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contents

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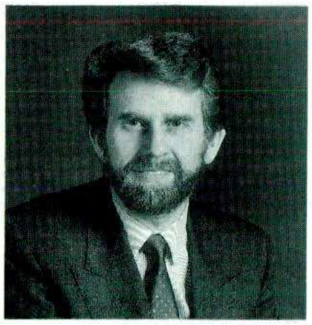

Dear Fellow Member

This issue will be mailed as delegates make their preparations for the two Windermere conferences; the published programmes promise busy schedules with workshops, discussion groups and demonstrations given particular prominence. These have become an important part of the Institute's annual calendar and it looks as though there will again be good numerical support particularly from our collaborating organisations at the Reproduced Sound 9 conference. The inclusion of a Training Course at this conference is an innovation that will be studied carefully for future years.

You will be pleased to note later in this issue that the Institute has been successful in its bid to host the Inter•noise '96 conference. This is scheduled to take place at the Britannia Adelphi Hotel in Liverpool during July-August. The process by which the decision was made at Inter•noise '93 in Leuven had something in common with another decision about a sporting event made in Monaco recently; although the scale might have been somewhat different, Bernard Berry's presentation to the Inter•noise council was a model for others to follow in the future.

You will be interested to note that at the Engineering Assembly in July, Sir John Fairclough remarked that 'there would always be a need for an Institute of Acoustics'. Those who have kept abreast of our negotiations with the Engineering Council will find this as encouraging as I do.

The next issue of the Bulletin will be a bumper one, being a special edition on Environmental Noise and will be published in time for the November conference on that topic; there will again be colour pages for advertisers. In that issue I expect to be able to inform you about discussions between the long-established but hardly energetic Federation of Acoustical Societies of Europe and the fledgling European Acoustics Association (EEIG).

Finally I think it is worth repeating, for the benefit of those who may miss it, the quote in the Hansard pages of Lord Meston, '..... I read that a Minister recently had said with some pride, he had addressed something called "Euronoise" - which I assume is nothing to do with what we have been enduring (in the Lords) for the past few weeks....'.

With best wishes

Yours sincerely

Peter Wheeler.

STANDARDS FOR HEARING PROTECTORS

Peter D Wheeler FIOA

In the first of a series of articles concerning standards in specialised areas of acoustics, the President takes a reflective look at developments in the field of personal hearing protection and reviews the evolution of standards in this area.

Introduction

This year has seen the introduction of new European Standards for hearing protectors, in support of the framework of regulations under the Personal Protective Equipment Directive [1]. Through the work of BSI Technical Committees PSM/25 and EPC1/11, and with the benefit of strong industrial involvement and related research projects at ISVR, Salford University and HSE Noise Group at Buxton, the UK has been able to exert considerable influence in both European and International standardisation activities in this field. Many IOA members have played active roles in this work, both in the national and international committees, where the UK has gained a reputation for being a strong but fair-minded delegation.

In the two decades since the attenuation measurement standard BS 5108 [2] was introduced, several new avenues in hearing protector modelling, design and testing have been explored. For example, attempts have been made to provide, by passive means, a level-dependent attenuation characteristic, or a more uniform attenuation performance across the frequency range [3], in order to improve the communication difficulties sometimes experienced when wearing hearing protectors in noise. Electronic hearing protectors offering sophisticated attenuation characteristics have become commonplace. Many researchers have tried to relate the attenuation of the hearing protector measured subjectively, as in BS 5108, to that measured objectively on a flat plate coupler.

My own interest in hearing protector design, and in attenuation measurement, began in the late 1970's when, in the course of developing the Active Noise Reduction aircrew headset for MOD, we looked for ways of overcoming the conflicting design requirements for high passive attenuation and wide bandwidth ANR in a circumaural earmuff, and devised test methods which would reduce the uncertainties of traditional subjective tests so that small changes in attenuation resulting from design modifications could be identified.

Factors Affecting Hearing Protector Attenuation and its Measurement

The attenuation performance of the circumaural earmuff was investigated by Shaw and Thiessen [4] in the 1960's. They showed that at low frequencies, typically less than 300 – 500 Hz, attenuation is controlled by the volume of the internal cavity and by the stiffness of the cushion, at middle frequencies by the mass of the earmuff, and at high frequencies by internal cavity resonances (and therefore the amount of absorption material in the cavity), by leakage around the cushion and by bone conduction, which effectively provides a flanking path with approximately 45 – 55 dB attenuation. In practice, the compliance of the skin surrounding the outer ear and the presence of hair both reduce the amount of attenuation achieved. In his 1979 review paper, Edgar Shaw [5] highlights the reduction in performance resulting from this 'weakness of the flesh', and comments that 'in recent years men's hair styles have clearly been designed without regard to the performance of circumaural ear defenders...'! These factors are primarily responsible for the differences found between flat plate coupler and real head attenuation measurements on earmuffs.

The recent trend of introducing electroacoustic transducers into earmuffs, for communications, attenuation control or noise cancellation purposes has lead to a revival of interest in understanding the acoustics of these small cavities, which even at frequencies for which the wavelength is several times greater than the cavity dimension, can show unusual effects. Attenuation test methods currently under development for these classes of protector are intended to take account of such point to point variability.

Attenuation Testing Techniques

Traditionally the attenuation of a hearing protector has been measured by determining the difference in absolute threshold of an audio frequency signal with and without the hearing protector worn. Early test methods used frontal presentation of sinusoidal signals [6]. Uncertainties in the measurement, due to variability in the sound field from point to point, binaural threshold effects, finite resolution in the audiometric method and, not least, protector fitting, resulted in an individual repeatability of perhaps 8 – 12 dB, and several subjects (typically 10 to 20) were needed to obtain a reliable mean value of attenuation.

The UK was the first, with BS 5108, to introduce a third octave band random noise signal and a diffuse sound field of controlled uniformity for attenuation measurement. Either a reverberant chamber or a tetrahedral array of loudspeaker sources in an anechoic chamber were used to provide this sound field (see Figure 1). Whittle and Robinson [7] gave a comprehensive account of the background to the development of the standard and presented the early experience of its application in their 1977 NPL Report.

More recently, 'semi-objective' attenuation testing, in which a miniature microphone is placed in the concha or ear canal of a human subject and the difference in occluded and unoccluded sound levels in a steady noise is measured, has found favour for both laboratory and field measurements on earmuffs [8].

Microphone in the real ear (MIRE) attenuation meas-

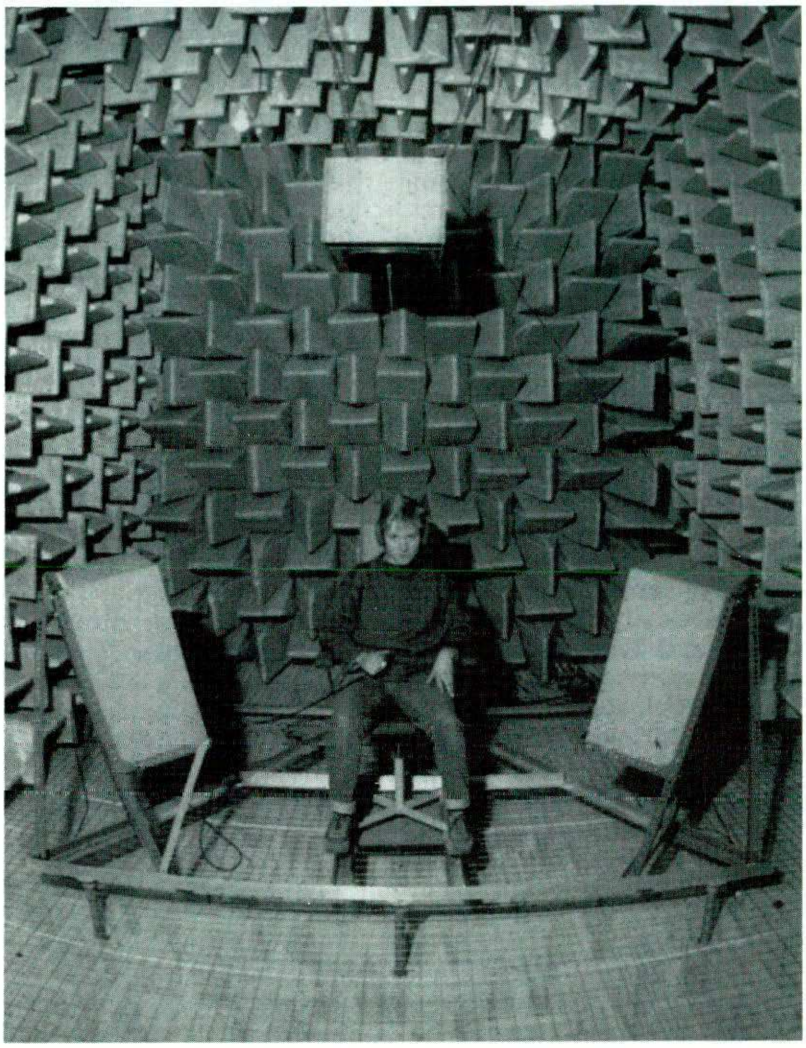

Fig. 1. Anechoic chamber with tetrahedral loudspeaker array

urements have been found to compare well with subjective real ear at threshold (REAT) measurements, except at 63 and 125 Hz, where, due to physiological masking effects, REAT attenuation values can be typically 5-10 dB higher than those measured using the microphone technique.

In the 1960s and 70s, much research was directed at replacing subjective testing, which was seen as time–consuming, expensive and unreliable, with objective measurements on an artificial head or acoustic test fixture, acting essentially as a flat plate coupler. The term 'insertion loss' was used to differentiate such measurements from the subjectively determined 'attenuation' of the earmuff. Early versions of these ATFs comprised a solid block of wood or metal housing an instrumentation microphone over which the earmuff could be positioned. Later, attempts were made to accommodate the effects of skin compliance and hair leakage [9,10] and to provide a coupler for earplugs that incorporated an artificial ear canal.

An illustration of the pitfalls of standards making is given in the case of objective testing of earmuffs. To allow quality control testing in production, a plane wave test technique, using a lined duct or 'tunnel', had been proposed in ISO DP6290 [11] for objective ATF measurements of Insertion Loss. The draft document defined the sound field uniformity requirements for the tunnel and gave a dimensioned drawing showing a rectangular section duct with a corner cutout, standing on legs some 1m above the ground.

As inter-laboratory comparisons had reported some repeatability problems with ATF testing, it was widely thought at the time that the corner cutout was intended to minimise cross–modal effects in the duct at middle to high frequencies. The reason for the 1m high support structure was thought to perhaps be associated with low frequency groundplane effects at the open end of the duct.

When, some time later, we came to use this technique in the first UK hearing protector 'product' standard, BS 6344 [12], I researched the background to the ISO design, to find that the drawing had been supplied by a committee member, based on a prototype built in his own laboratory where, to save space, the tunnel had been installed over an intruding radiator, necessitating the corner section being cut away! Presumably no one had questioned the need for the cutout in the duct during the drafting work! The moral of this true story is as relevant today as it was then – only put in a standard what is absolutely necessary to ensure the reliability of the measurement method and do not rely on individual interpretations of what has been found to 'work'. I am pleased to say that the latest version of the ISO Standard [ISO/TR 4869–3:1989) shows a square section duct with no cutout!

The Evolution of Product Standards for Hearing Protectors

In BSI, attenuation and insertion loss testing for hearing protectors falls within the province of the Environment and Pollution Committee structure (EPC1/11 being the relevant sub–committee of EPC/1 Acoustics), mirroring the arrangement in ISO TC43 Acoustics where the subject is the responsibility of WG17. In 1980, under the auspices of the Personal Safety Equipment Committee (PSM/–) a new BSI Technical Committee for Hearing Protectors (PSM/25) was established, with balanced representation from manufacturers, major industrial users, and acousticians. I joined PSM/25 in 1981, becoming its Chairman shortly afterwards.

A new standard for hearing protectors, BS 6344, was issued in 1984, forming the basis for a 'Kitemark' quality scheme for such products. The earmuff Standard set requirements for sizing and adjustability, and sought to ensure durability by placing a limit on any change in insertion loss after a mechanical cycling process which included headband stretching. A limit was also placed on any change in headband force arising after the cycling process.

At about this time, ISO formed a new Technical Committee (TC94/SC12) for hearing protectors as items of safety equipment, which I have had the honour to chair since its inception. Drawing on BS 6344, together with US, Nordic, French and German experience, draft product standards for hearing protectors and guidelines standards for the selection, use and maintenance of hearing protectors were developed and issued.

CEN Standards for Hearing Protectors

In 1989 the EEC published the Personal Protective Equipment Directive, setting requirements for the design and supply of items of protection equipment such as respirators, safety helmets, flame-resistant suits and hearing protectors. A related directive, The Use of Personal Protective at Work Directive (89/656/EEC) requires that PPE is used at work where there is a risk to health and safety that is not controlled adequately by other means. These EEC Directives have been implemented in the UK by Regulations – Statutory Instruments 1992/3139 and 1992/2966 respectively. A useful guide to the Regulations and to the requirements for PPE design, manufacture and supply is given in a DTI booklet [13].

With the advent of the PPE Directives and the EEC Noise Directive, CEN started work on hearing protectors, under a technical committee (TC159) with Swedish secretariat. The prior work in BSI and ISO was put to good effect, forming the basis of the new European Standards issued this year. The work has been speeded by the strong committee membership built up under the earlier ISO activity. Fellow IOA members who have been involved in ISO and/or CEN standardisation work will know that successful standards making requires effective national representation, a considerable degree of tact, and a willingness to compromise when appropriate. UK delegates often are able to play a pole part in discussion because the vast majority of meetings are held in English (or rather in 'Euro-English'). The downside of the deal is that one can all too easily end up speaking this rather quaint, limited vocabulary, eurospeak rather than the Queen's English at other events at home!

Driven by the tight deadlines (in standards terms) needed to meet EEC regulatory timescales, TC159 has now successfully completed a family of hearing protector standards, and is well advanced with the second generation standards for specialised products such as amplitude-dependent protectors.

EN 352 'Hearing Protectors - Safety Requirements and Testing: Part 1 – Earmuffs' [14] sets minimum performance and design requirements in areas such as sizing and adjustability, provides limits for comfort-related criteria such as headband force and cushion pressure, and requires the mechanical cycling durability assessment. Consistency of performance is looked for by introducing a limit on the standard deviation of the insertion loss values of a group of earmuffs, some of which are new and others of which have been through the cycling scheme.

Importantly, EN 352-1 requires that the subjective attenuation data published for the product are those measured on four samples of the earmuffs which have been mechanically cycled and maintained by the fitting of new cushions and liners. In the past it has been the practice to use brand new products supplied by the manufacturer for the test.

In EN 352-2 [15] for earplugs, many types of which are intended to be disposable items, there is no mechanical cycling scheme, but for products marked as reusable, the attenuation data published are those measured for samples which have been cleaned according to the manufacturer's instructions before wearing.

