, N.S.W., 2137
P.O. Box 120, Concord, N.S.W., 2137
Telephone: (02) 736 - 1755 Telex: 26246
Cable: BRUJA SYDNEY

MELBOURNE OFFICE:
8/12 Pascoe Vale Road, Moonee Ponds, Vic., 3039
P.O. Box 233 Moonee Ponds, Vic., 3039
Telephone: (03) 370 - 7666 : 370 - 7166
Telex: 33728

PERTH OFFICE:
P.O. Box 64, Mundaring, 6073
Telephone: (09) 295 - 1658

ADELAIDE OFFICE:
P.O. Box 420, Norwood S.A. 5067
Telephone: (08) 272-8403

80-317

The Statistics of Pure Tone Reverberant Sound Fields

John L Davy
Division of Building Research
Commonwealth Scientific & Industrial Research Organization
Melbourne, Australia

SUMMARY

This paper reports work concerning the precision of pure-tone sound-power measurements at low frequencies in a reverberation room. A formula is presented for the relative variance of the pressure squared measured by a microphone when the room is excited by a pure-tone point source of constant volume velocity. The random variables are the positions of point source and microphone in the room, the frequency of excitation, and the reverberation room chosen. This formula is extended to cover the case when the pressure squared is obtained by averaging over a number of source and microphone positions in a room.

The formula is compared with experimental results obtained in a 600 m³ reverberation room. There is reasonable agreement between the formula and the experimental results.

It is difficult to make precise measurements of the sound power of a pure-tone source in a reverberation room. There are two reasons for this. The first is the great irregularity of the interference pattern that is generated in a reverberation room by a pure-tone sound source. This can be overcome by using a large number of microphone positions or a moving microphone which covers a large traverse.

The second reason is that at low frequencies the input impedance presented by the room to a pure-tone sound source is a very irregular function of frequency and source position. Using multiple source positions will reduce some of this variance, but we must vary the modal frequencies to reduce all of it.

One way to vary the modal frequencies is to use a moveable diffuser. A more unusual way to vary the modal frequencies is to change the temperature of the air in the room. Making the measurement in a large number of different reverberation rooms or varying the frequency of the sound source will have the same effect. Adding low frequency absorbers to the reverberation room will also reduce this variance because it broadens the modal bandwidths and thus increases the modal overlap.

These two sources of uncertainty are not independent of each other and this paper presents the results of a study [1] into their combined effect. The incentive for this work was the disagreement between the papers of Lyon [2] and Waterhouse [3].

Consider a reverberation room with a pure-tone sound source at $\underset{\sim}{y}$ with volume velocity $Q(\underset{\sim}{y})$ and frequency f, and a point receiver at $\underset{\sim}{x}$. Define the transmission function R by

$$R(f, \underset{\sim}{x}, \underset{\sim}{y},) = \left| \frac{p(\underset{\sim}{x})}{Q(\underset{\sim}{y})} \right|^2 ,$$

where $p(\underset{\sim}{x})$ is the sound pressure at $\underset{\sim}{x}$. If NL measurements of the transmission function are made between N source positions $\underset{\sim}{y}_j$ and L receiver positions $\underset{\sim}{x}_i$ then the averaged value of the transmission function is denoted by $T(f)$. That is,

$$T(f) = \frac{1}{NL} \sum_{i=1}^{L} \sum_{j=1}^{N} R(f, \underset{\sim}{x}_i, \underset{\sim}{y}_j).$$

It is assumed that all the $\underset{\sim}{x}_i$ and $\underset{\sim}{y}_j$ are separated by at least half a wave-length from each other and that each $\underset{\sim}{x}_i$ is more than the reverberation distance from each $\underset{\sim}{y}_j$. (The reverberation distance is the distance from the source at which the direct sound field is equal to the reverberant sound field.)

This paper looks at the variance of $T(f)$ over the ensemble of all possible reverberation rooms with the same volume V and reverberation time T_{60}, and all possible choices of $\underset{\sim}{x}_i$ and $\underset{\sim}{y}_j$ in each room. The value of $T(f)$ depends on the difference between the frequency of the source and the modal frequencies of the room, and the values of the modal spatial function at the source and receiver positions. Thus the averages involved in the calculation of the variance of

T(f) will be taken over the ensemble of all possible values of modal frequencies and all possible modal spatial functions for reverberation rooms of volume V and reverberation time T_{60}.

In theory this requires an average over different room shapes. This can be achieved by changing the geometry of a single room or making measurements in different rooms. In practice, because T(f) depends only on the modal frequencies (and their associated modal spatial functions) which are very close to the excitation frequency, changing the excitation frequency will change the selection of modal frequencies and modal spatial functions which determine the value of T(f). The same effect can be obtained by leaving the excitation frequency fixed and varying the room temperature and hence the speed of sound in the room. This will also change the selection of modal frequencies and modal spatial functions which determine the value of T(f).

Changing the source and receiver positions will not give the full variation, because while the modal spatial function values will be varied, the modal frequencies which determine the value of T(f) will stay fixed (see Bodlund [4]).

The relative covariance of T(f) is defined to be

$$\frac{<T(f)T(f+\Delta f)>}{<T(f)><T(f+\Delta f)>} - 1,$$

where the brackets <> denote an average over the ensemble described above.

In [1] it is deduced that the relative covariance of T(f) is equal to

$$\{ \frac{1}{LN} + \frac{1}{M_s}$$

$$[(\frac{<p_m^4(\underline{x})>}{<p_m^2(\underline{x})>^2} - \frac{1}{2}) \frac{1}{L} + (1 - \frac{1}{L})]$$

$$[(\frac{<p_m^4(\underline{y})>}{<p_m^2(\underline{y})>^2} - \frac{1}{2}) \frac{1}{N} + (1 - \frac{1}{N})]\} \phi(\Delta f),$$

where p_m is the mth modal spatial function,

M_s is the statistical modal overlap and $\phi(\Delta f)$

is Schroeder's "frequency autocorrelation function" [5]. This formula extends Lyon's work [2] since Lyon only considered the case L=N=1. It also corrects an error in Lyon's derivation by replacing

$$\frac{<p_m^4>}{2<p_m^2>^2} \quad \text{with} \quad \frac{<p_m^4>}{<p_m^2>^2} - \frac{1}{2}.$$

Waterhouse's theory [3] predicts that the relative variance of T(f) will be

$$\frac{1}{LN} + \frac{1}{L} + \frac{1}{N}.$$

This formula is derived from the incorrect assumption that the transmission function R can be separated into a source dependent factor and a receiver dependent factor.

To evaluate the formula given above the value of $<p_m^4>/<p_m^2>^2$ is needed. In a rectangular room with hard walls $<p_m^4>/<p_m^2>^2$ is equal to $(3/2)^3$ for oblique modes, $(3/2)^2$ for tangential modes, and (3/2) for axial modes. The densities of the three classes of modes are calculated using the formulae given in [6] applied to a cube of volume V, and used to obtain the average value of $<p_m^4>/<p_m^2>^2$.

It is assumed that this value is a good approximation to the result which would be obtained by averaging across our whole ensemble of rooms.

This average value is a function of frequency, which tends asymptotically to $(3/2)^3$ at high frequencies.

The statistical modal overlap M_s (see [1]) is equal to

$$\frac{3n(f)\ell n(10)}{T_{60}}$$

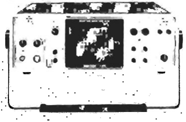
where n(f) is the modal density. Schroeder's "frequency autocorrelation function" $\phi(\Delta f)$ (see [5]) is equal to

$$\left[1 + \frac{\pi T_{60} \Delta f}{3\ell n(10)} \right]^{-1}$$

In the experiments described in this paper there was one source position and the receiver was moved in a circle of radius r.

This circular receiver traverse is equivalent to L independent receiver positions where L is the circumference of the circular traverse divided by half the wavelength of the sound [7]. In this case N=1 and $L=4\pi r/\lambda$, where λ is the wavelength of the sound. The experimental work was performed basically as required for the pure-tone sound-power qualification procedure [8], [9].

