THE BULLETIN

OF THE

AUSTRALIAN ACOUSTICAL SOCIETY

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C O N T E N T S

FROM THE PRESIDENT

This represents the first of what I hope will be a continuing series in the Bulletin and I wish to begin it by extending to all members of the Society my warmest wishes for a successful 1976.

Since its formation, the Australian Acoustical Society has grown rapidly until today it has 300 members drawn from many disciplines, including architects, engineers, physicians and physiologists. It is a vigorous society which sponsors and co-sponsors a variety of activities at both the National and State levels. At present, it has three State Divisions - New South Wales, Victoria and Western Australia - and it is anticipated that South Australia will be ratified as the fourth State Division at the next meeting of Council in February, 1976.

The credit for the formation and subsequent success of the Society belongs to many dedicated and hard-working people. In particular, I would like to acknowledge the contributions made by:

Vivian Taylor, the foundation President and Peter Knowland, the immediate past-President, both of whom led the Society with distinction;

Ron Barden, former Chairman of the Victoria Division and former Councillor, who in so many ways contributed to the formation and development of the Society;

Graeme Harding, Chairman of the Victoria Division and Councillor, who has been responsible for structuring a great number of the Society's administrative procedures;

Anita Lawrence, immediate past-Chairman of the New South Wales Division and former Councillor, who contributed substantially to the Society's Memorandum and Articles of Association;

and Jack Rose, Convenor of the Society's International Congress of Acoustics Organising Sub-Committee and former Councillor, who has contributed substantially towards gaining recognition of the Society overseas.

Recognition by acoustical societies in other countries has brought with it the responsibility for hosting the tenth International Congress of Acoustics (I.C.A.), to be held in Sydney in 1980. This is a considerable honour for the Society and will require the unstinting support of all members to ensure its success. Much of the support required is financial and, to assist towards this, Council has found it necessary to place an annual levy on all members, effective from June 30, 1976. While this levy, which is currently $5-00 and subject to annual review, will effectively increase subscription rates, the benefits to all members from the tenth I.C.A. will be so substantial that they will more than offset this increase.

In addition to hosting the I.C.A. in 1980, Council is currently assessing the feasibility of co-sponsoring a Pan-Pacific Journal in association with the Japanese Acoustical Society and of becoming a member of the International Institute of Noise Control Engineering.

Apart from the Society's activities, acoustics work within the community appears to have continued to expand during 1975 despite the downturn in the economy generally and in the building industry particularly. This expansion has been caused partly by the increasing demand for adequate environmental management and the consequent attempts by governments to provide adequate legislative controls. During 1975, most States have been particularly active in noise control legislation and the long awaited New South Wales Noise Control Act was proclaimed in December. In addition, Victoria proposed amendments to its Environmental Protection Act to extend its noise abatement powers, South Australia forwarded a noise abatement act to Parliament, Tasmania and Western Australia worked on new regulations, as well as amendments to existing regulations, under their Acts and Queensland continued to develop its draft noise control legislation. As well as this growth in legislation, there appears to have been an increased demand for the inclusion of acoustics as a design parameter in a variety of real property development.

At this stage, it seems that the increased demand for acoustics advice will continue and that to meet it with the current number of technically competent personnel within Australia could be difficult. There are few tertiary courses available here that are specific to acoustics, although the number of 'crash' or 'potted' courses appears to be increasing. Whether the latter will be adequate to meet this increased demand remains to be seen - perhaps this is an aspect the Society may like to consider during 1976.

I hope that all of you will continue to give the Society your fullest support during 1976 and that, in turn, the Society will provide you with the services and support you seek from it. If there are any particular services you would like to see expanded or initiated, please do not hesitate to contact me or the General Secretary.

Carolyn Mather
PRESIDENT

NEWS & NOTES

END OF THE YEAR TREAT FOR W.A. DIVISION

R.S. Minchin

The use of the human voice as a natural medium for conveying expressions such as surprise, distress and affection, was demonstrated by Molly McGurk and her pupils at the Christmas meeting of the Western Australian Division of the Society on 8th December, 1975.

The guest speaker, a prominent Perth recitalist and teacher, introduced her topic: "Speaking, Sound and Song" with a short talk about the characteristics of the human voice and some of the techniques of teaching singing.

There followed a most delightful informal recital by 12 of Miss McGurk's pupils, illustrating the various colours in different voice combinations.

About 50 members and visitors were present, following a buffet dinner.

VISIT TO HYDROPHONE CALIBRATION FACILITY

Caleb Smith

Society members and their families had an interesting and enjoyable day at Woronora Dam on the 18th October 1975 when RANAL technical staff arranged an inspection of their Hydrophone Calibration Platform.

Without the pomp and ceremony of the Admiral's barge, guests were ferried to the Platform where a carefully guided tour of the deck (was necessary to avoid disappearing through a hatchway) and sophisticated electronic equipment of the Operations "Shack" was given by Dr Jeremy Ranicar, assisted by Mike Burgess.

The floating Platform, approximately 6 m square, is moored in 60 m of water, away from the reflecting surface of the dam wall.

Dr Ranicar described how Absolute Transducer Calibration is achieved by the Reciprocity Method on 3 hydrophones suspended at a depth well below the thermal interface, thus avoiding unwanted sound reflections.

The Direct Comparison Method of hydrophone calibration was demonstrated to us using a hydrophone sound source and 2 adjacent receiving hydrophones, one of known performance and the other for Comparison Calibration.

Quoting from notes of the day (written with toothpick and the juices of a rare T-bone), I see that signals used for both methods of calibration range from about 200 Hz through to 100 KHz at a depth of 20 - 30 m while the distance between sending and receiving hydrophones is 2 m for the Reciprocity Method and 3 m for the Direct Comparison Method.
Dr Ranicar is currently investigating the use of piston phones for future calibration checks.

Many questions were asked by the acoustically minded land lubbers and the ladies were entertained with suitable reproductions of deepwater noises, including the mating calls of ships and submarines, whales and shrimps.

The barbecue picnic that followed completed a most enjoyable day.

FIRST AUTUMN SCHOOL IN AUDIOLOGY

P.M. Grayson

The Office for Continuing Education at the University of Melbourne has commenced planning of a programme in audiology which will be sponsored by the Department of Otolaryngology, University of Melbourne, Royal Victorian Eye and Ear Hospital. The programme will be for a week and will be held end-on with the conference of the Otolaryngological Society of Australia and the jubilee celebrations of the Royal Australasian College of Surgeons in Melbourne during May 1977.

Dr. med. Ole Bentzen, Head of the State Hearing Centre, Aarhus, Denmark and Professor James Jerger, Head of the Division of Audiology and Speech Pathology at Baylor College of Medicine, Houston, Texas have both accepted invitations to contribute to the programme. The School will provide a varied programme of lectures, demonstrations, practical classes and seminars over the range of specialist areas of audiology. The School will also provide opportunities for participants to gain practical experience in the areas of most interest to them, through sessions at the Royal Victorian Eye and Ear Hospital, the Royal Children's Hospital, the National Acoustics Laboratories of Victoria and the Victorian Department of Health.

The Planning of the School will be completed during 1976 and prospective participants are invited to write to Professor G.M. Clark, Department of Otolaryngology, University of Melbourne, Victoria. 3002, about any matters of special interest to them.

Notice of course on Environmental Acoustics

A graduate course on Environmental Acoustics (M 3.38) will be given in the Department of Mechanical Engineering, University of Sydney, during the first half of 1976. The course will be given by Professor Malcolm Crocker and outside specialist lecturers from 5.15 pm to 7.20 pm on Wednesday evenings, from March 10th to July 28th.

The course will include:

Fundamentals of acoustics, measurement of noise, aerodynamic noise, aircraft noise. Wave propagation in finite acoustic media, vibration of standard members, acoustic coupling, random noise transmission, energetics. Physiological effects of noise, industrial noise, exposure indices, community noise measurement and criteria, transportation noise. Legal and practical problems of noise legislation. Case-study seminar.

Lectures will be held in Tutorial Room 2, Level 2 of the Mechanical and Aeronautical Engineering Building, Shepherd Street, Darlington. Entrance opposite Ivy Street.

The course may be taken by anyone who is interested or may be included in a programme of work leading to the degree of M.Eng.Sc.

Applications for enrolment to the course should be in writing giving full name, qualifications and a brief summary of experience. They should be forwarded together with the course fee of $40.00 (cheques payable to "The University of Sydney") to Dr. L.F. Henderson, Adviser to Graduate Students, Department of Mechanical Engineering, University of Sydney, Sydney, N.S.W., 2006, (Telephone: 660 0522 Extn. 2288 or 2341) from whom further information may be obtained.

W.A. SYMPOSIUM ON ROAD TRAFFIC NOISE

A successful symposium on Road Traffic Noise, attended by about 30 people, was held at Murdoch University on November 12th, 1975. The papers presented at the Symposium will be published in forthcoming editions of The Bulletin.

UNIVERSITY OF N.S.W. SYMPOSIUM ON NOISE

David Eden

The University of N.S.W. conducts each November a symposium on a topic to which the University feels it can contribute.

The 1975 Symposium was on "Noise", a topic made controversial since the N.S.W. Government's "Noise Control Act 1975". The following covers brief details from the papers and contributions from the audience.

The opening address was presented by the Hon. Sir John Fuller, Minister for Planning and Environment, who gave a history of the recent N.S.W. noise legislation, and a summary of its provisions. He expressed the attitude that he would rather have people voluntarily reduce noise levels than resort to a rash of prosecutions.