Under the PPE Regulations, hearing protectors are classified as mid-category products, for which type-examination by an 'Approved Body' is required. Type examination involves an assessment against the appropriate European Standard, or other equivalent criteria, and an examination of the technical documentation relating to the design and manufacture of the product. The 'Approved Bodies' are so designated by the DTI, under accreditation schemes operated by NACCB – the National Accreditation Council for Certification Bodies – or NAMAS. There are also accreditation requirements for laboratories undertaking testing of

UK data

Frequency, Hz

		63	125	250	500	1k	2k	3.15k	4k	6.3k	8k
Laboratory A	Mean	18.8	17.9	20.4	22.4	23.3	28.3	36.4	36.6	35.5	33.5
	sd	6.5	7.3	6.4	6.7	6.3	6.1	5.5	5.7	6.5	7.4
Laboratory B	Mean	15.9	17.6	20.3	22.2	23.6	31.0	35.7	35.9	34.6	31.7
	sd	8.1	9.2	8.6	8.3	6.0	5.8	6.3	7.9	5.8	7.9
Laboratory C	Mean	-	16.6	19.2	23.9	24.4	31.3	36.8	37.5	34.3	33.7
	sd	-	6.9	6.8	8.3	6.9	5.1	6.0	6.4	6.1	7.5

US quoted data

Frequency, Hz

	63	125	250	500	1k	2k	3.15k	4k	6.3k	8k
Mean	-	27	28	29	32	37	44	43	43	44
sd	-	3.3	3.2	3.1	2.4	2.8	2.1	2.3	3.9	2.7

Table 1. Comparative attenuation data for earplug 'X'

PPE and earlier this year Salford University was granted NAMAS accreditation for its hearing protector testing.

Only by meeting these type-approval requirements can hearing protectors carry the 'CE' mark allowing them to be sold in Europe. Another DTI booklet entitled 'Conformity Assessment' gives a concise guide to the subject of testing, acceditation and certification for the single market.

Estimating Protection Performance

In the UK we have, by tradition, used the octave band method to calculate the sound level at the ear when a hearing protector is worn. Generally, the mean value minus one standard deviation 'assumed protection' attenuation data have been used for this calculation. With the increased use of single number rating schemes, ISO TC43/WG17 has prepared ISO 4869-2 'Estimation of effective A-weighted sound pressure levels when hearing protectors are worn'. The document has very recently been accepted in ISO but has been rejected in CEN – an interesting situation because whereas the adoption of ISO standards in member states is optional, a CEN standard becomes mandatory in EEC member states on its introduction. The UK and Germany both voted against the adoption of the CEN standard because of inconsistencies in the application of 63 Hz attenuation data and undue complexity in the calculation methods. ISO has now made editorial changes to the text which it is hoped will allow its adoption by CEN. ISO 4869-2 offers three calculation methods – the octave band method, the HML method developed by Rune Lundin, and the SNR method. In the future, CE-marked hearing protectors will be sold with attenuation data for all of these three methods, and there is a risk that users will be confused by the plethora of numbers relating to their attenuation performance. The situation is compounded in ISO 4869-2 by the use of a multiplier, α, for the standard deviation so that the 'assumed protection value' can be calculated for any percentage of the population. Thus for 85% protection, the standard deviation is multiplied by 1.04, and for 80% by 0.84. WG17's view is that just having a multiplier of unity, implying an 84% protection value for a 'normal' distribution, suggests an inappropriate degree of accuracy in protection performance assessment – 80% and 85% are seen as 'round numbers' by WG17 but 84% is held to imply 1% accuracy. It is hard to find sympathy with this view when the alternative proposal involves multiplying the standard deviation, itself normally quoted to one decimal place in decibels, by a three digit number! The compromise solution offered by ISO is to say in the text that 'a multiplier of unity is often used'!

Readers will be familiar with the octave band method and, perhaps, with single number rating systems which require only the C-weighted sound pressure level to be measured. The HML method requires measurement of the C-weighted and A-weighted sound levels rather than the octave band spectrum and is capable of estimating the sound level at the ear to nearly the same accuracy as the octave band method. The HML attenuation data published for the protector relate to the noise reduction achieved in spectra having $L_C - L_A$ values of −2, 2, and 10 dB respectively. The manufacturer or test laboratory will have calculated the HML values for the protector. This is done, using the measured attenuation values, the subjective test, by determining the A-weighted sound level at the ear for a data base of 100 noise spectra whose $L_C - L_A$ values cover the range from -2 to 10 dB. Two straight lines intersecting at a $L_C - L_A$ value of 2 dB are then fitted to the data by rectilinear regression. The intercepts of these lines at -2 and 10 dB give the H and L values. The process is very easy to apply - to use the method one just has to plot two straight lines between H and M, and between M and L values on a graph of noise reduction against $L_C - L_A$, and interpolate for the particular value of $L_C - L_A$ of the noise in question. The technique is illustrated in the CEN Guidelines standard EN 458 [16], due to be published shortly, and discussed by Hempstock, Edwards and Needham [17]. There is even a sound level meter now available which will do the calculation for you!

The Future of Hearing Protector Testing

The subjective attenuation test standard ISO 4869 [18], which has its origins in BS 5108, has been adopted by CEN as a European Standard (EN 24869). Inter-laboratory variability in the subjective measurement of the attenuation of hearing protectors is a topic which continues to be the subject of debate within the profession on an international basis. Within the UK, in the past, three laboratories have provided this measurement service – ISVR, NPL Acoustics Division and the Department of Applied Acoustics at Salford University. UK inter-laboratory comparisons undertaken at the time of the introduction of the BSI Kitemark scheme showed good correlation in data [19], and more recently, international comparisons between UK, US, German and Nordic laboratories have demonstrated that the test method can give reliable, repeatable, data for a good quality product. However, controversy still lingers over some products which have high inherent variability in attenuation, and over measurements made under the earlier US ANSI standard (ASA STD1 −1975) which allowed the experimenter to fit the protector to the subject – sometimes achieving incredibly high attenuation performance with amazingly low standard deviations. Table 1 shows the attenuation data measured by the three UK laboratories according to BS 5108 for a particular type of glass-down earplug and the US published data for the product. The three sets of UK data can be seen to compare extremely well in terms of both mean values and standard deviations. By comparison, the data obtained under US testing shows much higher mean values and standard deviations that are lower than those often found for well-fitting circumaural earmuffs.

Current debate in attenuation testing centres on inter-laboratory variability from unintentional directional sound field effects which can be found within the defined limits in EN 24869, and on 'outliers' – those test results, on some test subjects at some frequencies, which fall well outside the 'normal' range of results. This topic, described recently by Berger [20], lies at the heart of the issue of subjective testing. In the UK, it has always been held that by taking a representative number of test subjects, who are capable of fitting the protector under test without discomfort, a measure of the attenuation achievable in practice (for a 'new' sample of the product) would be obtained. The range of attenuation achieved by users has been taken into account by taking the mean value less one standard deviation as the 'assumed protection' of the protector for noise exposure assessment. On the other hand, if as appears to be the case, there is a random but infrequent occurrence of outlier results in hearing protector test data, with perhaps just one 'rogue' value at just one test frequency every few tests, it might be argued that this is not a reliable basis for the comparison of products in the marketplace. It would be reasonable under these circumstances to be allowed to remove statistically proven 'outlier' data from the test results, provided that we do not fall into the trap of the US 'experimenter-fit' situation, which resulted in 1983 in OSHA instructing its officers to derate NRR attenuation data by a factor of two when assessing hearing conservation programmes. There is much support for the argument that 'outlier' results occur in real life and that some allowance should be made for them in assessing hearing protector performance.

A product standard for hearing protectors attached to a safety helmet (prEN 352–3) is well advanced under the Convenership of Paul Clarke of Inspec Laboratories, and is expected to be submitted for formal voting in CEN in early 1994. Work on the 'electronic' level–dependent earmuff standard (prEN 352–4) is also in its final stages and will be submitted for enquiry under the CEN PQ procedure within the next six months. These products are generally intended for use in impulse noise but are also used in intermittent noise environments. The standard places a limit on the level at which sounds can be reproduced under the earmuff in order to prevent unnecessary noise exposure of wearers, who, with some of the products on the market today can find themselves listening to reproduced sounds at 90 - 95 dBA in an external sound level of 85 dBA!

The other major area of interest in hearing protector standardisation for the future is that of performance in impulse noise. The EEC Noise Directive sets an overriding exposure limit of 200 Pascals peak pressure. The question that cannot be answered yet is what reduction in peak sound pressure will a hearing protector give! There is unlikely to be a simple answer to this question since most of the available evidence points towards a non–linear response which is dependent on the level and duration of the incident impulse. This area is the subject of an EEC–funded research project in which Salford University is involved, the results of which will be taken up by CEN and ISO in future standards development.

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The opinions expressed in this article are the author's own and not necessarily those of the Institute or BSI.

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ECMA STANDARDS

Don Baines MIOA

Following John Woodgate's article 'Standards 1993 - A tutorial overview' (Acoustics Bulletin May-June 1993) it seems appropriate to offer a short description of the work of ECMA, European Computer Manufacturers Association, with respect to acoustical standards. For over thirty years ECMA has actively contributed to worldwide standardization in information technology and telecommunications. More than 180 ECMA Standards and 60 Technical Reports have been published.

ECMA TC 26 - Acoustics has in its scope: To recommend standards for determining the noise outputs of different categories of individual items of information technology equipment intended for use in defined working environments; standards for determining total noise levels in the said working environments, these standards to include corresponding methods of measurement; preferred methods of predicting total levels if units of known noise output are installed together.

To date this committee has prepared the following standards and technical reports:

ECMA-74 Measurement of airborne noise emitted by computers and business equipment, 3rd edition (Dec 1992). This standard was the base document for ISO 7779 (EN 27779).

ECMA-108 Measurement of high frequency noise emitted by computers and business equipment, 2nd edition (June 1989 and presently under review). This standard was the base document for ISO 9295 (EN 29295).

ECMA-109 Declared noise emission values of computer and business equipment, 3rd edition (Dec 1992). This standard was the base document for ISO 9296.

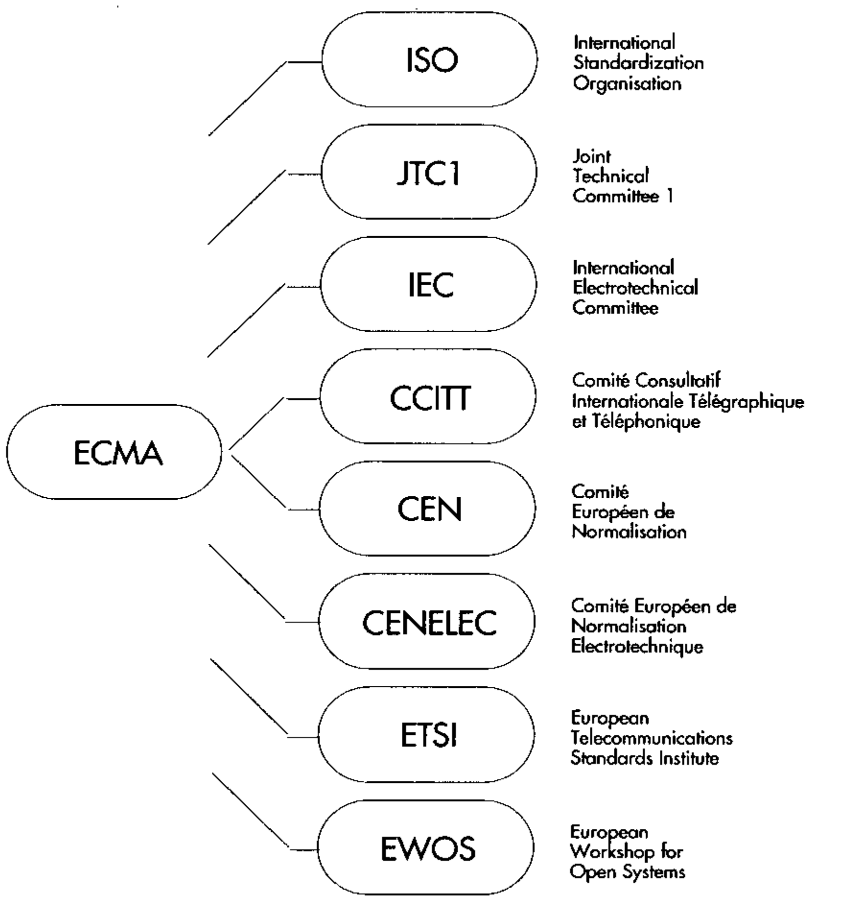
ECMA-160 Determination of sound power levels of computer and business equipment using sound intensity methods; scanning method in controlled rooms. This standard is based on ISO/DIS 9614-2.

ECMA TR/27 Method for the prediction of installation noise levels, 1st edition (March 1985 and presently under review).

ECMA TR/62 Product noise emission of computer and business equipment. This technical report gives an overview of the latest developments in noise control standards and legislation and the interpretation of noise emission values of computer and business equipment. It describes the standardized quantities for the measurement and declaration of product noise emission. This information is useful when comparing the noise emission of equipment of the same product category as well as of different equipment used in the same environment. A comprehensive collection of product noise emission values for various categories of computer and business equipment is provided.

The inter-relationship of ECMA and ISO standards, and the relationship of ECMA with respect to other standards bodies is shown in the attached tables.

ECMA has a collaboration agreement with ETSI and, indeed, prepares many of ETSI's documents for them. ECMA TC 26 is at present approaching ETSI with respect to collaborating on producing acoustical standards applicable to telecommunications equipment and in particular with respect to acoustic shock. This has emerged as a hazard to user of headphones etc, and has safety impli-



ECMA's Role in International Standardization
(ECMA has close working relations - such as liaisons, co-operation agreements, memberships - with European and International standardization bodies)

cations for the users of multi-media systems.

On a personal note I have had the pleasure, and honour, of being the chairman or vice-chairman, alternating on a three-year cycle, since ECMA TC26 started its work in 1978. I represent ECMA on ISO TC43/SC/WG23 and recently have become a member of BS EPC/1/4, representing EEA.

For those interested, copies of ECMA standards are available free of charge from: ECMA, 114 Rue du Rhône, Geneva, Switzerland.

I would like to endorse John Woodgate's final statement 'Perhaps the time has come for a change in this respect' and suggest that perhaps now is the time to form an IOA standards committee.