As demanded in these sound power standards, the data were corrected for the response of the loudspeaker by dividing the reverberant sound pressure by the near-field sound pressure. In some cases the near-field

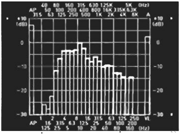


Ideal for On-site or Laboratory Work

The RION's small size, light weight (8.5kg), and internal rechargeable battery, make the RION SA-24 a go-anywhere analysis tool. Its 240V capability makes it ideal for all benchwork.

Versatile

Three quick-change plug-in filter options are available:
i) 1/3 octave Low Frequency 1-250Hz (25 bands)
ii) 1/3 octave High Frequency 31.5-8kHz (25 bands)
iii) 1/1 octave High Frequency 31.5-8kHz (9 bands)



Illuminated Screen Graticule (Fig. 1)

Makes photographic records and night viewing possible.

Detailed Observation of Display

This can be achieved with instantaneous hold facility or "Automatic Hold" as determined by pre-set level control.

Extended Portable Operation

This is possible by means of the optional external battery pack or car battery and gives up to approximately 8 hours' operation.

REAL-TIME ANALYSER

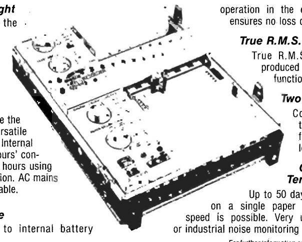
MODEL SA-24

NEW RELEASES!

RION ®

LEVEL RECORDER

MODEL LR-04



Portable—Light Weight

Weighing only 4.5kg, the LR-04 makes an ideal companion instrument to the SA-24 Real Time Analyser for all on-site or bench analysis.

Mains or Battery Operation

Three power options make the LR-04 one of the most versatile level recorders available. Internal batteries give up to 10 hours' continuous operation and 20 hours using external battery pack option. AC mains may be used where available.

No Loss of Records Due to Mains Failure

Automatic changeover to internal battery operation in the event of mains failure, ensures no loss of record continuity.

True R.M.S.

True R.M.S. recordings can be produced in addition to AC linear function.

Two Pen Speeds

Constant or exponential to IEC-179. Ideal for impulsive input levels.

Continuous Long Term Measurement

Up to 50 days' continuous recording on a single paper roll using the slowest speed is possible. Very useful in environmental or industrial noise monitoring situations.

For further information on the extensive Rion range contact

WF WARBURTON FRANKI

● ADELAIDE (08) 356-7333 ● BRISBANE (07) 52-7255 ● HOBART (002) 28-0321
● MELBOURNE (03) 699-4999 ● PERTH (09) 277-7000 ● SYDNEY (02) 648-1711
● AUCKLAND N.Z. (09) 77-0924 ● WELLINGTON N.Z. (04) 69-8272

sound pressure measurements were made in a hemi-anechoic room (an anechoic room with a reflecting floor, sometimes called a semi-anechoic room), and in other cases in a reverberation room. In one case the relative near-field sound pressure was deduced from displacement measurements of the sound diaphragm.

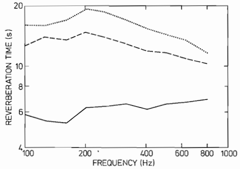


Figure 1. Reverberation time of room, ..., First configuration; - - -, second configuration; ———, third configuration.

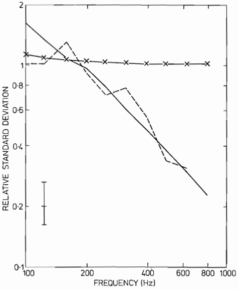


Figure 2 Relative standard deviation of transmission function averaged over a circular microphone traverse with the room in the first configuration. - - -, Experiment; ———, theory; x — x, Waterhouse's theory. Vertical bar shows size of ninety per cent confidence intervals.

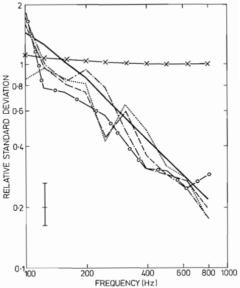


Figure 3 Relative standard deviation of transmission function averaged over a circular microphone traverse with the room in the second configuration. Loudspeaker situated away from room surfaces, - - -; near room surface, ...; near room edge, -·-; near a right angle room corner — o —. Theory, ———; Waterhouse's theory, x ——— x. Vertical bar shows size of ninety per cent confidence intervals.

The sound source was a 150 mm diameter high-compliance loudspeaker, placed in one wall of a tightly sealed box, 240 x 200 x 180mm, constructed of 12mm plywood. The microphone was moved in a circle of radius 2.2m on a plane inclined at 30° to the horizontal. The output from the microphone was squared and averaged over one complete period of rotation of the microphone by a real-time analyzer.

The measurements were performed in a $607m^3$ reverberation room. The room was used with three different amounts of absorption in it. The reverberation time of the room in the three different configurations is shown in Fig. 1.

The second configuration included a large rotating diffuser which was stationary during the measurements described here. In the third configuration low-frequency absorbers were added to the room as well.

Fig. 2 shows a comparison of the standard deviations predicted by the theory described in this paper, Waterhouse's theory, and experiment for the first room configuration. Near-field pressure measurements taken in a hemi-anechoic room were used to correct this set of results.

Fig. 3 compares results for the second room configuration. This set of results was corrected using near-field pressure measurements taken in the reverberation room. The four different sets of experimental results were obtained with the loudspeaker away from all room surfaces, near a room surface, near a room edge, and near a right angle room corner. It was hoped to observe a trend in the results, but no such trend is apparent.

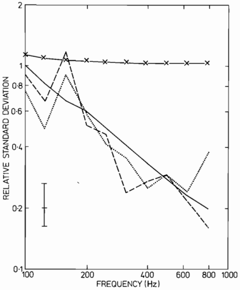


Figure 4 Relative standard deviation of transmission function averaged over a circular microphone traverse with the room in the third configuration. Theory, ———; experiment with near-field pressure reference, - - -; experiment with loudspeaker cone displacement reference, ...; Waterhouse's theory, x ——— x. Vertical bar shows size of ninety per cent confidence intervals.

Fig. 4 compares results for the third room configuration. One set of experimental results was corrected using near-field pressure measurements taken in a hemi-anechoic room and the other set was corrected using loudspeaker diaphragm displacement measurements.

A set of measurements was also performed with the microphone stationary, so that there was no averaging over different microphone positions. The second room configuration was used and the measurements were corrected using near-field pressure measurements taken in the reverberation room. The comparison of results for this case is shown in Fig. 5.

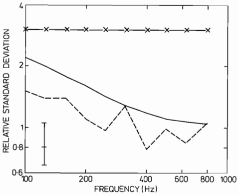


Figure 5 Relative standard deviation of transmission function with no microphone averaging and with room in second configuration. - - -, Experiment; ———, theory; x ——— x, Waterhouse's theory. Vertical bar shows size of ninety per cent confidence intervals.

Conclusion

From an examination of the figures it can be concluded that the extended and corrected form of Lyon's formula presented in this paper agrees reasonably well with experiment while Waterhouse's formula does not.

References

1. J.L. Davy, "The relative variance of the transmission function of a reverberation room", Journal of Sound and Vibration (in press).

2. R.H. Lyon, "Statistical analysis of power injection and response in structures and rooms", Journal of the Acoustical Society of America 45 (1969), 545-565.

3. R.V. Waterhouse, "Estimation of monopole power radiated in a reverberation chamber", Journal of the Acoustical Society of America 64 (1978), 1443-1446.

4. K. Bodlund, "A normal mode analysis of the sound power injection in reverberation chambers at low frequencies and the effects of some response averaging methods", Journal of Sound and Vibration 55 (1977), 563-590.

5. M.R. Schroeder, "Frequency-correlation functions of frequency responses in rooms", Journal of the Acoustical Society of America 34 (1962), 1819-1823.

6. P.M. Morse and K.U. Ingard, "Theoretical acoustics", McGraw-Hill Book Company, New York, 1968.

7. D. Lubman, R.V. Waterhouse, and Chi-Shing Chien, "Effectiveness of continuous spatial averaging in a diffuse sound field", Journal of the Acoustical Society of America 53 (1973), 650-659.

8. American National Standard Institute, ANSI S1.21-1972, "Methods for the determination of sound power levels of small sources in reverberation rooms".

9. International Organization for Standardization, ISO 3742-1975(E), "Acoustics - Determination of sound power levels of noise sources - Precision methods for discrete-frequency and narrow-band sources in reverberation rooms".