The morning sessions covered what noise is and how it affects the individual and the community. Speakers included Assoc. Prof. Howard Pollard who demonstrated various physical characteristics of noise and Prof. Laurence Brown who reviewed social and psychological studies showing how limited we are in coping with or trying to reduce noise.

Assoc. Prof. Anita Lawrence discussed sources of noise and its impact on the community. Dr. Zula Nittim discussed noise in a town planning context, touching on the usefulness of noise levels for ranking perceived satisfaction in suburbia and the way social pressures can reduce the number of complaints.

Mr. Horrie Weston expressed the view that hearing conservation limits should be set by legislation with built-in requirements that lower limits will prevail at a given time in the future.

The afternoon session covered legal aspects of noise control. Mr. Julian Disney explained in some detail the N.S.W. legislation, pointing out that "the public will" is important if the legislation is to succeed and that previously existing law has not been used as much as it could have been. Dr. Robert Hayes in his address pointed out that in cases of public nuisance affecting whole communities there remains a need for further legislation to permit private legal action in the public interest, rather than leaving control of these problems exclusively to governments who may not choose to act.

Mr. Ken Buckley covered the issues of civil liberties versus control of noise. Two audience members said that people who want to should be allowed to make as much noise or rock-music as they like and that we don't often hear demands of this type because these people are not politically organised. Ald. Jeremy Bingham spoke on his experience in noise abatement and complaint reduction using public relations techniques.

Dr. Carolyn Mather described West Australian experience with their Noise Abatement Act 1972, explaining changes they have found necessary to allow for generally lower ambients in W.A. than suggested by AS 1055-1973 "Noise Assessment in Residential Areas".

Those representatives of the Australian Acoustical Society who attended would like to thank the University for making this contribution to the understanding of noise and noise control.

VISITING PROFESSOR

Professor Malcolm Crocker will spend seven months in Sydney (January to July 1976) on sabbatical leave from Purdue University in Indiana, U.S.A.. Professor Crocker is a world renown figure in the field of noise control.

Other acoustics activities in which he is engaged are editorship of Noise Control Engineering and co-directorship of the International Institute of Noise Control Engineering. He has also served on numerous professional society and standards committees concerned with noise and vibration.

Professor Crocker who is a Fellow of the Acoustical Society of America and member of the British Acoustical Society, is the author of over fifty technical papers on acoustics, the author of one book on Noise Control and the Editor of another two.

While in Australia, Professor Crocker will be taking part in acoustics teaching and research activities in the Department of Mechanical Engineering at Sydney University and the University of N.S.W..

CENTREPOINT TOWER

Richard Heggie

Several members of the Society recently attended a very interesting Address entitled "Design and Construction of the Centrepoint Tower." The Address was presented by Mr. Alex Wargon (a partner of Wargon Chapman and Associates Pty. Ltd.) to a meeting of the Civil Engineering Branch of the Institution of Engineers (Sydney Division).

Mr. Wargon briefly outlined the design concepts and methods of construction, and went on to deal in some detail with the dynamic problems associated with such a tall, slender structure.

The tower comprises a 7m diameter slotted steel tube housing lifts, stairs and services. It is constructed in weathering steel and is guyed by 56 parallel wire cables forming one sheet of hyperboloid of revolution. The tower is surmounted by a seven storied turret approximately 30 metres in diameter. On completion, the Centrepoint Tower will reach a height of 300m above sea level, and be a major feature of the Sydney skyline.

The fundamental period of natural vibration of the complete tower structure is 6.7 seconds. The strength design criteria accommodate wind loads which occur over a 1000 year return period, and based on 1.2% g acceleration as the threshhold of perceptibility (90% pop.), it is expected that perception of movement will be possible on 5 to 7 occasions per year.

In order to comply with Fire Regulations, it was necessary to include a 160,000 litre water tank in the top section of the seven storey turret. This mass of water also functions as a dynamic damping system to significantly reduce the amplitude of wind-induced vibration in the tower.

The water-tank is suspended by a set of cables from the roof of the turret, and is therefore free to move in relation to the tower/turret structure. The fundamental period of oscillation of the suspended tank is equal to that of the tower itself. Wind induced vibrations in the tower therefore result in an out-of-phase movement of the tank, thereby opposing and damping vibration in the tower.

Mr. Wargon pointed out that perception of vibration is proportional to structural acceleration at very low frequencies. Stiffening a structure to reduce the amplitude of vibration therefore tends to be self-defeating with respect to human perception and comfort criteria. The stiffer structure has a higher natural frequency, and although the amplitude of vibration is reduced, the acceleration and perception of movement remains relatively constant.

PUBLICATIONS HELD BY THE SOCIETY

Publications have been received by the Society for many years and usually kept with the correspondence file. In the past few months, following I.C.A. activity, there have been three requests for The Bulletin on an exchange basis for other Journals.

Ray Piesse has kindly offered space in the library of the National Acoustics Laboratory in Sydney. The publications, clearly marked as the property of the Society, will be filed in a special section of the library. The following have been placed, or will be placed in the library:

Journal of Acoustical Society of Japan
- mainly Japanese with English abstracts
- from 1975

Journal of Technical Physics (from Poland)
- published quarterly in English
- from 1976

Archiwum Akustyki (from Poland)
- published quarterly in English
- from 1976

Reports which arrive at irregular intervals will also be placed in the library including:

OCDE - OECD Report on Environmental Impact of Airport Development, Paris 1974

O Som ... Esse Desconhecido by Jose Antonio Hernando (Portuguese)

MARION BURGESS
Hon. Secretary
N.S.W. Division

MSc(Acoustics) University of New South Wales

A part-time course leading to the degree of MSc(Acoustics) is conducted by the Faculty of Architecture, with the assistance of the School of Physics. The course is designed for graduates in architecture, engineering or science who wish to specialize in acoustics and it is suitable for those who wish to practise as acoustical consultants, or who wish to work in acoustics in industry, research establishments or in larger architectural or engineering offices.

The first year of the course consists of a basic study of acoustic theory, the ear and hearing, sound sources, including machinery, speech and music, acoustic measurements and instrumentation, and community noise. In the second year of the course some specialisation is possible, and in addition to formal coursework in noise control, auditorium acoustics and advanced physical acoustics, graduate projects may be chosen over a wide range of acoustical topics.

Graduates in engineering, science or architecture holding four-year degrees may be admitted directly into the first year of the course (which will be offered again next in 1977); graduates holding three-year degrees or their equivalent are required to complete a Preparatory Year (which is offered in 1976 and 1978) on a part-time basis, with a syllabus made-up according to topics not covered in their first-degree courses.

Further enquiries regarding the course may be made to The Dean, Faculty of Architecture. Applications for admission in 1976 should be made immediately to The Registrar, University of New South Wales.

LETTERS

AIRCRAFT NOISE

Sir,

I certainly found the articles on aspects of aircraft noise (AAS Bulletin Vol.3, No.2, 1975) by both Dr. C.E. Mather and Mr. W.L. Burke most informative.

Dr. C.E. Mather's article on the Australian Draft Standard "Building Siting and Construction Against Aircraft Noise Intrusion" was of particular interest to me.

Some 8 years ago I attempted to gain pertinent information regarding the degree of sound attenuation required by domestic dwellings for the benefit of residents under flight paths to the Sydney airport. The purpose in that instance was to provide information to a particular manufacturer of building materials on the usefulness of its products (Victorboard and Insulwool) in providing noise attenuation of aircraft noise in building construction. By monitoring aircraft noise from a house in the Leichhardt area under the North - South glide path to Sydney airport, an assessment of noise reduction effectiveness was to be carried out with and without the introduction of various acoustical treatments. Perhaps we were a little ahead of our time in view of the apparent expertise introduced in the formulation of data provided by the proposed Standard.

However, a very significant factor found at the time of my surveys in residential areas under flight paths in Sydney is that residents do not spend their entire home life indoors. Like other citizens of this fine weather city they also enjoy the conversation of their family and friends in their open houses and outdoor entertainment areas, barbecues, swimpools etc. where no acoustic correction can be introduced save siting the flight paths over uninhabited areas. For these latter reasons it is to be hoped that noise annoyance data for residents of Sydney and other fine weather airport cities will not be directly compared with those of some Northern Hemisphere poor weather city.

Yours faithfully

CALEB SMITH M.A.A.S.
34 Northcott Street
WENTWORTHVILLE NSW 2145

SOUND INSULATION – ANOMALY ?

Dear Sir,

Mark Eisner recently suggested to me that the sound insulation between rooms was greater for the peaks of noise than for the troughs, where the noise is rapidly fluctuating in level, such as occurs in general offices and music rooms.

Mark and I have now carried out some testing which indicates that there is such an effect. We used as our source some tape recordings of office noise and of a brass band, both of which gave us L_{10} - L_{90} of about 20 dB. Statistical analysis in sending and receiving rooms yielded a difference between L_{10} values that was one or two decibels higher than the difference between L_{90} values. This was done in several locations, and care was taken to avoid the influence of other sources on the L_{90} value in the receiving rooms.

Non-linearity of the sound path is a possible explanation, but we have not observed the effect when using different levels of steady random noise. Mark thinks that it may be associated with the rate of change of level, and will be doing some more tests. In the meantime I wonder if anyone has observed this effect or can explain it.

