THE BULLETIN

OF THE AUSTRALIAN ACOUSTICAL SOCIETY

Volume 4, Number 2, June 1976

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THE BULLETIN

OF THE AUSTRALIAN ACOUSTICAL SOCIETY

VOLUME 4, NUMBER 2
JUNE 1976

EDITORIAL

FEDERALISM & ACOUSTICS

The Australian community is currently enmeshed in controversy over the relative roles of State and federal responsibilities. The simplistic concept is that the decisions should be made as closely as possible to those most directly affected, and preferably by those who ultimately experience the effects of those decisions. The desideratum is that commitments for others should not be undertaken by those remote from the scene and relatively unaffected by the consequences. The AAS should clearly be thinking of how implementation of such principles may affect the issues in which it is interested; particularly this would seem to be aspects of noise control.

In recent years there has been an upsurge of interest and activity in regard to the limitation of noise for improvement of the environment, particularly in our cities. It has culminated in the enactment of legislation, and the Society has played its part both as an organisation and through its individual members. This work is far from done for there remains a great deal to be completed by way of the compilation of realistic and enforceable regulations within the coverage provided by present enabling legislation, which of necessity touches lightly on the intricate problems of a complex technical subject. There is need to consider the viability of such regulations from a national rather than a parochial viewpoint.

So many problems have arisen in other areas that there is precedent enough for the Society and its members to recognise the risks of inadequate forethought. No-one suggests that Australia will be afflicted again by regional decisions with such unfortunate results as occurred when each state went its own way with railway gauges. Nevertheless, there are aspects of noise control regulation that may lead to costly consequences if based on a multiplicity of uncoordinated local decisions.

Difficulties can clearly arise with manufactured products that are to be marketed throughout the country as a whole. It is easy to think in terms of motor vehicles not only because they are a major source of noise annoyance and are distributed nationally, but because they also are extremely mobile. Not only will they need to conform to the noise emission requirements for new vehicles (which are likely to be standardised throughout the states by reason of the interstate co-operation organised through the Australian Transport Advisory Council), but they may well have to satisfy additional vehicle-in-use tests throughout their life. Long after their initial sale they may turn up anywhere between Cape York and Cape Leeuwin.

These are the self-evident situations, and as a result are the ones most likely to receive forethought and be resolved. It is the less obvious situations that can be overlooked and for which it is likely to be difficult to gain public and political support. These include methods of measurement, test procedures, and measuring instrument performances. In the complex art of acoustics the results obtained may depend significantly on the characteristics of the measuring equipment and its method of use. The test environment can also be a major influence in acoustic measurements, which is often not the case with other physical measurements where the shape and materials of construction of the test space are usually inconsequential.

It may be quite useless, for instance, to stipulate a standard value for the sound attenuation of an item of construction required for some specific purpose throughout Australia unless there is clearly stated whether determination of the value is to be made in the field or in the laboratory, and what are the essential parameters of the procedure. Similarly, determination of the sound power of, say, a diesel engine, from which the sound levels can be derived for many different situations, requires careful specification of the conditions of measurement.

We cannot shrug off these problems by saying that standardisation on a national level is a matter for the Standards Association of Australia, and that the situation is firmly in hand. There is unlikely to be much popular support — to which even SAA must respond even if indirectly — in cases where the product may be used by only a handful of people throughout Australia. It is incumbent on the Society and its members to point out at all times the dependence of effective noise control on soundly prepared basic practices and procedures.

E. T. WESTON
Editorial Subcommittee

THE BULLETIN
OF THE AUSTRALIAN ACOUSTICAL SOCIETY

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OF THE AUSTRALIAN ACOUSTICAL SOCIETY

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FROM THE PRESIDENT

Owing to the very limited time available to me to write a column for this issue, I have confined it to a few notes on overseas events that may be of interest to members. Firstly, Inter-noise 76, which was held in Washington D.C. during April placed emphasis on noise problems associated with transportation. An interesting aspect of the conference was the use of "noise clinics" as after-dinner sessions, in which a panel led the delegates in debate on the pros and cons of various "solutions" to noise problems. The 91st meeting of the Acoustical Society of America was also held in Washington, during the same period as Inter-noise, and two joint sessions had been arranged, both of which were very successful.

Whilst in England, I attended a meeting of the Council of the Institute of Acoustics. It was of interest to me to observe the similarity of matters under consideration to those considered in our own Council meetings. However, in comparison, the Institute of Acoustics' Council meeting was of commendably short duration – but I was assured this was an exception and definitely not a rule!

With regard to the topic I am studying whilst overseas, noise abatement legislation, it is also of interest to note the similarity of many of the technical difficulties being experienced in the United States and England to those being experienced in Australia. For example, which of the many available indices will best predict the extent of noise induced annoyance being, or likely to be, experienced by communities. At present, the equivalent sound level or some modification of it, sometimes in association with an absolute maximum sound level during the night hours, is favoured and has been introduced by regulation in both the United States and England. Those involved in construction and demolition work and in the control of noise from it in the latter country are concerned that the equivalent sound level may not be the best index owing partly to the unpredictability of when given activities will occur on construction and demolition sites.

In California, a great deal is being done to limit the noise from motor vehicles by the Californian Highway Patrol. This Patrol has been involved with motor vehicle noise since the 1940s and has established stringent emission limits for new and "on highway" vehicles. Traffic streams are monitored for noisy vehicles by teams of traffic patrol officers carrying a simple sound level meter and any driver of a vehicle found to be exceeding the relevant emission limit is either issued with a work order or, in special circumstances, fined under the appropriate section of the regulations. In addition to these measures, the Highway Patrol has developed a method of test for assessing the extent of noise reduction achieved by mufflers and, from 1977, will be requiring all muffler manufacturers to market their product accompanied by a statement of performance.

I hope to report on some further aspects of noise abatement legislation in the next issue, particularly those measures being used in Europe and Japan.

Carolyn Mather

(Carolyn Mather)
PRESIDENT

NEWS & NOTES

SA OCCUPATIONAL NOISE LEGISLATION

The SA Government has passed legislation dealing with worker exposure to noise in industrial premises.

Regulation 49 – Noise Levels and Protection from Noise – is part of the Industrial Safety Code Regulations 1975, and will be administered by the SA Department of Labour and Industry.

The Regulation was gazetted in June 1975, and takes effect from 1st September 1976, so that industry has been given approximately 15 months notice of what will be required. Many companies are using this time to assess their work places and take steps to reduce noise levels where necessary.

Further information and copies of Regulation 49 are available from:

Department of Labour and Industry
Adelaide House
55 Waymouth Street
ADELAIDE SA 5000

REPRINTS OF TECHNICAL PAPERS, ARTICLES

Printed copies of technical papers, notes and articles appearing in The Bulletin are available as reprints in minimum quantities of 50. The cost per page is $7.00 for 50 copies and $9.00 for 100 copies. Enquiries should be addressed to The Editor, The Bulletin of the Australian Acoustical Society, 157 Gloucester Street, Sydney. 2000.

INSTITUTE OF ENGINEERS

The Library of the Institute of Engineers (157 Gloucester Street, Sydney) has received the following reports.

Noise

Construction site noise, by E.A.A. Akam, P. Lawson. *G.B. BRE, n CP 57/75, June 1975.*

An international survey of research into road traffic noise, by W. E. Scholes, L. C. Fothergill, *G.B. BRE, n. CP 55/75, June 1975.*

Motorway noise and barriers, by W. E. Scholes, A. C. Salvidge, J. W. Sargent, D. J. Fisk. *G.B. BRE, n. CP 35/75, April 1975.*

Quieter demolition techniques, by A.A.B. Musannif. *G.B. BRE, n. CP 66/75, July 1975.*

Noise Measurement

The measurement of noise performance factors: a metrology guide. *U.S. NBS, Mono., n. 142, June 1974.*

NOISE DOSIMETRY – NSW MEETING

Members are invited to attend an address by Mr R. S. Brief entitled 'Noise Dosimetry and Related Problems'. Mr Brief is Director of Industrial Hygiene within the Medical Department of Exxon Corporation, U.S.A.

The address commences at 4.00 pm on Thursday 30th September, 1976, and will be held in the Conference Room, Mezzanine Floor, Esso House, 127 Kent Street, Sydney. Further information and booking details are available from Phil Williams, (02) 239-4066.

PROFESSOR ATHERLEY VISIT

The New South Wales Division of the National Safety Council of Australia has announced details of a luncheon at which the guest speaker will be Professor Gordon Atherley.

Professor Atherley established the first chair of Safety and Hygiene at Aston University in 1971. He was formerly a Lecturer in Occupational and Pure and Applied Physics at the Universities of Manchester and Oxford, with a special interest in noise.

The Smorgasbord luncheon and talk will be held at the International Function Centre at Sydney International Airport on Tuesday 31st August 1976 at 12.30 pm for 1.00 pm. Applications and cheques for $9.00 should be forwarded to the NSCA Division office at 491 Kent Street, Sydney. Attendance is limited to 150 persons.

NOISE CONTROL ENGINEERING AND NOISE/NEWS

Published by the Institute of Noise Control Engineering in co-operation with the Acoustical Society of America.

The Institute of Noise Control Engineering (INCE) announced two publications for all those interested in noise control.

NOISE CONTROL ENGINEERING, initially published quarterly and now bimonthly, began publication in the summer of 1973. The first issue contains authoritative engineering articles on aircraft noise, community noise, noise in buildings and noise measurements, noise control in the textile industry, and principles of noise reduction. The second issue contains articles on noise legislation, standards, quiet jet engines, noise barriers, air conditioner noise, vehicle noise, and sound transmission. The third issue is devoted mainly to industrial and machinery noise. The fourth issue features articles on community noise in both the US and Europe, centrifugal pump noise in power plants, sound insulation, and the last in the three-part series on physical principles of noise reduction.

NOISE/NEWS is a bimonthly publication which started in January 1972. For everyone interested in noise control and reduction, NOISE/NEWS carries indepth discussions on current activities related to noise control, news of noise legislation and standards, items from the Federal Register and Congressional Record, information on recent noise contracts, lists of government noise reports, and other information.

Individuals may become Associates of INCE and receive a one-year subscription to both Noise Control Engineering and Noise/News from $30 surface mail; $42.50 air mail.

Libraries may subscribe to Noise Control Engineering for one year for $30.00 surface mail and $36.50 air mail; to Noise/News for one year for $18.00 suface mail and $25.25 air mail.

Back issues of both publications are available: $21.00 for the first four issues of Noise Control Engineering and $9.00 per six issues of Noise/News.

All prices quoted are U.S. Currency.

NOISE CONTROL ENGINEERING, 9 Saddle Rd., Cedar Knolls, New Jersey. 70927. U.S.A.

CONFERENCE & SYMPOSIUM ANNOUNCEMENTS

AAS 1976 ANNUAL CONFERENCE

The 1976 Annual Conference of the Society is to be held in Melbourne on September 17th & 18th. The theme for the Conference is, *"Progress in Acoustics 1976"*. The emphasis will be on new developments since the September 1975 Conference at Medlow Bath.

Contributions are expected from the CSIRO, Universities, Government Departments, the Standards Association and engineers involved in noise control.