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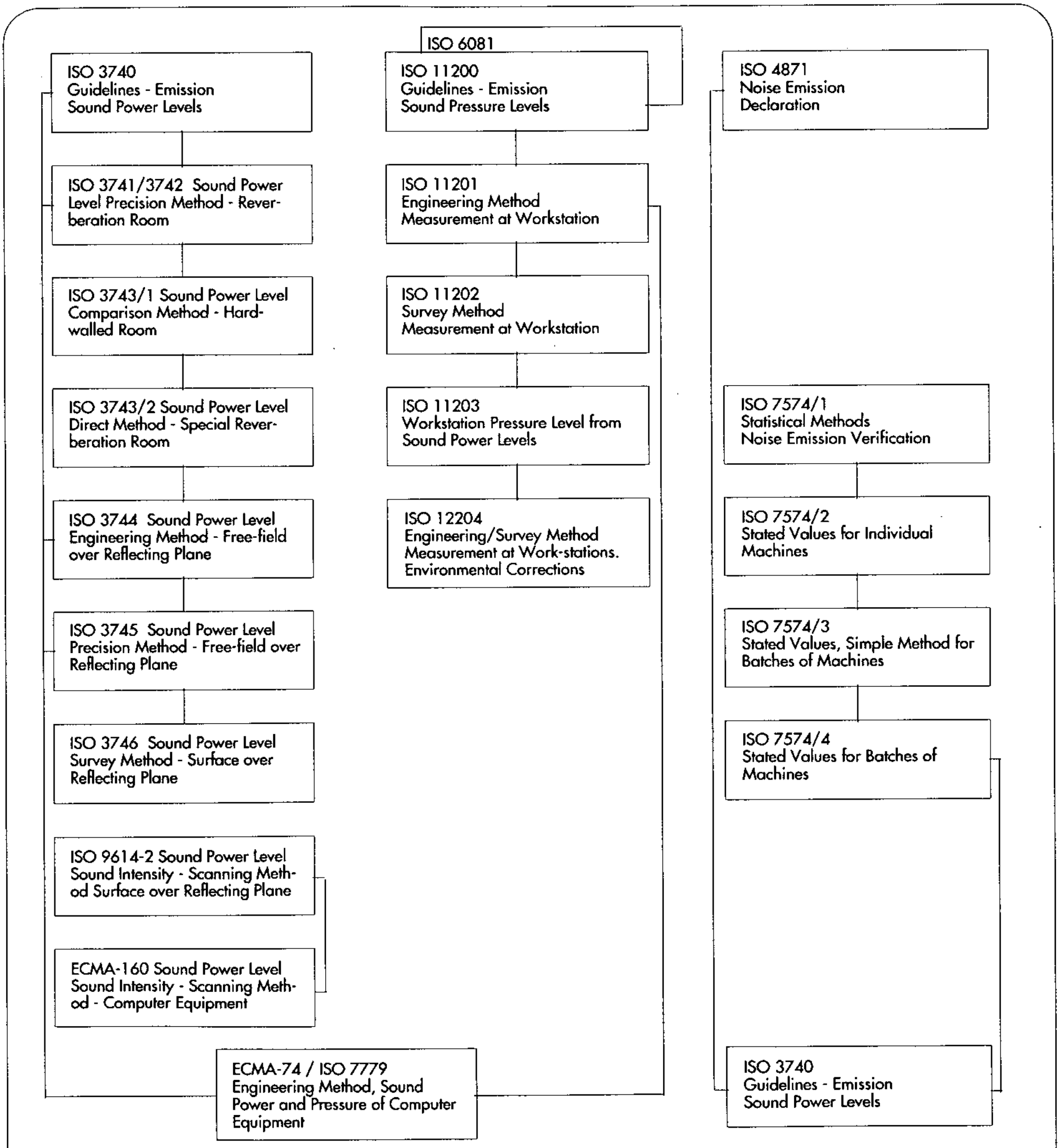

The relationship between IT Equipment specific test codes and International Standards

DEVELOPMENTS IN FORENSIC SPEAKER IDENTIFICATION

J Peter French

Introduction

The purpose of this article is twofold. The first purpose is to update the wider acoustics community on the role now occupied by acoustic-phonetic examinations of speech in one area of forensic phonetics, namely speaker identification. The second purpose is to bring to the attention of readers the existence of a professional body, the International Association for Forensic Phonetics, recently established to promote research and regulate practice for those working in this area.

Forensic phonetics - the application of phonetic analysis in the resolution of legal disputes - has undergone a number of methodological shifts and developments over the past thirty years. In particular, the position of acoustic-phonetic analysis in the identification of speakers in criminal audio recordings has been a major subject of debate [1], [2], [3].

The 'Voiceprint' Tradition: USA

From the time in the early nineteen sixties when courts began to have a need for the identification of speakers in audio recordings, two diametrically opposed methodological traditions evolved; one in the United States, the other in Britain. In the United States, the identification of speakers tended to be carried out by acoustic analysis alone. Within this approach, the so called 'voicegram' or 'voiceprint' tradition, speech spectrograms - graphs showing the distribution of energy across frequencies against time - were made of the voice represented in sections of criminal recordings and compared with those made of known suspects and defendants.

The underlying assumptions were that: (a) different renderings of the same words or sounds from one individual would throw spectrographic patterns which preserved important similarities; and (b) speech from different individuals would produce significantly divergent patterns. The problems with this approach to speaker identification were both theoretical and empirical.

As is well known, spectrographic examinations of multiple productions of any utterance by the same individual will, inevitably, reveal differences, both in the timing of constituent segments (vowels and consonants) and in their energy-frequency structures. Further, spectrograms of utterances produced by different speakers, particularly where they share the same regional or social accent, may show closely similar patterns in the time and frequency domains. Protagonists of the voiceprint approach, [4], [5], whilst sometimes offering unmitigated positive identifications of speakers, failed to explain, indeed many phoneticians would say were quite unable to explain, what should be taken to constitute a significant or diagnostic similarity or difference between spectrograms. In the view of many, the voiceprint approach amounted to no more than a crude form of 'picture matching', with wholly unexplicated criteria of what might be considered a match or mismatch.

Further discussion of theoretical and practical difficulties associated with this approach may be found in inter alia [6], [7], [8].

During the nineteen sixties and seventies the 'voiceprint' approach generated a great deal of enthusiasm both among certain restricted sections of the phonetics community and among law enforcement personnel in the USA. Its over-zealous application in criminal trials almost certainly led to miscarriages of justice and a judicial review was instituted which resulted in its rejection as legal testimony by a number of States.

The Auditory Tradition: UK

Concurrent with the development of this purely acoustic tradition in the USA, a purely auditory-phonetic approach to the problem was emerging in Britain. This involved phoneticians listening to and making notes upon voice and speech patterns represented in criminal recordings and comparing them with those found in known recordings of speech from suspects. Auditory impressions of voice quality, rhythm, stress, intonation and segmental features provided the basis for assessing comparability.

Theoretical justifications for rejecting acoustic analysis were never fully articulated by proponents of the purely auditory approach. Indeed, one of its unusual hallmarks was that it gathered momentum as a body of practices unsupported by any serious attempt to explain its basis in the academic or professional literature (though see [9] and [10]). It is only quite recently that any systematic defence of the position has been put forward [6].

Whilst no miscarriage of justice has ever been established to have arisen from this approach, its shortcomings, both in my own view and that of most other forensic phoneticians, are quite clear. Firstly, acoustically different speech data may engender similar auditory impressions. Thus, listening - albeit trained listening - may fail to disclose important differences between samples [3]. Further, and working in accordance with accepted scientific principles, a conclusion upon any matter - speaker identity included - which is informed by two different and independent types of analysis may be considered stronger and more reliable than one founded upon one method alone [6]. Thus, the vast body of professional opinion internationally now espouses a joint auditory-acoustic-phonetic approach [6], [11].

Acoustic-Phonetic Testing

For reasons of space it is not possible to provide a full description of all acoustic-phonetic tests carried out within

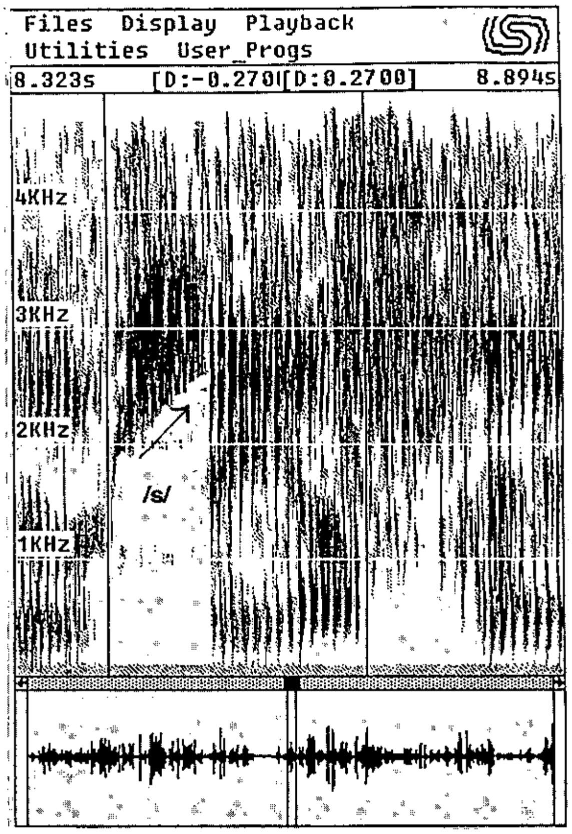

Fig. 1. Criminal sample: /s/ of 'see you on'

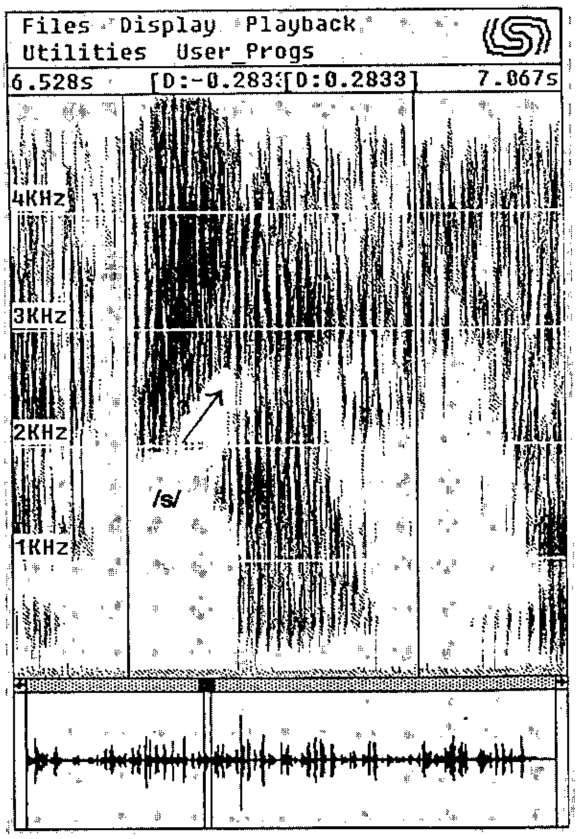

Fig. 2. Known sample: /s/ of 'sound'

this joint approach in the present article. However, the following should provide some general indication of the areas examined.

Spectrographic Analysis

Whilst time-frequency-amplitude examinations, undertaken either with conventional spectrograms or more recently available alternatives such as linear predictive coefficient analysis, do play a part in the overall approach, unlike in the earlier 'voiceprint' tradition, these do not constitute the exclusive focus of the acoustic examinations. Moreover, similarities and differences revealed by such examinations are - and must be - subject to careful interpretation, both in the context of wider sets of features revealed within the particular samples by other types of phonetic investigations and against the background of any available normative data and the analyst's accumulated experience.

Frequency Domain Examinations

Experience and research have shown that certain sound segments are better indicators of individual speaker identity than others; for example in relation to consonants /s/ is noted as a potential carrier of inter-speaker variability [12]. The spectrogram in Figure 1 shows an unusual pattern of energy distribution for the consonant /s/ taken from a recording brought in evidence in a recent criminal trial concerning indecent telephone calls. Sound energy associated with /s/ typically occurs from around 3.4 kHz upwards. Here energy is visible from around 2.0 kHz upwards, reflecting a retracted tongue position more usual for the palato-aveolar /ʃ/ than for the alveolar /s/. Further, the upslope of the lowest frequency energy across its production (2.0 kHz to 2.6 kHz) indicates that the /ʃ/-like character is most marked at point of onset, the tongue moving towards - though never achieving - a more conventional alveolar type stricture as articulation of the consonant progresses. This distribution of energy for /s/ was found to be quite consistent across the criminal recordings and the known sample of speech from the suspect. Figure 2 represents a spectrogram of a comparable token taken from the known sample.

More precise estimations of the distribution of energy can be derived from conventional type FFT displays made at fixed points across the duration of sounds. These, and in certain cases power spectra averaging procedures, have been found useful in association with sound spectrograms for building up acoustic profiles of speaker practices and habits concerning the articulation of consonant and vowel segments [7].

Time Domain Examinations

Spectrograms provide a convenient and highly accurate basis for measuring durations of segmental and subsegmental elements of the speech chain. Such measurements can assist with the determination of speaker identity, particularly where unusual or pathological tendencies are present in the samples. One such case reported by the author [6] involved a criminal telephone recording in which the caller's speech was found to contain evidence of two sub-varieties of stammer: (a) prolongation - a tendency (most commonly associated with

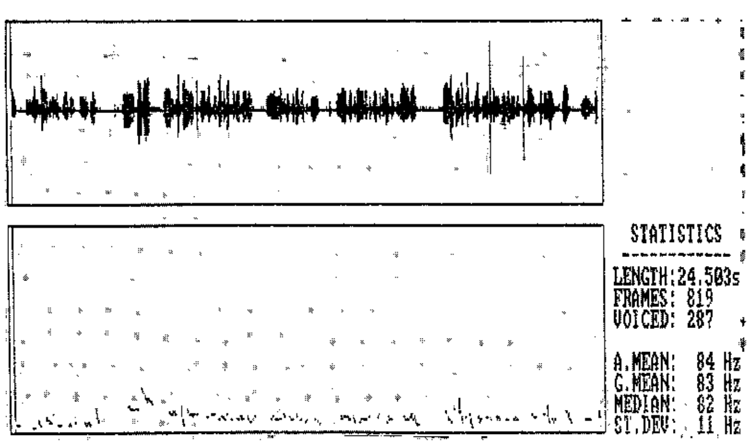

Fig. 3. f0 plot of 25 seconds of speech showing average values

fricatives) to sustain consonants beyond their normal durations; (b) block - the tendency to arrest the development of consonants. This latter tendency is usually associated with plosives which, if affected, may exhibit very long hold phases. Both tendencies were apparent in the criminal call and in the speech sample provided of the suspect simply from listening. However, by isolating instances and subsequently deriving durational measurements from spectrograms it was possible to calculate averages for both samples, which transpired to be extremely similar. This, together with relatively tight correspondences on other acoustic- and auditory-phonetic parameters, formed the basis of an opinion of identity between the samples.

More generally, spectrographically-derived measurements of a range of features including duration of aspiration on fortis plosives are becoming acknowledged as worth a place in the tests used by forensic phoneticians.

Fundamental Frequency Examinations

Average f0

Estimations of average rate of vocal cord vibration may be made for sections of speech from both known and criminal recordings by peak-picking, auto correlation or cepstral algorithms available within many new generation Apple Macintosh and PC-based 'speech laboratory' programmes, as well as by dedicated 'stand-alone' instrumentation. Average fundamental frequency (f0) values can be compared, not only across known and criminal samples, but also against normative data [11]. In this way it is possible to estimate the incidence of the averages established for the samples within relevant sections of the population.

Creak Transition Points

Points in the pitch range at which transitions from normal phonation into glottal creak occur are also recoverable from f0 analyses and comparability across samples in this respect may be assessed.

Intonation

Where f0 estimation devices give graphic displays of pitch movement, these allow one to observe and document characteristic patterns of intonation present in the samples.

Jitter Estimation

Estimation of jitter - perturbation of the vocal cords which occurs simultaneously with the basic rate of vibration - has for a long time been used in clinical phonology as a means of assessing the degree of hoarseness shown by patients with voice pathologies. One factor which has impeded its introduction into forensic phonetics has been that accurate values needed to be based upon examples of sustained phonation by the subject with f0 being held relatively constant (laboratory-elicited productions of 'ahhhh') [13], [14]. Work by the German Bundeskriminalamt (state police) speaker identification laboratory is currently being directed towards developing an adjustment algorithm whereby jitter co-efficients may be determined for speakers from naturally-occurring vocalic elements extracted from known and criminal recordings.