For our tests we have been using four loudspeakers in the sending room, and a single fixed microphone in each room. Statistical analysis is done with an entirely new electronic analyser designed and built for us by David Tuck. This has proved so much more useful than the equivalent B & K electro-mechanical apparatus that we are considering the development of an even better one which will yield the level of any percentile directly, as well as L_{eq}. If enough people want these the cost would be only about $2000 each.

We would appreciate any comment from members about our results, and any expressions of interest in our proposed new statistical analyser.

Yours sincerely

JOHN MOFFATT
for CARR & WILKINSON

MORE ON SOUND INSULATION

Dear Sir,

I have a brief comment on John Moffat's letter regarding sound insulation and rapidly fluctuating sound levels. Although we have not carried out the type of testing referred to I think that some of our experience in measuring sound attenuation of building envelopes against road traffic noise may be relevant.

Briefly, we have carried out simultaneous, synchronised recordings of traffic noise outside and inside buildings, for later laboratory analysis. The various L values are obtained by a computerised curve-fitting programme (so that no assumptions need to be made about the statistical distribution of the noise source). Usually, there is some variation in the level differences obtained according to the L value used, both for A-weighted and one-third octave band analyses. However, this is not surprising, since the L values only give a generalised picture of the fluctuating sound sources.

In order to determine a more accurate level-difference we have recently taken very short samples of our synchronised inside-outside recordings, using the GR Real-time analyser, so that we can be sure that the levels refer to the same noise source (e.g. a particular vehicle which peaks some 10 dB(A), or more, above the general level). However, there are still many more problems to be solved regarding location of microphones both outside and inside buildings, before a confident appraisal of envelope attenuation can be made.

Yours faithfully,

ANITA LAWRENCE
University of New South Wales
School of Architecture

It would seem probable that the difference between L_{10} *and* L_{90} *transmission loss values would also be dependent on the receiving room reverberation time. Would other members care to comment from their experience?* Ed.

SOME NEWS FROM OVERSEAS

Dear Sir

During my stay in Europe I have visited a number of research establishments and made observations on selected aspects of acoustical work in progress, particularly in France and Holland. Of necessity the notes are brief, and make no claim to be comprehensive in coverage. However, they may be of interest to your readers and, if further information is sought on the aspects described, or on other projects not discussed, I would welcome enquiries addressed to me care of ir J. van den Eijk, Research Institute for Environmental Hygiene, TNO, Postbus 214, DELFT, NEDERLANDS.

Noise From Domestic Appliances

The problems associated with the transfer of vibration to the building structure by such domestic equipment as washing machine and dish washers are under investigation at the Centre Scientifique et Technique du Batiment and are under consideration by Dr. Judith Lang of Vienna.

A test rig has been devised at CSTB consisting of a heavy concrete base on which the appliances are placed. The concrete base is supported on piezoelectric transducers that pick up the vibrations and enable an indication to be obtained of the amplitudes involved.

Dr. Lang holds the view that it is important that international uniformity with regard to test procedures be established early to prevent confusion that will otherwise arise from a proliferation of different procedures and statements of noise emission that will emunate based on the different results obtained.

Field Measurement of Airborne Sound Transmission Loss

Work aimed at devising rapid methods for the determination of sound insulation in buildings is in progress in various research organisations in Europe. CSTB has devised and tested a method using a pistol shot or fire cracker as the sound source, but has experienced difficulty in obtaining an adequately reproducible source of broad-band impulsive sound. A report on the method is available.

The first draft standard prepared for SAA technical committee AK/4 on measurement of airborne sound insulation in buildings has been submitted to members of the Research Institute for Environmental Hygiene for their comment.

Traffic Noise

How traffic noise is influenced by the many different configurations of buildings near a traffic route is under study at CSTB in model form. The scale of the models is 1:100, and the test room in which they are housed is maintained at constant conditions of temperature and humidity. Rows of sound sources operated by compressed air are used to simulate motor traffic noise and can provide a wide spectrum of from 10 Hz to 10kHz.

Extensive tests to establish the validity of the system have already been made and contract research has been undertaken for various authorities in France.

Sonic Booms

Extensive studies have been made at CSTB of the effects of sonic booms on buildings ranging from ancient monuments to modern dwelling units. Wall and ceiling constructions up to 10 m^2 to 12 m^2 can be accommodated in a test facility installed at the Grenoble laboratory of CSTB where sonic booms are simulated. The simulation is achieved by a transducer that is, in effect, a large loudspeaker driven hydraulically. The speaker is 1.6 m in diameter, weighs 120 kgm, has a minimum travel of $\pm$ 66 mm, and can provide a peak pressure in the test room of 400 Pa. The transducer has a frequency range with flat response up to 16 Hz and a maximum limiting frequency of 30 Hz.

Already a large number of wall and ceiling specimens has been tested to destruction in this laboratory.

Yours faithfully

J.A. IRVINE

CONFERENCE & SYMPOSIUM ANNOUNCEMENTS

INTER-NOISE 76

INTER-NOISE 76 will be held at the Shoreham-Americana Hotel in Washington, DC, on 5-7 April 1976 and will run concurrent with the Spring 1976 Meeting at the Acoustical Society of America (5-9 April 1976) at the Statler Hotel, Washington, DC. The conference will include technical sessions consisting of invited and contributed presentations on world-wide noise control technology and legislative developments, as well as noise clinics and an equipment exposition. Further information can be obtained from:

INTER-NOISE 76
ARL-PSU
P.O. Box 30
State College, PA 16801
U.S.A.

Telephone: (814) 863-0275

TENTH I.C.A.

At the meeting of the International Commission on Acoustics held concurrently with the 8th International Congress on Acoustics in London last year, the Australian proposal for holding the 10th I.C.A. in Sydney in 1980 was given first priority and planning has continued to consolidate this position with the main activities being the preparation of a sound financial structure, the acquisition of expertise in the running of large conferences and negotiations with other national societies to obtain the benefit of their experience and for future co-operation.

The AAS/ICA Sub-committee which was formerly attached to the N.S.W. Division has been given direct access to the Council of the Society with the right to deal directly with the Executive. The Convenor/Secretary attends meetings of the Council, a separate I.C.A. bank account has been set up and a decision was made to strike an annual levy to provide working capital for the Congress.

Contact is being maintained with two organisations whose main activity is the running of conventions and congresses with a view to their possible use in the final year before the Congress.

With the concurrence of the N.S.W. Minister for the Environment a proposal for conversion of portion of the facilities of the Royal Agricultural Society into a conference centre is in preparation and even if the present plans to use the facilities of the University of N.S.W. for our conference continue, the presence of an alternative venue will add to planning confidence.

J.A. ROSE
Secretary/Convenor

INTERNATIONAL ACOUSTICAL EVENTS FOR 1976

The International Commission on Acoustics Information and Coordination Service has provided the following information about acoustics conferences in 1976:

Austria

(a) 28-30 August 1976, Salzburg
"Annual Meeting of the Societas Linguistica Europaea"

(b) 1-4 September 1976, Vienna
"3rd International Phonology Meeting"

Czechoslovakia

(a) 5-9 July 1976, Prague, Techn. University
"15th Conference on Acoustics - Ultrasonics"

(b) 4-8 October 1976, High Tatra Mountains PARK Hotel Smokovec
"14th Conference on Acoustics - Speech Acoustics and Sound Perception"

Federal Republic of Germany

13-16 September 1976, Heidelberg
"D A G A '76 Meeting"
held by Deutsche Arbeitsgemeinschaft für Akustik

Great Britain

(a) 27-28 or
28-29 January 1976, Leeds
"Noise Legislation"

(b) 25 February 1976, NPL Teddington
"Design, Performance and Evaluation of Hearing Protectors"

(c) 24 March 1976, University of Loughborough
"Aircraft Noise"

(d) 31 March-1 April 1976, AUWE Portland
"Underwater Acoustics"

(e) 13-15 April 1976, Polytechnic Liverpool
"Spring Meeting"
(Physical aspects of nonlinearity in solids, loudness perception, acoustic imaging, noise control in buildings)

(f) 19 May 1976, Lanchester Poly., Coventry
"Construction Noise"

(g) 16 June 1976, (to be advised)
"Wave-Induced Dynamic Loads in Structures"

(h) 19-23 July 1976, Southampton
"IUTAM Symposium on Stochastic Problems in Dynamics"

Hungary

(a) 22-26 April 1976, Budapest
"VI Acoustical Conference Budapest"
- all branches of acoustics -

(b) 26-27 April 1976, Budapest
"Acoustical Problems of Light-Structure Construction in Buildings"
- Symposium

Italy

18-22 October 1976, Florence
"XIII. International Congress of Audiology"

Japan

26-31 August 1976, Tokyo
"3rd World Congress of Phoneticians"

Roumania

June 1976, Bucarest (to be advised)
"Conference Nationale d'Acoustique"
- with international participation -

Switzerland

2-5 March 1976, Zurich, Hotel International
"53rd AES Convention"
(Foreseen technical sections: new dimensions in music, sound recording and reproduction, logic application in audio, solid and air-borne vibrations, multi-channel technique, non-linear audio signal treatment, audio in the video field)

U.S.A.