The Conference will be held at the National Science Centre, 191 Royal Parade, Parkville, Victoria. The programme is as follows: ns:

Friday	6.00 pm	Informal discussions with refreshments at 7.30 pm
	6.30 pm	Annual General Meeting of the Society
	7.30 pm	Dinner
Saturday	9.00 am	Registration
	9.20 am	Opening Address
	9.30 am to 4.30 pm	Technical Sessions.

Further information:
John Moffatt,
Honorary Secretary,
Victoria Division of the A.A.S.,
National Science Centre,
191 Royal Parade,
PARKVILLE, VICTORIA, 3052

AUDITORY ASPECTS OF SPEECH & LANGUAGE

The first convention of the Australian Association of Speech and Hearing entitled, *"Auditory Aspects of Speech and Language"*, will be held in Sydney. The convention will be held in the Boulevard Hotel from the 5th to the 9th of July.

About fifty papers are to be presented including papers by guest speakers Dr. D. Ling and Dr. A. H. Ling from the School of Human Communication Disorders, McGill University, Canada. Workshop sessions and a formidable social programme have also been arranged.

Registration fees are $55.00 for members, $60.00 for non-members and $30.00 for students. The half day rate is $8.00. (Accommodation and social programme activities are extra). Registration forms should reach
1st AASH Convention
P.O. Box 391
DARLINGHURST, NSW, 2010
AUSTRALIA
by 14th June. Further information can be obtained by telephoning (02) 929-4011.

10th ICA IN SYDNEY, 1980

Planning for the 10th International Congress on Acoustics to be held in 1980 in Sydney is now well under way. Six subcommittees are to be formed to deal with various aspects of conference planning.

(i) Technical Programme
(ii) Finance
(iii) Satellite Symposia
(iv) Exhibitions and Technical Visits, General Facilities (travel, accommodation, catering, publicity and venues)
(vi) Social Programme.

Anyone having experience that may be of value to these subcommittees are requested to contact Mr Jack Rose at the National Acoustics Laboratory, 5 Hickson Road, Sydney, 2000 (02-2 0537).

VIBRATION & NOISE CONTROL ENGINEERING

The Institution of Engineers Panel on Vibration and Noise has preparations well in hand for the Vibration and Noise Control Engineering Conference (VANCE) to be held in Sydney on 11-12th October, 1976.

There will be three types of presentations at the Conference:

(i) Standard technical presentation
(ii) Workshop sessions
(iii) Poster presentation

The Conference should be of interest to practising engineers and architects and is sponsored by the Acoustical Society, the Institute of Architects and the Association of Consulting Engineers in conjunction with the Institute of Engineers, Australia.

9th INTERNATIONAL CONGRESS ON ACOUSTICS

Madrid, Monday 4th — Saturday 9th July 1977

The International Congresses on Acoustics, open to those of all nations interested in the subject, are held every three years and constitute the most important world event in this field: the last Congress took place in London, July 1974, and was attended by over 1,400 participants.

The 9th International Congress will be held in Madrid in the Palacio de Congresos y Exposiciones, an integrated building with appropriate Congress facilities. All the sessions and the equipment exhibition will take place in this building located in the main Avenue of modern Madrid which has good communications with those areas where there are hotel establishments of different types and reasonable

prices. Special accommodation in student residences will also be available.

ADVANCE PROGRAMME

Sunday 3rd and Monday 4th July:
Reception of participants and distribution of information.
Monday 4th (morning):
Opening session.
Monday 4th to Friday 8th:
Invited lectures, and scientific sessions.
Friday 8th (afternoon):
Closing session
Friday 8th (evening)
Official banquet and Folklore festival
Saturday 9th (morning):
Meetings of International Organizations and Societies.

COMPLEMENTARY ACTIVITIES

The following complementary activities will take place during the week of the Congress.

Technical visits
To research and applied acoustics establishments.

Official events
Receptions and Concerts, for participants and accompanying members, during free hours.

Ladies programme:
Conducted visits to the town, Prada Museum and Royal Palace. Opportunities will be given to attend typical Spanish handicraft, fashion and cooking demonstrations.

Excursions
One day visits to typical Castillian towns near Madrid, will be available. Special arrangements will be made for the weekend.

SATELLITE SYMPOSIA

Barcelona, Friday 1st and Saturday 2nd (morning) July: Sound Recording and reproduction.

Sevilla, Monday 11th and Tuesday 12th July: Hearing and industrial noise environments, including a special meeting on impulsive noise hazards.

As in previous ICA Congresses, specialized Symposia have been planned for the days just before and after the Congress. On this occasion Barcelona and Sevilla, two interesting cities with appropriate backgrounds for their respective subjects, will be the sites of these Symposia.

The sessions will consist of specialized lectures — 30 minutes long — followed by round table meetings.

Both Symposia will include complementary actvities and equipment exhibition.

AUSTRALIAN PARTICIPATION

The Australian Acoustical Society is particularly interested in encouraging Australian participation and attendance at the 9th ICA in Madrid. Anyone considering contributing or attending are requested to contact Mr Jack Rose as soon as possible at the National Acoustics Laboratories, 5 Hickson Road, Sydney, 2000 (02-2 0537).

ULTRASONICS INTERNATIONAL 77

Ultrasonics International 77 Conference and Exhibition will be held at Imperial College, London, England from the 29th June to 1st July 1977.

The first call for papers has been published in the January 1976 issue of the journal "Ultrasonics" and abstracts are invited from all over the world. The deadline for receipt of abstracts is 31st December 1976 and the deadline for full papers is 1st June 1977.

Brochures containing further information about the Conference are available from:
Dr. Z. Novak,
Conference Organizer
Ultrasonics International 77,
IPC House, 32 High Street,
Guildford
Surrey GUI 3 EW
England.

INTERNATIONAL EVENTS — 1976 & 1977

Federal Republic of Germany: (change of date)
20-23 September, 1976, Heidelberg
"D A G A '76 Meeting"
Contributions (to 1 April 76):
—D A G A '76—
z. Hd. Herrn Prof. Dr. F. Mechel
Grunzweig + Hartmann und Gasfaser AG
D-6802 Ladenburg, Am Hagen 2

Great Britain:

a) 17-18 September 1976, Glasgow
"Thermal, Acoustical & Viscoelastic Properties of Polymers"
Secretary:
Institute of Acoustics
P.G.C. Mylne
47 Belgrave Square
London SW1X 8QX

b) 14-17 November 1977, London
"FASE Symposium — 1977
European Noise Legislation"
The technical programme will include consideration of criteria, instrumentation, standards, laws and regulations, their nature, enforcement and effectiveness — invited speakers, discussions)
held by the Institute of Acoustics
Secretary P.G.C. Mylne
47 Belgrave Square
London SW1X 8QX

Italy:

11-13 October 1976, Rome.
4th Meeting of the Acoustical Society of Italy
—all fields of acoustics—
Associazone Italiana de Acustica
c/- Instituto di Acustica O.M. Corbino
Via Cassia 1216, 00189 Rome

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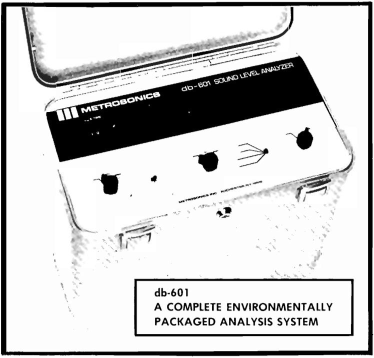

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Japan:

7-9 October 1976, Hiroshima University
"Meeting of the Acoustical Society of Japan"
—all branches of acoustics—
On both venues details from:
Acoustical Society of Japan
Ikeda Building,
7 Yoyogi 2-chome
Shibuya-ku, Tokyo

Norway

24-27 August 1976, Sanderjord
"The Acoustical Society of Scandinavia Conference"
Details from:
NAS
ELAB
N-7034 Trondheim-NTH

Poland:

13-15 October 1976, Warszawa
"76 Noise Control Conference"
(Industrial Transportation, Buildings, Community Noise, Effects of Noise and Vibration on Man, Methodology and instrumentation for noise and vibration measurements, standards, legisl.)
held by Polish Academy of Sciences, Committee of Acoustics and Polish Acoustical Society.
Secretary of Conference:
Ewa Glinska M.Sc.
Swietokrzyska 21 p.82 IPPT PAN
00-049 Warszawa

U.S.A.:

a) 7-10 June 1977, State College PA
"Meeting of the Acoustical Society of America"
—all branches of acoustics—
Chairman:
John C. Johnson
Pennsylvania State University
PA 16802

b) November 26 - December 1, 1977, Honolulu, Hawaii
"Meeting of the Acoustical Society of America"
—all branches of acoustics—
Chairman:
John G. Clark
Institute of Acoustical Research
615 SW Second Avenue
Miami, FL 33130

TECHNICAL NOTES

PERCY GRAINGER'S FREE MUSIC MACHINES

John A. Moffatt

The following technical note is a resume of a talk given to members of the Victoria Division by Mr. Burnett Cross, of New York, U.S.A.

Percy Aldridge Grainger conceived 'Free Music' as a child at Albert Park and Brighton in Victoria, before he went overseas on his successful career as a composer and concert pianist. He was inspired by the wave-movements of the sea to write music without discrete steps of pitch and without regular rhythm, and although he developed a system of notation to write the music he had to wait many years to hear it played as it was intended to be played — on a machine. The essential thing about Free Music was that it had controlled glides of pitch and loudness, and the control was to be in the hands of the composer, not those of a performer who might not be able to do exactly what the composer intended, and might even impose his own 'interpretation' on the music.

From 1945 until the composer's death in 1961 Mr. Cross worked with Grainger on the development of machines to play Free Music, and he came to Melbourne in March 1976 to assist in the reconstruction of the Free Music Machines at the Grainger Museum.

An early machine was a combination of a player-piano and three Melanette keyboard instruments. The piano was operated by its perforated paper roll mechanism, but the strings were not struck. Instead the mechanism operated the three Melanette keyboards by a system of strings and pulleys. The tuning of each Melanette was adjusted to give intervals of much less than a semi-tone. This gave an approximation of the required gliding tones, using discrete steps, but it was not good enough.

The next machine, the 'Reed-box Tone-tool', was made from a number of harmonium reed-boxes, with a close pitch spacing of the reeds. Again a perforated paper roll was used, to control the flow of air through the reeds. Air was either blown or sucked by a vacuum cleaner. The paper roll was several feet wide, and Grainger punched the holes in it as it lay on the kitchen floor. The machine was so big that it extended from one room through a doorway into the next room of Grainger's house.

The Reed-box tone-tool was better than the keyboard machine, but its glides were still only approximate. The next big step forward was the 'Kangaroo-pouch Machine', using continuously variable electronic oscillators. One machine using this method had four oscillators, the frequency and strength of each of which was changed by a variable resistor operated by a pivoted lever, the free end of which slid over the hills and dales of a control graph cut out of paper. The four pairs of graphs were fixed to a main paper roll which was over seven feet high. This machine could play properly controlled glides of pitch and loudness, but because the control levers were moved only by paper the rate of rise and fall was limited. There were problems of oscillator stability, too, and Mr. Cross observed that the machine was a good detector of the variable characteristics of thermionic valves.