TECHNICAL NOTES

SOUND TRANSMISSION IN AND AROUND BUILDINGS

(A DESIGN MANUAL IN THE DEPT. OF HOUSING & CONSTRUCTION/AIRAH DESIGN AID SERIES)

By M.D. Mason, Association for Computer Aided Design (ACADS)

Over the last two to three years the Australian Government Department of Housing and Construction and the Australian Institute of Refrigeration Air Conditioning and Heating (AIRAH) and in more recent times the Association for Computer Aided Design (ACADS) have come together with the common interest activity, of documenting design methods and data and the development of associated computer programs in the mechanical building services area. As part of these activities a Design Manual entitled "Noise Control In and Around Buildings Part 3 - Sound Transmission" has recently been prepared and is now being released for comment. This document is one of a series of design aids being prepared to provide practical assistance to designers with their day to day tasks. It is the third part of a Design Manual which seeks to set down knowledge of the art and current practice in the particular area of noise control in and around buildings as it applies to the mechanical building services engineer. It should also be of interest and value to architects working with mechanical building services engineers.

In Part 1 of the series which was published early in 1980, the more commonly used terminology is described together with the methods of rating the various types of noise and recommended design criteria to be used. In Part 3 the various sound transmission paths in and around buildings are identified. Practical design methods and associated data are presented to enable the designer to analyse the sound transmission from the various noise sources encountered both inside and outside buildings so that the noise level at any nominated position can be evaluated. The transmission of speech is also discussed and various methods of evaluating speech privacy and speech interference presented.

The Design Manual will be the technical supporting document for computer program WOMBAT, currently being developed by ACADS. This program will enable a designer to analyse sound transmission from a variety of noise sources into and throughout a building so that the total noise level at any point within the building can be evaluated. The acoustical properties of a wide range of materials including sound absorption and transmission properties will be stored in the program which will also have the capability of evaluating speech privacy and speech interference levels.

The authors of the Design Manual and computer program are Murray Mason and Tom Hamilton who are currently on loan to ACADS from the Australian Government Department of Housing & Construction. These two mechanical engineers have between them a wealth of experience in mechanical building services design and acoustics and in the development, use and application of computers.

Other design aids in the series published to date are as follows:

- Centrifugal Pumps - Selection and Application
- Noise Control in and around Buildings, Part 1 Fundamentals, Noise Ratings and Criteria
- Air Conditioning Duct Design Manual
- User's Guide for the Department of Housing and Constructions Computer Program "DONKEY" (No. LM102) -Air Conditioning Duct Design
- Special four-ring binder cover.

Any person wishing to comment on the Design Manual or discuss the proposed computer program or other design aids in the series may contact Tom or Murray at ACADS on (03) 51.9153.

GOSSIP

From RON CARR & COMPANY PTY. LTD., Technology-Management and Acoustical Consultants we have received a card advising that the Victorian office is now located at Executive House, 626 Bourke Street, Melbourne, telephone number 602 1701. From this we take it that Ron Carr is back in acoustics again in Victoria. It is perhaps not well known in this South East corner of Australia that Ron has been active in acoustics in recent years being President of the Association of Australian Acoustical Consultants, and of course continuing his operations as Ron Carr & Company Pty. Ltd., in Perth and as Cheah, Carr & Wilkinson Pty. Ltd. in Singapore.

The CARR ACOUSTIC GROUP PTY. LTD. (JIM WATSON, GRAEME MOSS, DOUG GROWCOTT), of course continue as a separate independant consulting organisation. The Carr Acoustic Group for a consideration have used the "Carr" part of their name since they formed their group to carry on the consulting practice previously provided by Ron Carr & Company Pty. Ltd. There I hope you have got it all right; and tnat I got it right for you to get it right. Once before when not quite right there were threats of legal action against me and the AAS. Sorry, no I cannot tell you what it was about or when; anyway to do so would make this column a lot less juicy.

THE ROYAL WE. I have received some comment about my use of we, with some people wanting to know if it arises from my split personality. My apologies to my critics but as a column of I's looks a bit too egotistical, I sometimes hide behind the royal we.

New news - KEN SHEERS has moved from General Motors Holdens Limited to Riley Barden & Kirkhope. Victoria members may remember Ken's very informative address at the joint meeting on motor vehicle noise held at the Country Roads Board.

The axe - It is most disturbing to hear that the Experimental Building Station, North Ryde, NSW, The Division of Mechanical Engineering, CSIRO, Highett, Vic., and the Division of Building Research, CSIRO, Highett are the subject of the Razor Gang. The exploits of the Razor Gang have not been fully documented in the newspapers but your gossip columnist gathers that the E.B.S. is to be sold! Perhaps the A.A.S. should make a bid for the acoustic laboratories. The CSIRO Division of Mechanical Engineering will, we understand, become part of the Division of Manufacturing Technology; and the Division of Building Research is at present, we understand, just "under investigation".

N.Z. news - Harold Marshall has taken on an Associate and the name of their organisation is now Marshall, Day, Associates. From a letter from Chris Day we have learnt of some of the work they have in hand such as a Civic complex in Auckland with a 2500 seat auditorium and 600 seat theatre; and the Wellington Town Hall. I notice that our old friend Rod Satory is Vice-President of the New Zealand Acoustical Society and suggest that he and all other New Zealanders send over a bit of news.

Out of work - JOHN MOFFATT M.A.A.S., is a man of leisure following the end of the research grant for the research work he was doing at Monash University. GREGORY TUNNY, a graduate (Physics) from the Capricornia Institute of Advanced Education has written to us and various other organisations seeking employment, and attaching a resume of his studies showing such things as distinctions in final year acoustics.

In work - LOUIS CHALLIS has, we hear, been retained as the acoustical consultant both for the New Parliament House, Canberra, and for the new A.B.C. studios in Melbourne.

ROB LAW, Senior Environment Protection Officer with the Victorian E.P.A. leaves the E.P.A. on July 1. Rob and his family have the exciting task of shifting to HONG KONG where Rob will set up environmental noise control legislation for the Colony; Rob will be employed by the Hong Kong government for two three year contracts.

Over the years we, and others, have mentioned the about to be gazetted noise control policy of the E.P.A. To all whom these presents come let it be known that the Victorian Government Gazette No. 27 - Thursday 26 March 1981 has published this policy.

Turning idly through the last bulletin and, WOW that is better than NAP's previous advertisements - no it's an ad. for the next conference. You should hear the reaction from some of the wives - it's got nothing to do with acoustics - it will be cold and wintery anway, etc. etc. Yet at least we all looked at that page. Yes you guessed right I am talking about the picture of the young lady holding a fairy penguin. Victoria hasn't organised a live-in conference since I helped organise the Warburton Conference just over 10 years ago; now there are 10 good reasons why you should be at Cowes on the evening of Thursday September 17.

The next issue of The Bulletin will be the last published by this committee - let us see if some one can actually send me some gossip. Send it to me at KNOWLAND HARDING FITZELL PTY. LTD., 22a Liddiard Street, HAWTHORN, VIC., 3122. Phone: 819 4522.

Graeme E. Harding

A Criterion for Low Frequency Noise Annoyance

Dr. Norman Broner
Vipac & Partners Pty. Ltd.
Sth Yarra, Victoria, 3141 Australia

INTRODUCTION

Over the last few years, the number of complaints regarding low frequency noise emitted by industrial plants and by service equipment has increased. Sources of high level low frequency noise (0-100 Hz) and especially of infrasound (0-20 Hz) have now been widely documented and include such items as boilers, compressors, oil and gas burners, ventilation and airconditioning equipment (e.g. Leventhall and Kyriakides, 1976; Bryan, 1976; Broner, 1978). Many of these sources are unbalanced towards the low frequencies in that they exhibit a spectrum which shows a general decrease of sound pressure level (SPL) with increase in frequency and it is now apparent that in some situations, this type of noise is clearly the source of annoyance (e.g. Tempest, 1973; Bryan, 1976; Vasuderan and Gordon, 1977; Leventhall, 1980). A review of the case histories available would in fact suggest that such an unbalanced spectrum occurs when the difference between linear SPL and A-weighted SPL [SPL(A)] is greater than approximately 20 and when the SPL(A) is low. Often the more common broadband type sources are treated in such a way as to also result in a similar falling SPL characteristic with the rationale being that higher frequencies are more annoying and contribute more to the A-weighted SPL. Likewise, the noise transmission loss through a residential wall is such that it shapes the noise immission spectrum similarly and for cases where the high frequency emission is controlled the normal wall transmission loss exacerbates the spectrum shaping towards unbalance. For all these scenarios, the result can be that the annoyance experienced due to the unbalanced noise immission can be high even though the SPL(A) is such that based on normal criteria, no annoyance would be expected. It is therefore clear that the SPL(A) is not a valid basis for determining the justification of a complaint where the intruding noise is unbalanced in that it contains most energy in the lower frequencies. The common assumption that the conventional assessment of loudness and annoyance are equivalent is also seen to break down in these cases and may in part be due to the unsteady nature of the low frequency noise that is emitted.