(a) 5-9 April 1976, Washington D.C.
"Meeting of the Acoustical Society of America" - all branches of acoustics

(b) 16-19 November 1976, San Diego, Calif.
"Meeting of the Acoustical Society of America" - all branches of acoustics

Yugoslavia

31 May-5 June 1976, Opatija
"XX ETAN Conference"
- all branches of acoustics -

Further information can be obtained from:

1. ICA Information and Coordination Service
c/- Acoustical Commission of the Czechoslovak Academy of Sciences
Provaznicka 8, 110 00 Prague 1

or

2. Secretary
NSW Division
Australian Acoustical Society
Science House
157 Gloucester Street
SYDNEY NSW 2000

VIBRATION AND NOISE CONTROL ENGINEERING

A Conference and Workshop on Vibration and Noise Control Engineering will be held in Sydney on October 11-12, 1976. It is being organized by the Institution of Engineers' National Committee on Applied Mechanics and should be of interest to both engineers and architects.

Contributions have been invited on both vibration and noise and, in particular, the interface area concerning the relationship between vibration and noise. The programme will be announced in March 1976.

1976 IEEE INTERNATIONAL CONFERENCE ON ACOUSTICS, SPEECH AND SIGNAL PROCESSING

The 1976 IEEE International Conference on Acoustics, Speech and Signal Processing will be held at the Philadelphia Marriott Hotel on April 12-14, 1976. The conference is sponsored by the IEEE Group on Acoustics, Speech and Signal Processing and by the Philadelphia Section of the IEEE, and is the first in a series of annual conferences.

For further information:

Conference Chairman
Mr. Charles F. Teacher
Aeronutronic-Ford Corporation
3900 Welsh Road
Willow Grove, PA 19090 U.S.A.

STANDARDS REPORT

STANDARDS ASSOCIATION OF AUSTRALIA

R. NAGARAJAN

Engineer - Secretary
Standards Association of
Australia

The Association's work on acoustics standards continued to develop during the last quarter of 1975. As many as 12 meetings of various Acoustics Committees were held since the last Standards Report, included in Vol. 2, No. 2 - 1975. The Association's Acoustic Committees approved the following standards for printing:

1. AS , Laboratory Measurement of Sound Transmission Loss of Building Partitions.

2. AS 1259, Part 3, Precision Sound Level Meter for Measurement of Impulsive Sounds.

   These two standards will be available in a printed form in March/ April 1976.

   The following draft standards were also issued for public review:

1. DR 74136, Draft Code for Ambient Sound Levels for Areas of Occupancy Within Buildings. (Latest date for comment is 15 February 1975).

2. DR 74137, Measurement of Noise and Estimation of Noise Exposure from Agricultural Tractors and Earthmoving Machinery. (Latest date for comment is 15 February 1975).

3. DR 75155, Draft Specification for Electric Circulating Fans for Household and Similar Use. (Latest date for comment is 15 March 1976). This document provides for a noise rating test for fans in Appendix A.

Copies of these public review drafts are available for submitting comments, free of cost at the headquarters of the Standards Association of Australia at 80 Arthur Street, North Sydney, N.S.W. 2060 or any of their branches in capital cities and Newcastle. Members of the Society are requested to obtain these documents from the Standards Association, if they are of interest to them and to submit comments within the last date for comment.

Progress has been made by the Association's Committees in dealing with comments made on the following public review documents, issued earlier for public comment:

1. DR 74073, Method for Measurement of Noise on Board Vessels.

2. DR 74074, Method for Measurement of Noise Emitted by Vessels on Waterways in Ports and Harbours.

3. DR 74163, Draft Code of Practice for Building Siting and Construction Against Aircraft Noise.

4. DR 75060, Draft Method for Measurement of Normal Incidence Sound Absorption Coefficient and Normal Acoustic Impedance of Acoustic Materials by the Tube Method.

5. DR 75075, Draft Method of Measurement for the Determination of Motor Vehicle Noise Emission.

These public review documents have now been progressed to the postal ballot stage and it is hoped that they will be available as printed standards later in 1976.

The Association's Committees have also progressed with the following work:

1. Amendments to AS 1055, Noise Assessment in Residential Areas.

2. Draft Method for Field Measurement of the Reduction of Airborne Sound Transmission in Buildings.

3. Draft Code for Hearing Conservation (to be AS 1269).

The Association's Acoustics Committees spent considerable time in studying various International Organisation for Standardization (ISO) Draft Standards, with a view to represent the Australian view point and keep ourselves abreast of overseas developments in this field. The Association's Acoustics Committees recognise the importance of aligning our national standards in line with international standards and for this purpose participation in ISO Committee work in earlier stages of drafting standards by the Association's Committee is necessary.

BULLETIN PUBLICATION DEADLINES

Members and persons interested in the Society and acoustics are invited to submit items for publication in forthcoming Bulletins: technical articles, shorter technical notes, brief reports on current research, news of members' and Divisions' activities, letters, or any items of general interest to members.

Contributions should be forwarded to "The Bulletin, Australian Acoustical Society, c/o Science House, 157 Gloucester Street, Sydney, 2000".

Acceptance deadlines for publication are as follows:

	Vol. 4, No. 1	Vol. 4, No. 2
Full Technical Articles	6th Feb., 1976	7th May, 1976
Other Shorter Items	27th Feb., 1976	28th May, 1976

SOUND PROPAGATION IN URBAN AREAS

Robert Bullen

SUMMARY

The prediction of sound levels in urban streets is discussed, with particular emphasis on the importance of sound scattering. Some attempt is made at a theoretical description of the scattering processes involved.

Introduction

In recent years there has been increasing awareness of the problems associated with high noise levels in urban areas. The control of noise produced by high concentrations of road traffic, aircraft, etc., is a complex problem. However, here are three basic ways in which the problem may be approached:

(a) Control of noise levels at the source.
(b) Prediction, and possibly control, of the sound level resulting from a given source at some distance from it, in the presence of large built-form structures.
(c) Acoustic insulation of buildings, to attenuate external noise and ensure acceptable levels within the buildings.

Ultimately, all these approaches will be necessary. This report is concerned with the second of these.

Sound Absorption and Scattering in a Street

The fundamental problem which has been studied by most workers in this field may be stated as follows: A sound source is located in a long straight street, with high buildings on either side. ("Long" and "high" are taken to mean large in comparison to the wavelength of the sound, and are usually treated as infinite, for the purposes of theory.) The street is wide (not infinite) in comparison to the wavelength. What is the resulting sound level in the street at a distance r from the source? (Propagation into side-streets is, of course, also an important problem, but this will not be dealt with here.)

On the assumption that the street walls and ground are plane and perfectly-reflecting, it can be shown that the sound level will attenuate at the rate of 3 dB/d.d. (3 decibels per doubling of distance from the source) (1,2). However, field studies have shown much higher rates of attenuation than this - ranging from 6 to 12 dB/d.d. (3,4) (6 dB/d.d. is the attenuation rate expected in the absence of any street walls). Two possible explanations have been put forward to account for this discrepancy - absorption of sound by the street walls and the ground, and scattering of sound by irregularities in the walls.

Most workers have concentrated on the effects of sound absorption. This has been studied in detail by Lee and Davies (5) who have derived theoretical attenuation curves for a street with plane walls, and sound reflection co-efficient R, where $0<R\leqq 1$. These show an initial attenuation of 3 dB/d.d., tending to 6 dB/d.d. at large distances, for $R<1$. Although these results are in good agreement with the results of model studies designed to test them, they are not in agreement with the results of full-scale tests. In particular, under these assumptions, attenuations of greater than 6 dB/d.d. are impossible.

Lyon (6) suggests that non-specular reflection from street walls may be an important factor influencing the attenuation rate, and this idea is borne out by a model study by Lyon, Holme, Donovan and Kursmark (7), using non-planar street walls. This study showed an attenuation curve of a totally different form from those using plane-walled streets. It therefore appeared that a detailed study of sound scattering in a street could provide useful results.

Theory of Scattering in a Street

The theoretical study of sound scattering requires a different mathematical approach to that used for studying absorption. For the latter, it is convenient to regard the sound field as resulting from an infinite string of "image sources" (Figure 1(a)). For the former, it is more useful to regard it as being composed of a number of "modes" - vibrations with wavelengths longer than that of the original sound, propagating directly down the street (Figure 1(b)). The "order" of the mode is half the number of modes across the width of the street. It can be shown that these two descriptions of the sound field are entirely equivalent.

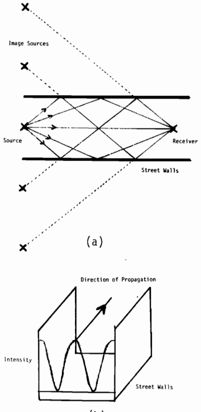

Fig. 1. Alternative Descriptions of Sound Propagation
(a) Image Sources
(b) Mode (1st Order)

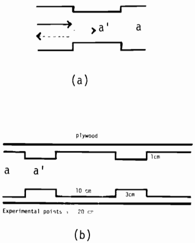

Fig. 2. (a) Change in street width
(b) Model street

When the sound source is small compared to the width of the street, high-order modes will be predominate. In this work, it has been assumed that the energy is concentrated in the mode of the highest possible order. (The order number of this highest mode depends on the frequency of the sound, and on the street width.)

An obstruction in the street may be represented as shown in Figure 2(a), i.e. as a change in street width. When a mode propagating down the street encounters such a change, it is partially reflected and partially transmitted. Under the assumption that only one mode is transmitted, and only one reflected, it can be shown that the proportion of the energy which is reflected is

$$R = \left(\frac{x_n - x_m'}{x_n + x_m'} \right)^2$$

where

$$x_n = \sqrt{1-\left(\frac{n\lambda}{a}\right)^2} \quad \text{and} \quad x_m' = \sqrt{1-\left(\frac{m\lambda}{a'}\right)^2}$$

n and m are the orders of the incident and transmitted modes respectively, and λ is the wavelength of the sound. If the incident mode is of the highest possible order, n will be the integer part of a/λ.