Acoustic Analysis in Context

In considering acoustic-phonetic examinations, the following points must be borne in mind:

1) They must be seen as complementing rather than replacing auditory phonetic examinations of the recordings. Just as there are certain features of speech which are more readily disclosed by instrumental means, so there are others (certain aspects of voice quality, for example) which, within the present state of technological development, are not amenable to machine examination, but which may be readily apparent to the ear of the analyst who has undergone a training in auditory phonetics. Unless accompanied by auditory-phonetic analyses undertaken by a qualified and experienced phonetician, the results of purely acoustic-phonetic comparisons would be quite meaningless.

2) Even when criminal and suspect recordings have been compared on the widest possible range of auditory and acoustic dimensions, it must be recognised that one cannot establish speaker identity with absolute scientific certainty. If, as in most judicial systems, the conviction of a criminal entails proving guilt 'beyond reasonable doubt', then forensic speaker identification evidence is, in itself, an insufficient basis for a conviction. Notwithstanding an increasingly 'high-tech' acoustic-phonetic input to the comparisons the forensic phonetician undertakes, the conclusions he/she draws remain at the level of expert opinion. The opinion is normally expressed in terms of a likelihood and, when offered in evidence in a criminal court, it must be used corroboratively.

Professional Developments

In 1991 the *International Association for Forensic Phonetics (IAFP) was founded at the Fourth Annual Conference on Forensic Applications of Phonetics in York. Through its Professional Conduct Committee, the Association has established a Code of Practice designed to regulate the activities of its members [15]. A set of guidelines concerning procedures for processing recordings and maintaining records of analysis is currently being formulated. These may be seen as important steps towards establishing and enforcing the highest professional standards for those involved in the area.

A further aim of IAFP is to foster research in forensic phonetics. Through its Research Committee, this aim is pursued in two ways. Firstly, it acts to co-ordinate research proposals from networks of members working within different universities, government and private sector organisations and to assist with the presentation of these for large-scale funding from public bodies. Secondly, it awards small research grants to members from its own funds.

In 1993 IAFP was registered as the professional body for those engaged in forensic phonetic casework, and it currently draws members from Germany, the Netherlands, Australia, New Zealand, African countries and the United States as well as the UK.

The next Annual Conference of IAFP will be held at the Cardiff Institute of Higher Education in July 1994. In the meantime, certain members will be presenting papers in the Forensic Phonetics session of the Institute of Acoustics' Reproduced Sound 9 Conference at Windermere.

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**Membership of IAFP is open to established phoneticians with operational or academic interests in forensic phonetics. Student Membership is open to students undertaking a course in higher education in phonetics or a closely related discipline. Associate Membership is open to those working within disciplines related to phonetics, including acoustic engineering, signal processing and speech pathology. Membership details from: Marion Shirt, IAFP Membership Secretary, Department of Linguistics and Phonetics, University of Leeds, Leeds LS2 9JT.*

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HAND-ARM VIBRATION REVIEW: The 6th International Conference, Bonn 1992

Alan W Bednall MIOA

Introduction

This paper looks at some of the technical developments in the measurement, assessment and control of exposure to hand-arm vibration which were presented at the 6th International Conference on Hand-Arm Vibration. Medical aspects are not covered.

The principal purpose of this paper is to draw the technical developments discussed at the conference to the attention of a wider audience and thereby help to stimulate their practical application to the reduction and management of the health risks associated with exposure to Hand-Arm Vibration (HAV).

The Conference: General

The International Conference on Hand-Arm Vibration is the foremost international event in this field. The first meeting took place in Dundee in 1972 and subsequently meetings have been held every 4 to 5 years. The purpose of these conferences has been and is, not only to encourage the documentation and discussion of recent scientific developments in the field but also to promote their implementation and to this end the 6th conference was targeted on the European Year of Health and Safety.

The latest Conference, which took place in Bonn, Germany from the 19 to 22 May 1992 was organised by the Confederation of Professional Insurances Associations' Institute for Health and Safety at Work, with the support of the International Commission on Occupational Health (ICOH) and the International Advisory Committee of the International Conference on Hand-Arm Vibration.

More than 230 delegates from 23 countries participated in the presentation and discussion of 110 papers covering a wide range of medical, technical, legal and management aspects of hand-arm vibration, its effects on those exposed to it and the reduction and control of associated health risks. The papers and posters presented will be published in the Conference Proceedings [1].

Review of Selected Topics

Legal Aspects

Dr Van der Venne of the Commission of European Communities (CEC) presented his views on a proposed physical agents directive [2] and specifically on those aspects concerning exposure to hand-arm vibration.

His views were broadly as outlined in the original draft annex with useful additions to clarify and simplify matters; he stated:

1. that Directive should not be viewed in isolation.
2. that the 'International Documents' which will accompany the Physical Agents Directive will:
   - provide a common understanding of what is required
   - ensure dynamic and co-ordinated application of requirements.
   - ensure homologation of technical requirements. NB State of the Art must be followed.
3. standards provide the technical specification and will be used to achieve and sustain 'State of the Art'; they are also intended to be of assistance to end users.
4. with regard to vibration measurement, the use of vector sum was to be required but with the use of a single dominant axis value where the levels on any other axis do not exceed 60% of the dominant axis value.

Vibration Action Levels mentioned by Dr Van der Venne were broadly similar to those previously suggested by him, ie:

- Threshold Level = 1 m/s^2
- Ceiling Level = 5 m/s^2
- Worker, Exposure Action Level = 2.5 m/s^2
- Machine Vibration Action Levels of 2.5, 10 & 20 m/s^2.

Inaba et al [3] reported a study carried out in Japan to obtain a vibration dose limit for workers exposed to hand-arm vibration. Their conclusions were that a daily limit of 2.5 m/s^2 might decrease the risk of VWF.

A Japanese paper [4] on the legal aspects of handling the hand arm vibration syndrome was not presented and only a few of the other papers referred directly to this topic. Wilfred Kalwa of the Federal Ministry of Labour and Social Affairs did, however, indicate that Germany had reviewed a decision taken some years ago concerning ratification of the vibration requirements of ILO 148 and was, as a result, likely to ratify this clause within the next two years. The German accident regulations now being prepared (UVV 'Vibration') utilise an '8hr assessment value' of 2.6 m/s^2 rms [5].

Vibration Measurements

Hartung and Dupuis et al [6], [7] reported research which supported Dr Van der Venne's proposal that vibration exposure be assessed on the basis of the so called 'Vector Sum' of measurements in three axes.

They also recommended on the basis of other work, that regulations dealing with hand-arm vibration should take into account the forces which are exerted between vibrating surfaces and the hands of workers who have to hold such surfaces.

This latter may sound sensible, though several years of study would almost certainly be needed to obtain good epidemiological evidence on which to base any revised 'dose-effect' relationship and to develop practical and convenient means of measuring the grip force simultaneously with the vibration. In practice it would be difficult, if not impractical, to measure both the forces and the acceleration (or the vibration energy absorbed by the hand) simultaneously in the field. However, a simplified approach described in a further paper [8] may offer an acceptable alternative.

Risk Assessment

Despite the obvious need for revision of the basic international standard for the measurement and assessment of human exposure to hand-arm vibration (a process which has already started within the relevant ISO technical committee) other papers support the view that the existing standard, ISO 5349, [9] can successfully be used as a basis for the measurement and assessment of workplace vibration environments and for subsequent, effective action to reduce associated risks to health [10], [11]. However, as Schenk [12] indicated, current standards do not adequately deal with impulsive vibration of the type produced by bolt guns, nailing guns and cartridge operated tools.

It is clear from several of the papers presented, that while measurements of vibration acceleration are being carried out in a uniform way in various parts of the World, the methods used to determine the actual length of time for which worker's hands are exposed to vibration vary considerably. This is no doubt one of the reasons why some researchers found a good correlation between assessments based on ISO 5349 and actual clinical experience and others did not [13].

The 'dose-effect' relationships given in the annexes to ISO 5349 (now ENV203549) and BS 6842, [14] were based on research in which typical daily exposure times were determined by questioning either the workers concerned or their managers. Research has shown that such estimates, generally, over-estimate the time for which vibration is passing into the hands of workers at risk. Today many researchers measure this time very precisely using, in some cases, video observation of the contact between hand and vibrating surface. Consequently it is not surprising to find that, when a worker says he is doing a particular job for 5 or 6 hours a day the true exposure time may be found to be less than an hour and that an assessment of risk, based on the very precise measurement of exposure time, may suggest there is no risk (or the risk is low) when that is not in fact the case.

Kaulbars related BIA experience in attempting to measure the vibration of handles and other gripped surfaces and in particular of the difficulties experienced in measuring on handles of elliptical cross section. BIA have developed their own mounting method and a lightweight mechanical filter for use on rigid handles. For handles and other surfaces covered with a resilient material BIA have developed a mounting 'shell' which can be moulded to the form of any surface whose vibration is to be measured [15]. It should be noted that one problem with lightweight mechanical filters is that their 'cut-off frequency' may be too high and vibration at frequencies above the range of interest may overload the measurement system causing significant errors.

The use of laser vibrometers is of increasing interest to researchers in this field and Dr Boileau described the use of such a vibrometer to establish the frequency response of a wrist band accelerometer mounting [16]. The use of lasers for vibration measurement is also being explored by researchers in Germany and the UK. In the UK, for example, the Health and Safety Executive Buxton laboratories have been investigating their use for vibration measurements in situations were measurements by other methods are particularly difficult eg chipping hammer chisels. The measurement of vibration during the underwater use of pneumatic drills and breakers was outlined in a poster session [18].

Machinery Type Testing

In order to measure hand-arm vibration values on lawn mowers, the Fraunhofer Institute has developed a procedure similar to the normal work situation in which the operator guides the mower over a special, elastic, mat which simulates the effects of meadow ground. The results are said to be reproducible [17].

Vibration Exposure

Research into the exposure of groups of workers was reported by a number of authors. Holland [15] found that 57% of Federal Germany's 649,000 building workers were regularly exposed to hand-held machines such as vibrators, power trowels and joint cutters. Extreme exposure values were found for groups such as pavers and road workers. 89% of the 54,000 strong group are exposed, for more than 4 hours a day, to levels of weighted vibration in the range 7.9 to 8.3 m/s^2, created by vibrating rollers, plate vibrators and IC engine powered compactors.

Engel [18] reported that vibratory disease headed the list of industrial diseases in Poland with about 450 to 500 cases being reported each year. Two particularly prominent areas giving rise to these diseases were the coal and the metal industries. Louda [19] investigated a group of Czechoslovak workers who were using tie (nail?) guns to fabricate wooden panels, who were exposed to some 2,400 impulses per shift giving a total of 30 minutes exposure time. Bovenzi [20] Starck, Nagase and Futsaka [22] reported studies of chain saw users.

Research carried out in Holland by Peters [13] shows that workers involved in the maintenance of railroads may be exposed to vibration values of from 4 to 60 m/s^2 for between 0.5 and 5 hours a day. 40% of a sample of 25% of the exposed population had experienced neurological and/or musculoskeletal complaints. Many other aspects of the Hand-arm Vibration Syndrome (HAVS) are dealt with in other papers.

American and Canadian speakers stated that those countries were experiencing an increasing number of cases of the HAVS. Problems appeared to be greatest in the heavy industries, manufacturing, agriculture and meat processing. Ergonomic guidelines were said to have been produced for the American meat packing industry by OSHA [23], [24].

Vibration Reduction

Sixteen papers and posters dealing with aspects of vibration exposure reduction were presented. Some were of a very general nature, detailing the difficulties facing the manufacturers of hand tools and the ways in which they have succeeded in reducing the weight and increasing the power output of their products while at the same time improving their ergonomic design and, in some cases, reducing vibration levels. Over the past 25 years, for example, the power to weight ratio of many power hand tools has increased from about 200 watts/kg to over 600 watts/kg. In the same period the vibration of electric hedge cutters, for example, has been reduced from 15 to 2.5 m/s^2 [25].

For designers, the work now being carried out by Cronjager [21] on the vibration classification of hand-held percussive tools should be useful. On the basis of an extensive market investigation his colleagues have established dynamic descriptions of different types of tool which enable them to be classified into separate groups. This information identifies the criteria important for different tools and (according to the authors) can be used to optimise pneumatic tool, anti-vibration system, design.

Stark [10] described the progress made in the Finnish Forestry Industry in reducing the vibration hazard to which chain saw users were exposed. In a 20 year period chain saw capacities have almost halved, speeds have increased and weights have fallen by almost 40 percent. As a result of the various technical changes to chain saw design, vibration levels have fallen from 14 to 2 m/s^2 and there has been an 8 dB reduction in 'impulsiveness'. The chain saws also feature heated handles. Forestry managements have taken other preventative measures such as the provision of warm transport, warm cabins, meals and clothes. Physical training is provided and better working methods have been developed with the result that the risk of workers developing vibration white finger is now very low.

Kirchberg [26] gave an overview of the technical possibilities for the reduction of chipping hammer, grinder, drill etc vibration by design but the most interesting paper on this topic was that given by Professor Dobry of the Technical University of Poznan, Poland [27]. Dr Dobry and his colleagues have developed a series of pneumatic impact tools which incorporate their 'WOSSO' system of vibration isolation. This ensures a constant interaction force between the operator's hands and the machine regardless of the deflection of the vibration isolation system within the tool. The result is that machines of from 7 to 18 J capacity, operating at 25 to 30 Hz, have under standard test conditions, handle vibration levels in the range 0.7 to 1.5 m/s^2. Currently 200 of these tools are in use in mines and quarries and further products are being developed.

In discussion, one researcher reported that measurements on a vibration reduced tamper of a type used in railway maintenance gave values of 15 m/s^2 or more than twice the values quoted by its manufacturer. The manufacturers representative explained that the tool was originally designed for rock drilling where it was required to provide a high penetration rate but under the conditions of use found on railway applications the piston could strike the end of its cylinder causing increased vibration. They recommended that the railway reduce the chisel penetration rate and change the chisel [5].

Grinders are probably the more widespread source of exposure to hand-arm vibration and several papers dealt with these; Fritz [28] reported on a project carried out in a steel works with the aim of reducing the exposure of billet grinders. The measures introduced included the use of elastic grinder handles to reduce vibration exposure of 25%, the introduction of lighter grinders, and workplace reorganisation to improve the posture of the grinder users. Their view was that, if further improvements were to be made, mechanisation of the processes would be necessary. Kochinashvili [29] reported on work carried out in the USSR to control exposure to grinder vibration by the use of springs, shock absorbers and other measures. A novel means of limiting grinder vibration was outlined by Kaneda [30] which uses feedback control of motor speed to minimise vibration transmission of the handle.

Nut runners are also widely used in industry and work carried out by Kihlberg [31] showed that the use of nut runners featuring torque cut-off devices produced vibration levels in use of only 1.5 m/s^2 compared with the values of 5 m/s^2 generated by the impact wrenches they replaced. They pointed out, however, that the characteristics of the cut-off devices must be taken into account in selecting these tools.