As part of an investigation into low frequency noise annoyance at Chelsea College, London, annoyance responses to and unacceptability ratings of low frequency noise were obtained. This paper reports the results of the unacceptability ratings and calls on Vipac and other case histories to suggest a criterion for low frequency annoyance assessment.

METHOD

Test Chamber

The test chamber used was an I.A.C. moduline with 100 mm thick walls originally designed for work on domestic gas units. The large size (3.65 x 3.05 x 2.44 m) provided spaciousness and comfort and face validity with respect to the judgements having to be made as if relaxing at home.

Noise Stimuli

The noise stimuli were produced by ten KEF 310 25 cm ovuloid loudspeakers which were mounted in a 2 x 5 matrix on one of the walls of the chamber. The amplifier used was an AMCRON DC300 A.

The test stimuli were confined to frequencies below 100 Hz. Thus the noise stimuli consisted of the seven 10 Hz bandwidths between 20-90 Hz (generated by a General Radio 1381 Gaussion Random Noise Generator in conjunction with a Barr and Straud Variable Filter Type EF2) and each was presented at an overall SPL of 55, 65 and 75 dB. The sequence of 21 stimuli is shown in Table 1. It can be seen that some of these stimuli are near the threshold of auidibility. The A-weighted SPL range for these stimuli was 19-52 (see Table 2).

Subjects

The total number of subjects (Ss) used in the study was 75. This paper is, however, concerned only with those 21 Ss who had previously co-operated with the Acoustics Research Group in its investigation of the low frequency noise annoyance phenomenon. Some of these Ss had travelled many miles to take

part in the study and were very willing to help any investigations which could have helped solve the mystery of "their problem". All travelling expenses were re-imbursed.

TABLE 1: THE SEQUENCE OF 21 LOW FREQUENCY NOISE STIMULI

STIMULUS NUMBER	FREQUENCY (Hz)	OVERALL (dB)
1	50-60	65
2	80-90	75
3	30-40	55
4	20-30	75
5	40-50	65
6	70-80	55
7	60-70	75
8	20-30	55
9	70-80	65
10	40-50	75
11	80-90	55
12	50-60	75
13	60-70	65
14	40-50	55
15	80-90	65
16	20-30	65
17	50-60	55
18	30-40	75
19	70-80	75
20	60-70	55
21	30-40	65

Of the 21 Ss, 10 had had their hearing threshold tested previously (Walford, 1978) and their hearing was found to be generally poor. In fact it was found to be significantly poorer than a control group for frequencies above 50 Hz, though, below 50 Hz there was no significant difference. The mean age of the group of Ss was 54.3 years with a standard deviation of 12.6 years.

Unacceptability Rating

The Ss partook in a study of annoyance and were to imagine that after a hard day's work they had just been comfortably seated in their chairs and had intended to read their newspapers. The main instructions dealt with the rating of annoyance by means of the magnitude estimation technique (e.g. see Broner and Leventhall, 1978). Following the annoyance response the Ss were instructed as shown in Figure 1.

FIGURE 1: UNACCEPTABILITY RATING INSTRUCTION AND REACTION SHEET

After recording your annoyance response, I want you to indicate whether or not you believe the sound you have just heard would be acceptable to you. By this I mean whether or not you feel that you could learn to live with it if you heard it regularly in your own home.

After recording your acceptability response, you may comment on any effects, if any, that you may have perceived due to each sound. Such effects as chest vibrations or a pressure sensation are of interest.

Finally, would you please indicate in the space provided whether you regard yourself as being sensitive to noise.

Thank you.

SEC. 2

NAME: J. SMITH AGE: 23

SEX: M TIME: 1100

Do you regard yourself as being sensitive to noise?

YES

NO

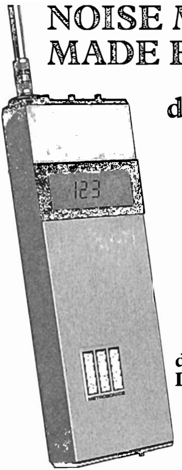
REACTION SHEET

NOISE NUMBER	RATING	ACCEPTABLE YES	ACCEPTABLE NO	COMMENTS
1	70			Throbbing
2	23			
3	30			

TABLE 2: dB(A) NOISE LEVELS FOR THE LOW FREQUENCY NOISE STIMULI

	Frequency Hz						
OASPL	20-30	30-40	40-50	50-60	60-70	70-80	80-90
55dB	19.8	22.4	24.3	27.5	31.1	31.8	31.4
65	24.3	31.6	34.0	37.0	38.7	40.2	42.0
75	33.2	40.5	44.3	47.9	49.4	50.8	52.2

NOISE MEASUREMENTS MADE EASY...



db-306 Metrologger®
Series Now In
LED and LCD
Display Versions

- Real Time Sound Pressure Level (SPL)
- "Average Level" L_{eq}, L_{osha}, L_{dod}
- Maximum Level
- Test Duration
- 64 db Dynamic Range
- Complies With Applicable Portions of ANSI S1.4-1971 and S1.25-1978

db-306A
LCD Display

db-306
LED Display

The db-306 series Metrologgers are unique pocket size computers which combine the functions of a sound level meter, dosimeter and average level meter. Their applications range from environmental surveys and law enforcement, to occupational health measurements and sound power computations.

User plug-in PROMs determine the trading ratio and measuring range of the db-306 and adapt the instruments for measurements in accordance with ISO, OSHA, and DOD criteria. Metrosonics db-306 series Metrologgers are unquestionably the most versatile hand held acoustical computers in field use today.

AUSTRALIAN GENERAL ELECTRIC (SALES) LTD

86 BAY ST ULTIMO N.S.W. 2007 PH (02) 212-3711
PH. PERTH (09) 328-7677 PH. MELBOURNE (03) 233-7711 PH. BRISBANE (07) 36-7288

Test Procedure

The first 9 stimuli were duplicated and added to the sequence shown in Table 1, thus resulting in a total of 30 stimuli. In this way, an S could be started at any one of the first ten stimuli, thus providing a degree of randomness. Each stimulus was presented for 20 seconds with a 10 second interval between stimuli, resulting in a total test session length of 10.5 minutes for the 21 stimuli. The S carried out the rating task while seated in the test chamber. To ensure that no stimulus was missed, a green light came on 0.25 seconds prior to each noise stimulus.

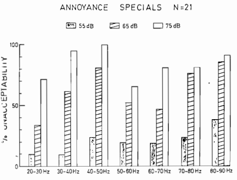


FIGURE 2: UNACCEPTABILITY RATINGS FOR THE GROUP OF "SPECIALS" TO THE 21 NOISE STIMULI

RESULTS

Figure 2 shows the percentage of Ss expressing unacceptability for three overall SPL's (OASPL). It can be seen that for an OASPL of 55 dB, an average 20% of the sensitive group of respondents expressed unacceptability while for 65 and 75 dB OASPL, the average percentages rose to 50% and 80% respectively. There is also some evidence that the 30-50 Hz range is more aversive than the surrounding frequencies. It should also be noted that as the frequency is increased from 70 Hz, the unacceptability again increases and tends towards the rating expected of higher frequencies at the given SPL(A)'s.