In a street containing a series of these steps, the sound intensity will be the sum of the intensities of direct and reflected waves. Ignoring secondary reflections, and approximating sums by integrals, the resulting intensity at a distance r from the source is

$$I(r) = I_0\{\frac{(1-R)^{r/d}}{r} + \frac{R}{2d(1-R)} E_1(-\frac{r}{d}\ln(1-R))\}$$

where $E_1(x) = \int_x^{\infty} \frac{e^{-t}}{t}\, dt$

where d is the distance between steps.

Experimental Results

A plywood model was built (Figure 2(b)), and the results shown in Figure 3 were obtained, using a sound source consisting of four crossed air-jets. The agreement between theory and experiment is seen to be quite good.

The form of these curves is consistent with those obtained by Lyon et al (5), and also with the results of Delaney's full-scale test (4). However, the absence of certain parameters in the reports of their work precludes any quantitative comparison.

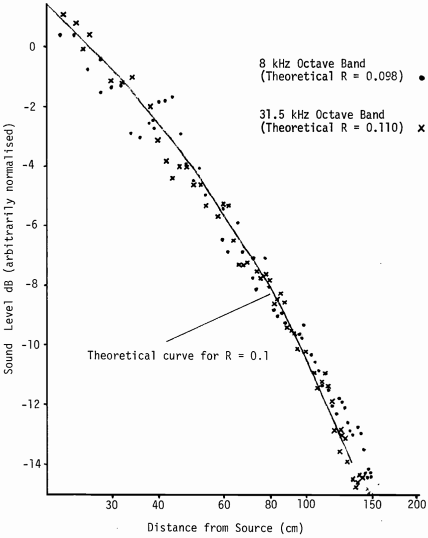

Fig. 3. Sound Attenuation Curve.

Further Work

Work is continuing on the effects of two-dimensional scattering, i.e. scattering from small protrusions rather than from lines. Preliminary results appear quite hopeful, with good agreement between theory and experiment, in most cases.

To this point, absorption by the street walls or the ground has been ignored. This could conceivably be taken into account using a more detailed theory.

Propagation into a side-street will also be a subject for future study.

Conclusion

The scattering of sound appears to play an important part in determining the way in which it propagates in urban areas. A model of a street such as Figure 2(b) would seem to be far more useful and realistic than models used by other workers for predicting sound attenuations. Thus, the general method of treating the problem described above could lead to a better understanding of the factors influencing sound propagation in urban areas, and thereby to more accurate methods of prediction and control of sound levels.

Acknowledgement

I wish to acknowledge the assistance of my supervisor, Dr Ferg Fricke, and of the technicians and staff of the Department of Architectural Science, University of Sydney, in this work.

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THE USE OF WALLS AND BARRIERS AGAINST MOTORWAY NOISE

Fergus R. Fricke

SUMMARY

The use of walls or barriers for controlling noise has been appreciated for many years. Their applicability to situations where buildings are situated near busy roads is however strictly limited by a number of factors. In this paper the results of model investigations are presented for two alternatives to the conventional barrier. These alternatives appear to offer improved acoustics, economics and aesthetics in some situations.

Introduction

The effect of walls and barriers on the attenuation of sound has, in the last few years, been well researched and documented. (This literature has been excellently reviewed recently by Kurze (1)), at least for cases where the barrier is infinite or semi-infinite in length, the source or receiver is close to the barrier and the atmospheric and ground conditions are uniform. Most of the work done has been of theoretical or model nature, though there have been some full scale tests e.g. (2).

Barriers and cuttings have been used near urban motorways in the U.K. (3) to attenuate noise but they have several shortcomings besides the fairly limited sound attenuation (8 dBA in the case of the Heston barrier (3)):

(i) They are expensive
(ii) They are often unsightly
(iii) They can be hazardous to traffic
(iv) They can cause an unacceptable amount of shading
(v) They do not protect high rise buildings from noise.

The alternatives until recently were double glazing (which still does not make the outdoor area usable and necessitates forces ventilation in many cases) or distance (this does not help those already living near busy roads). In 1973, a block of flats was completed near Newcastle-Upon-Tyne, U.K. which had an almost blank wall facing the adjoining motorway and its windows facing in the opposite direction. This is a useful advance but it still has its limitations where natural lighting and ventilation are concerned, and also, the outdoor space on the far side of such a building will still be unsatisfactory unless the building is sufficiently long or there are other buildings adjoining it.

The present work was concerned with alternative methods of attenuating sound, similar to the Newcastle idea, where barriers would be unsatisfactory for any one of the reasons indicated earlier. Two alternatives were tested:

(i) Courtyard Housing
(ii) Balconies

Each alternative was tested using isolated models in an anechoic room.

Courtyard Housing

Courtyard housing is a traditional form of housing in many countries. It has several inherent advantages over other housing types. In plan the courtyard house is a hollow rectangle. It turns windowless walls to the outside, all rooms looking inward to the courtyard from which only the sky can be seen (unless there happen to be some multi-storey buildings nearby). The courtyard house combines visual privacy with acoustic privacy (there being no windows to provide weak acoustic links between external noise sources and the house interior) to give a feeling of security and well being, or so my architect research student told me. (He also maintained that the courtyard acted as an indoor activity nucleus as well, but as I don't know what that means I had best not claim it as another advantage of this type of housing.) An example of this type of housing is given in Figure 1.

Although the advantages of courtyard housing over more conventional housing forms has been proclaimed for many years, no qualitative information, as far as I can find out, exists on the sound attenuation that can be obtained, apart from that given by Ettouney and Fricke (4).

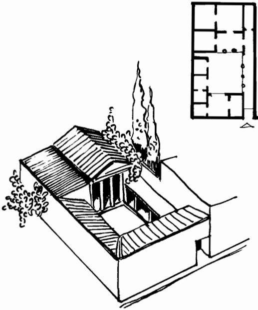

Fig. 1 An example of a courtyard house; a Greek house at Priene.

Experimental Arrangement for Courtyard House Tests

The experimental arrangement used is shown in Figure 2. In order to get results a number of simplifications had to be made:

(i) A 300 Hz bandwidth of white noise centred on 4000 Hz was used. This centre frequency corresponds to a centre frequency of 2000 Hz in the full scale. The 4000 Hz centre frequency was chosen because the source of sound closely approximated to a point source at this frequency and 2000 Hz, in the full scale, is the frequency at which the ear is most sensitive. This choice of frequency (or rather the limitation to one frequency band) is undesirable though, because road vehicle noise is predominantly low frequency in content, and this is where barriers are least effective and hence is where disturbance is most likely to occur.

(ii) A half-scale model was used. In order to obtain results in a non-dimensional form other scales would need to be tested also.

(iii) The model was isolated. In an urban environment the density of built form may be sufficient to create an appreciable reverberant field (see for example Lyon (5)).

(iv) The line joining the source and receiver was kept perpendicular to the barrier.

(v) A point source was used. This is very realistic for determining the attenuation of a child's screen but traffic noise often approximates to a line source rather than a point source of sound.

(vi) The barrier was thin which does not accurately represent a courtyard house if there are rooms on all four sides.

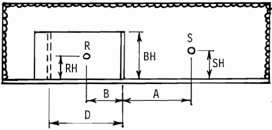

Fig. 2 Cross section of semi-anechoic room showing experimental arrangement for courtyard tests.

The absorption coefficients of the ground and walls in the model could be changed from a value of zero to a value of unity, by adding a layer of foam rubber. The height and position of the source and receiver could also be altered, as could the position of the side walls and rear wall of the courtyard.

Courtyard Sound Attenuation

Initially the attenuation of a simple barrier was obtained and the results were all within 4 dB of Maekawa's (6) results under nominally the same conditions.

The sound attenuation results are too numerous to present fully and cannot be reduced to a single universal curve, so Fig. 3 shows the effect of changing the ratio of the open area to the total area, of the rear wall of the courtyard (i.e. the porosity) from 0.25 to 1. Attenuations of 18 dB or more were obtained for a 4 kHz signal. In the full scale this attenuation would be achieved with a 2 kHz signal 6 m from the external wall of the building.

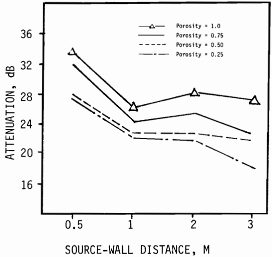

Fig. 3 Effect of backwall porosity on attenuation of sound by a courtyard. Receiver 0.5 m behind wall.

Fig. 4 shows that as the depth of the courtyard increases, the attenuation increases. There is a strange trend in these results though; as the distance of the source from the barrier is increased beyond 2 m the tendency is for the attenuation to rise again, which may well be an interference effect. The effect of courtyard depth on the attenuation of the courtyard is shown in Fig. 5.

Fig. 6 shows the agreement between experimental results and a simple theory using an arrangement of image sources.

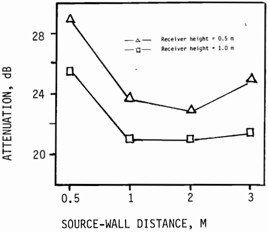

Fig. 4 Effect of receiver height on the sound attenuation of a courtyard Receiver 0.5 m behind wall.