The next machine was considerably better in all important respects. The music was written as inked bands of varying width on a roll of clear plastic sheet, five feet wide, and the oscillator frequency and strength were controlled by photo-electric detectors which responded to the varying transmission of light through the sheet as it was pulled through a light beam. Not only could this machine give almost any rate of rise and fall of pitch and strength, but also the composer could hear the music while he was writing it in the plastic sheet. The use of transistors in place of valves ensured the necessary frequency stability, and now Grainger could have his Free Music played as he wanted it, with glides of pitch and strength controlled by the composer.

Mr. Cross played recordings of music played on each machine, and showed us pictures he had taken of the machines, of Percy Grainger and of Mrs. Grainger. It was a fascinating evening.

Post Script: None of the machines are at present working, because parts are missing. The reed-boxes for the 'Reed-box Tone-tool' have been located in the Smithsonian Institute in U.S.A., and will be sent to the Grainger Museum. The amplifiers of the 'Kangaroo-pouch' machine are missing, as is the whole of the photo-electric machine. During his visit Mr. Cross restored the other mechanical and electrical equipment to working order. Unfortunately Grainger did not write anything other than short experimental pieces for the machines, so even when they do work there will not be much to hear, other than some fragments of Grainger's dream.

Mr. Cross' visit to Australia was funded by the Australian-American Educational Foundation, and we extend our thanks to the Foundation and to Dr. Dreyfus of the Grainger Museum, as well as to our Guest Speaker.

The Grainger Museum at Melbourne University is now open for inspection between 10 am and 5 pm except on public holidays and during University annual holidays. For many years this museum, founded by Grainger and containing many interesting documents and musical instruments, has been collecting dust. The dust is being blown away, and treasures are being discovered.

Further Reading:

'Free Music' Percy Grainger *Recorded Sound.* No. 45-46 Jan-April 1972.

'Grainger Free Music Machine' Burnett Cross. (as above).

'Free Music of Percy Grainger', Margaret Hee-Leng Tan, (as above).

'The Recorded Works of Percy Grainger', Eric Hughes. (as above).

'Grainger's Free Music', Ivar C. Dorum, *Studies in Music,* 2. 1968.

'Percy Grainger's Free Music' Richard Franko Goldman. *The Juilliard Review.* Fall 1955.

PRIORITIES IN NOISE REDUCTION

Malcolm J. Crocker

Almost every study that I have seen shows that in industrialized countries traffic noise is a bigger problem than aircraft noise. This can be demonstrated by several statistics.

A U.S. Environmental Protection Agency (EPA) report estimated that in 1970 about 15,000 kilowatt-hours of acoustic energy were generated each day by transportation vehicles in the U.S.A. Over half, or about 7,800 kilowatt-hours, were generated by road traffic (of which 5,000 were from trucks and 1,800 from cars). Aircraft contributed only about one quarter – or about 4,650 kilowatt-hours (with scheduled airliners contributing the vast majority – 4,530 of this total). Rail vehicles produced about 1,250 kilowatt-hours and recreational vehicles 1,060. Judged by the criterion of acoustics energy emitted, highway vehicles are the predominant noise source in the U.S.A., in particular medium and heavy trucks. Commercial aircraft also produce considerable amounts of noise energy but except during take-off and landing, this energy is generated away from population centres. The same conclusion may be drawn about rail and recreational vehicles. However, in contrast to aircraft, in addition to producing the most acoustic energy, trucks and cars generate much of this noise in close proximity to residential areas.

Thus it should be expected that highway traffic would be the major U.S. noise community problem on two counts: it generates the most acoustic energy; and it is generated closest to the community. This seems to be confirmed by the 1973 U.S. EPA report which estimated that 26.8 million people were exposed to a day-night sound level (L_{dn}) from road traffic noise exceeding 65dB, while only 7.5 million were exposed to the same level from aircraft operations. An L_{dn} of 65 dB usually produces widespread complaints and several threats of legal action. In a 1971 survey of 1200 residents in the U.S.A., 72% classified their neighbourhood as noisy. Of these 55% identified traffic noise as the main source while only 15% identified aircraft. Fully 12% identified voices as a major noise source!

These statistics are confirmed in several other industrialized countries by social surveys. For example, in Britain 36% of people when at home complained of noise from road traffic, while only 9% complained of aircraft noise in a 1962 study in central London. Also in Britain a large number of people have accepted one of the house sound insulation grant schemes for protection against excessive aircraft noise but have then insulated rooms facing a busy road and have left unprotected the rooms and roofs facing the airport and flight routes. In Norway in a 1968 survey, 20% of people complained about road traffic noise while only 5% about aircraft. These data tend to substantiate the hypothesis that about four times as many people are disturbed by road traffic noise as aircraft noise in most industralized countries.

Dickenson [Noise Control Engineering, Vol. 4, No. 1, 1975] has reported a recent study of the noise environment around one of England's busiest provincial airports, with aircraft movements exceeding 65,000 each year. Since aircraft noise was the motivation for the study, a system of

monitoring positions was installed under or near aircraft flight routes within five miles of the city. However the noise exposure from road traffic exceeded that from aircraft in all but a few locations! The night-weighted Community Noise Equivalent Level, CNEL, was used to evaluate noise exposure. An average of the noise exposure (over three weeks) at 45 locations under flight paths gave 72 CNEL for road traffic, 65 CNEL for aircraft and 61 CNEL for trains! None of the 45 locations was situated near motorways and all in fact were picked so as to concentrate on aircraft noise exclusively without much disturbance from other sources. Thus the effect of aircraft noise was *overestimated* and that of traffic noise *underestimated!*

Why then does aircraft noise receive the most attention in the press, radio, and televison? Why do some people complain bitterly about aircraft noise, but accept without complaint traffic noise with a CNEL of 10 or more greater? There are several answers which may be hypothesized.

Alexandre [Noise Control Engineering, Vol. 2, No. 2, 1974] reports the results of a 1970 study of French suburban dwellers. Noise from traffic and building sites was mentioned by 43% of respondents as the suburban problem they most felt like complaining about. All other nuisances: remoteness, lack of security, air pollution, poor sanitation, etc. were mentioned much less. However when people were asked what they had actually complained about the result was completely opposite with road traffic noise receiving least mention. It seems obvious. In France people realize that if they complain about poor public transportation, refuse collection, air pollution, unsuitable housing, crime, noise from neighbours, then there is usually an accessible public official to hear the complaint and corrective action is often taken. The same is not true of road traffic noise. The situation is similar in Australia, where telephone numbers are listed in Sydney for pollution complaints and for aircraft noise but none specifically for traffic noise.

There are other reasons, however. One must admit that very near an airport, the degree of annoyance may be higher than near a busy highway because the noise level fluctuates widely with time and for short times is quite intense. People living near airports are able to form protest and action groups partly because they live close to each other. In the U.S.A. such groups have been quite vigorous and some have been successful in winning damages in court cases. People bothered by traffic noise are probably too widely spread to form such protest groups easily. Also of course people are unwilling to support legislation or regulations which curtail their own 'freedom'. Since so many people drive cars, then they are more likely to be tolerant of traffic noise. A much smaller fraction of the population in most countries utilize scheduled airline services and are thus much less tolerant of aircraft noise. Perhaps some of the anti-aircraft sentiment is also due to the current anti-technology syndrome. Arguments which are often aimed at Concorde and lumped in with its noise are: 1) that it will deplete the ozone layer (despite the fact that a United Nations agency — the World Meteorological Organization (W.M.O.) has stated that the effect of using a fleet of 30-50 supersonic transports would be minimal ... the W.M.O. expressed more concern about the use of freon releasing aerosols ... but reducing their use would curtail individual 'freedom') and 2) that Concorde will help deplete the world oil reserves (again the effect is minimal ... less than one tenth of one percent of total daily Australian oil consumption even with daily Concorde flights between England and Australia ... we could all achieve much more by buying smaller cars, car-pooling or eliminating unnecessary trips ... but that would curtail our own 'freedom').

Which is the bigger community noise problem: traffic or aircraft? Is this a non-question? Some say yes. I do not think so. Aircraft noise has received prime attention for much too long. It has diverted our attention from the much more serious and difficult problem of traffic noise.

In the U.S.A., government and industry spending has been at least an order of magnitude greater on aircraft noise than road vehicle noise for many years. Congress, government agencies and state and local authorities have encouraged strict enforcement of aircraft regulations while being lax on vehicle noise regulations. A good example is New York State which has had venicle noise limits since 1965 with minimal or almost no enforcement, although the Port Authority is now threatening to ban Concorde operations.

Personally I don't like any type of noise. However I do feel that our priorities are wrong and should be changed. Where I live in Sydney, I am invariably wakened late at night and early morning by cars starting on the hill outside my house, although I am little troubled by aircraft noise even though I live near an aircraft flight path with a noise exposure forecast (NEF) of 25. Give me a daily Concorde overflight in exchange for the noisy cars at night, the power lawn mowers that can ruin a weekend, the early morning powered garbage trucks and the early morning milk truck any day.

STATISTICAL SOUND LEVEL ANALYSERS

Richard Heggie

INTRODUCTION

Statistical analysis of noise levels has long been recognised as a most useful and probably essential technique for describing time-varying noise levels. The technique has been particularly applicable in the fields of community noise assessment (road, air, rail traffic and fluctuating industrial noise) and occupational noise assessment.

Suitable instrumentation for measuring operators' exposure to noise in industry has been available for several years. These dosemeters sample the varying noise levels over a period of exposure and then calculate the single number, 'equivalent continuous noise level' which would result in the same degree of risk of hearing impairment .

In community noise assessment evaluation of statistical values (L_{10}, L_{90}, L_{50}, L_{eq} etc) and the derived indices (TNI, L_{DN}, NPL etc) has, until recently involved various manual sampling or computation techniques. Processing has been tedious, time consuming, of questionable reliability, and relatively expensive, even with computer assistance. These factors have inhibited collection of sufficient data to evaluate and establish noise level criteria and measuring techniques and caused delay in formulating standards and regulations.

At the time of writing, however, four makes of statistical sound level analyser had recently become commercially available in Australia. Table I on the following pages sets out and compares the manufacturer's specifications.

While the four instruments have similar basic features, they do differ in several significant respects. Very careful study of each instrument's capabilities in relation to a potential application is strongly recommended before making a decision to purchase.

The following discussion describes the common features of all the instruments and highlights the particular features and limitations of each instrument. The discussion is based on technical data sheets and specifications provided by the manufacturers.

MAJOR FEATURES COMMON TO ALL INSTRUMENTS

The sensitivities of the various inputs on all four instruments are generally compatible with most microphones and tape recorders.

So that they may be operated independently (i.e. without a separate sound level meter) the GR 1945 and B & K 4426 have inbuilt supply voltages for their own respective microphone and preamp systems. The CEL-134 has supply voltages for both the B & K and the GR systems. The Metrosonics dB-602 requires operational interfaces 600-09 ($333) for B & K mics/preamps and 660-10 ($141) for GR mics/preamps.

All instruments provide at least A-weighting on the low level input and Linear on the high level input. All (except CEL-134, not stated) provide FAST and SLOW averaging response in accordance with IEC 179.

Each instrument will function as a digital sound level meter and display dB(A) continuously during analysis. All provide at least the three basic L_n percentiles L_{10}, L_{50}, and L_{90} at the end of the analysis period. With the B & K and Metrosonics instruments the progressive values of the percentile levels may be displayed during the analysis period.

The GR 1945 and B & K 4426 compute L_{eq}. The Metrosonics dB-601 requires an L_{eq} option, 600-01 ($395) and the CEL-134 requires an additional instrument, the CEL-144 Noise Average Meter ($1980).