CASE HISTORIES AND FIELD STUDIES

All the evidence for a modified limit of establishing noise criteria to account for annoyance caused by low frequency/low level noise comes from the various case histories and field studies documented by consultants and researchers since 1971. Typically, the background noise within a residence has been very low so that the presence of the low frequency noise is not masked to any extent. In many cases, the accompanying low frequency fluctuations and modulations cause a "throbbing" which results in the annoyance. In others, the secondary effect of rattling of windows and doors leads to fear and annoyance. The inability to locate the source of disturbance is also seen to contribute to the expressed annoyance whereas in the cases where sources are known, vigorous complaints arise. One such case was recently investigated by Vipac. The source of the disturbing low frequency "rumble and throbbing" was a set of two vibrating screens within a sand mixing plant and approximately 400 m away. With the plant running, high SPL's occurred at the screen frequencies of 45 Hz and 63 Hz, thus, with the plant running the noise level was 56 dB, 29 dB(A) in the complainant's bedroom. Figure 3 shows the spectrum during plant operation. For comparison, the spectrum after shutdown is also shown. The noise level was found to drop to 52 dB, 22 dB(A) following shutdown and was deemed acceptable to the complainants.

Other examples include complaints due to machinery in an adjoining dry cleaners causing an immission level of 31 dB(A), 53 dB and due to an adjacent air conditioning plant with similar immission levels (Leventhall 1980). These noises were reported to have an unpleasant throbbing characteristic. In Japan, the rattling of windows and doors (especially in wooden houses) due to inaudible low frequency noise has been found to cause anxiety in inhabitants (Yamada et al, 1980) and complaints about the effects of low frequency noise have occurred at levels as low as 65 dB (2-90 Hz) (Tokita, 1980). Low frequency pure tones just at or above the threshold of hearing have also been found to cause extreme annoyance (e.g. Broner, 1978; Bryan and Tempest, 1979; Chatterton, 1979). Typical sources are a central heating unit, an industrial forced draft fan boiler and a cupola furnace in resonance.

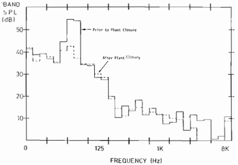


FIGURE 3: THIRD OCTAVE SPECTRA SHOWING THE NOISE MEASURED IN THE BEDROOM PRIOR TO AND AFTER PLANT CLOSURE

Meet the New Member.

NAGRA TI

The new NAGRA TI Portable Professional Instrumentation Recorder is the latest product to be included in the well-known Nagra range of tape recorders. The NAGRA TI is a four channel twin capstan reel-to-reel recorder, intended for use with standard ¼" intermediate-band instrumentation tape.

Nagra TI Instrumentation Tape Recorder

Adjustable Stand Module

All mechanical functions are performed and regulated by a separate servo-controlled motor. Eight bi-directional servo controlled tape speeds from 15/32 ips. to 60 ips. may be selected, with further facilities for manually controlled speed variation to permit full interchangeability of tape recorded at non standards speeds. The 13 pushbutton keyboard allows selection of 51 functions, including speed and counter.

Three types of record/reproduce plug-in modules are available – FM, Direct Modulation and Synchro-Voice Modules – and are easily interchangeable by the user. A fourth module included in the basic NAGRA TI is for calibration and monitoring of each track.

Thanks to its compactness and to the plug-in modules available, the NAGRA TI covers a large variety of applications for present and future customer requirements. Completely self-contained, with internal calibration facilities and battery pack, it has been designed to be used anywhere, in the field or laboratory.

NAGRA

Another recent addition to the NAGRA range is the TRVR Reel-to-Reel Logging Recorder for Automatic Long Recording, with four speeds, mains power supply and for 19" rack mounting.
Check these features:

- Two channels plus one reference track.
- AC/DC operation.
- Excellent signal to noise ratio and response curve at lowest speed.
- Long recording time (more than 12 hours).
- Continuous recording self-check by comparison of input signal and playback signal.
- Tape transport designed to protect and handle tape gently.
- Autostart by input signal.
- Numerous maintenance facilities.
- Full remote control with positive operation and display facilities.
- High working security due to keyboard locking device.
- Bi-directional servo-controlled tape drive.
- End of tape sensing.
- Multiple tape processing facilities.
- Built-in time compressor/expander.
- Built-in time code generator.
- Cascade starting of supplementary standby recorders on alarm signal.

For further technical information contact:

Rank Electronics
Studio Equipment Division

Peter Schaper Sydney (02) 449 5666
Paul Brooker Melbourne (03) 541 8444
Or write to your local Rank Electronics office.

CHOICE OF A CRITERION LIMIT

The choice of a criterion limit is dependent on whether one wishes to "protect" sensitive people in the sense of accepting a complaint by them to be justified and on the degree of complaint justification that one wishes to afford these people. It would certainly appear that such a limit should be proposed, at least for the purpose of making Environmental Health Officers aware that the normal criteria do not apply to "sensitive" people where low frequency noise predominates. As we are dealing with people who are sensitive to low frequency noise, it would also be reasonable to suggest a criterion which would result in 95% of this population having their complaints found to be valid. On the basis of the above experimental evidence and various case histories, a criterion limit is postulated for cases of unbalanced noise immissions into home environments as:

LOW FREQUENCY NOISE
CRITERION (LFNR) LIMIT

$SPL(A) \leq 30$ $OASPL = 55$ dB
$SPL(A) > 30$ $OASPL \simeq SPL(A) + 30$ dB

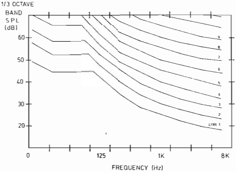


FIGURE 4: PROPOSED LOW FREQUENCY NOISE CRITERION (LFNR) CURVES

Figure 4 is a graphical presentation of this low frequency criterion and is based on a modification to the NR curves. The justification assessment is carried out by superimposing 1/3 octave noise spectrum on the LFNR curves, as for the NR rating. Considering all 1/3 octaves above 100 Hz, the lowest curve which is not exceeded by the noise spectrum is the LFNR rating of the noise. If any 1/3 octave below 125 Hz exceeds the LFNR rating, then a complaint about the given low frequency noise immission can be regarded as justified.

Regarding a noise limit in work (e.g. office and industrial) settings, the evidence also suggests that the limit need not be as strict, possibly due to the different expectations regarding a satisfactory background as compared to the home setting. This is reflected in the higher A-weighted ambient sound level criteria for these settings as recommended by Australian Standard A.S. 2107-1977 and also by the shape of LFNR curves below 100 Hz which allow increasingly higher levels of low frequency noise with increasing SPL(A) before the immission is regarded as unacceptable.

REFERENCES

1. BRONER, N. (1978) "The Effects of Low Frequency Noise on People - A Review" J. Sound & Vibration, 58 (4), 483-500.
2. BRONER, N., LEVENTHALL, H.G. (1978) "Low Frequency Noise Annoyance and the dB(A)" Acoustics Letters, 2, 16-21.
3. BRYAN, M.E. (1976) "Low Frequency Annoyance" in 'Infrasound and and Low Frequency Vibration' W. Tempest (ed.), Academic Press, London, 65-96.
4. BRYAN, M.E. TEMPEST, W. (1979) "Low Frequency Noise Annoyance" I.O.A. Low Frequency Noise Conference, Chelsea College, Jan.
5. CHATTERTON, P.F. (1979) "A Case History of a Low Frequency Noise Problem" Noise Control Vibration Isolation. Aug/Sept. 295-298.
6. LEVENTHALL, H.G. (1980) "Annoyance Caused by Low Frequency/Low Level Noise" Proc. Conf. on Low Frequency Noise and Hearing, 7-9 May, Aalborg, Denmark, Moller and Rubak (eds.), Aalborg University Press, 113-120.
7. LEVENTHALL, H.G., KYRIAKIDES, K. (1976) "Environmental Infrasound: Its Occurence and Measurement" in 'Infrasound and Low Frequency Vibration' W. Tempest (ed.), Academic Press, 1-18.
8. TEMPEST, W. (1973) "Loudness and Annoyance Due to Low Frequency Sound" Acustica, 29, 205-209.
9. TOKITA, Y. (1980) "Low Frequency Noise Pollution Problems in Japan" Proc. Conf. on Low Frequency Noise and Hearing, 7-9 May, Aalborg, Denmark, Moller and Rubak (eds.), Aalborg University Press, 189-196.
10. VASUDEVAN, R.N., GORDON, C.G. (1977) "Experimental Study of Annoyance Due to Low Frequency Environmental Noise" Applied Acoustics, 10, 57-69.
11. YAMADA, S. et al (1980) "Hearing of Low Frequency Sound and Influence on Human Body" Proc. Conf. on Low Frequency Noise and Hearing, 7-9 May, Aalborg, Denmark, Moller and Rubak (eds.), Aalborg University Press, 95-102.
12. AUSTRALIAN STANDARD A.S. 2107-1977 "Ambient Sound Levels for Areas of Occupancy Within Buildings".