Balconies as Noise Barriers

It is not possible to protect high rise buildings by conventional barriers at road level. In this second part of the work improved experimental techniques were used (white noise source was available which could be moved in any direction). The model scale for this work was 10:1. The idea was to determine whether balconies on high rise buildings could be built to give useful noise attenuation without intruding visually or restricting ventilation unduly.

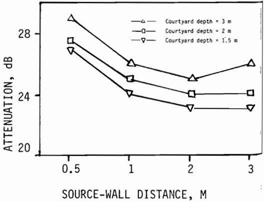

Fig. 5 Effect of courtyard depth on the sound attenuation. Receiver 0.5 m behind wall.

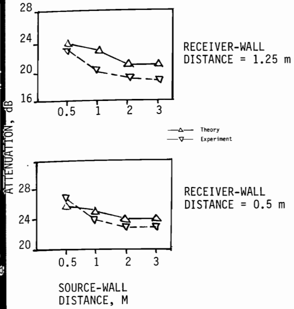

Fig. 6 Comparison of experimental results with simple geometrical theory. Courtyard depth is 1.5 m

The maximum attenuation obtainable was approximately 8 dBA (using a white noise source) as shown in Fig. 7. The trends in the results were as one would expect:

(i) maximum attenuation at the high frequencies

(ii) maximum attenuation when the source and the receiver were normal to the barrier. This has the effect of reducing the variability in level of sound from a source moving past the building, e.g. a motor vehicle. Hence the reduction in annoyance is greater than the reduction in maximum attenuation indicates

(iii) maximum attenuation when the source was close to the building.

These results were obtained with a horizontal barrier only. Extra attenuation could be obtained if vertical barriers were used on the facade of the building.

Conclusions

The two methods investigated do give improved acoustical environment. The courtyard house gives sound attenuation to

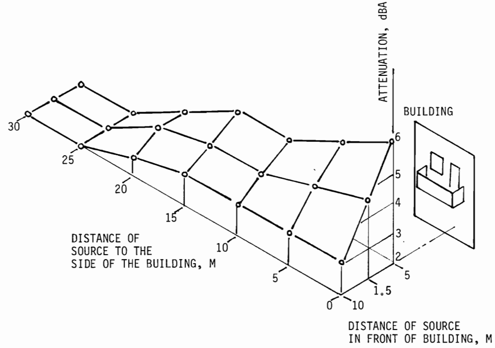

Fig. 7 Attenuation of white noise by a balcony. The attenuation, in dBA, is the difference between measurements inside a model building, with and without a balcony.

both the internal and external areas of the dwelling whereas balconies provide internal attenuation only. Balconies, though, have the advantage that they can be erected on existing buildings.

There are several extensions that can be made to the present work:

(i) Computer modelling rather than physical modelling of alternative building forms such as those already outlined.

(ii) Investigation of other building forms, especially those applicable to existing housing, and methods of attenuation of sound.

(iii) Overcoming the limitations that I outlined earlier, to provide more accurate results.

(iv) Psychoacoustical research into the value of methods such as masking and visual deprivation on the disturbance caused by traffic noise (Rettinger (7) noted that people judged traffic noise to be only half as loud when they were cut off visually from the traffic).

(v) Looking into the effects of non-parallel walls and absorption in the courtyard, especially when the source contains significant pure tone components.

(vi) Full scale measurements. The most urgent extension of this work, though, is to make architects aware of noise problems and existing methods of designing against it, which can probably best be done by building several full scale buildings.

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NOISE CONTROL PROGRAMME OF THE MARITIME SERVICES BOARD OF NSW

J.C. Hawkless

SUMMARY

The Maritime Services Board noise control programme has been approached on two fronts: firstly, the control of noise from recreational boating activities, and secondly, noise from commerical shipping and related activities.

Recreational Boating

Control of noise from recreational boating was attempted for many years through the provision in the N.S.W. Water Traffic Regulations of the requirement that all power craft must be fitted with an "effective silencer". No definition of the word "effective" was given and policing of this Regulation could only consist of ensuring that a silencer of some sort was fitted to all craft. This Regulation proved to lack effectiveness in maintaining a reasonable noise level from power boats as the boating population increased and the size of engines grew larger.

Three years ago it was clear that a more effective form of control must be implemented. It also became clear that this could only be done by specifying a maximum permitted noise level and issuing policing officers with noise level meters to test craft suspected of offending.

The first problem faced was that of determining an acceptable noise level to set as a permitted maximum. With the co-operation of the N.S.W. Water Ski Association testing was carried out on a number of craft fitted with outboard and inboard engines of various sizes. It was found that a majority of these craft had noise levels falling below 85 decibels (A scale) when measured at a distance of 100 feet. There were, however, a significant number with very high noise levels up to 105 dB(A).

It was known that 85 dB(A) had been selected by the United Kingdom Traffic Authorities as the maximum permitted noise level from motor vehicles measured at 25 feet. The level of 85 dB(A) suggested itself, therefore, as a reasonable maximum to apply. Since the Board's Water Traffic Regulations prohibit the operation of craft at speed closer than 100 feet from land, 100 feet appeared a logical choice as the distance from which this specific noise level should be measured.

It was decided, therefore, to impose this noise level maximum and to enforce it under the recently promulgated Management of Waters and Waterside Lands Regulations. These Regulations, made under the Maritime Services Act, give an officer of the Board power to impose a "stop order" on any craft which, in his opinion, was excessively noisy. The Officers were instructed to enforce this requirement if their measurements showed the noise from a craft exceeded 85 dB(A). The "stop order" prevented the owner of a craft from operating his craft until he had modified it and resubmitted his craft for another test. To overcome any objections the owner might have as to the conditions under which his craft was tested, noise test ranges were established at strategic locations to enable the testing to be done under controlled conditions.

The noise level meters used by the Board's officers comply with the relevant

Australian Standards, are calibrated by the officers using portable calibrators before and after each use, and are subjected to full calibration in a laboratory registered with the National Association of Testing Authorities once every year.

As might be appreciated, co-operation of the major water sport organisations played a large part in the success of this programme. Those organisations were kept fully informed of the Board's intentions through informal contact and at a meeting chaired by the President of the Board immediately preceding the introduction of the controls.

The success of this facet of the Board's noise control programme can be judged by the considerable reduction in complaints received of noise from speedboats over the last two years.

Commercial Vessels

The control of noise from commercial vessels is carried out through the Management of Waters and Waterside Land Regulations mentioned before and will also be carried out through the recently gazetted N.S.W. Noise Control Act.

Obviously the determination of an acceptable noise level from commercial shipping is not as straightforward as is the setting of a limit for recreational boating noise. Whereas recreational boating noise generally occurs only during daylight hours, commercial activities extend throughout the full 24 hours of each day.

We have been using Australian Standard 1055 as a basis for determining whether a noise complaint is justified and, although our experience is somewhat limited, we have found that it works reasonably well as a primary assessment. That is, as a means of determining whether a complaint is clearly justified, or clearly not justified.

The susceptibility of people to noise, particularly at night time, varies widely depending upon their psychological make-up and emotional condition. A good indication of the seriousness of a particular noise incident can be obtained from the number of complaints received.

The Management of Waters and Waterside Lands Regulations again gives the power to the Board to direct cessation of noise from commercial vessels and also gives the owner of the vessel the right to lodge an objection to the Board's action and to request an investigation of the particular noise problem by a tribunal consisting of a representative of the Board, a representative of the ship-owner, and an independent expert in the field of acoustics. This procedure is admittedly somewhat unwieldy and possibly for this reason has not yet been called into action. Nevertheless, the appeal procedure will ensure that any final decision is scrupulously fair. This must be so when the noise nuisance may be present continually for many days, but where it's enforced cessation may involve the ship-owner in the expenditure of many thousands of dollars either directly, or through loss of revenue.

The Noise Act goes one step further than this and gives the Board the power to specify the installation and operation of noise mitigating equipment. This will require the Board to obtain the necessary expertise to be able to specify the equipment and ensure its correct installation and operation. The situation is complicated, as it always is when dealing with international shipping, because commercial vessels as potential noise sources are frequently only in port for a matter of days or a week at the most. The problems of effective implementation of the powers conferred on the Board by the Noise Act are currently under consideration.

Conclusions

Regardless of any punitive powers given to authorities to enforce noise control, I would stress the desirability of seeking the direct co-operation of the creator of a noise in reducing the problem. In many cases it needs only the drawing of attention to a problem to cause action to be taken to reduce the noise if it is feasible to do so. Also, face to face and sympathetic contact with a complainant can often eliminate what might be considered an unreasonable complaint.

There is little doubt that there is still much to be learned and much to be done in the field of legislative noise control. I trust what we have done and the direction in which we are going is laying the groundwork for effective future control of this important environmental field.

SHIP NOISE CRITERIA

L.C. Kenna

SUMMARY

A logical beginning to any evaluation of a noisy environment or the identification of potential problems in that environment is the selection of suitable noise criteria. Noise criteria are essential standards of reference against which it is possible to compare existing or predicted noise conditions. Such a comparison indicates the severity of a problem and guides the selection and the extensiveness of the acoustical treatments required.

Introduction

The principal noise sources on board ships are propulsion and auxiliary machinery, ventilation services and persons aboard the ship. For passengers on ships the main noise problems are those of ensuring adequate privacy between cabins and keeping the transmission of noise from machinery spaces or due to the ventilation to a suitably low level. For the crew, similar problems arise to some extent, but there is also the problem of noise in machinery spaces. Unlike other types of workers, "occupational" noise for the crews of ships includes not only the noise to which they are exposed in the course of their normal duties, but also noise they are exposed to when off duty, in their accommodation and sleeping areas.