The CEL-134 operates on internal or external 24V DC batteries. The other three instruments operate on 12V internal or external batteries. All except the CEL-134 are available in a weatherproof enclosure (comes standard on Metrosonics.

The prices of the instruments in standard form (at 1/7/76) were as follows:

Metrosonics dB-602	$4056
GR 1945	$2704
CEL-134	$2138
B & K 4426	$4070

BRUEL & KJAER TYPE 4426

Additional Features:

- Impulse response to IEC 179
- Will sample 'instantaneous' level or maximum level during each sampling period – selectable.
- All L_N values L_1 to L_{99} and L_{eq} are available for display (and as electrical output in analog and digital form) both progressively during the analysis period, and when analysis is complete.
- Probability and cumilative distributions available on display (and in analog and digital form at electrical output) both during and after analysis.
- Sampling rate and number of samples independently selectable.
- Pause control to inhibit sampling without losing previous data.
- Lightweight, 2.2 kg.
- Logarithmic DC input 100 mV/dB, 0 – 6.4V for prerectified signals.

Limitations (relative to the other instruments)

- Low level input is always A-weighted. Calibration with Pistonphone not recommended because of tolerances on A-weighting curve at 250 Hz. 1 kHz calibrator required.
- 64 dB dynamic range.
- Single analysis period only with no delay times.

COMPUTER ELECTRONICS LTD. CEL-134

Additional Features:

- Both low and high level inputs are switchable A-weight or LINEAR response.
- Will store a selected L_N for up to 31 consecutive analysis periods. Internal timer to delay first analysis for up to 24 hours.
- Pause control inhibits sampling and holds all register valves. Sampling may then proceed without losing previously sampled data.
- Probability distribution available at data output in analog form (not available on front panel display).

Limitations (relative to the other instruments):

- Will not display progressive values of L_n or L_{eq} during analysis.
- Requires separate instrument for L_{eq}
- Dynamic range 63 dB.
- Limited memory capacity, 1000 samples, with maximum analysis period 1 hour.
- No cumulative distribution available

GENERAL RADIO GR 1945

Additional Features:

- Switchable A, C or LIN response on high and low level inputs.
- 100 dB dynamic range, with 14 dB crest factor.
- One, two or three consecutive analysis periods. Internal timer to delay first analysis by up to 24 hours
- Probability distribution available in analog form at data output (not available on front panel display).

(cont. page 20)

TABLE I: Comparison of Manufacturers' Specifications

Manufacturer Model No.	Bruel & Kjaer Type 4426	Computer Electronics Ltd. CEL-134	General Radio GR 1945	Metrosonics, Inc dB-602
Name	Noise Level Analyser and Statistical Processor	Statistical Level Meter	Community Noise Analyser	Sound Level Analyser
Country of Origin	Denmark	England	U.S.A.	U.S.A.
Australian Supplier	Bruel & Kjaer Aust. Pty. Ltd. 33 Majors Bay Road CONCORD, N.S.W., 2137	Tecnico Electronics, Premier Street, MARRICKVILLE, N.S.W. 2204	Warburton Franki Pty. Ltd. 199 Parramatta Road, AUBURN, N.S.W. 2144	Australian General Electric Ltd., 86-90 Bay Street, ULTIMO, N.S.W., 2007
Weighting	A weighting on low level input. Linear (0 Hz to 20 Khz ± 1 dB) on high level input.	Switchable A weight or linear	Switchable A, C or linear (+ 0.5 dB, – 3 dB 10 Hz to 25 kHz)	A weighting on low level input. Linear (10 Hz to 20 kHz ± 0.5 dB) on high level input
Averaging Response	Fast, slow and impulse response to IEC 179	Not stated	Fast and slow response to IEC 179	Fast and slow response to IEC 179
Percentile Exceedence Levels	L_1 to L_{99} in L_1 steps, available during and after analysis period.	L_{10} to L_{90} in L_{10} steps, available after analysis period	$L_{0.1}$, L_1, L_2, L_5, L_{10}, L_{20}, L_{50}, L_{90}, L_{99} available after analysis period	L_0 to L_{99} in L_1 steps, available during and after analysis period. 5 values only.
Leq	Standard, updated once per 1s. (0.1 dB resolution) during and after analysis period	Requires CEL Noise Average Meter	Standard, available after analysis period	Requires 600-01 Leq option
Sound Level Meter Display (Digital)	Will display dB(A), dB(A) Max, Leq, L_1 to L_{99}, Probability density, cumulative Probability Density, continuously during analysis period. Will hold dB(A) Max.	Will display dB(A) or dB (LIN) continuously during analysis period	Will display dB(A), or dB (LIN) continuously during analysis period.	Will display dB(A) continuously during analysis period
Dynamic Range	64 dB	63 dB	100 dB	100 dB
Detector Accuracy	± 0.5 dB	± 0.5 dB	± 0.25 dB	± 0.5 dB
Detector/Crest Factor	True RMS with 10 dB crest factor at max. reading	Not stated	True RMS with 14 dB crest factor at max. reading	True RMS with 14 dB crest factor at max. reading

TABLE I (cont): Comparison of Manufacturers' Specifications

Analysis Resolution	0.25 dB	Not stated	1 dB	1 dB
Sampling Rates and Analysis Duration	Selectable sampling period 0.1, 0.2, 0.5, 1, 2, 5 or 10s (or External). Number of samples selectable from 1000 to 65 000. Analysis duration set by selecting sampling period and number of samples. Analysis may be stopped manually. Statistical values available during and after analysis.	Analysis duration selectable 5, 10, 15, 30 and 60 minutes. Number of samples fixed at 1000. Analysis must be completed before statistical values are available.	Analysis duration selectable as follows: 0.5, 1, 2, 3, 4, 6, 8, 12 or 24 hours. Sampling rate is fixed. Divide by 3 option available to give minimum 10 minute analysis duration. Analysis must be completed before statistical values are available.	1 Sample per second standard. Optional 32 per second to 1 every 32 seconds. 6.5 million sample capacity. Statistical values are available during and after analysis.
Delay Timer, Measurement Periods	Single analysis period only with no delay timer (provision for external control of delays and analysis periods).	Up to 31 consecutive analysis periods. Internal timer to delay first analysis for up to 24 hours.	One, two or three consecutive analysis periods. Internal timer to delay first analysis by up to 24 hours	Four statistical values may be stored at programmed intervals from 15 minutes up to 25 hours (in 15 minute increments).
Standby or Pause Control	Stops sampling, holds all register values.	Stops sampling, holds all register values.	None	None
Probability Distribution and Outputs.	Available as number of samples or percent of total samples versus level (0.25 dB increments at electrical output, 2 dB increments on display). Available during and after analysis period. Analog output for level recorder or XY plotter and digital output for alpha-numeric printer.	Not available on front panel display. Statistical values are available in analog form at electrical output at end of measurement period.	Not available on front panel display. Statistical values are available in analog form at electrical output at end of measurement period.	Requires 600-05 Analog Plotter Interface and XY plotter or chart recorder. Not available on front panel display.
Cumulative Probability Distribution	Available as number of samples or percent of total samples for which sound level equalled or exceeded selected level (0.25 dB increments at electrical output, 2 dB increments on front panel display). Available during and after analysis period. Analog and digital outputs available.	Not available on front panel display.	Not available on front panel display. Digital output available with 1 dB resolution.	Not available on front panel display. Requires 600-05 Analog Plotter Interface.

TABLE I (cont): Comparison of Manufacturers' Specifications

Low Level Input	Polarisation, sensitivity and supply voltages to suit B & K mics and preamps. 50mV/Pa or 12.5 mV/Pa, adjustable + 6 dB – 4 dB.	Polarisation, sensitivity and supply voltages to suit B & K and GR mics and preamps – standard.	Sensitivity and supply voltages to suit GR mics and preamps. –35 dB to –45 dB re 1V/Pa.	Sensitivity – 24 dB to –50 dB re 1V/Pa. B & K and GR MIC/preamp, interfaces available as options.
AC High Level Input	1V for max. reading, impedance 22,000 ohms.	High level input available, sensitivity not stated.	0.5V for max. reading, impedance 20 000 ohms.	20V for max. reading impedance 200 000 ohms.
DC High Level Input	100mV/dB, 0–6.4V impedance 22 000 ohms.	None	None	None
Power Requirements	6 Standard D-cells, 6 rechargeable NiCd cells, 12V auto battery or Type 2808 Mains Power Supply.	Internal or external 24V DC batteries or 110-240V AC.	8 standard D-cells or external 12V DC auto battery.	Internal rechargeable, lead-acid batteries, external 120V AC or 12V DC.
Power Consumption	Display off 1.8 VA. Display on 3.3 VA. Approx. 16 hours operation with display off using NiCd cells.	Not stated	24 hours running time on 8 standard D-cells.	48 hours minimum operating time on internal batteries.
Dimensions (mm)	133 (H) c 210 (W) x 200 (D)	265 (H) x 100 (W) x 330 (D)	273 (H) x 216 (W) x 238 (D)	229 (H) x 368 (W) x 406 (D)
Weight	2.2 kg	6.5 kg	7.5 kg	10.4 kg

Limitations (relative to the other instruments)

- Will not display L_n or L_{eq} until analysis complete.
- Fixed sampling rate.
- Cumulative distribution only available at electrical output in digital form (not available in analog form for XY plotter and cannot be displayed on front panel.

METROSONICS dB-602

Additional Features:

- 100 dB dynamic range with 14 dB crest factor.
- Very large memory, 6.5 million samples.
- L_0 to L_{99} in L_1 steps (5 percentiles only, must be selected prior to analysis).
- Selected percentiles (or L_{eq}) may be displayed progressively during analysis.
- Four statistical values may be stored at programmed intervals from 15 minutes up to 25 hours (in 15 minute increments).

Limitations (relative to the other instruments):

- Low level input is always A-weighted. Requires 1 kHz calibrator.
- Probability and cumulative distributions not available on front panel display — available at electrical output in digital form only. (Requires 600-05 Analog Inter-Face option for XY plotter or chart recorder)
- Standard sample rate 1 per second. Other rates available (32 per sec to 1 every 32 secs) but must be preset.
- Only 5 percentiles (or 4 percentiles plus L_{eq}) can be calculated, and must be selected before analysis commences.
- No 'pause' control to eliminate unwanted data.
- Relatively heavy, 10.4 kg.

Australian Acoustical Society

Unconfirmed Minutes of the 5th Annual General Meeting

The 5th Annual General Meeting of the Australian Acoustical Society was held at the Hydro Majestic Hotel, Medlow Bath, N.S.W. on Friday 19th September, 1975.

The meeting was declared open at 6.05 pm

PRESENT: 32 members entitled to vote were present. The President of the Society, Mr. P. R. Knowland was in the chair.

1. Apologies & Proxies

Apoligies were received from Keith Keen and David Hassall.
No proxies were received.