BOOK REVIEWS

"ACOUSTICAL DESIGN OF CONCERT HALLS AND THEATRES"

Vilhelm Lassen Jordan

Applied Science Publishers Ltd. London

This book is sub-titled "A personal Account" and as such is quite different from the usual basic textbook on the mathematics and science of architectural acoustics as applied to auditorium design. In short, it is a summary of the author's experience as an acoustical consultant in many parts of the world.

As a "career autobiography", the first chapter deals with Jordan's experience as a young acoustician during the construction of the Broadcasting House of Copenhagen in the years of the Second World War. Since the Danes were determined that inauguration would not take place while the Germans were in occupation, construction was deliberately delayed, giving the author the luxury of time to carry out acoustic experimentation. At this time, sound isolation requirements were well-defined but the frequency of dependence of reverberation time and correct diffusion were largely unknown characteristics. His work during these formative years created an interest in scale-model testing which he has since applied with continuing refinement to many other projects.

A brief historical survey follows which discusses ancient Greek and Roman Theatres, moves through the Italian Renaissance period with the first enclosed theatre, and then onto the classical concepts of concert halls.

The format of the book from this point on is a series of case histories on halls and theatres in more or less chronological order interspersed with chapters on the development of criteria and model research at increasing levels of sophistication. There is a certain amount of jumping about in time and, although full details are given for each hall at the end of the chapter, I feel it would be helpful if the year of completion was included in the text the first time a particular hall is mentioned.

This book offers much to architects and theatre designers as well as acousticians and can be profitably read by post-graduate students in acoustics. The case histories alone will make interesting reading at under-graduate level. It contains some lessons to be learned, such as the importance of correctly ranking priorities of function for multi-purpose halls. (An amusing account is given of an attempt to present Shakespearean drama to an audience of 2,800 in the New York State Theatre, which highlights the problems of misunderstanding by theatre management of a theatre's acoustic capability).

The book is well illustrated by Niels V. Jordon and has a comprehensive bibliography at the end of each chapter together with appendices giving theoretical considerations and development of formulae. Of particular interest to Australians is a separate chapter on the Sydney Opera House.

A minor quibble is that, although there are tantalising mentions of the problems of achieving low ambient sound levels and a brief discussion on diffuser design, the control of noise from air conditioning systems as applied to theatres and concert halls, is not covered in sufficient detail to satisfy the interested engineer.

Valerie Bray,
PETER KNOWLAND & ASSOCIATES

GUIDE TO ACOUSTIC PRACTICE - A NEW BBC BOOK

The BBC's Guide to Acoustic Practice has for many years provided a vital link for BBC staff between theoretical acoustic design information and the bricks and motor of a real building site. This book describes in detail how to put theory into practice when building anything from a remotely-controlled announcer's booth to a complete multiple studio complex. In fact, although all its examples are for studio type areas, the same principles can be applied to any other construction where acoustic considerations are important, for example in doctors' surgeries, school music rooms and conference halls.

The book does not attempt to repeat the basic theory which can be found in many other reference works: its starting point is the BBC's established acoustic design criteria. It takes these and describes the details which have to be considered to ensure that an area meets its acoustic design, dealing in turn with sound isolation, background noise and the control of a room's acoustics. It concludes by pointing out some of the often forgotten secondary effects of building elements, such as the way power and signal distribution conduit can seriously compromise sound insulation, and ways of overcoming these problems.

95 pages 227 x 210 mm Paperback
Price £10

Copies are available from:

John Hawkins
Manager, Engineering Publicity,
707 Henry Wood House,
BBC,
Broadcasting House,
LONDON W1A 1AA

CONFERENCES & SYMPOSIA

CANADIAN ACOUSTICAL ASSOCIATION ANNUAL SYMPOSIUM 1980

1. OVERVIEW

An annual event in the caldendar of the Canadian Acoustical Association, this Symposium was held in the Constellation Hotel, Montreal, on October 22 and 23, and was attended by approximately 150 delegates. A total of 46 technical papers were delivered at a Symposium which was structured to have two sessions running concurrently for all of the first day and for the morning of the second day. The afternoon of the second day was taken up with a technical tour of the Transport Canada Motor Vehicle Test Centre.

The six technical sessions of the Symposium were entitled:

1. Industrial noise and audiometry
2. Architectural acoustics and transportation
3. Transportation
4. Miscellaneous
5. Measurement and protection of hearing in industry
6. General acoustics

I attended papers related to my interests in road and traffic noise, and have included some highlights of these papers.

It was interesting to note that five papers dealt with some aspect of highway noise attenuation barriers. This was indicative of the commitment to and investment in barriers as a traffic noise control strategy within Canada, particularly within the Provinces of Ontario and Quebec. Informal discussions during the Symposium confirmed my observation that there is considerable research effort ongoing in Canada aimed at improving barrier technology and practice. The existing level of barrier technology in Canada is further advanced than that in Australia, where barriers are a comparative rarity.

The relevant Symposium papers and informal discussions also revealed that there have been many social surveys related to noise annoyance conducted in Canada. The interesting observations here were that the problems, pitfalls and data complexities associated with such surveys experienced in Canada are indeed very similar to those found in Australia. Finally, it would seem from the Symposium that the states of the arts in traffic noise measurement and prediction practice are very comparable between Australia and Canada. The obvious differences are the much 'larger' freeways and traffic volumes in Canada and the greater frequency of, and importance placed upon traffic noise prediction in that country compared to Australia.

2. HIGHLIGHTS OF SOME PAPERS

F.W. Jung. 'Sound Barriers, Noise Attenuation, Height and Sound Transmission loss'.

This paper explored the relationships between traffic noise attenuation and barrier parameters such as height, material and distance from the pavement. The United States FHWA traffic noise prediction model was used, drawing on traffic and topographical data from three major routes in Ontario (Highway 401, the Ottawa Queensway and the Queen Elizabeth Way). It was concluded that to achieve significant traffic noise reductions in the order of 10dB(A) at the first row of houses adjacent to the highway, barriers must be at least 4.0 m high. As expected, the more massive barriers (concrete) produced greater attenuation than the less massive steel barriers.

In the paper, design curves for traffic noise attenuation plotted against barrier height were given. Families of curves for varying barrier transmission loss were also given. It was shown that 'steel barriers made of thin gauge steel panels must be built considerably higher than solid wall barriers (concrete) to achieve the same effect, especially when high values of attenuation are desired.' As an example, the curves given for the attenuation achieved at 20 m from a barrier 6.7 m from the nearside running lane of the Queen Elizabeth Way claimed that values of 8dB(A) may be obtained from a 3.2 m high solid concrete barrier or a 3.6 m high steel panel barrier. (In this example the concrete barrier had a transmission loss of 32dB while the steel barrier transmission loss was 15dB).

J. Desormeaux. 'Field Assessment of Highway Noise Barriers'.

In the early 1970's the Ontario Ministry of Transportation and Communications (OMTC) commenced what has proved to be a very large and ongoing investment in a highway noise attenuation program. One part of this program involved the construction of barriers on both existing and new freeways. There has been some interest, therefore, in assessing the actual performance of these barriers.

This paper dealt with the details of a field measurement program for conducting such an assessment. It was found necessary to adopt a measurement approach, since the analytical procedures were regarded as still being 'rather crude' and unreliable. Actual barrier performance data were not included in this paper, since these had been discussed previously by F.W. Jung. Some features of the measurement procedure adopted were:

* Measurements were taken only when the mean wind speed was less than 20 km/h and the highway surface was neither wet nor snow covered.

* All data were recorded on magnetic tape and returned to the lab for analysis.

* Only linear (unweighted) data were recorded. This allowed a range of analyses to be conducted in the lab. Most data was finally reported, however, in terms of dB(A).