Criteria are required in three different areas of concern for shipboard noise, as for other types of noise. These are (i) criteria to provide suitable acoustic conditions from a comfort aspect, which is the chief consideration in the setting of criteria levels in accommodation or recreation spaces; (ii) criteria to ensure that communication by speech is possible without masking by noise in areas where such communication is essential, such as on the bridge. It is unfortunate that some of the words used as instructions in manoeuvering ships have similar sounds, for example "Ahead" and "Astern". If a misunderstanding due to noise making speech communication difficult led to the confusion of these two words, the consequences could be drastic, and (iii) criteria for maximum permissible exposure levels, so that personnel are not subject to the risk of permanent damage to hearing due to excessive noise in their working environment.

Various noise criteria have been published both for civil and for naval ships. While these levels may be compared, the requirements leading to selection of a particular level on a naval ship may be rather different from those on a merchant vessel. The naval vessels will possibly have higher powered engines in relation to the weight of the vessel than a merchant ship, and may also be of a lighter type of construction with more compact accommodation spaces. The crews of merchant vessels will spend much longer periods at sea than will the crews of naval vessels, since for economic reasons a merchant ship will be in transit for the maximum possible time.

Maximum Noise Level

The criterion level which is most easily agreed upon is that for the maximum noise level to which the ship's personnel should be exposed. This is because such levels have been widely researched and investigated in industry in general, and the same criteria can be applied to ship noise or any form of industrial noise at high levels. The criterion level which is set for a particular area may vary depending on whether the wearing of ear protection is a mandatory requirement for work in the area. However, it is desirable that the criterion be aimed at such a level that the wearing of ear muffs is not required at all. The level generally selected is one which will permit an 8 hour daily exposure without causing an unnecessarily high risk of hearing damage, which means a criterion level in the vicinity of 90 dBA. In some cases it is specified in dBA and in other cases as equivalent NR values. In this area, the naval criteria do not differ greatly from those prescribed for civil shipping. In some cases higher levels are permitted in certain areas, but with a provision that ear muffs must be worn for exposure time in such areas must be restricted or both.

Comfort Levels

For the establishment of criteria based on standards of comfort, the required noise levels are much lower than those specified for hearing conservation purposes. However, they are much more difficult to define because at the lower levels of noise human response is mainly subjective. Also the amount of annoyance or distraction which a noise produces is dependent on what level of noise could be reasonably expected. For example, it may be thought desirable that noise levels in accommodation spaces in passenger ships should be comparable with equivalent areas in hotels on land since in other aspects the environment of the ship may be similar to a hotel. Although lower levels may be desirable, somewhat higher noise levels will generally be tolerated, at least as far as noise produced by the propulsion machinery is concerned, because it will be accepted that the ship must be propelled if the voyage is to be completed. The same tolerance may not extend to acceptance of excessive noise from ventilation or plumbing services on the ship, or noise produced by passengers in adjoining cabins and passageways.

It can be argued that the criteria for accommodation spaces should not be excessively strict. This is because a lower level of noise in cabins places an increased requirement on the sound insulation required of the bulkheads separating the cabins, and separating cabins from passageways, if adequate privacy in cabins is to be ensured. Privacy may be provided either by an increase in bulkhead attenuation which may mean more costly and massive construction methods, or by a higher level of ambient noise in the receiving areas.

The rating method used for comfort

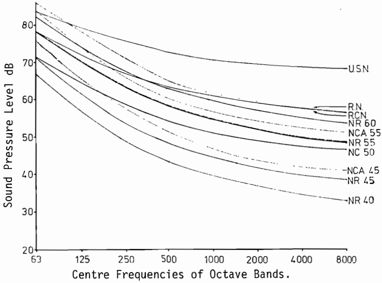


Fig. 1. Comparison of NR and NCA Ratings.

criteria is most commonly by a single number method, but this is seldom the A-weighted sound level. The rating is generally as either an NCA (Noise Criterion Alternate) number or as an NR (Noise Rating) number. The reason for selecting the NCA system is on the grounds of economy as well as habitability. As shown in Figure 1, the NCA curves permit a somewhat higher level of low frequency noise versus the middle frequencies for equal comfort rating than do either the NR or NC curves, and it is the low frequency noises which tend to be the most difficult and costly to eliminate. Rather high levels of low frequency noises are commonly present on ships due to the propulsion machinery, which for stability reasons is generally rigidly connected to the hull. Vibrations are then transmitted throughout the ship by the many paths available for vibration to travel.

The NR curves are generally specified by European organisations, and have also been used in specifications for Australian vessels. Their advantage is that they are commonly used by countries following ISO standards for all types of noise, not only ships, and also an environment whose noise spectrum follows the shape of the NR curves is generally preferred to one which follows the shape of the NCA curves, although the overall sound pressure levels may be similar.

Figure 2 shows a comparison of the different criteria which have been recommended by various organisations for accommodation spaces. It shows that levels recommended for living spaces in merchant ships are lower than those recommended for crew quarters in naval ships. The most commonly recommended figure is NR 55, but the range of recommended figures runs from NR 40 to NR or NCA 60. By comparison, the naval recommendations which are available, when fitted to NR curves, permit levels in crews quarters in the region of NR 63 to 73. The civil criteria often allow a tolerance of 5 dB above the target levels before the levels are considered unacceptable. As a contrast with these levels, a noise environment considered desirable for normal domestic sleeping areas would be NR 30, which is considerably lower than the levels accepted on ships.

In non-accommodation areas on ships, apart from machinery spaces, such as passageways, the criteria generally allow noise levels to be 10 to 15 dB higher than the figure recommended for accommodation spaces and range from NC 55 to NR 70. These figures are for civil ships as none of the naval noise categories would appear to specifically suit all passageways.

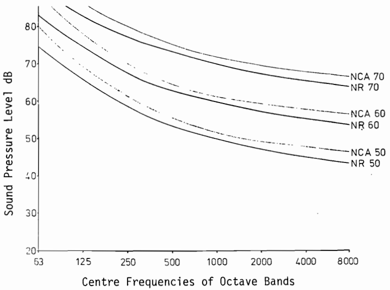


Fig. 2. Comparison of Criteria.

Communication Criteria

For the establishment of noise criteria for areas where verbal communication is essential for safety reasons, such as in the wheelhouse, the levels can be set by consideration of the likely distance over which speech communication will be required, and relating this distance to the results of research work which has been published concerned with the Preferred Speech Interference Level, which involves octave band measurement in the bands centred on 500 Hz, 1 kHz and 2kHz.

Target Levels

The target noise levels for control areas of ships, such as the bridge, are areas where the naval criteria are lower than some of the civil criteria. The naval requirements generally are for a speech interference level in the vicinity of 60, which will allow communication at normal voice levels over a distance of about 6 feet. Most of the civil criteria are in the same vicinity, but one permits levels on the bridge up to NR 75. This seems rather high, since although the actual speech interference level in this environment could be satisfactory, depending on the shape of the noise spectrum, a situation in which it was necessary to shout to communicate over a distance of six feet could be permissible using the NR 75 criterion.

Conclusions

Several of the criteria available have been checked against measurements made in ships of various ages and have been shown to be realistic. Consequently, it would appear that satisfactory levels would be:

(i) For accommodation spaces - NR 55
(ii) For bridge and other areas where communication is essential - NR 60
(iii) For other non-accommodation areas, including workshops and control rooms within the machinery spaces - NR 65.

This should include all areas where people must remain for any reasonable length of time. If required to go briefly into higher noise level areas, the normal hearing conservation procedures used in industry generally should apply.

Although these are practically achievable levels, there are reports that ships are becoming noisier rather than quieter. This is due to a number of factors in modern ships, such as:

(1) smaller but noisier main propulsion systems in larger vessels;
(2) increased quantities of auxiliary equipment;
(3) crew quarters crowded around engine rooms and above propellers;
(4) lighter construction;
(5) easy-to-clean but less absorbent cabin surfaces;
(6) high velocity ventilation systems;
(7) proportionately greater periods spent at sea.

All of these factors have been introduced for economic reasons. However, ships crews are unlikely to tolerate without complaint noise levels which could be labelled excessive. If suitably low noise levels are not designed into the ship the saving in initial construction costs may be far outweighted over the life of the ship by such possible consequences as payment of penalty rates to the crew-members, or requiring multiple crews for the ship, or attempting noise control measures on the ship after construction, which may be extremely expensive.

TECHNICAL NOTES

REVERBERATION TIME SOUND SOURCE

Caleb Smith

A small explosive device has been found to be ideal as a sound source in the determination of Reverberation Time.

The entire set up enables one person to perform all the operations involved in an R.T. measurement while standing adjacent to the sound level meter, tape recorder and R.T. source Control Button.(See Fig. 1).

Using a specially built up capsule of explosive, based on the standard detonator fuse head, a sharp sound is generated having frequency content, loudness and rise time characteristics suitable for most R.T. analysis.

The detailed manufacture of the R.T. Capsule ensures repeatability of loudness and spectral content with successive firings.

This R.T. Capsule is fired by an electric current from a dry cell battery and push button switch. The device is safe to use near an audience as no flying pellet or debris is discharged.

Alternatively, the standard detonator fuse head may be used as a simple method of remotely bursting a balloon if this sound source is preferred.

Performance characteristics of loudness and frequency content of the R.T.