Although these machines are not in widespread use in the UK, the measures adopted by workers in Finland to reduce vibration levels of Snowmobiles can be considered with respect to ride-on mowers and certain all-terrain vehicles. They identified the critical points as the motor mountings and resonance of the steering yoke and identified the need for appropriate isolators and damping [4].

Geis [32] described how the physical loads imposed in rock drilling can be reduced by using hammer action drills instead of the percussion drills which are currently widely used. Although more costly, the rate of penetration may be higher and by incorporating absorbing handles and other features vibration values could be reduced. The particular value of this paper is that it, like a number of the others, was presented by a manufacturer.

The availability of low vibration tools is one thing but getting users to purchase and use them is quite another! Donati [33] outlined the action taken in France by the INRS with respect to road breakers. In France 50% of compensation cases relate to users of breakers and research has shown that although several vibration reduced breakers are commercially available knowledge of this fact is poor. Where firms have tried such machines they have generally used them incorrectly and there has been considerable worker resistance to their introduction. Hirers of such equipment will not buy the low vibration machines, unless it is made compulsory to do so, because of increased cost and maintenance.

IRNS have initiated a campaign to raise awareness of low vibration breakers and the benefits they offer. Their campaign will include the issuing of 12,000 leaflets, advertising in newspapers, conferences and demonstrations and the preparation of an information pack. A key element in the campaign is the offer by IRNS to pay breaker users the difference in cost between the prices of vibration reduced and traditional breakers - plus 10 per cent. Resources to subsidise 600 breakers have been allocated.

Anti-Vibration Gloves

Four papers dealt with research relevant to the design, and testing of so called 'anti-vibration' gloves. Cronjager [34], and Liwkowicz [35] reported work on the testing of resilient materials which might be used in gloves (or to cover handles). Hohmann [36] described the standard test procedure which is currently being developed by a CEN/TC 231 working group. Of the gloves so far tested by the group, only one has provided attenuation of vibration at frequencies down to 150 Hz.

This suggests that gloves might provide rather more protection than was suggested by Bednall, but tends to confirm that such gloves are unlikely to provide any significant protection in the frequency range (5 to 32 Hz) to which the human hand-arm system appears to be the most susceptible.

Subsequently, delegates who visited the laboratories of the Professional Insurance Association's Institute at Sankt Augustine were able to see the glove test rig in operation and try it out for themselves. The design of the proposed test was queried by a number of delegates. Brammer suggested that what was being assessed was the protection offered to the palm of the hand and not necessarily that provided for the fingers. Nelson queried the effect of the palm fitting transducer adapter.

Jetzer [23] presented the results of work carried out to assess the one commercially available vibration damping material in reducing the clinical symptoms of the hand-arm vibration syndrome (HAVS) in foundry workers. A material called 'Viscolas' was tested on grinders and chipping hammers and found to be effective in reducing vibration above 1 kHz. The clinical findings suggested that high frequency vibration might be significant both for workers discomfort and for the development of HAVS.

Reduced Vibration Power Tools

A number of manufacturers had displays at the conference which indicated the commercial potential of vibration reduced, hand-held power tools. Atlas Copco market a wide range of vibration reduced hand-held tools including breakers, chipping hammers, rammers, grinders, riveting guns, and needle descalers. The AEG Electric Powertool Company Ltd markets vibration reduced, electric, hammer drills which feature internal 'vibration damping' (said to halve the vibration reaching the user's hands) and soft, ergonomically, designed handles.

Frolich & Kluppel, manufacturers of pneumatic power tools, can supply low vibration pneumatic stone hammers (chipping hammers of a type used by stone masons). One of the features of these tools is a resilient sleeve which provides protection for the hand used to hold and manipulate the chisel. Tests carried out by a BIA confirm that the new design provides a substantial reduction in vibration transmitted to the tool users hands.

The Berlin based Map Pneumatic Tool Company claim a 95% reduction in vibration for their new range of reduced vibration chipping, riveting and other pneumatic hammers. Suitable for applications in construction, quarrying, and metalworking, the hammers are available in 7 performance classes. The smaller hammers incorporate a preloaded helical spring between the axially moving cylinder and the handheld surfaces which absorbs the vibration. Medium sized hammers also feature a spring to absorb the relative motion of the cylinder but for these an air cushion is also provided. For the largest in their range of hammers the firm utilise their patented 'tapered cylinder' principle to reduce vibration transmitted to the grip surfaces. With some of their products, maximum output can only be achieved when the hammer chisel exerts a predetermined force on a workpiece [37].

A road drill (breaker) was displayed in the laboratories of the BIA. Tests carried out by the latter organisation indicate that the vibration levels on the new design are 4.5 m/s^2 or roughly one third of the values measured, under standard test conditions, on breakers of a more traditional design.

Concluding Comments

The scientific, technical and medical papers presented at this conference should be of considerable value not only to those carrying out research on hand-arm vibration but also to vibration specialists, engineers, designers, occupational hygienists, consultants and other health professionals seeking solutions to current problems.

It will also assist European legislation and those involved in the enforcement of specific regulations on hand-arm vibration, to ensure that such legislation is a practical and effective tool with which to shape a healthier working environment for workers of the 21st Century.

References

[1] Proceedings of the 6th International Conference on Hand-Arm Vibration; Bonn 19 to 22 May 1992**

Note The references that form part of these proceedings are shown by an asterisk.

[2] Protection from risks due to vibration at work: the views and activities of the Commission of the European Communities, Marcel van der Venne, (CEC)*

[3] R INABA, S M MIRBOD, Y DOMURAM, H YOSHIDA, C NAGATA, K MIYASHITA, S FUJITA & H IWATA, Vibration dose limit for Japanese workers exposed to hand-arm vibration. (Japan)*

[4] H ANTTONEN & H VIROKANNAS, Hand vibration in snowmobile and prediction of VWF by the vibration standard. (Japan)*

[5] U HOLLAND, Vibration exposure in building industry. (Federal Rep of Germany)*

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[7] J STELLING, E HARTUNG & H DUPUIS, Multiaxial hand-arm vibration simulation and biodynamic response. (Federal Rep of Germany)*

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[9] ISO 5439

[10] J STARK, K KOSKIMIES, I PYYKKO, J PEKKARINEN & R INABA, Chain saw vibration and changes in the prevalence of vibration syndrome during a follow-up 1972-1990. (Finland)*

[11] S YAMADA & H SAKAKIBARA, Prevention of vibration syndrome in national forestry. (Japan)*

[12] T SCHENK, Measurement of single shocks, effective the hand-arm system. (Federal Rep of Germany)*

[13] J H W PETERS, Hand-arm vibration and railroad maintenance work. (Netherlands)

[14] BS 6842

[15] U KAULBARS & E CHRIST, Coupling systems for accelerometers with vibrating tools. (Federal Rep of Germany)*

[16] P E BOILEAU, J BOUTIN & P DROUIN, Experimental validation of a wrist measurement method using laser interferometry. (Canada)

[17] R ECKERT & P LAUSTER, Development of a simulated working procedure for measuring vibration load of hand-guided motor mowers. (Federal Rep of Germany)*

[18] Z ENGEL & A KOWERSKI, Problems of hand-arm vibration control in Polish industry. (Poland)*

[19] L LAUDA, H ROUSKOVA, L SVOBODA & V MUFF, Disease and disorders resulting from hand-arm shocks. (CSFR)*

[20] M BOVENZI, Sensorineural disorders in forestry workers using chain saws. (Italy)*

[21] L CRONJAGER, G GILLMEISTER, & I ZEGLAM-VERCH, Vibration classification of hand-held percussive tools. (Federal Rep of Germany)*

[22] M FUTATSUKA, R OHTSUKA, T INAOKA & K MOJI, T IGARISHI, T SAKURAI, An epidemiological study on the occurrence of vibration syndrome in a tropical rain forest area. (Japan)*

[23] T JETZER, The measurement and prevention of hand-arm vibration syndrome with vibration absorbing materials. (USA)*

[24] P L PELMEAR, Laboratory tests for the evaluation of the hand-arm vibration-syndrome. (Canada)*

[25] M SCHULZ, Measuring methods and vibration attenuation of hand-held electric tools. (Federal Rep of Germany)*

[26] S KIRCHBERG, Technical design for vibration attenuation for chiselling, grinding and drilling tools. (Federal Rep of Germany)*

[27] M W DOBRY, Application of the constant interaction force vibroisolation method to effective reduction of vibration levels in pneumatic impact tools. (Poland)*

[28] A H FRITZ & J STERNBERG, Vibration attenuation in grinding tools. (Federal Rep of Germany)*

[29] M GAUTHERIE, S MEYER, J P WALTER, J L DEUTSCHER, G AUSSEDAT, G BERTIN, C BRUY, A CANTINEAU & P DONATI, Multicentre use of computerised chronothermodynamic examinations for the early detection and follow-up of the hand-arm vibration disease under ambulatory conditions. (France)*

[30] K KANEDA, K SETO & S OHTSU, Vibration isolation using feedback control of the disk grinders. (Japan)*

[31] S KIHLBERG, A KJELLBERG & L LINDBECK, Impulsive forces from nut runners. (Sweden)*

[32] W GEIS, Possibilities for vibration reduction of impact drilling machines. (Federal Rep of Germany)*

[33] P DONATI & J BITSCH, Promotion of suspended breakers: an example of transfer of knowledge from the laboratory to the users. (France)*

[34] L CRONJAGER, I ZEGLAM-VERCH & F GILLMEISTER, Measurement and evaluation methods to determine the vibration attenuation of resilient materials. (Fed Rep of Germany)*

[35] J LIWKOWICZ & B SMAGOWSKA, the measurement of antivibration properties of polymeric materials. (Poland)

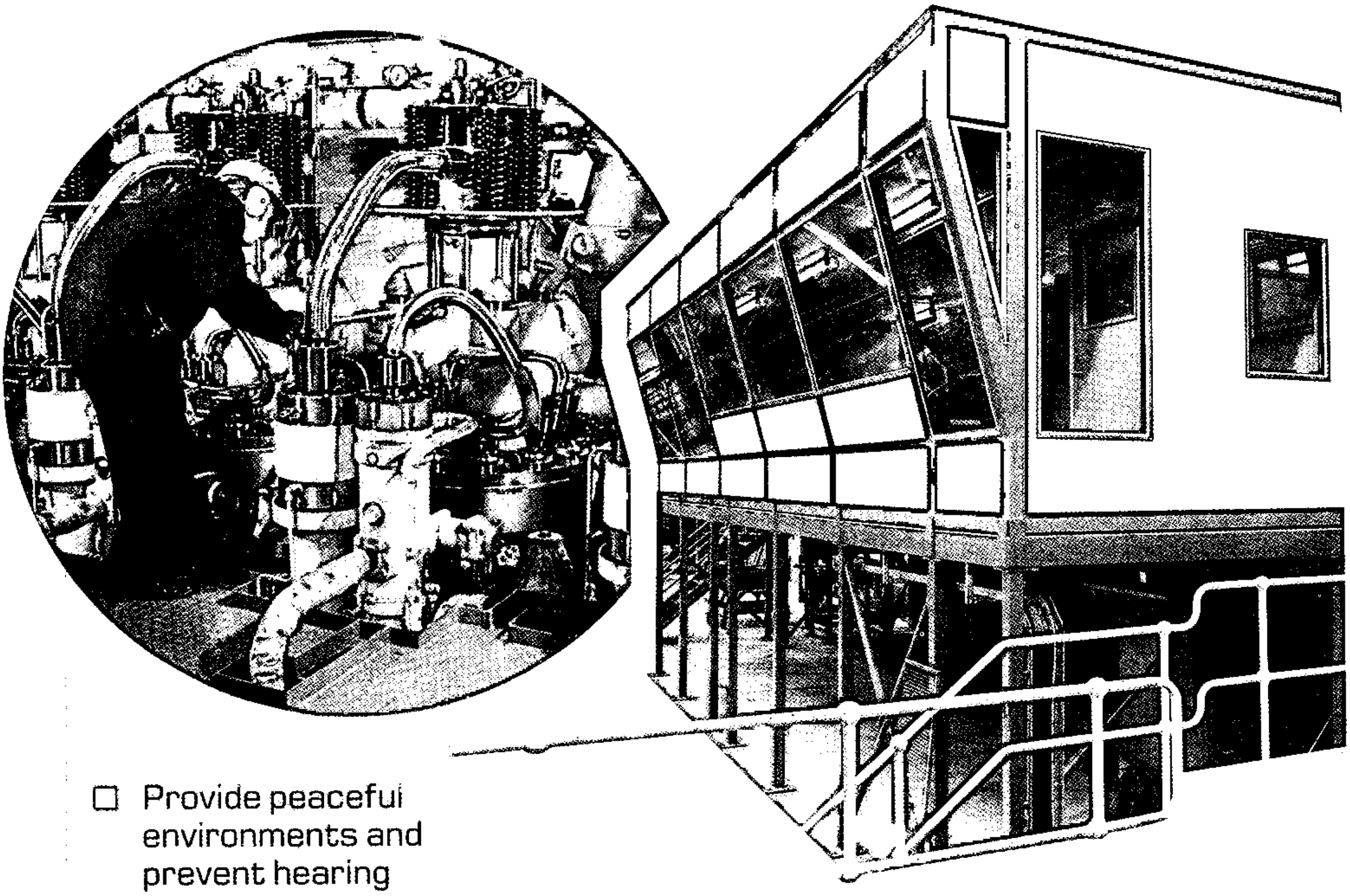
[36] B W HOHMANN & R THALI, Measurement of the vibration attenuation provided by gloves. (Switzerland)

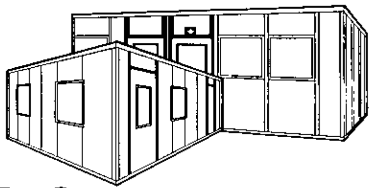
[37] W WEIDNER, Reducing the effects of vibration during work with pneumatic hammers. (Einwirklung der Vibrationen beim arbeiten mit Druckluft-Hammern mindern). Werkstatt und Betrieb, 125 (1992) 2, 133-134

** For further information on the Proceedings contact Prof H Dupis, Aibeitsgruppe Erganomie, Hiffelsheimer Strasse 5, D-6550, Bad Kreuznads, Germany. Tel 06 71 23 02.

The views expressed in this paper are solely those of the author and do not represent or reflect the views of any official body.

Alan Bednall MIOA is with HSE, Bootle. ❖





PROPOSED EUROPEAN COMMUNITY DIRECTIVE ON PHYSICAL AGENTS AT WORK

John W Tyler FIOA

Introduction

In March this year the European Commission published a proposal for a Directive on protection of workers from risks caused by physical agents. The Health and Safety Commission have since then been developing advice to the Government during the negotiations on the proposal and have written to various organisations likely to have interests in this area asking for an indication of their interest and also for any information which they think should be taken into account in the negotiations.

The Institute is taking this opportunity to inform or remind members of this proposal and to ask them to respond, if they have not already done so via other organisations, to the Institute at St Albans to enable a considered response to be made to the Health and Safety Commission.