2. Minutes of the 4th Annual General Meeting

The meeting was reminded that the minutes of the 4th Annual General Meeting have been published in the Bulletin Vol. 3 No. 1 — 1975 which has been distributed to each member of the Society. Motion "the minutes be confirmed"

3. Report of Council for year 1974-1975

The President read the report of Council.
Motion "the report of Council be received"

Davern/Mather

4. Treasurer's Report

Mr. R. Piesse in the absence of the Treasurer reported on the Society's financial position.
Motion "the Treasurer's report be received"

Rose/Riley

5. Appointment of an Auditor and determination of the Auditor's remuneration

It was moved by V. Taylor and seconded by G. Pickford that Mr. F. J. Morton of Elanora Road, Elanora, N.S.W. be appointed the Society's auditor at a fee not exceeding one hundred dollars.

6. Report on the ICA

Mr. J. Rose presented a report on the 10th ICA to be held in Australia in 1980.

7. Other Business

There was no other business.
The meeting closed at 6.30 pm.

STANDARDS REPORT

INTERNATIONAL STANDARDS IN ACOUSTICS

R. Nagarajan,
Engineer-Secretary,
Acoustics Standards Committee,
Standards Association of Australia.

Introduction:

Acoustics is one of the new areas of technology in which international standardization is attempting to precede standardization at the national levels. Considerable international effort is being devoted towards the formulation of International Standards right from the beginning; avoiding significant differences between national standards (which are likely to take note of the international work in this area) thus heading off additional problems arising from these differences.

The International Standards in Acoustics are dealt with by the International Organization of Standardization (ISO) Technical Committee 43, Acoustics, and the International Electrotechnical Commission (IEC) Technical Committee 29, Electroacoustics. For details of the work of these two international standards bodies, which operate in close liaison with each other (from the same building in Geneva, in fact) reference is invited to the publication, 'International Standardization and National Standards' Standards Association of Australia, October, 1972 (available free of cost from the Standards Association of Australia offices at capital cities and Newcastle).

Work of ISO Technical Committee TC 43, Acoustics

The work of this Technical Committee is related to all areas in Acoustics, other than Electro-acoustics, which comes within the scope of IEC Technical Committee 29. This Technical Committee (TC) is a very active one and is assisted by three Working Groups (WG) and two Subcommittees (SC) both assisted by 23 Working Groups (WG). The scope and extent of coverage of subjects is seen from the structure of ISO TC 43 given in Table 1.

TC 43 assisted by the subcommittees and working groups listed in Table 1 has published a number of Standards (earlier known as Recommendations) and Technical Reports listed in Table 2, which are available for sale from the Headquarters of the Standards Association of Australia.

TC 43 is also currently engaged in studying a large number of prospects, which are in various stages of progress and these are listed in Table 3.

Work of IEC Technical Committee TC 29, Electro-Acoustics

The structure of IEC Technical Committee TC 29, Electro-acoustics, is given in Table 4.

The list of IEC Publications of IEC TC 29 and its subcommittees is given in Table 5.

The list of prospects being handled, including some nearing publication by IEC 29 is given in Table 6.

Australian Position

The foregoing discussion demonstrates that a considerable number of international standards on acoustics have already been published and a larger number are currently in preparation. There appears to be a vast demand for international standards. The Acoustics Standards Committee of the Standards Association of Australia is seeking to ensure that the work in the international field is fully taken into account in the development of Australian Standards. Technical differences between international standards and Australian standards should be avoided and Australia should participate more effectively in international standardization activity, so that Australian interests and viewpoints are accommodated during the formulation of international standards.

How can we ensure that Australian viewpoints and interests are taken care of in the preparation of international standards? It is only through correspondence and communication of comments at the early committee drafting stages and participation by Australian representatives attending the Technical Committee, Subcommittee and Working Group meetings (which are usually held in Europe) that we can attempt this objective. The vast distance between Europe and Australia however often prevents attendance by Australian representatives in required strength at these meetings.

It may however be noted that Dr. Carolyn Mather, President of the Australian Acoustical Society, and some other members of the Society are attending meetings of ISO TC 43 and IEC TC 29, and Mr. J. A. Irvine who is presently in Europe, has been requested to attend the forthcoming meetings of ISO TC 43/SC2, Building Acoustics, to be held in Paris in June 1976. At present the Standards Association of Australia distributes draft international standards at various committee stages to various sectors of industry, government departments, universities and consultants (most of whom are members of the Acoustical Society) for comments. It is a matter of regret that the percentage of persons communicating comments on most of the documents to the Standards Association of Australia is only between 10 to 15 percent. Very few persons really find time to study the above international draft standard documents carefully and pass on comments duly supported by laboratory or field data. Only by sizeable contribution of comments on draft documents can we make a significant Australian contribution to the development of international standards in acoustics.

The recent significant increase in international standards activity has assisted in the formulation of a general policy for preparation of Australian standards in acoustics. The Acoustics Standards Committee of the Standards Association of Australia considers that in a large number of cases, it is worthwhile to wait for international standards to fully develop before we start our own preparation of Australian Standards. Furthermore, it is desirable that work for preparation of Australian Standards on any subject should be taken up only when a positive need has been established, so that our scarce resources for preparation of standards is advantageously utilised for optimum overall efficiency and economy.

General

An attempt has been made in this article to give a brief resume of the international standards activity in acoustics. Members of the Australian Acoustical Society desiring more information on any specific area considered in this article, are requested to contact Mr. R. Nagarajan at the Headquarters Office of the Standards Association of Australia in North Sydney (Telephone 02 9296022) or Mr. R. K. Profitt at the Melbourne Offices in Parkville (Telephone 03 3477911).

TABLE 1. STRUCTURE OF ISO TC 43 AS AT DECEMBER, 1975

TC	SC	WG	TITLE	SECRETARIAT OR CONVENOR
43			Acoustics	Denmark
		1	Normal threshold of hearing	Denmark
		2	Acoustical reference quantities	Denmark
		3	Techniques for audiometry	Netherlands
	1		Noise	Denmark
		2	Noise from aircraft	Denmark
		3	Noise from heating, ventilating and air conditioning equipment	Germany
		5	Noise emitted by ships and railways and noise inside vehicles	Germany
		6	Measurement of sound emitted by machinery and equipment	U.S.A.
		7	Noise assessment with respect to speech communication	France
		8	Noise emitted by road vehicles	France
		9	Noise from compressors, pneumatic tools and pneumatic machines	Sweden
		10	Noise from earth moving equipment	
		11	Assessment of sound quality	
		12	Measurement of speech intelligibility	USA
		13	Noise emitted by rotating electrical machines	Germany
		14	Noise from gas turbines	Belgium
		15	Assessment of fluctuating noise	South Africa
		16	Quantities for digital and hybrid/analogue processing of acoustic signals	–
		17	Measurement of sound attenuation of ear protectors	Denmark
	2		Building acoustics	Germany
		1	Plumbing noise	Netherlands
		2	Revision of ISO/R 140	Germany
		3	Reduction of impact sound transmission by floor finishes	France
		4	Sound insulation of windows and doors	Germany
		5	Rating of sound insulation for buildings and building elements	
		6	Measurement of sound insulation of suspended ceilings	–

TABLE 2. LIST OF INTERNATIONAL STANDARDS AND TECHNICAL REPORTS PUBLISHED BY ISO TC 43

NO.	DESIGNATION	TITLE OF THE STANDARD/TECHNICAL REPORT
1	ISO/R 16-1965	Standard tuning frequency (Standard musical pitch)
2	ISO/R 131-1959	Expression of the physical and subjective magnitudes of sound or noise
3	ISO/R 140-1960	Field and laboratory measurements of airborne and impact sound transmission
4	ISO/R 226-1961	Normal equal-loudness contours for pure tones and normal threshold of hearing under free field listening conditions
5	ISO/R 266-1962	Preferred frequencies for acoustical measurement
6	ISO/R 354-1963	Measurement of absorption coefficients in a reverberation room
7	ISO/R 357-1963	Expression of the power and intensity levels of sound or noise
8	ISO/R 362-1964	Measurement of noise emitted by vehicles
9	ISO/R 389-1964	Standard reference zero for the calibration of pure-tone audiometers
10	ISO/R 454-1965	Relation between sound pressure levels of narrow bands of noise in a diffuse field and in a frontally-incident free field for equal loudness
11	ISO/R 495-1966	General requirements for the preparation of test codes for measuring the noise emitted by machines
12	ISO/R 507-1966	Procedure for describing aircraft noise around an airport, 2nd Edition
13	ISO/R 532-1966	Method for calculating loudness level
14	ISO/R 717-1968	Rating of sound insulation for dwellings
15	ISO/R 1680-1970	Test code for the measurement of the airborne noise emitted by rotating electrical machinery
16	ISO/R 1761-1970	Monitoring aircraft noise around an airport
17	ISO/R 1996-1971	Acoustics – Assessment of noise with respect to community response
18	ISO/R 1999-1971	Acoustics – Assessment of occupational noise exposure for hearing conservation purposes
19	ISO 2204-1973	Acoustics – Guide to the measurement of airborne acoustical noise and evaluation of its effects on man
20	ISO 2249-1973	Acoustics – Description and measurement of physical properties of sonic booms
21	ISO/TR 3352-1974	Acoustics – Assessment of noise with respect to its effect on the intelligibility of speech

TABLE 3. ISO TC 43 PROJECTS IN HAND

NO.	TITLE OF THE PROJECT IN HAND
1	Determination of sound power levels of noise sources – Precision methods for discrete-frequency and narrow-band sound sources operating in reverberation rooms. (To be published as ISO 3742.)
2	Determination of sound power levels of noise sources – Engineering methods for special reverberant test rooms (To be published as ISO 3743.)
3	Determination of sound power levels of noise sources – Engineering methods for free-field conditions over a reflecting plane. (To be published as ISO 3744.)
4	Determination of sound power levels of noise sources – Precision methods for anechoic and semi-anechoic rooms. (To be published as ISO 3745.)
5	Determination of sound power levels of noise sources – Survey method
6	Measurement of sound transmission from room to room by shafts and ducts
7	Laboratory tests on noise emission by appliances and equipment in water supply installations. Part I: Method of measurement
8	Laboratory tests on noise emission by appliances and equipment in water supply installations. Part II: Mounting and operating conditions of draw-off taps
9	Laboratory tests on noise emission by appliances and equipment in water supply installations. Part III: Mounting and operating conditions of in-line valves and appliances
10	Measurement of sound insulation in buildings and of building elements. (Revision of ISO R140 and its Parts.) Part I: Requirements for laboratories. Part II: Statement of precision requirement methods for determination of the sound transmission loss of suspended ceilings Part III: Laboratory measurements of air-borne sound insulation of building elements. Part IV: Field measurements of airborne sound insulation between rooms. Part V: Field measurement of airborne sound insulation of facade elements and facades Part VI: Laboratory measurements of impact sound insulation of floors. Part VII: Field measurements of impact sound insulation of floors Part VIII: Laboratory measurements of the reduction of transmitted impact noise by floor coverings on a standard floor.