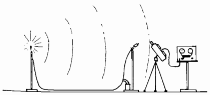
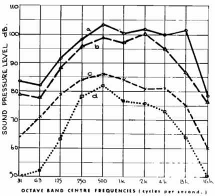


Fig. 1. Instrumentation

Capsule and for Balloons are graphically presented in Figure 2.



R.T. Cap at 10 metres
a. HMT Sydney, no audience
b. " " with audience

90 cm Balloon at 10 metres
c. Bankstown Town Hall, no audience
d. " " " with audience

Fig. 2

THEATRE ROYAL - VIBRATION ISOLATION

David Eden

This note is a summary of the work conducted by Peter R. Knowland and Associates to ensure that Sydney's new Theatre Royal would not suffer excessive vibration and noise from the Eastern Suburbs Railway located directly underneath the Theatre auditorium.

The juxtaposition of the M.L.C. tower building and the new Theatre Royal on one site left the developers with only one location for the Theatre, straddling two tracks of the Eastern Suburbs Railway between Town Hall and Martin Place stations. To ensure a successful theatre, intruding noise had to be kept to a very low level. Airborne noise was not considered to be a problem because of a separating rock thickness of roughly 4.5m. The regeneration of noise due to the auditorium structure vibrating was seen as the problem of major importance.

The following design steps were taken to vibration isolate the building from its surroundings and reduce the source of train vibration.

The major isolation is achieved by mounting the structure on high-deflection (7mm) rubber pads. Problems of stability were treated by using further pads as side restraints. This isolation alone would have reduced the train noise to a level still noticeably above the Theatre background, especially at the lower frequencies.

To enable the vibration generated by trains to be measured, the Public Transport Commission co-operated by laying to their Eastern Suburbs Railway design a short length of track in the existing city rail loop. By comparing these measurements with those taken by the British Rail Research Establishment for various different tracks, it was possible to propose a rail support system with lower vibration levels. This system used rails continuously supported on a thick cork/neoprene layer so as to reduce low frequency vibration due to the wheels rolling over sleepers.

At the time the Public Transport Commission was considering this alternative track, we proposed that the concrete on which it was to be laid should be isolated by a layer of resilient material as a further vibration barrier. Some thirty different vibration isolation tests were conducted on cork, fibreglass, mineral wool, felt, rubbers, neoprenes and other synthetics to arrive at a satisfactory material for this exacting job. Fibreglass was recommended although neoprene was eventually used.

Prior to deciding to implement both modifications to the rail track bed, a simulation of the train vibration was conducted in the particlly completed auditorium by operating four jack-picks in the tunnel and measuring vibration isolation across the building rubber footings. The isolation at that time was far less than design, due to bridging across isolation joints. Subsequent supervision and rectification led to considerable improvement in isolation.

It was expected that only by using a range of isolation methods effective at different frequencies could the end result be confidently predicted. With the opening of the Eastern Suburbs Railway still two years off, the prediction may only be confirmed earlier by further experiments.

BOOK REVIEWS

ACOUSTICS 1974

The invited lectures presented at The Eighth International Congress on Acoustics, London 1974. Edited by R.W.B. Stephens, Chapman and Hall (1975), Price: 5.00 pounds stg.

The theme of the Eighth International Congress on Acoustics was "Environmental Acoustics" which appears to include nearly all fields of acoustics, if the invited lectures are any indication. Briefly, the topics covered include sound generation, noise abatement, measurement and criteria, hearing, ultrasonic surgery, underwater acoustics, electronic applications of surface waves and psychoacoustics. The papers include literature reviews (e.g. Maekawa) kite-flyers (e.g. Bolt) and reports on particular pieces of research (e.g. Schroeder) though most are "state of the art" reviews (Johnson, Goliama, Collins, Ingerslev and Cremer). Cremer's paper is in German, Busnel's in French and the other ten are in English.

F.R. Fricke

ACOUSTIC DESIGN AND NOISE CONTROL

Michael Rettinger
Chemical Publishing Co. Inc. N.Y. 1973
562 pages. Price: Aust $32.00

This is an important acoustics text and one that will, I suspect, be almost unknown in Australia. There are three reasons why it makes enlightening reading:

(i) It contains a personal philosophy and history as well as an acoustic text
(ii) The author treats basic acoustics information in a refreshing different way to basic texts
(iii) It contains a lot of information for a designer, consultant or practician which is readily accessible.

The inclusion of personal philosophy in an acoustics text is a departure from normal practice which is fraught with dangers but, probably because it has not been tried by other authors of acoustics books, it succeeds. Rettinger makes the point in the preface that, "To prepare a collected fund of knowledge in many a science, without some personal remarks, some human note in the interpretation of the information relative to society, is to prepare a mere catalogue of facts and data". Watson makes a similar statement in The Double Helix: the more readable it is, the better it is. On the other hand, if the reader is after certain factual information, philosophical tit-bits are a waste of time and he is probably inclined to believe Alexander Flemming when he said, "If it can't be said in half a page, it is not worth saying at all".

As an example of Rettinger's philosophy-cum-history-cum-general knowledge or anecdotal approach, I quote in full one paragraph under the heading "Air Absorption" (2nd paragraph, p. 98).

"It is strange how one master teacher can foster another master teacher, and he in turn can arouse the interest of a number of students not necessarily destined to become teachers themselves, but to practice what they learned, like disciples. It might have been thus with John the Baptist, Jesus, and the apostles, and it certainly was so with Socrates, Plato, and the Platonists, as well as with Karl Marx, Lenin, and the Soviets. It was thus also with Professor Harvey Fletcher who taught Knudsen, and the many who through Knudsen became interested in architectural acoustics. Knudsen was of course a master teacher par excellence in his own right. His lectures were little

jewels of enthusiastic information, and he could extol the pleasures of acoustics almost as eloquently as those of a bottle of 1921, 1937, or 1942 Chateau d'Yquem (the "queen of all sauternes"), of a fine vintage Bernkaesteler Doctor, or even a good California zinfandel."

After giving the basic information on the Physics of Sound, Room Acoustics, Noise and Noise Reduction, Rettinger treats Room Design. In this section he treats individually the acoustic design of Hi-Fi Rooms through to High-Rise Buildings and Restaurants through to Recording Studios and Reverberation Chambers. Under "Churches" he even goes in to the design of a Drive-In Church.

As a book on fundamentals of Architectural Acoustics it is excellent. The treatment of specialised rooms and sound reinforcing systems will though, only make useful background reading for the designer. Nevertheless, for reasons explained earlier it is a book well worth while reading, especially if you are contemplating drinking Californian wines, or wish to know what Schopenhauer or Pope Pius XII said about noise.

F.R. Fricke

THE AUTHORS

Robert Bullen

Robert Bullen graduated with a BSc (Honours) degree in Physics at Sydney University in 1974. He is now enrolled for a PhD at Sydney. His paper described briefly some of the work he has done for his dissertation.

FERGUS R. FRICKE

Fergus Fricke is a lecturer in Architectural Science at Sydney University. He obtained a Ph.D. in Aero-acoustics at Monash University and subsequently held positions at the Institute of Sound and Vibration Research and Sheffield University in the U.K. and Purdue University in the U.S.A.. His present interest in acoustics centres on sound propagation in and around buildings.

JOHN C. HAWKLESS

Mr Hawkless is Deputy Senior Research Engineer with the Maritime Services Board of N.S.W.. He graduated from the University of N.S.W. with a degree in Chemical Engineering in 1962. Upon graduation he entered the oil industry where he was engaged in work associated with control of product quality and oil refinery plant efficiency testing. He joined the Maritime Services Board in 1968 in the research division of the Board's Engineering Branch which is associated with environment protection, hydraulic investigations, the technical aspects of dangerous goods handling and soil and concrete testing. Amongst other duties, Mr Hawkless is responsible for technical control of the Board's noise control programme.

L.C. KENNA

Leigh Kenna is an engineer with the National Acoustic Laboratories. He graduated from Sydney University with the degrees of B.Sc. in 1966 and B.E. in 1968. In 1974 he received the degree of M.Eng.Sc. from the University of New South Wales. At the National Acoustic Laboratories he is in charge of the Noise Evaluation Section. His work has included measurement and assessment of noise levels, advising on engineering noise control and hearing conservation, development of systems, standards and techniques for investigation of noise problems and evaluation of overseas noise measurement systems and techniques when applied to local conditions.

AUSTRALIAN ACOUSTICAL SOCIETY
INCOME AND EXPENDITURE ACCOUNT
FOR YEAR ENDED 30th JUNE 1975

EXPENDITURE			INCOME		
To New South Wales Division	1549	79	By Sustaining Members	500	00
Bulletin Costs	450.00		Levy on Victorian Division	2000	00
Travelling and Accommodation	245	10	Bank Errors	27	51
Postage and Stationery	8	26			
Bank Fees.	12	00			
	2265	15			
Surplus For Year	262	36			
	2527	51		2527	51

BALANCE SHEET
AS AT 30th JUNE 1975

LIABILITIES					ASSETS		
ACCUMULATED FUNDS					Commercial Banking Co. Of Sydney		
Balance as at 30th June 1974	395	48			Crows Nest	657	84
Add Surplus this year	262	36	657	84			
			657	84		657	84

AUDITORS REPORT

I report that I have examined the records ofr the Australian Acoustical Society for the year ended 30th June 1975, and in my opinion the above Balance Sheet and Income and Expenditure Account are properly drawn up so as to give a true and fair view of the state of affairs of the Society.

Elanora. 18th November 1975

F.J.Morton

Registered under the Public Accountants Registration Act,1945,as amended