For the benefit of members who have not seen the proposals or those who would like to be reminded of the salient points, these are:

1. The EC is proposing that the European Community should establish a new framework of legal requirements which could apply to any physical agent at work, except ionising radiation (requirements on this already exist). Initially the framework would apply to the agents listed below but others could be added later. The HSE would like to identify all processes which would be affected by the proposed legislation, the changes which would have to be made to them and how many workers would be affected. Thus the response required is: 'is your organisation interested in this proposal and, if so, have you any information or comments on its effect?'.

2. The term physical agents includes at present:
- noise
- mechanical vibration (hand–arm and whole body)
- optical (infra-red, visible and ultra-violet)
- electrical and/or magnetic fields with a wavelength of 100 nanometres or more.

Employers would have to carry out an assessment of the risks to workers resulting from exposure to physical agents. Each physical agent would have to be assessed and, when necessary, be measured to identify workers and workplaces covered by the directive and to determine the conditions where specific provisions would apply. Certain activities will be considered as representing an increased risk and these must be declared to the responsible authority. Member States will be required to ensure that appropriate measures are taken in order to control the risks associated with these activities. Assessments and measurements would have to be competently planned and carried out at suitable intervals. Rules are also proposed to control the harmful effects of the physical agent when exposure extends beyond normal working hours for reasons related to work. Member States would have restricted powers to grant derogations from some of the requirements.

3. The provisions on noise and vibration are shown in detail below as these are of principal interest to IOA

members. As outlined in the EC proposal the noise values extend the scope of 86/188/EEC, which would be revoked, and re-evaluate the threshold levels. The proposal sets out three types of level to be observed, a **ceiling level** which must not be exceeded, a **threshold level** towards which implementation of the directive should be geared and **action levels**, situated between the threshold and ceiling levels, above which one or more of the specified measures must be undertaken.

Noise

This refers to the risk to health and safety from exposure to noise, particularly the risk to hearing and of accidents.

Daily personal exposure noise levels expressed as $L_{EX,8h}$ in dB(A) for a nominal 8 hour day and/or maximum value of peak acoustic pressure P_{max} in Pascals of the C- weighted instantaneous sound pressure. All noises present at work, whatever their time characteristics, are to be included when determining exposure.

Threshold level: $L_{EX,8h}$ = 75 dB(A); Above this workers must be informed on risks.

Ceiling level: $L_{EX,8h}$ = 90 dB(A) and P_{max} = 200 Pa

Action levels:

(i) $L_{EX,8h}$ = 80 dB(A) and/or P_{max} = 112 Pa; Workers likely to be exposed to these levels would have to be informed. Personal protective equipment supplied to workers who requested it.

(ii) $L_{EX,8h}$ = 85 dB(A) and/or P_{max} = 112 Pa; Workers likely to be exposed to these levels would have to be given training in the implementation of measures taken pursuant to the directive, information provided on the noise produced by work equipment likely to give rise to such exposure where it related to a reference duration of eight hours and a programme of technical and/or work organisation measures aimed at reducing exposure would have to be instituted.

(iii) $L_{EX,8h}$ = 90 dB(A) and/or P_{max} = 200 Pa; Areas where workers were likely to be exposed to these levels would have to be delimited and access restricted. Ear protectors must be used. Systematic health surveillance by or under a doctor must be carried out.

(iv) $L_{EX,8h}$ > 105 dB(A) and/or P_{max} > 600 Pa; Activities to be declared to the 'authority responsible' which must take appropriate measures to control the risk. Where rest areas are provided for workers the noise level must be reduced to 60 dB(A) during sleep.

Hand-arm Vibration

This refers to the risk to health and safety resulting from exposure to vibration transmitted to hand-arm: vascular, bone and joint, neurological or muscle disorders. The predictor of the hazard is the daily hand-transmitted vibration exposure A(8) as defined in BS 6842:1987.

Threshold level: 1 m/s^2; Risks to be reduced to the lowest achievable level; workers to be informed on risks.

Ceiling level: 5 m/s^2

Action levels:

(i) 2.5 m/s^2; Vibration exposure assessments and when necessary, measurement. Where vibration levels cannot be reliably quantified the exposure to be evaluated (observation of working practices and information on equipment used) and action taken if exposure above the action level cannot be ruled out. Information for workers on protective and control measures. Workers entitled to health surveillance. Employers to establish a programme of control measures. Workers representatives and workers to receive results of the exposure assessments and the programme of measures for control.

(ii) 5 m/s^2; Systematic health surveillance must be carried out. If vibration levels cannot be adequately reduced, exposure to be controlled by restricting exposure time. For a period of five years from implementation Member States may grant derogations from this requirement if the state of the art does not allow this limit to be respected.

(iii) 10 m/s^2 (short term level); If the vibration over a period of 'a few minutes' reaches this level 'increased efforts' must be made to reduce vibration. An unclear provision seems to require that where the efforts do not succeed in reducing the average to this value then sufficient breaks must be introduced in the work to bring down the average level.

(iv) 20 m/s^2; Equipment to be marked. Activities to be declared to the 'authority responsible' which must take appropriate measures to control the risk.

Whole-body Vibration

This refers to the risk to health and safety resulting from exposure to vibration transmitted to the whole body: low back morbidity and trauma of the spine, as well as severe discomfort. The predictor of the hazard is the daily whole-body vibration exposure as defined in ISO 2631.

Threshold level: 0.25 m/s^2; Risks to be reduced to the lowest achievable level. An unclear requirement specifies that as long as adequate personal protection equipment is not available, provisions are to be 'complemented by measures reducing the hazard'. Information for workers on risks.

Ceiling level: 0.7 m/s^2

Action levels:

(i) 0.5 m/s^2 (or 1.25 m/s^2 1-hour average); Employers to establish a programme of control measures. Information for workers on protective and control measures. Training in implementation of measures. Vibration exposure assessments and when necessary, measurements. Workers entitled to health surveillance. Workers' representatives and workers to receive results of exposure assessments and the programme of measures for control.

(ii) 0.7 m/s^2; Systematic health surveillance must be carried out. If vibration levels cannot be adequately reduced, exposure to be controlled by restricting exposure time. For a period of five years from implementation Member States may grant derogations from this requirement if the state of the art does not allow the value to be respected.

(iii) 1.25 m/s^2; Activities to be declared to the 'authority responsible' which must take appropriate measures to control the risk.

A copy of the complete EC proposal is available for consultation at the Institute office in St Albans. Comments should be addressed to the Institute or to the Bulletin Editor if intended as a letter to the Bulletin. ❖

CALL FOR PAPERS

1994 Spring Conference

Acoustics '94

University of Salford 18-21 April 1994

Building/Architectural acoustics
Active noise and vibration control
Occupational noise and hearing protection
Impulsive noise measurement and assessment
Instrumentation, measurement and quality
Noise and sleep disturbance
Aircraft noise and effects
Student sessions
Open session

Social programme
Reception in the Salford 'Lowry' Art Gallery
Exclusive evening visit to Granada TV
Annual Dinner will be a Jacobean Banquet
Rayleigh, Tyndell medal lectures and Stephens Lecture .

Papers presented at this conference will be published in
Volume 16 of the Proceedings of the Institute of Acoustics
(The Institute plans to introduce a scheme to referee specific papers in time for the conference)

Please send abstracts of 200 words to
the conference organiser, Mr G Kerry FIOA
University of Salford, Dept of Applied Acoustics, Salford M4 5WT

INSTITUTE DIARY 1993/4

5 NOV
IOA CofC in Env Noise M'ment; 2nd exam
Accredited Centres

11 NOV
IOA Education Committee
St Albans

12 NOV
IOA CofC in W'place Noise Assess't Adv Committee
London

18 NOV
IOA 1993 Autumn Conference, Env Noise, 4 days
Windermere

24 NOV
Bulletin Editorial Board
St Albans

26 NOV
IOA CofC in Env Noise M'ment; Advisory Committee
St Albans

2 DEC
IOA Executive Committee
St Albans

2 DEC
IOA Membership & Meetings Committees
St Albans

9 DEC
IOA Medals & Awards, Publications Committee, am
St Albans

9 DEC
IOA Council, pm
St Albans

20 DEC
Underwater Acoustic Communication, Underwater Acoustics Group 2-day Meeting
University of Birmingham

1994

10 JAN
Noise & Vibration from Underground Transport
London (rearranged date)

3 FEB
IOA Membership & Meetings Committees
St Albans

8 FEB
The Safety & Health at Work Exhibition 1994, 3 days
Olympia, London

10 FEB
IOA Education Committee
St Albans

11 FEB
IOA CofC in Workplace Noise Assessment, exam
Accredited Centres

24 FEB
IOA Medals & Awards, Publications, Council
St Albans

4 MARCH
IOA CofC in Env Noise M'ment; 3rd exam
Accredited Centres

11 MARCH
IOA CofC in W'place Noise Ass't Advisory Committee
St Albans

25 MARCH
IOA CofC in Environmental Noise M'ment Advisory Committee
St Albans

19 APRIL
ACOUSTICS '94, 3 days
University of Salford

12 MAY
IOA Education Committee
St Albans

19 MAY
IOA Membership & Meetings Committees
St Albans

20 MAY
IOA CofC in Workplace Noise Assessment exam
Accredited Centres

26 MAY
IOA Medals & Awards, Publications, Council
St Albans

7 JUNE
RoSPA International Safety & Health Exhibition, 3 days
NEC, Birmingham

10 JUNE
IOA CofC in Env Noise M'ment; 4th exam
Accredited Centres

24 JUNE
IOA CofC in W'place Noise Ass't Advisory Committee
St Albans

8 JULY
IOA CofC in Environmental Noise Mm'nt Advisory Committee
St Albans

29 SEP
IOA Membership & Meetings Committees
St Albans

6 OCT
IOA Medals & Awards, Publications, Council
St Albans

4 NOV
IOA CofC in Env Noise M'ment; 5th exam
Accredited Centres

10 NOV
IOA Education Committee
St Albans

11 NOV
IOA CofC in W'place Noise Ass't Advisory Committee
St Albans

17 NOV
Autumn Conference - Speech & Hearing, organised by the Speech Group, 4 days
Windermere

1 DEC
IOA Membership & Meetings Committees
St Albans

CONFERENCE NOTICE

Underwater Acoustic Communication

University of Birmingham 20-21 December 1993

General

The previous Institute of Acoustics Conference on Underwater Acoustics Communication, Navigation and Positioning was held at the University of East Anglia in 1987. During the six years that have elapsed since then, notable progress has been made, in Underwater Communications in particular. This is reflected in the range of papers submitted to the organisers and has persuaded us to narrow the title of the conference to cover only communications.

The keynote address will be given by **Dr Frank Carey of Woods Hole Oceanographic Institute.** He will describe his work on developing and using fish tag telemetry. Many of his studies have been conducted on large sportfish in the Pacific Ocean. Interestingly, in conducting a bibliographic survey to review the progress of underwater acoustic communications since the last Conference was held, the single largest group of papers, describing the practical use of acoustic communications, had to do with telemetry tags for one or other marine animals. This is reflected in the conference in the submission of two other papers on fish-tag telemetry and one on dolphin tracking.

Several papers deal with field measurements of acoustic propagation as it relates to communications and one to the measurement of noise background at communications frequencies.

Another broad class of interest is concerned with high-rate communications at ranges to a few kilometres. Finally two papers will approach the topic of parametric transduction and its impact on acoustic communication to ranges of some tens of kilometres.

Papers

The development of a reliable high speed digital communications link for underwater applications, *O Hinton, A E Adams, G B Henderson & A Tweedy* • Title to be announced, *J-M Coudeville* • Title to be announced, *R F W Coates, R Owen & M Tsang* • Wideband underwater acoustic communication, *J J Davies & S A Pointer* • Effects of Doppler shifts in spread spectrum acquisitions, *P R Atkins & T Delve* • Design of quasiorthogonal Code for BPSK Signals at asychronous transmission, *S Tujaka* • Tracking dolphins by detecting their sonar clicks with an array of hydrophones, *N Morphett, B Woodward & A D Goodson* • Position fixing of transponders from surface measurements, *B Woodward & Z Zheng* • Investigation of parametric array field in shallow sea; theory and experiment, *V Yu Zaitsev & A M Sutin* • Decomposition of underwater signals on bounded domain functions, *A C Perez-Pignol* • Acoustic tracking of fish in the sea: current status and future prospects, *A D F Johnstone & G G Urquhart* • Investigation of the behaviour of deep-sea fish using an ingestible code activated transponder (CAT) fish tag operating at abyssal depths, *P M Bagley & I G Priede* • Experimental study on statistical characteristics of pulses transmission in the shallow sea *M Zheng* • Acoustic communication system with broadband phase-manipulated signals, *B F Kuryanov & A K Morozov* • Underwater acoustic communication channel characterization at low frequencies *J B Franklin* • Some experimental results from MAST-I SNECOW project *G Tacconi, A Tesei & L Minna* • Underwater acoustics, an oil industry perspective, *I Edwards & I Milroy* • General properties of ray sequences in the ocean, *A L Virovlyansky* • Narrow-band pulse propagation problem in a deep random ocean, *A Sarontov & V Farfel*

Underwater Acoustic Communication: University of Birmingham 20-21 December 1993

Name: Title:
Organisation:
Address for correspondence:

Tel no: Fax no:

☐ Please register me as a delegate to the conference

Registration fees: Members and authors £105.75 (VAT included); Student members £82.25 (VAT included); Non-Members £129.25 (VAT included). The fee includes lunches, refreshments, conference dinner and a copy of the proceedings)

Registration will be from 4pm on Sunday 19 December 1993 in University House and from 9am on Monday and Tuesday in the School of Electronics and Electrical Engineering

Accommodation has been reserved in the University Halls of Residence. Buffet supper on arrival and bed and breakfast for 2 nights £58.75 (VAT included).

☐ Please reserve accommodation for me in the Halls of Residence as above

(A list of alternative accommodation can be obtained from Mrs Rita Howard, Tel. +44(0)21 414 4305 Fax. +44(0)21 414 429).

☐ I enclose a cheque for £....... calculated from the above information; **Payment must be made in Pounds Sterling**

☐ I require vegetarian meals.

Please return this registration form or a photocopy, as soon as possible, to the Institute of Acoustics, 5 Holywell Hill, St Albans, Herts AL1 1EU. Tel: +44 (0)727 848195 Fax: +44 (0)727 850553. Registered Charity no. 267026

INSTITUTE MEETINGS & CONFERENCES

1993
18 October *
'Noise Insulation Regulations for Railways and Calculation Procedures', (workshop)
47 Belgrave Square, London.
** This has been postponed on account of the delay in publication of the relevant document*

28 - 31 October
'Reproduced Sound 9',
Hydro Hotel, Windermere.

18 - 21 November
1993 Autumn Conference
'Environmental Noise',
Hydro Hotel, Windermere.

20 - 21 December
Underwater Acoustics Group
'Underwater Acoustic Communication'
University of Birmingham.

1994
10 January
'Noise and Vibration from Underground Transport'
London

March
'Assessment of Entertainment Noise'
London

18 - 21 April
Acoustics '94
1994 Spring Conference
University of Salford.