TABLE 3 (cont). ISO TC 43 PROJECTS IN HAND

NO.	TITLE OF THE PROJECT IN HAND
11	Preferred reference quantities for acoustic levels
12	Measurement and description of noise inside aircraft
13	Determination of flow resistance of materials used for acoustic purposes in buildings
14	Measurement of noise from light aircraft
15	Measurement of noise from VTOL and STOL aircraft
16	Calibration and characteristics of the reference sound source
17	Measurement of airborne noise emitted by pneumatic tools and machines – Engineering method for determinination of sound power levels
18	Measurement of airborne noise emitted by compressor units including primemovers – Engineering method for the determination of sound power levels
19	Noise from earth moving machinery – Measurement at operator's workplace
20	Determination of airborne noise emitted by earth moving machinery to the surroundings – Survey method
21	Assessment of sound quality
22	Measurement of speech intelligibility
23	Revision if ISO/R 362 – Measurement of noise emitted by road vehicles
24	Survey method for the measurement of noise emitted by stationary motor vehicles
25	Threshold of hearing expressed as sound pressure levels in an artificial ear
26	Threshold of hearing as a function of age
27	Pure tone audiometry
28	Revision of ISO/R 1680 – Test code for the measurement of the airborne noise emitted by rotating electrical machinery Noise from gas turbines
29	Assessment of fluctuating noise
30	Code for noise classification of pneumatic equipment for construction sites
31	Report on noise classification of machines
32	Procedure for describing aircraft noise heard on the ground
33	Methods for single number rating of sound insulating for buildings and building elements, including revision of ISO/R 717
34	Examination of ISO/R 354 "Measurement of absorption coefficients in a reverberation room" concerning the transformation to an International Standard
35	Designation of sound power emitted by machinery and equipment
36	Measurement of sound pressure levels
37	Measurement and characterization of noise radiation by structural components that are not an integral part of a machine
38	Quantities to be specified for acoustic signal processing by hybrid digital/analogue system
39	Measurement of sound attenuation of hearing protectors
40	Determination of airborne noise emitted by civil engineering equipment for outdoor use
41	Measurement of noise from reciprocating internal combustion engines
42	Noise classification and labelling of equipment and machinery
43	Noise level measurement at the operator's workplace on agricultural tractors and field machinery

TABLE 4. STRUCTURE OF IEC TC 29 AS IN 1975

TC	SC	TITLE	SECRETARIAT
29		Electro-acoustics	Netherlands
	SC29B	Audio-engineering	Netherlands
	SC29C	Measuring devices	France
	SC29D	Ultrasonics	USSR

TABLE 5. LIST OF PUBLICATIONS OF IEC TC 29

DESIGNATION	TITLE
89 (1957)[1]	Recommendations for the characteristics of audio apparatus to be specified for application purposes.
90 (1973)	Dimensions of plugs for hearing aids.
118 (1959)	Recommended methods for measurements of the electro-acoustical characteristics of hearing-aids.
	Amendment No. 1 (1973).
123 (1961)	Recommendations for sound level meters.
124 (1960)[2]	Recommendations for the rated impedances and dimensions of loudspeakers.
126 (1973)	IEC reference coupler for the measurement of hearing aids using earphones coupled to the ear by means of ear inserts.
150 (1963)	Testing and calibration of ultrasonic therapeutic equipment.
177 (1965)	Pure tone audiometers for general diagnoistic purposes.
178 (1965)	Pure tone screening audiometers.
179 (1973)	Precision sound level meters.
179A (1973)	First supplement of Publication 179 (1973).
184 (1965)	Methods for specifying the characteristics of electro-mechanical transducers for shock and vibration measurements.
200 (1966)[3]	Methods of measurement for loudspeakers.
222 (1966)	Methods for specifying the characteristics of auxiliary equipment for shock and vibration measurement.
224 (1966)	Marking of control settings on hearing aids.
225 (1966)	Octave, half-octave and third-octave band filters intended for the analysis of sounds and vibrations.
263 (1968)	Scales and sizes for plotting frequency characteristics.
268:–	Sound system equipment.
268-1 (1968)	Part 1. General
268-1A (1970)	First supplement of Publication 268-1 (1968).
268-1B (1972)	Second supplement to Publication 268-1 (1968).
268-1 (1971)	Part 2. Explanation of general terms.
268-3 (1969)	Part 3. Sound system amplifiers.
268-3A (1970)	First supplement to Publication 268-3 (1969).
268-4 (1972)	Part 4. Microphones.
268-5 (1972)	Part 5. Loudspeakers.
268-6 (1971)	Part 6. Auxiliary passive elements
268-8 (1973)	Part 8. Automatic gain control devices.
268-14 (1971)	Part 14. Mechanical design features.
268-14A (1973)	First supplement to Publication 268-14 (1971).
303 (1970)	IEC provisional reference coupler for the calibration of earphones used in audiometry.
318 (1970)	An IEC artificial ear, of the wide band type, for the calibration of earphones used in audiometry.
327 (1971)	Precision method for pressure calibration of one-inch standard condenser microphones by a reciprocity technique.
373 (1971)	An IEC mechanical coupler for the calibration of bone vibrators having a specified contact area and being applied with a specified static force.
402 (1972)	Simplified method for pressure calibration of one-inch condenser microphones by the reciprocity technique.
486 (1974)	Precision method for free-field calibration of one-inch standard condenser microphones by the reciprocity technique.
500 (1974)	IEC standard hydrophone.

[1] This publication has been superseded by Publication 268.
[2] This publication has been superseded by Publication 268-14 (1971).
[3] This publication has been superseded by Publication 268-5 (1972).

TABLE 6. LIST OF PROJECTS BEING HANDLED BY IEC 29.

DRAFTS IN VARIOUS STAGES

1 Measurement of the characteristics of hearing aids with induction pick-up coil input – 29 (C.O.) 101.
2 Second edition of Publication 263: Scales and sizes for plotting frequency characteristics and polar diagrams – 29(C.O.)102.
3 Publication 268-3: Second supplement, modifications and additions.
4 Publication 268-7: Headphones and headsets.
5 Publication 268-9: Artificial reverberation, time delay and frequency shift equipment.
6 Publication 268-15: Preferred values for the interconnection of sound system components.
7 Methods of measurement of loudspeaker systems and units when supplied with noise signals.
8 Minimum requirements for high fidelity audio equipment and systems. Part I: General. Part 2: Amplifiers.
9 29C(C.O.)25: Electro-acoustical performance requirements for aircraft noise certification measurements..
10 29C(C.O.)26: Frequency weighting for the measurement for aircraft noise (D-Weighting).
11 Consolidated revision of IEC Publications 123 and 179.
12 Calibration of hydrophones.

SUBJECTS UNDER CONSIDERATION:

13 Terminology
14 Supplement to Publication 118
15 Supplement to Publication 268-10.
16 Measurement of amplifier mains transformer temperature rise.
17 Definition of dynamic range at the input of digital signal processing equipment for acoustical measurements. Audiometers.

Note: For particulars of designations in this table, see Table 5.

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.

All submissions for publication should be clearly legible, and preferably typed with 1½ spacing. Apart from Technical Papers there are no special requirements for the format or presentation of items submitted for publication.

Technical papers (articles on technical topics exceeding about 2000 words) should be typed with 1½ spacing, and include a summary of approximately 150 words. Relevant information about the author should also be provided (approximately 100 words).

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

Acceptance deadlines for publication are as follows:

Volume 4, Number 3, September 1976	
Full Technical Papers	6th August
Other Shorter Items	27th August
Volume 4, Number 4, December 1976	
Full Technical Papers	5th November
Other Shorter Items	26th November

BOOK REVIEWS

THE FOUNDATIONS OF ACOUSTICS – BASIC MATHEMATICS AND BASIC ACOUSTICS

Eugen Skudrzyk. 790 pages. Springer-Verlag, Wien and New York, 1971. Price $US73.80.

The author believes that the serious acoustician today needs a good understanding of mathematics, dynamics, hydrodynamics, physics, statistics, signal processing, and electrical theory. Since obtaining a background in these subjects is so time consuming and laborious, and requires the study of many books, he has tried to put much of this background information between two covers. The result is a very long and impressive book of almost 800 pages, including nearly 200 figures and well over 1000 references.

The first twelve chapters (269 pages) deal with introductory material: units, complex notation, analytic functions, Fourier analysis, Laplace transforms, integral transforms, integral transforms, correlation analysis, filters, probability theory, and signal processing. This introductory material comprises almost forty percent of the text pages. The remaining sixteen chapters (406 pages) discuss the one-dimensional wave equation; reflection and transmission of plane waves; three-dimensional plane waves; sound propagation in tubes; spherical waves and sources; the wave equation in spherical, cylindrical, and spheriodal coordinates; the Helmholtz Huygens integral, the Rubinowicz-Kirchoff and Sommerfield theories of diffraction; sound radiation from arrays and membranes; Green's Functions of the Helmholtz equation; and self and mutual radiation impedance.

Skudrzyk writes with clarity, and takes considerable care to develop the material carefully and logically throughout. The notation is carefully explained, and symbols are defined in the text and are listed at the end of the book. The author has striven more for completeness than for brevity, so that, in most cases, complete derivations of mathematical results are given, with few intermediate steps omitted. Since the book is so complete, most readers with a reasonable mathematical background should have little trouble in following the book through, providing they apply sufficient effort. It should be necessary to use very few additional references. Some people may find the inclusion of so much background material (the first twelve chapters) unnecessary and irksome. This reviewer personally did not. The format and treatment of the material are original, although the author draws on a great number of sources. Nevertheless, the book reads as an integrated whole. The author's knowledge of German has been used in including results from a large number of articles and books originally written in that language. There are a few omissions: the subjects of coherence and statistical energy analysis are not discussed; but, on the whole, the reviewer finds few faults in the work.

This book is useful for those with a serious interest in theoretical acoustics, and it is not for the casual reader. Despite its great cost, this reviewer believes that the book is an invaluable reference to maintain in a personal acoustics library. It should remain as such for many years.

Reviewed by Malcolm J. Crocker.

REDUCTION OF MACHINERY NOISE
(Revised Edition)

Ed. Malcolm J. Crocker, Purdue University, West Lafayette, Indiana 47907, USA, 1975. X + 365 pp; illus; Price: US$20.00.

This book is the printed proceedings of papers presented in two short courses, "Fundamentals of Noise Control, Dec 8 - 9 1975" and "Reduction of Machinery Noise, Dec 10 - 12 1975", held at Purdue University.

The first twelve chapters are on the fundamentals of noise control. There are seventeen chapters on the reduction of machinery noise and four chapters on case histories.

The chapters on the fundamentals of noise control are obviously meant to give engineers a working knowledge of acoustics in a short space of time. Theoretical treatment is therefore minimal. These introductory chapters which include acoustical definitions, sound propagation, psycho-acoustics, instrumentation, vibration, noise control by absorption and barriers and noise legislation are written by staff in the Department of Mechanical Engineering, Aeronautics and Astronautics and Audiology and Speech Sciences at Purdue University. The treatment is precise and succinct with adequate references given for those wishing to follow the work in more depth.

In the reduction of machinery noise section, chapters are written by an impressive selection of noise control practitioners including Baade, Kamperman, Yerges, Diehl and Graham. The chapters cover in varying depth noise control in fans, compressors, valves, metal forming processes, construction machinery, diesel engines, petrochemical facilities and trucks.

For the practicing engineer the four noise case history chapters provide a very valuable insight into the investigation and control of new noise sources, at the source. The book should prove valuable to noise control novices and experts alike. The cover design is another selling point, being as close as one can get to "Visible-Noise".

Reviewed by Fergus Fricke.

RECEIVER SOUND CONTROL IN AUDITORIA

I. J. STAPLETON and F. R. FRICKE

SUMMARY

The concept of 'sound control at the receiver' in auditoria is examined as a method of improving speech intelligibility. Two reflectors were tested and it was found that articulation index scores could be increased by up to 8%.