* Two measurements were always taken when assessing barrier performance. One was some 2 to 5 m behind the barrier, while the other 'control' measurement was taken at the same setback from the highway in an otherwise similar location where there was no barrier present.

Barrier performance was assessed from these measurements and attenuation curves such as those produced in Jung's paper. An interesting additional calculation was performed to estimate the net benefit of the barrier on residences alongside the highway. This noise barrier benefit parameter was of the following form and used subsequently in cost/ benefit analyses.

$$\text{Benefit} = \frac{\Sigma\Delta}{N}(L_B - 57)$$

Where Δ = The attenuation provided by the barrier at each residence under consideration.

L_B = The 'before' level; that is, the traffic noise level (LEQ(24 hour)) prior to the installation of the barrier. This was measured at the 'control' position.

N = Number of residences affected with the LEQ (24 hr) noise levels in excess of 57dB(A) prior to the installation of the barrier.

J. O'Grady. 'Residents' Perceptions of the Environment Impacts of Freeway Noise Barriers'.

O'Grady reported on surveys conducted in four locations where freeway noise barriers have been constructed. These surveys attempted to 'identify and quantify the changes in quality of life in the affected (by the barriers) residential neighbourhoods. All surveys were conducted some time after the barriers were constructed. Accompanying noise data showed that the barriers produced reductions of 5 to 8 dB(A) in the LEQ(24 hr) at the first row of houses at the four sites.

The results of these surveys are too complex to allow detailed treatment in this report, so only the most important outcomes will be mentioned. Firstly, there was a generally reported improvement in residents' satisfaction with their neighbourhood' following the construction of the barriers. Traffic noise reduction was stated as the major reason for this, but it was by no means the only reason. Following closely behind were improvement in privacy, protection from road salt spray during the winter and, to a lesser degree, protection from traffic generated dust.

J.J. Hajek. 'Performance of Parallel Highway Noise Barriers'.

The term 'parallel highway barriers' refers to the situation where barriers have been erected on both sides of a highway. In Ontario the incidence of parallel barriers is greater than that of single barriers and hence OMTC have expended some effort in studying their performance. In particular it is of interest to determine if there is any reduction in barrier performance due to the complex acoustical field created around the highway as a result of the presence of two barriers.

Hajek explored the effects of multiple reflections of sound between parallel barriers, claiming that in some situations a complete analysis of these effects necessitates considering up to 15 reflections. He presented a complex analytical solution for parallel barriers using geometrical acoustics. These analytical results were then compared with field experimental results for both the parallel barrier situation and the case of a highway in a cutting with vertical retaining walls. He concluded that the effectiveness of a single barrier can be significantly degraded by erecting an opposite barrier. Indeed he has shown that in some situations parallel barriers can act as sound amplifiers. Further analytical and experimental work by Hajek has shown that these adverse effects may be reduced by the addition of absorptive lining on the highway side of the barriers, and by slightly inclining the barriers. The interesting results of this paper indicate the care with which traffic noise control measures must be approached.

R.G.S. Gaspar and P.V. Beneteau. 'Computer Programming for Road and Rail Noise Impact Evaluation'.

This paper dealt with the often incurred and difficult problems of predicting the combined effects of road traffic and railway noise. It presented an algorithm, suitable for use on a HP41C pocket calculator, which combined prediction methods used by the Ontario Ministry of the Environment and the Ontario Central Mortgage and Housing Corporation. The algorithm contained techniques for predicting the separate or combined effects of road and rail noise and included the interesting additional option of allowing for the effects of train whistle noise. Usual parameters such as traffic volume, speed and local topography were required to run the program which predicted LEQ(1 hour).

The algorithm used search routines to determine the source to receiver distance from any combination of road and rail sources. It was designed to predict the location of a requested LEQ noise level from sources which may consist of any number of railways and roads that bound a site on two non-parallel sides. Having obtained several such locations, a LEQ contour may be drawn. The authors then described a more extensive FORTRAN program, for use on a mainframe computer, which will automatically produce LEQ contours from any combination of noise sources surrounding a given site. Results presented showed that a satisfactory result may be obtained from the programs, which provide a ready solution to a somewhat complex problem.

S. Birnie, S.M. Taylor and F.L. Hall. 'Annoyance due to General Aviation Noise.'

This paper was of interest as it demonstrated the almost universal difficulties and frustrations associated with determining community annoyance to various noise nuisances. In this case the annoyance was related to the operation of light aircraft around three small airports in Canada. The survey took the form of 'open-ended in-depth interviews' and was designed to determine, among other things, 'the causes of annoyance and actions taken in response to noise'.

However, only 30 interviews were conducted, and with such a small sample size statistical inference from the data was impossible. Even so, the interview results did indicate that noise was the major factor which annoyed respondents, particularly when it was associated with aircraft manoeuvres that were either known or felt by the respondents to be illegal.

The value of this paper lay not in its conclusions or in its insight into aircraft noise annoyance, but in its interviewing technique used to determine respondents' real reactions and opinions. Open ended interviews are gaining in popularity at the moment, since it is felt that detailed discussions with an individual provide a better estimate of his real opinion than is obtained when he merely completes a multi-choice answer style of questionnaire. This was apparent in several of the paper's examples, particularly in those difficult 'grey' areas where respondents find themselves annoyed some of the time yet not at all annoyed on other occasions. It is the variable response in these areas which has frequently confounded previous traffic noise/ annoyance studies and thus this open ended interview has much to commend it in future such studies.

G. Migneron. 'Simulation Ultrasoninque de 'l' impact Acoustique des Autoroutes'.

This interesting paper was made even more so by both its written and oral presentations being given in French. Migneron assured me (in fluent English) that an English version of the paper will appear shortly in the Journal of the Acoustical Society of America.

The paper described, in some detail, an impressive and extensive laboratory facility in which road traffic noise and all its attendant generation and propogation parameters may be accurately simulated. A scale model of a freeway or highway with its surrounding landform, buildings, trees and vegetation was set up in the acoustically treated laboratory. A moving array of specially designed loud speakers on the scale roadway emitted signals which simulated traffic noise. Migneron outlined the lengthy procedures for calibrating these speakers and for checking that important parameters such as vegetation absorption have been scaled correctly. Data given in the paper showed very good agreement between noise levels and time histories measures alongside a freeway in Quebec City and noise measured in the laboratory scale model of this same roadway.

The procedures of Migneron obviously represent a significant advance in the art of laboratory modelling of traffic noise, which has to date frequently suffered from poor technique and thus has often been unreliable and inaccurate. More importantly, these new procedures have been shown to be well suited to the task of evaluating alternative noise reduction design strategies.

F. King. 'Acoustical Model Measurements for Double Barrier Barriers'.

A double barrier is an unusual and rarely used procedure of having two barriers on the same side of a roadway. These barriers would be in the order of 4 m high and separated by 1 to 3 m. King attempt to evaluate the performance of such barriers using both an analytical approach and 1/30 scale laboratory modelling procedure. This modelling was by no means in the same category as that of Migneron. It merely consisted of a stationary loud speaker in an anechoice chamber emitting signals which were received, on the other side of the scaled barrier, by a microphone which was connected to appropriate signal conditioning instrumentation.

King's results indicated that the double barrier generally provided a marginal improvement over the single barrier. This was not always the case, and in some examples where the barrier separation was increased, the ground effects induced by varying ground vegetation had a significant degrading effect on the double barrier performance.

Stephen Samuels

NEW PRODUCTS

NEW NOISE CONTROL CATALOGUE

NAP (Aust) Pty. Ltd., has released a new catalogue detailing the performance of its range of Dingo Duct Silencers.

The 8 page catalogue gives full technical descriptions of these silencers which are used for noise control in ventilation systems, acoustic enclosures, process plants, blowers, fans and on cooling towers.

Used in commercial applications or heavy duty industrial applications such as power stations, chemical plant or steel mills their accurate airflow and acoustic performance and long life construction permit optimum selection for cost effective noise control.

The Dingo Duct Silencer catalogue is available free of charge through NAP (Aust) Pty. Ltd., Melbourne (03) 786 9533, Sydney (02) 647 1633 or NAP's accredited agents in all other States.