18 May
'Noise Nuisance & the Law',
London Branch one-day meeting

May
'Clay Target Shooting'
London

June
Joint IOA/ANC meeting
'Calibration'
London

September
'Active Noise Control in Buildings'
London

NON-INSTITUTE MEETINGS & CONFERENCES

1993
November
9-10
Annual Conference of the Australian Acoustical Society, Glenelg, SA

December
7-9
British Medical Ultrasound Society meeting, Eastbourne
15-17
Symposium on Ocean Electronics, Cochin

1994
February
27-2 March
96th AES Convention, Amsterdam

May
1-4
NOISE-CON 94, Fort Lauderdale
2-6
3rd French Congress on Acoustics, Toulouse
16-20
1994 Symposium on Aircraft Noise Receiver Technology, Maryland
30-3 June
31st Conference on Acoustics, Prague

June
5-9
127th Meeting of the Acoustical Society of America, Massachusetts, USA
6-8
Scandinavian Acoustical Meeting, Aarhus
23
Royal Society Lecture
The Acoustics of Concert Halls, London

July
4-8
2nd European Conference on Underwater Acoustics, Denmark
18-21
5th International Conference on recent advances in structural dynamics, Southampton
19-21
Electronic engineering in oceanography, Cambridge

August
23-25
WESTPAC 5, Seoul
29-31
INTER-NOISE 94, Yokohama

November
28-2 December
128th Meeting of the Acoustical Society of America, Texas, USA

1995
May
31 - 4 June
129th Meeting of the Acoustical Society of America, Washington DC, USA

July
10-12
INTER-NOISE 95, California, USA

October
25-28
6th European Conference on NDT, Nice
28-29
Swiss Society for Acoustics General Meeting, St Gallen

November
27-1 December
130th Meeting of the Acoustical Society of America, St Louis, Missouri, USA

The Institute is wishing to build up its library at St Albans.
Anyone wishing to dispose of acoustics books, journals, tapes or other resource materials should contact the Institute office.

ACOUSTICS '93

1993 Spring Conference, 21–23 April, Southampton

Introduction

Acoustics '93, the Spring Meeting of the Institute was organised in cooperation with Société Française d'Acoustique and held in the familiar surroundings of the University of Southampton. It was an impressively successful event.

The task of conference organiser was undertaken energetically by Professor Frank Fahy of ISVR who also served as programme committee chairman. There were 122 papers presented at the conference and the total number of delegates attending was 202 of whom 52 were from across the channel.

Highlights of the conference included the Joint Tyndall Medal Lectures given by P A Nelson and S J Elliott, the 1993 Rayleigh Medal Lecture given by M Bruneau, the 1992 A B Wood medal lecture by C H Harrison and three invited lectures presented by X Boutillon, J Jacques and J–L Guyader.

The conference banquet was held in the magnificent Winchester Great Hall and included the presentation of Honorary Fellowships to Professors B L Clarkson, P Lord and D W Robinson. Professor M Zacharia, President of SFA, expressed the greetings of the French delegates.

Medal Lectures

The awards were publicised in the July/August issue of the Bulletin.

1993 Rayleigh Medal

Acoustics of fluid filled, small cavities; theoretical models and applications, M Bruneau, Universite du Maine

M Bruneau gave an absorbing and clearly presented lecture on what is a complex subject. He dealt with the subject in three phases, firstly dealing with the developments in the theory related to acoustics in dissipative fluids in bounded spaces over the last ten years, then giving examples of applications and finally describing recent work required by the current levels of miniaturisation and new, non-conventional demands on the behaviour of the devices properties ie response, frequency range, precision, etc, which will lead future research.

1992 A B Wood Medal Lecture

A Simple 3-D Model?, C H Harrison

In a fascinating presentation - for underwater acousticians at least, but hopefully for others - C H Harrison put forward a view that is often forgotten by those 'in the trade'. It is simply this: one of the most difficult things in underwater acoustics is to see the wood for the trees. The easiest way to deal with complex propagation problems is often a brute force computer intensive numerical approach. Generally, however, this gives only a numerical answer, with no insight into the underlying physics. The only way to gain this insight is to tackle the maths directly, applying Ockham's razor, and making whatever simplifications are needed to reduce the equations to the basic formulae that can be understood in an intuitive sense. Dr Harrison described the results of work aimed at achieving these objectives.

This was an informative and interesting lecture, and the contribution that Chris Harrison has made to understanding underwater sound propagation, as opposed to simply modelling it, amply justifies the award of the A B Wood medal.

Joint Tyndall Medal Lectures

For the first time the Tyndall Medal was shared by two eminent workers in one field of research. P Nelson and S Elliott of ISVR have worked in associated areas of active noise/vibration control for many years.

Their individual backgrounds were outlined in the July/August Bulletin and the high standard of presentation expected from a perusal of that information was amply realised on the day.

Both speakers enlivened their lectures with demonstrations, P Nelson with a video presentation of wave fronts and S Elliott with a live demonstration of active noise cancellation. There was no doubt in anyone's mind at the conclusion of the presentations that the joint award of the Tyndall medal was well deserved.

Invited and Contributed Papers

Aerospace Technology, Noise and Vibration

The first session showed strong local origins, with a University of Southampton link to all presentations.

First, P Collins from ESTEC described how signals from the microvibration monitor PAX on board the ESA satellite Olympus were being used as data to gain experience in automatic event detection and selective condition monitoring of spacecraft system's mechanisms. Audio reproduction of typical signals and display of PAX equipment enhanced the presentation of a topic which offers much potential for development.

M Smith's paper concerned the prediction of high frequency microvibration levels on the future ESA DRS satellite Artemis. SEA modelling and knowledge gained from Olympus PAX data were applied to gain insight into satellite structural dynamic behaviour but the predictions had to be made by scaling from the current to the future satellite, highlighting the need for more comprehensive ground testing of spacecraft structures and mechanisms if absolute response levels are to be predicted in future, a need paralleled in the field of structure–borne noise in terrestrial applications.

The next three presentations arose from studies concerning transmission of aircraft propeller noise into a passenger fuselage. S Chow of BAe described two models for the prediction of the incident acoustic field arising from single and contra–rotating propellers. One method used an array of rotating source points whilst a second, simpler model was based on steady load noise. However, for the situation modelled concerning the sound pressure on the external fuselage surface, the predictions were found to be in close agreement. Major differences were predicted between the free–field and rigid fuselage–field situations.

Professor M Zacharia President of SFA

K Holland described an experimental investigation into the sound transmission performance of aircraft interior side–wall treatments, applying a reciprocity technique. A scale model showed less than expected benefits from either a heavy limp–mass treatment or a Helmholtz resonator treatment, compared with full and limited area lightweight treatments. The resonators responded most below their free–field design frequency when an asymmetric internal acoustic field was set up in the fuselage model.

To avoid the requirements for many hours of main frame computing resources for FEA of a structurally detailed fuselage model, models based on a smeared cylindrical shell have been developed (eg PAIN). R Langley described a further development using a method employing dynamic stiffness structural analysis which does not require the free–vibration modes to be determined. Application of interior acoustic boundary elements avoids the need for the interior acoustic modes to be calculated. A sample application was described which took less than one minute of personal computer CPU time. Predicted results compared well with published model experimental results, including the effects of internal linings.

In the final paper, N Pinder described another study, of sound transmission, undertaken for ESA, in this case through the stiff payload–bay fairing of the Ariane spacecraft launcher, which employs a honeycomb sandwich rather than monocoque wall construction. The intention again was to provide a technique with a low resource requirement and also in this case both to span the frequency range poorly served by FEA and SEA and to model non–diffuse external excitation fields. For this situation, co–author F J Fahy had adopted Modal Interaction Analysis. The model's code (PROXMODE), which can be run on a personal computer, showed that the measured effect of parameter changes can be well predicted.

All the presentations concerned interesting and necessary topical applications in the aerospace industries, which remain as demanding as ever of solutions to acoustic and vibration problems.

The second session contained three papers on quite different aspects of noise and vibration in aerospace technology. The first paper, which was presented by P Lamary of Dassault Aviation, concerned a novel approach to the numerical analysis of vibration–acoustic interaction problems. This approach, which is known as the Coupled Finite Element and Singularity (CFES) method, centres around the use of interfacing grids to couple together the interior and exterior acoustic models and the structural dynamic model. The interior acoustic model and the structure are typically modelled by using finite elements, while the exterior acoustic field is modelled by using boundary elements. On the basis of this paper, the technique would appear to offer an efficient way of analysing complex interaction problems, and a number of interesting results concerning a spacecraft launch were presented at the conference.

The second paper in the session, which concerned noise emission from light propeller aircraft, was presented by Mlle M Chusseau of the aircraft manufacturer SOCATA. The work reported was the result of collaboration between SOCATA and the Acoustic Laboratory of CERT/ONERA, and the aim was to determine experimentally the contribution of the three main noise sources: engine, exhaust and propeller. A major difficulty in identifying the various contributions lies in the close proximity of the three sources, and an interesting sound intensity measurement technique is presented in the paper. The method and the results obtained are of particular current interest, given the recent changes in the regulations concerning light aircraft noise.

The final paper in the session concerned noise which no one wants to hear in practice: the sound of the failure of an aircraft structure due to explosive detonation or rapid decompression. Work on the use of the cockpit voice recorder (CVR) and alternative devices such as accelerometers and pressure transducers to identify the cause of failure was presented by S J C Dyne of ISVR. The presentation included a number of interesting video and sound recordings concerning tests on an HS125 aircraft (on the ground!), and a clear difference between the CVR signals for blast and decompression was demonstrated. Ultimately this work may give accident investigators a set of CVR interpretation guidelines leading to an early indication of the cause of failure.

Taken together, the three papers in the session served to illustrate the diverse range of challenging problems which face the sound and vibration engineer working in the field of aerospace technology.

In the final session on this topic M Borello from Toulouse described an SAE–based model for predicting the vibroacoustic behaviour of the Vulcain engine which powers the Ariane V rocket launcher. The engine is subjected to its own internal excitations from pumps, combustion and fluid flow, and to external acoustic excitation from the booster rockets. He also presented the results of some preliminary work on the response of the launcher system to pyrotechnic shock.

Audio–frequency Vibration

The first session on Audio Frequency Vibration began with a presentation of a paper by K R Holland with F J Fahy, both of ISVR, on a simple transducer for registration of surface vibrational volume velocity. The tube transducer is of simple construction and promises an inexpensive and accurate method of measurement of surface velocity.

R J M Craik and A Osipov described a statistical energy analysis of the effect of cracks in vibration transmission in buildings and showed that the effect of 1% cracking is measurable but not significant. C J Wa of ISVR presented two papers, one with R White and the other with R White and Y Y Ma. The first was concerned with the reduction of vibrational power in periodic beams by means of spring–mass attachments. The second paper described an investigation of the effect of internal damping on the radiated sound from cylindrical shells. R A Fulford of Liverpool University presented a paper, co–authored by B Gibbs, on vibrational power in multipoint connected systems in which the effect of transfer and cross coupling on structure–borne emission was investigated for connected beams.

The discussion which followed the papers included the sensitivity of SEA to small structural perturbations, the likely availability of the surface velocity transducer and passive versus active control of beam vibration.

The session after coffee began with a presentation by Monsieurs M Djimadoum and J Roland of CSTB, Grenoble and J – L Guyader of INSA, Lyon on shock propagation through beam junctions.

The next three papers described work by the research group at Heriot–Watt University. R Wilson and R J M Craik invoked SEA in describing the effect of dry lining of cavity walls. It was shown that SEA reveals the hierarchy of transmission through ties, battens, infill etc. The same authors gave a paper with R Ming on the use of structure–borne intensimetry for measuring SEA coupling loss factors. The final paper of the session was by J A Steel who presented an analysis of structure–borne sound transmission in framed buildings where wall junctions are reinforced with hollow section columns. The session ended with an interesting discussion on resonant and non–

resonant transmission and the applicability of SEA in general.

The second session consisted of four papers covering the area of vibration transmission. The first presentation was a general, simple but numerically very efficient approach for the transmission of shock through an assembly of substructures and compared very favourably with direct integration techniques. In contrast, the other three presentations pertained to the transmission of vibration in building type structures which are tackled using the statistical energy analysis technique (SEA). The approaches are refined and improved the techniques for the analytical and experimental determination of the coupling loss factors for such structures. Significant work has been undertaken by R J M Craik, who co-authored two of these papers. It appears that comparison between simple SEA models and experimental results is very encouraging and the phenomenon of the coupling between the various wave types can be understood and characterised.

The third session was opened by an invited lecture by J-L Guyader of INSA de Lyon entitled 'Vibroacoustic Prediction Methods in the Medium Frequency Range'. He discussed the problem of prediction in the frequency range which is too high for Finite Element Analysis to be effective, but too low for statistical methods to be trusted. He discussed various means of reducing the size of the computational task including the use of simplified idealizations of complex structures, the application of the heat diffusion equation to the prediction of the propagation of vibrational energy flow throughout a structural system and a variational method based upon interpolation of selected modal responses. A lively discussion ensued.

The session continued with a presentation by M Gavric of CETIM, Senlis, on finite element analysis of the dispersion characteristics of vibrational waves in I-section beams which revealed certain deficiencies in existing models such as Euler-Bernoulli and Timoshenko at higher frequencies because of cross-sectional deformation.

The theme of energy flux formulations introduced by J-L Guyader was continued by A Le Bot of Eléctricité de France in his presentation on the application of energy formulations for vibrations of beams and membranes. He demonstrated that, although this formulation is potentially valuable in reducing the size of the model, there are certain unresolved problems relating to application of this technique to cylindrical spreading fields.

The last presentation in this session was made by J Lenaghan of ISVR who described the research which he is carrying out with F J Fahy on the statistics of vibrational power flow between coupled systems which are subject to random perturbations of their physical parameters. ISVR has set up an experimental network of coupled pipes of which some lengths can be perturbed under automatic control and the resulting distribution of power flows evaluated.

The work, which is being performed in collaboration with Oxford University, is aimed at developing a prediction procedure for confidence estimates in the application of Statistical Energy Analysis.

Professor Fahy (right) in deep conversation with Dr Per Bruel

Environmental Noise

T A Curson of Aspinwall & Co described three case histories concerned with the statutory requirement of local authorities to investigate complaints of noise from residents. Instances of poor practice were illustrated and examples provided of a more reasonable approach. M Maurin of INRETS–LEN et al presented some results obtained by applying data analysis techniques, with particular reference to cluster analysis, to a noise survey carried out in France. N D Porter of NPL gave an exceptionally clear and interesting account of her work with I Flindell and B F Berry which examined the role of noise measurements in noise rating and control and introduced an approach based on the acoustic features of the noise. The acoustic feature model is different from current methods in that it does not attempt to combine separate features into an overall combined noise index and aims at providing as complete a description as possible of the physical magnitudes of all the significant acoustic features present in the noise. F J Fahy, ISVR, presented the last paper on behalf of his co–authors D G Ramble, J G Walker and M Suguira. He described and displayed a novel form of sound absorbent facing for traffic noise barriers. In comparison with current designs which incorporate bulk absorbent, the new design employs single or double resonant cavity elements to enhance low frequency absorption. The claimed advantages include ease of application to existing barriers and resistance to contamination by rain and dirt while maintaining and possibly exceeding the absorption of existing designs. The speaker was understandably reticent about answering questions about cost and details of manufacture as the work had been done under contract as part of a LINK scheme.