1. INTRODUCTION

In recent years many investigations have been carried out with the purpose of improving speech communication in enclosures. Such investigations have generally been concerned with improving the signal (see for sample Haas[2] and developments in sound amplification systems for example Klepper[3] and Parkin and Morgan[4] and reducing the background noise (see Lochner and Burger[5]).

Improvement of communication, by altering conditions at the receiver, appears to be a neglected field but one worthy of more attention (as in noise control work where the receiver is an important consideration). This paper outlines the results of some tests done with the aim of determining the order of speech communication improvement possible by the use of various sound focussing and impedance matching devices in the vicinity of the ear (variations on the theme of an ear trumpet).

1.1 The Communication System

The process of speech communication involves three basic elements: the speech source, the medium through which it passes and the speech receiver. The source and the receiver are invariably respectively the human voice and ear. The medium, which can vary, is most commonly the atmosphere and the reflecting surfaces in the enclosure. In this work we are concerned with altering conditions at the receiver. In order that the receiver may understand a speech signal this system must operate in such a way as to achieve certain criteria. Most basically the system must be such that it is possible to convey the frequencies of speech sounds. The primary spectral distribution of speech sounds falls between 200 and 6,400 Hz (Fletcher[6]). Secondly, sounds must be of suitable intensity. It is generally accepted that 70 dBa re 2×10^{-5} N/m^2 is the optimum value of L_{eq} for speech communication. (At lower levels communication is hindered by missing consonants and at higher levels the ear becomes overloaded by the acoustical energy of the vowel sounds.) Thirdly, the level of the acoustic signals must be sufficiently above that of the ambient noise level. Finally, the sounds should not be distorted. Acoustical distortion occurs when the relative amplitudes of the frequency components of a sound are altered. To date there appears to be no generally accepted criteria against which to measure such distortion in speech, though the reverberent characteristics of the room give some measure of this.

1.2 Methods of Improving Speech Intelligibility

The quality of the source, the medium and the receiver are all critical in achieving the criteria outlined in 1.1. Any one of them may cause a breakdown in communication by adversely affecting one or more of these speech characteristics. The speaker may talk too softly or indistinctly, the noise in the auditorium may be too high, the receiver may not be listening or he may be deaf and so on. A speaker and his audience, to an extent, can adjust themselves to obtain optimum intelligibility. The speaker can speak more loudly and pronounce his words more carefully and the audience can listen more attentively whilst at the same time making as little noise as possible. If, nevertheless, intelligibility difficulties occur, a number of techniques are widely available to overcome them.

The most basic technique is to design or redesign the auditorium for good acoustics. In this process the various criteria mentioned above are translated into quite explicit rules about the shape, size and make up of the auditorium (Moore[8]). The distance to the rear seats should be minimised, the seats should be raked or the speaker elevated, large surfaces near, above and in front of the source should be used as reflectors of sound, other surfaces that may cause echoes or near echoes should be of absorbent or dispersive materials, concentration of sound by curved surfaces should be avoided as should sound shadows and standing waves, and the auditorium should be insulated from the penetration of external noise. Whilst there is some variation according to enclosure volume, a Reverberation Time of ¾ - 1 second is generally considered optimum. In order that this reverberation be of good quality the Early Decay Time should be less than the Reverberation Time and the Inversion Index less than one.

If the acoustics of an auditorium do prove inadquate, e.g. because of other constraints on the design, speech intelligibility may be improved by electronic sound reinforcement. Often, however, the expense and inconvenience of electronic amplification is not warranted for the few seats where the intelligibility of speech is not adequate and the few people who have hearing deficiencies. There is of course, always the possibility of using hearing aids though even these will be of little use if the signal to noise ratio is low.

1.3 Sound Focussing and Impedance Matching Devices

The aim of this paper is to evaluate some additional methods of improving speech intelligibility at the receiver's ear, namely the effect of various mechanical reflectors and impedance matching devices on the reception of speech. Such devices which, for the sake of convenience shall be called reflectors, justify such a course of investigation, as they are capable of increasing the intensity of a signal and reducing the ambient noise level heard by the receiver. The devices are intended to be part of the seating, though for convenience, some were fixed to the head in the present experiments.

2. EXPERIMENTAL FRAMEWORK

A number of types of reflectors were constructed. All were subsequently modified in various ways as tests on their effectiveness proceeded. The tests were of three general types, two of which were objective and one subjective. The first involved measuring sound pressure level improvements due to the use of a reflector over a number of frequency bands. The second test involved measuring such sound pressure level improvements over a number of different distances. The third measured the improvement in articulation scores due to the use of a reflector.

2.1 The Reflectors

Three types of reflectors were tested:

The first, shown in Fig. 1 was constructed for use in a similar way as headphones and is henceforth called the headset reflector. It consists of two semispherical metal cups attached to a head-band in such a way as to make adjustment to different head sizes possible. Each cup was cut away so it could fit closely behind the ear. The internal shape of this reflector was later successively modified with modelling clay and plaster in an attempt to improve its performance.

The second reflector type is shown in Fig. 2. It was of parabolic form (focal length of 100 mm) and was constructed of formica sheet. A spacer was placed at the vertex of the curve so that the reflector had two foci, one at each ear, when the head rests on the surface at the back of the reflector.

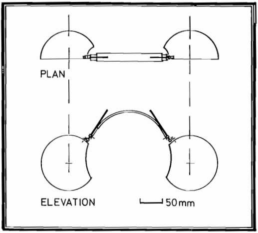

Fig. 1. Headset reflector

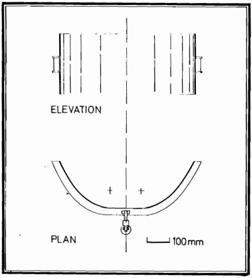

Fig. 2. Parabolic reflector

The third type of reflector tested, was of a horn shape. Two such reflectors were fabricated of fibre glass using horn speakers as moulds. Discussion of this type will not be made in this paper. All of these reflectors, of course, exhibit acceptability problems. For instance, for the user to maintain maximum benefit he must keep his ears near the focal points of the parabolic reflector. Nevertheless, questions of acceptability are by no means sufficient reason to ignore the possible benefits of the use of such reflectors.

2.2 Frequency/Sound Level Tests and the Amplification and Masking of Sound

The first of the tests was designed to give an indication of the effect of the reflector on both a signal and background noise. An artificial head complete with ears was fabricated from plaster and a 6 mm microphone incorporated in the entrance to the ear canal. Third octave band spectral analyses were made, with and without the reflector, of random noise from a source of fixed output, at a fixed distance, rotated through angles of incidence 0°, 45°, 90°, 135° and 180°, at a constant reverberation time. Figure 3 summarises the test procedure.

At any angle of incidence 0° (directly in front) to 180° (directly behind the head), the source of random noise can be considered either a noise or a signal and its effect gauged. At 0° incidence it is helpful to consider it as a signal. We can see the effect of the reflector on each third octave band between that centred on 250 Hz and that centred on 10,000 Hz. We can determine whether the reflector is masking or amplifying at any third octave band at any angle and so determine the usefulness of that reflector at that angle.

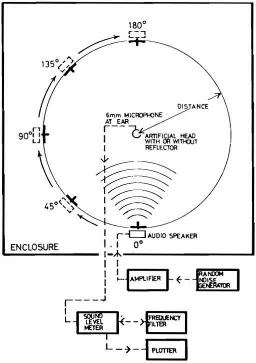

Fig. 3. Experimental arrangement for sound level tests

2.3 Distance/Sound Level Tests and the Proportion of Direct and Reverberant Sound at the Ear

The second type of objective test used was designed to test the ability of a reflector to increase the proportion of direct sound reaching the ear. Again using the artificial head with its inbuilt microphone the relationship between sound pressure level, with and without reflector, and distance between head and source was measured at the third octave bands centred on 1,000, 1,600 and 6,300 Hz, at constant reverberation time.

2.4 Articulation Tests

Whilst the former tests are likely to give good indications of the relative benefits of each reflector, results from articulation tests are desirable to be sure that improvements in sound pressure levels are not offset by intelligibility losses due to distortion.

The articulation tests were carried out as shown in Figure 4. This arrangement, to an extent, simulated the conditions that are generally present in a communication system: besides a signal source and a receiver there was, as well, a noise source. Before a test commenced the sound pressure levels of both the noise and the signal at the position of the subject were independently set at determined levels, random noise at 60 dBA and signal level so that 10% of the time there was a sound pressure level of 60 dBA or above.

Each test took the following form. A group of ten subjects listened to two phonetically balanced (PB) word lists each of fifty monosyllables and wrote down the words they heard above the background of random noise. Half the subjects used the reflector on the first word list, the other half on the second. Such a procedure enabled an allowance to be made in the results for the combined effect of differences in the word lists and familiarisation of the subject with the test situation and so on. It was then possible to arrive at the order of percentage articulation improvement due to the presence of the reflector.

3. THE PERFORMANCE OF THE REFLECTORS

3.1 Headset Reflectors: Amplification and Masking

Figure 5 graphs the results of the first set of sound level tests on the headset reflector. Each graph represents a different angle of incidence of sound received at the microphone placed in the ear. In this particular series of tests the sound source remained 2,500 mm from the head and the reverberation time was 2.3 seconds at the 1/3 octave band centred on 1,000 Hz.

Considering the above, it can be seen that when the source of random noise is directly in front, the pressure of the reflector changes the sound level spectrum quite markedly. Sound intensity is being increased from the 1/3 octave band centred on 250 Hz to that centred on 1,250 Hz, decreased from the 1/3 octave band centred on 1,600 Hz to that centred on 2,000 Hz and again increased from the 1/3 octave band centred on 2,500 Hz to that centred on 10,000 Hz. At other angles of incidence the low frequency levels were also increased using the headset while a small degree of attenuation (up to 5 dB) was obtained at the higher frequencies at angles greater than 45°.

The rather constant response over most angles of incidence indicates that the head was in the diffuse sound field of the room. One might expect improved masking, particularly at the higher angles of incidence, if the head was brought into the free field. In another test of a similar nature the distance between the source and the head was reduced to 1,000 mm.

At 1,000 mm the difference between results with and without the headset become more distinct (see Fig. 6). This is especially so at the higher frequencies. At lower frequencies, the movement is far less marked. These results suggest that the headset may be resonating at the lower frequencies. The increased differences at the higher frequencies can be explained in terms of an increased proportion of direct sound reaching the head (see Fig. 7).

The semispherical shape of the surfaces of the headset reflector are, as stated earlier, by no means the most ideally suited to the collecting of incident sound. The headset was modified and further tests made at 0° angle of incidence.

The reverberation time was 0.7 seconds at the third octave band centred on 1,000 Hz and the head was 2,000 mm from the source of random noise. The results that these modifications achieved, as shown in Figure 8, whilst not comparable to the previous tests are quite dramatic. In the first modification amplifications of between 3 and 16 dB were recorded. In the second modification over the same

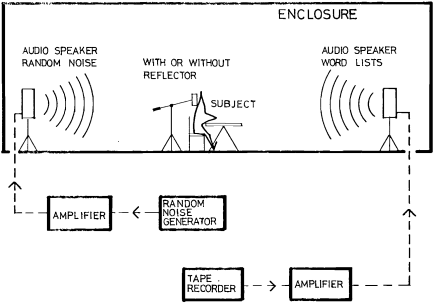

Fig. 4. Experimental arrangement for articulation tests.