DIGITAL CASSETTE RECORDER

The Digital Cassette Recorder Type 7400 developed by Bruel and Kjaer offers a new solution to the problem of recording digital outputs from measuring instruments in a compact and reconstructable form. Up to 500 kbytes of data, transmitted over the IEC/IEEE or B&K low-power interface bus, can be recorded on a standard digital tape cassette and then reconstructed on the bus at a later date. The 7400 incorporates full manual and remote control, and the recording formats used meet ECMA 34 and ECMA 41 (basic system).

Since the recorder can be manually as well as remotely controlled, it can be used independently of an IEC/IEEE controller, in recording/reading data in the field. A 4-digit tape location display always indicates the position of the tape, and a handy search function can be used to speed the retrieval of recorded data. Here, the location of the required data is entered into the 7400, which then makes a rapid search through the tape for that location. The data standing at the location may then be read over the interface bus, or new data recorded. Remote control of the 7400 is over its interface, which is compatible with IEC 625-1 and IEEE Std. 488.

Since the recorder meets the ECMA standards, cassettes recorded on it can be read by ECMA compatible computer terminals, and vice versa. The recorder can record/read data at 1000 bytes/second (average) with a tape speed of 15 ips. Sophisticated error-checking procedures are incorporated to ensure the integrity of recorder/read data. The search speed is 30 ips, and the rewind speed is approximately 100 ips.

HUMAN-RESPONSE VIBRATION METER

An entirely new area of vibration measurement, concerned with the effects of vibration on the human body, is opened up by the latest instrument from Bruel & Kjaer.

The Human-Response Vibration Meter Type 2512 is designed to carry out frequency-weighted measurements, in accordance with current standards, of both whole-body (including motion sickness) and hand-arm vibration. From these measurements, the equivalent continuous vibration level and the vibration exposure are calculated and compared with the appropriate criterion, which is pre-selected from a number of recommended criteria stored within the instrument. The measurement's maximum peak value, its equivalent continuous vibration level, and the current exposure (in % of that allowed), as well as the elapsed time, are available on the digital display at any time.

The instrument is fully portable, being powered from internal batteries; and used with B & K Uni-Gain accelerometers or the special Triaxial Seat-Accelerometer Type 4322 (for measurements on seated subjects), the 2512 forms a compatible calibrated system which is easy to set up and straightforward to use in the field or in the laboratory. It is therefore especially suitable for measurements on all types of vehicles, and on hand-held power tools. Results can be output digitally via an IEC interface e.g. to an Alphanumeric Printer Type 2312 or in analogue form to a Level Recorder Type 2306, to obtain hard copy of results in the field.

PORTABLE TAPE RECORDERS

A new generation of portable tape recorders for combined field and laboratory use are introduced by Bruel & Kjaer.

They are low-weight, attaché case size instruments which accept standard 7 inch spools of professional recording tape and are especially designed for multi-channel instrumentation recording of sound, vibration and other analogue signals in the frequency range from DC to 60 kHz.

Both the 7005 and 7006 have a self-contained, rechargeable, battery pack and feature a range of easily interchangeable plug-in units, enabling any combination of up to 4 IRIG wide-band FM and intermediate band direct record-reproduce channels to be obtained. Two tape speed settings of 1,5 and 15 in/s may be chosen, which for accurate and stable mobile use of the recorders are obtained using a phase locked, servo controlled, differential capstan drive. In addition a post record flutter compensation mode may be selected.

SUSTAINING MEMBERS

The Society values greatly the support given by the Sustaining Members listed below and invites enquiries regarding Sustaining Membership from other individuals or corporations who are interested in the welfare of the Society. Any person or corporation contributing $200.00 or more annually may be elected a Sustaining Member of the Society. Enquiries regarding membership may be made to The Secretary, Australian Acoustical Society, Science House, 35-43 Clarence Street, Sydney, N.S.W., 2000.

ACI FIBREGLASS PTY. LTD.
P.O. BOX 57, ST. PETERS, NSW, 2044

AUSTRALIAN GENERAL ELECTRIC LTD.
86-90 BAY ST., ULTIMO, NSW, 2027

AUSTRALIAN GYPSUM LTD.,
350 LATROBE ST., MELBOURNE, VIC., 3000

B.P. REFINERY (KWINANA) PTY. LTD.,
MASON ROAD, KWINANA, WA, 6167

BESTOBELL ENGINEERING PRODUCTS,
55 FALCOLN STREET, CROWS NEST, NSW, 2065

BRADFORD INSULATION INDUSTRIES PTY. LTD.
74-76 BURWOOD ROAD, BURWOOD, NSW, 2134

BRUEL & KJAER AUSTRALIA PTY. LTD.
33 MAJORS BAY ROAD, CONCORD, NSW, 2137

CRA SERVICES LTD.,
95 COLLINS ST., MELBOURNE, VIC., 3000

C.S.R. LIMITED,
BUILDING MATERIALS DIVISION, GPO BOX 483, SYDNEY, NSW, 2001

CEMAC INTERIORS,
A DIVISION OF CEMAC INDUSTRIES PTY. LTD., 9 GERTRUDE STREET, FITZROY, VIC., 3065

G.P. EMBLETON & CO. PTY. LTD.,
23 NANCARROW AVENUE, RYDE, NSW, 2112

HARDBOARDS (AUST.) LTD.,
P.O. BOX 467, NORTH SYDNEY, NSW, 2060

JAMES HARDIE INDUSTRIES LTD.,
G.P.O. BOX 3935, SYDNEY, NSW, 2001

JOHN LYSAGHT (AUST.) LTD.,
P.O. BOX 77, PORT KEMBLA, NSW, 2505

NYLEX CORPORATION LIMITED,
NEPEAN HIGHWAY, MENTONE, VIC., 3194

PEACE ENGINEERING PTY. LTD.,
8 FITZPATRICK STREET, REVESBY, NSW 2212

PICTON HOPKINS AUSTRALIA PTY. LTD.
138 BELL ST., PRESTON, VIC., 3072

QANTAS AIRWAYS,
70 HUNTER STREET, SYDNEY, NSW, 2000

RANK INDUSTRIES AUSTRALIA PTY. LTD.
P.O. BOX 632, CHATSWOOD, NSW, 2067

SOUNDGUARD PTY. LTD.,
34 PUNCH STREET, ARTARMON, NSW, 2064

THE CHADWICK GROUP,
292 BURNS BAY ROAD., LANE COVE, NSW, 2066

WARBURTON FRANKI PTY. LTD.,
199 PARRAMATTA ROAD, AUBURN, NSW, 2144

INFORMATION FOR CONTRIBUTORS

Items for publication in the Bulletin are of two types

(a) Shorter articles - which will appear typically under the heading 'News and Notes'

(b) Longer articles - which will appear as refereed technical articles.

The closing dates for the receipt of these articles are as follows:

Vol. 9 No. 3 Longer articles: Mid September; Shorter articles: Mid October.
Vol. 10 No. 1 will not be published in Victoria.

Articles may be sent directly to the editor or via the local State Bulletin representative.

There are no particular constraints on "shorter articles" except that they should be of relevance to the Society and be received on time.

Attention to the following matters will assist when processing "longer articles".

(i) Length - typically from 3 to 4 pages when printed.

(ii) Title and Authors Address - the title should be concise and honestly indicate the content of the paper. The author's name and that of his organisation together with an adequate address should also appear for the benefit of members who may wish to discuss the work privately with the author.

(iii) Summary - The summary should be self contained and be as explicit as possible. It should indicate the principal conclusions reached. That should be possible in less than 200 words. Many more members will read the summary than will read the paper. Everybody seems to be busy these days.

(iv) Main Body of the Article - This should contain an introduction, and be followed by a series of logical events which lead finally to the conclusions or recommendations. The use of headings greatly assists the reader in following the logic of the paper. The conclusions should of course be based on the work presented and not on other material.

(v) References - Any standardised system is acceptable - for example those used by Journal of Sound and Vibration, Journal of the Acoustical Society of America, or The Institution of Engineers, Australia. Page numbers and dates are important, particularly when referencing books.

(vi) Tables and Diagrams - As a general rule, Tables are best avoided. Diagrams may need to be redrawn during the editorial stage. They ought to be totally self explanatory, complete with a title, and with axes clearly labelled and units unambiguously shown.

The papers generally will be subject to review but this is not intended to discourage members. The author no doubt would prefer to have any anomaly drawn to his attention privately rather than to gain notoriety by having errors published widely.