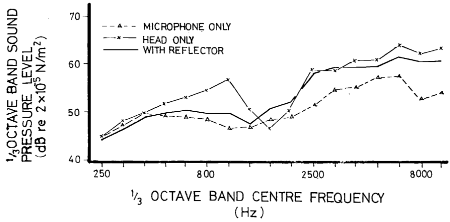

Fig. 5. Spectrum analysis comparing the effect of (i) the artificial head and (ii) the headset reflector and head on the performance of the 6 mm microphone (0° incidence, R.T. = 2.3 secs, distance 2.5 m)

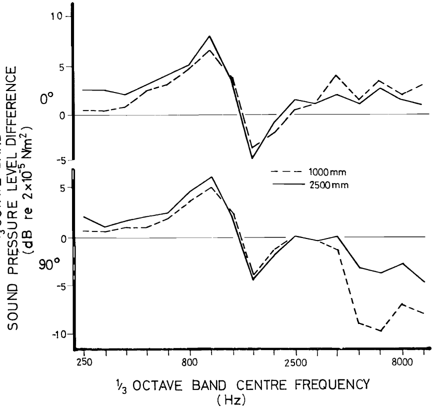

Fig. 6. Comparison of headset reflector results at distances of 2.5 m and 1 m at angles of incidence of 0° and 90° (R.T. = 2.3 secs.).

range the amplification was between 2 and 14 dB. Both the first and second modification increased the sound pressure levels by more than 7 dB over half the frequency spectrum; these increases being in the most useful part of the spectrum. Most interestingly the modifications have bettered the unaltered headset result at the third octave band centred on 1,000 Hz by about 50% and they have bridged the trough at the third octave bands centred on 1,600 and 2,000 Hz.

3.2 Parabolic Reflectors: Amplification and Masking

In this particular series of tests the sound source was at 2,500 mm from the head and the reverberation time at the third octave band centred on 1,000 Hz was 1.7 seconds. A third octave band spectral-analysis was taken a number of times for the following conditions: no head without any reflector, the head with the parabolic reflector and the head with the parabolic reflector of increased curvature. In the last condition of increased curvature, it was no longer possible to place the ears at the focal points of the reflector.

The presence of the reflectors has a marked effect on the sound pressure levels received at the ear (see Fig. 9). At 0° incidence the reflectors of both curvatures increase the sound level some 2.5 to 5 dB from the third octave band centred on 400 Hz to that centred on 1,000 Hz. As with the headset reflector the differences become negative around the centre of the spectrum. The effect of the different curvatures of the reflectors becomes marked in the third octave bands higher than that centred on 1,600 Hz.

The differences are often negative in the case of the reflector of greater curvature. In the case of the reflector at less curvature, with focal point at the entrance to the ear canal, quite large amplifications of sound occur particularly at the higher frequencies, 5.5 to 12.5 dB in the third octave bands above that centred on 4,000 Hz.

From these results the importance of placing the ear at the focal point of such parabolic reflectors seems clear. At incidence 0° such a reflector will amplify the sound intensity over most of the spectrum. At angles of 90° and above the reflector also offers considerable masking properties at the higher frequency bands. It appears that

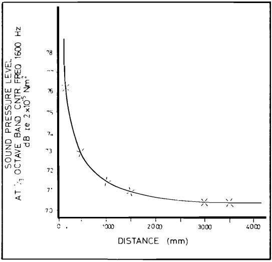

Fig. 7. Decay of sound pressure level in enclosure with distance. R.T. = 1.7 at 1000 Hz 1/3-octave band.

greater curvature will produce greater masking at these angles of incidence.

3.3 Parabolic and Headset Reflectors: Percentage Articulation Improvement

Table 1* shows the unadjusted percentage articulation scores for both reflectors tested.

The use of two modes in each of the reflector tests makes it possible to calculate, in each case, the average improvement due to differences in the list difficulty, familiarisation and so on. There appears to be a larger difference in difficulty between lists 1 and 2 than there is between 3 and 4 since it is unlikely that the subjects of the parabolic reflector tests adapted to the test situation any quicker than those of the headset tests.

In the first mode, when the reflector was used with the first word list in the test, the above factors reduced the articulation improvement by a certain amount. In the second mode the same factors increased the articulation improvement by an equal amount. The simple relationship exists: the higher average percentage score less an adjustment factor is equal to the lower average percentage score plus that same factor. Put another way:

$$\text{Adjustment factor} = \frac{\text{higher average} - \text{lower average}}{2}$$

*See page 36 for Table I.

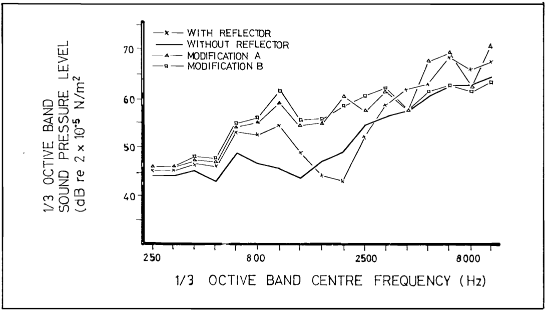

Fig. 8. Spectral analysis of two different modifications to the headset reflector. R.T. = 0.7 secs. Distance = 2,000 mm. 0° incidence.

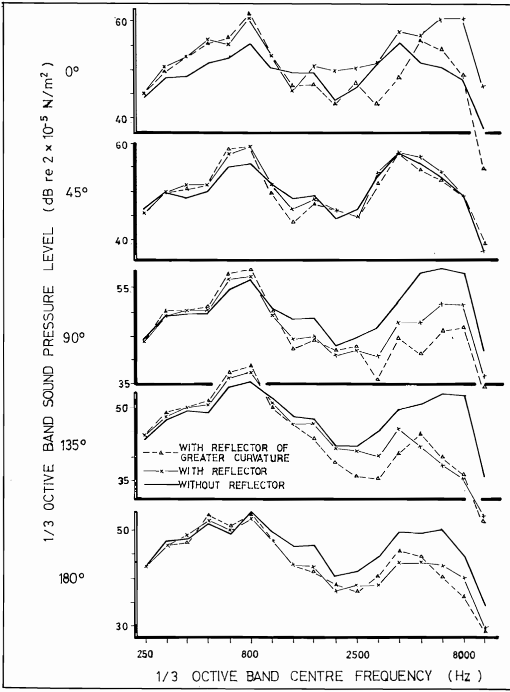

Fig. 9. Spectral analysis with and without parabolic reflector of five different angles of incidence. R.T. = 1.7 secs. Distance = 2,500 mm.

The adjustment factor for the headset reflector and parabolic reflector tests come to 2.0% and 3.4% respectively. Hence for the twenty subjects tested the adjusted average percentage articulation improvement for the headset was 7.6% and for the parabolic reflector 6.6%.

It is worth noting the subjective reactions to the use of these reflectors. Of the ten subjects who used the modified headset all but one said it had helped them. The other considered reception no better. Of the ten subjects who used the parabolic reflector only two thought it had helped, one thought it had hindered and the remainder considered it neither helped nor hindered.

DISCUSSION AND CONCLUSIONS

It is obvious from the subjective and objective tests carried out that the reflectors tested can increase the signal, decrease the level of masking and improve intelligibility of speech. At this stage we should indicate

(i) the significance of the improvement
(ii) why the reflectors give better results close to the source
(iii) what further improvements could be made

The subjective tests were carried out using ten subjects for each reflector and the difference in scores was large (see Table 1). Thus the statistical significance of these results is low [$Pr(\chi^2 \geqslant 11.6 | \nu = 9) \simeq 0.25$ and $Pr(\chi^2 \geqslant 15.2 | \nu = 9) \simeq 0.1$ for the parabolic reflector and headset, respectively]. If the aberage improvement in articulation index is taken as 7.6 and 6.6 (as indicated earlier) for the headset and parabolic reflector then the improvement in intelligibility ratings of percentage articulation scores of single syllable words as follows: 75% satisfactory, 85% good, 96% excellent. The improvements of the order achieved by the headset and parabolic reflectors would thus often be sufficient to push scores into higher intelligibility ratings; making a satisfactory communication a good communication and a good communication an excellent communication.

One interesting side issue that emerged from the subjective tests was that some subjects scored twice as well as others. This phenomenon was also noted by Carter and Farrant[9] when testing aircrew. The reason is nothing to do with hearing acuity but rather is due to inherent personal abilities to perceive speech in a noisy environment, which makes the specification of acceptable speech interference levels somewhat dubious.

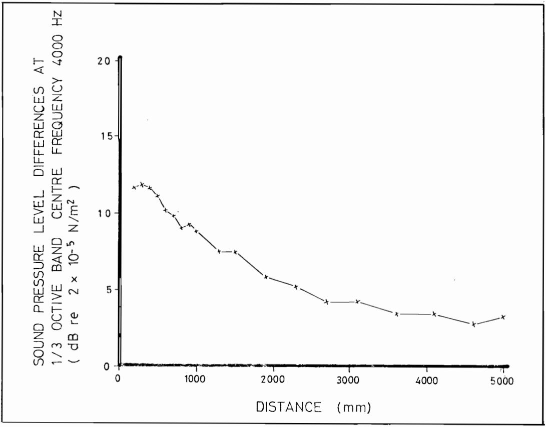

Fig. 10. Differences between sound pressure levels with and without a 150 mm 3-D parabolic reflector, plotted against distance from source for 1/3-octave band centred on 4000 Hz. R.T. = 0.6 secs.

The improvement in speech intelligibility obtained suing the reflectors will depend on the conditions existing in the room. The subjective tests carried out were for a case where the background noise level was high and the subject was close to the free field of the speech source and the noise source. In this situation some shielding from the noise source and some aplification of the source would occur. If the subject was well into the diffuse field of the noise and speech sources then a smaller increase in speech intelligibility would be expected.

This effect can best be explained by reference to Fig. 10 which plots the difference in sound level as measured by a 6 mm microphone when placed at the focus of a parabolic reflector and when used without the reflector. Close to the source the difference is large because that microphone is in the free field and reflector is focussing the sound at the microphone. Further away the microphone is in the diffuse field where the focussed sound level is less than the diffuse sound level.

Further work needs to be done with more subjects to determine what improvements in speech intelligibility can be expected in a range of situations. These would include variations in the position of the speech source (both in distance and direction) and the noise source, the reberberation time and the signal to noise ratio. Only when these measurements are available will the true significance of the present concept be known. Nevertheless, we feel confident that improved versions of the reflectors tested could be used to improve the performance of many auditoria. Sound control at the receiver is a viable method of improving speech intelligibility.

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TABLE I Percentage Articulation Scores

Subject	Reflector	% Articulation		
		List 1	List 2	Diff.
1	Parabolic: 1st list	32	32	0
2		72	70	2
3		64	60	4
4		56	52	4
5		66	60	6
6	Parabolic: 2nd list	64	70	6
7		56	64	8
8		50	66	16
9		56	66	10
10		56	66	10
		List 3	List 4	Diff.
11	Headset: 1st list	68	62	6
12		58	54	4
13		32	30	2
14		50	40	10
15		68	62	6
16	Headset: 2nd list	58	66	8
17		54	66	12
18		38	42	4
19		46	62	16
20		48	56	8