The last session took up most of the final afternoon of the conference. R Weston from the RAF Institute of Health and Medical Training described a new system for tracking high speed low flying aircraft using video recordings. A commercial video overlay card is used to manually position a moveable cursor over the aircraft for each frame of the recorded video signal. The PC system then calculates the aircraft track, height and speed from the digitised co-ordinates from two or three simultaneous video recordings. The system has been shown to be accurate to within plus or minus 5%.

S Moch from the same organisation described a comparison of ground plane and normal 1.2m measurement heights for low flying aircraft noise measurements. There are significant advantages to using the ground plane technique, but the differences between ground plane and normal height are uncertain for angles below 20 degrees to the horizontal.

K M Li from the Open University Faculty of Technology described his investigations of sound propagation through a medium with a velocity gradient and over a ground plane with a finite impedance. A second order approximation for the reflection coefficient was introduced to improve the solution for low angles of incidence above highly reflective ground. Future work will compare the results against experimental data.

G Parry from DNV Technica described some experimental results of long range propagation (up to 500m) across densely planted forest. The results show significantly greater attenuation through the woodland than predicted by the CONCAWE model for all frequencies except around 250 to 500 Hz, where the CONCAWE model was found to be substantially correct.

Finally, M Ikeda from Komatsu Ltd in Japan, presented the preliminary results from his investigations of subjective response to industrial type impulsive noises. The results indicated that a simple listening task using monophonic loudspeaker reproduction in a comfortable semi-reverberant listening room was as good as any of the more complex procedures tested using an anechoic test chamber or headphone listening.

Active Vibration Control

The two sessions on this subject produced eight papers including three from France. S Elliott described the use of adaptive digital filters in an active control system designed to reduce low frequency tones generated by the open sun roof of a car. G Pavic of CETIM discussed the control excitations of actuators to reduce vibration in infinite and semi–infinite plates and beams. The active cancellation of diesel engine vibration using a multichannel hydraulic adaptive control system was the subject of a paper by A Roure and colleagues of CNRS–LMA. The first session ended with a paper by G C Nicholson of University of Salford which described experimental work on the active control of normal–incidence surface acoustic impedance. While previous work has been motivated by the desire to create near–ideal acoustic absorbers, the work described in the paper extends the concept to allow the construction of frequency–dependent acoustic impedances which have applications in loudspeaker enclosures and architectural spaces.

M E Johnson of ISVR opened the second session with a paper on the active control of vibrations of a plate by the use of distributed, or integrating sensors attached to the plate; specifically piezoelectric sensors. There followed a paper by M J Brennan of the Royal Naval Engineering College and S Elliott and R J Pinnington of ISVR on strategies for actively controlling flexural waves on an Euler–Bernoulli beam. A model of a secondary force array which couples into flexural waves on an Euler–Bernoulli beam was proposed, together with examples of how the secondary array can be used to suppress an incident propagating wave and some or all of the waves generated by the array. The final paper in an interesting two sessions concerned the optimisation of active control inputs for radiating structures. This was given by P R Wagstaff of University of Compiègne et al and described the application of a numerical approach to determine the optimum actuator positions in active structural–acoustic control.

Transportation Noise.

Presentations on railway noise were given by V Chritin of Ecole Polytechnique Fédérale de Lausanne who spoke of the methodology being applied by Swiss railways to the identification of noise sources on trains, and M T Kalivoda of Perchtoldsdorf, Austria who presented and discussed measurements made around running trains; he demonstrated that the commonly–applied dipole model is seriously in error and therefore the projection of near field measured pressure levels, particularly towards elevated receivers, gives very unconservative estimates.

Presentation of the Student Prize to Marie Poujol of CNRS

S J Clampton of Vickers Shipbuilding and Engineering Ltd discussed the problems of fan noise in achieving adequate environmental noise conditions for submarine crews. He gave interesting examples of how sound intensity measurement can be used in acoustically challenging situations to rank order the radiation of sound power from fan equipment, both before and after installation, and thereby facilitate the selection of cost–effective noise reduction measures.

In the final session C G Swift of Arup Acoustics presented a paper which explored the problems of applying the CRTN method of calculating traffic noise, which was developed for use on roads up to 2–lane dual carriageway, to wider motorways having 3 or more lanes per carriageway. The validity of CRTN in predicting noise from 3 and 4 lane motorways was checked using a more detailed model as a control datum and an alternative two source model. It was shown that the CRTN single source method for wide roads could lead to overprediction of noise in unscreened sections and underprediction of noise where screening is present. The potential errors are minimised by using the CRTN two source method even when the central reserve is more than 5m wide.

For wide motorways the use of sound absorbent screens on the central reserve was proposed to enhance the performance of the side screens.

Aeroacoustics

Aeroacoustics is the branch of acoustics that deals with the generation and transmission of sound by fluid flow, and the three papers, of the six appearing in the Proceedings, that were delivered during this session covered the fairly involved mathematics of the subject. P E Doak's paper, which was similar and complimentary to one that he gave at Noise'93 in St Petersburg in May this year, derived the two principal equations involving the fluctuating total enthalpy field, H', which he presented as an important and potentially useful dependent 'acoustic' field. He demonstrated that H' is a physically desirable and mathematically convenient dependent variable for all aeroacoustic problems, including both subsonic and supersonic flows and flows with combustion.

R E Musafir presented a paper on jet noise which discussed the use of Lilley's equation for the description of jet noise in relation to the linear and nonlinear source terms. This was followed by J P Priou et al of the Laboratoire d'Etude Aerodynamiques, Poitiers, who discussed the calculation of acoustic modes in an inhomogeneous medium using finite element methods.

Musical Acoustics

The musical acoustics group provided a one–day session; inevitably, because there are relatively few researchers active in this field in the UK, the group tends to meet formally every three years, a frequency which gives suitable time for new work to be reported and to keep the sessions fresh. As usual, contributions covered a range of diverse topics, from the generation of new musical scales based on mode frequencies of spiral clock gongs (with musical demonstrations!) to more traditional topics such as modelling vibrational modes and radiation fields in guitars. As well as contributions from the 'familiar faces', there was one contribution from the Le Mans group, noted for their excellent work on wind instruments. The Edinburgh group, however, provided the bulk of the contributions with papers on inharmonicity in stiff strings, various aspects of spectral analysis, and brass instruments. The latter dealt with 'acoustic taxonomy' or the acoustical classification of instruments, proving that there is a need for more subtle distinctions than the usual description of 'conical' or 'cylindrical' plumbing. The final paper of the session provided a very interesting insight into the mechanics of the hurdy–gurdy.

As well as the seven contributed papers, delegates were treated to an invited paper by Xavier Boutillon on violin acoustics. M Boutillon now has a permanent base at the Laboratoire d'Acoustique Musicale at the Université Paris IV, one of the larger musical acoustics research groups in France. For his lecture, however, he drew partly on his experiences from the considerable time he has spent in various other laboratories around the world. The lecture, subtitled 'Physical problems and sensitive realities', dealt not only with a review of the large amount of information which is currently available about the mechanics of the instruments but also brought home the importance of interpreting this information in a musical context.

It was a great privilege to have M Boutillon and his French colleagues participating in the remainder of the session, and greater cooperation between the musical acoustics groups of the SFA and IOA would be welcome in future conferences.

Underwater Acoustics

The underwater acoustics sessions this year produced a response that has not been seen for some time, and the programme promised a total of 22 papers, giving 2 full days on the subject more or less equally from Great Britain and France, with a few from elsewhere. Unfortunately, a number of authors failed to materialise, and at times the discussion was as interesting as the presentations.

Though a wide variety of topics was covered, three were strongly represented - flextensional transducers, propagation modelling, and scattering from variously shaped underwater objects. Flextensional transducers have come of age now that they can be found in operational systems at sea, so interest has gone beyond the fundamental design and modelling, and these papers addressed practical problems. Because flextensionals are acoustically 'small', there is a temptation to group them close together in arrays, leading to potentially damaging mutual coupling. The study reported by Blottman and Decarpigny showed that these effects can be successfully modelled, although it requires a complex mix of finite elements, traditional equivalent circuits, modal analysis and some ingenuity. Then the papers by B Hamonic and colleagues from ISEN in Lille proposed a deceptively simple technique for overcoming the tendency of these transducers to fall apart if their depth limitation is exceeded, and examined the effects that occur when the transducer shell is fabricated from glass reinforced composites.

P Macey of Pafec stepped in admirably for the first missing author with an extempore talk on applications of finite elements and boundary element methods in acoustics, with a bias towards flextensional transducers, that was almost the advertised paper! Most of the presentations looking at underwater acoustic propagation delved into the computer intensive field of 3-D modelling (the subject of C Harrison's medal lecture). Just how intensive was brought home by D Lee, talking about a model called FOR3D, who displayed a table of the run times for various implementations - some of the entries were in years! This material was very theoretical, but experimental work was represented by a comparison of measured and predicted propagation loss reported by D Haigh and B Hughes of DRA Portland. Some fascinating work with a (very colourful) simulation of the underwater environment was described in two papers, one by P Cristini and the other by G Rabau, J Piraux, J Leandre and R Holtzer, all from CNRS in Marseille.

The other topic that produced several papers over the two days of underwater sessions can be summed up as the vibrations of water loaded shells of varying shapes. One of the more interesting was an experimental study reported by P Thorne and colleagues; they used the sort of pulse compression techniques familiar to sonar engineers to measure the backscattered echoes from spheres with sufficient resolution in the time domain to identify the various resonant components of the frequency domain form function. Two French papers by G Maze, F Leon and H Uberall and by D Decultot, F Lecroq, G Maze and J Ripoche, presented theoretical results describing the dispersion of surface wave velocities on air filled thin cylindrical shells and cylinders with spherical ends.

The various other topics represented included the ambient noise in the sea, the random nature of the sea water medium and target bearing estimation with noisy signals. The last paper on Friday afternoon was a novel application of signal processing techniques for detecting the occasional fleeting transient in a continuous background noise, presented by P R White.

Nonlinear Sound and Vibration

This session covered a variety of topics in seven papers that appear in the proceedings, though, unfortunately only five were presented. Perhaps unexpectedly the session began with a discussion of a class of linear systems, specifically those described by fractional operators relevant to visco-elastic materials. The other papers all dealt with nonlinear processes and included - a numerical approach to the study of nonlinear duct acoustics - the active control of nonlinear structural systems using frequency domain methods for harmonic excitation and a neural network controller for random excitation - the use of maximum length sequences for the identification of Volterra kernels characterising auditory pathways - the application of bispectra to describe acoustic and vibration signals with particular emphasis on periodic processes. The session was particularly interesting in that each paper addressed a practical problem and showed how advanced concepts could be applied effectively.

Factory Noise

Delgates who were not at the competing sessions enjoyed an entertaining invited lecture by J R Jacques on the history of noise prediction in workshops. The overview was based partly on the literature available but mostly on work done over the last 20 years at the Institut National de Recherche et de Securite. The concept of indoor noise prediction originated in the seventies, as a sub-branch of room acoustics, when health and safety at work started in most developed countries to become a subject of scientific and technical interest. It has now developed into a valuable planning tool as evidenced by its use in relation to the EC 'Noise at Work' directive.

This single session included five papers centred on the study of noise in factory spaces although in one case the 'factories' were off–shore platforms. The first paper presented by D N Lewis of Unilever Research reported case studies describing the use of ray tracing in the prediction of factory sound fields and the evaluation of the influence of building geometry, surface absorption, and machine layout and sound power on reverberation times and noise levels at operator positions. S M Dance, South Bank University, then spoke about the use of acoustic barriers around specific machinery and computer modelling to predict the insertion loss of a single barrier in an enclosed non–diffuse space. The next paper, by H A Akil et al of Liverpool University, dealt with the accurate measurement of scattering across factory fittings, which, they claimed, was necessary for the best use of the RAYSCAT model developed by Ondet–Barbry.

R M Windle, University of Salford, described the problem of 'dips' in the sound reduction properties of metal cladding used in factory constructions. The talk dealt with the prediction of the dips by the use of the two–dimensional Boundary Element Method and speculated on their causes. The final paper of the session by B R Wood of Acoustic Technology Ltd concerned the prediction of structure–borne noise on offshore oil and gas production platforms and drilling rigs and discussed the problems associated with estimating operator noise exposure levels.

Pipe Noise and Vibration

Four papers were presented at the first session. The first paper was presented by J Kirgomard from the Université du Maine for its authors L Desmons, J Hardy Y Auregan. Its subject was the determination of the source impedance of internal combustion engines which was well illustrated by the presented experimental results. B Laulagnet from the Laboratoire Vibrations–Acoustique at Lyon gave the second paper which was a theoretical study on the effects of small defects, in the sound radiated from infinite cylinders. A detailed account of the theoretical formulation was given and the predicted data was compared with theory. The next paper, presented by A Cummings from the University of Hull and co–authored by R J Astley from the University of New Zealand, dealt with the effect of flanking transmission on the sound attenuation in lined ducts, a problem of much interest to many delegates. Details of a set of experiments were given and a simple theory for the problem presented which illustrated the dual problems of the structural flanking path and the break out/break in flanking path. Again good experimental data was shown to confirm the theoretical predictions. The final paper, presented by K Trdak from the Centre Technique des Industries Mécaniques (CETIM) Senlis, examined the expansion of the theory for structural intensity in shells to include shear effects. Results were presented for both empty and fluid filled pipes. This final paper in the session provoked a lively debate on the merits of various shell theories.

The second session included papers covering a broad range of pipework applications. The two main strands appeared to be the extension of the usual linear analysis to make measurements and prediction of power and intensity and also to consider time varying geometric properties. In the first paper P O A L Davies, ISVR, gave an explanation of human voice production. This involves a time varying vocal tract geometry which can be modelled with a time varying one–dimensional acoustic transmission line. The complicated problem of perforations in an acoustic transmission line was considered by J Kergomard, University of Maine. All subsequent speakers, A R Briscoe, S Bourget and R J Pinnington of ISVR and J L Horner of Loughborough University, addressed the vibration transmission of the pipe wall alone or the transmission of fluid filled pipes in both the pipe wall and the fluid. The aim of these analyses was either to measure or predict vibrational power or intensity, with the overall intention of identifying the relative significance of a set of transmission paths between a vibration source and a receiving point.

Open Sessions

Open sessions are for papers which do not fit into the main headings and the wide and interesting range of topics covered in the three sessions confirms this. There were eight papers and these covered the following subjects – Automatic control of boundary layer transition using a double suction panel, by J –L Rioual et al; The coupling of acoustic energy between a transducer and glass beads, by Y Porat; The coupling of BEM and TLM method to solve transient acoustic problems in large area–two dimensional case, by G Zhang et al; Public address systems for emergency use: audit and performance assessment in the offshore and marine sections, by G Cowling; Modelling auditorium acoustics with light, by R J Pinnington et al; Modelling of an industrial machine using SEA, by D Nahya et al; Estimation of the prevalence of hand–arm vibration syndrome in Great Britain; and Sound propagation through particulate suspensions, by S H O Moss et al.

Students Session

The students session was chaired by P Lord and D Oldham and they reported an enterprising and varied range of topics in the ten presentations. Examples of the subjects included were loudspeaker analysis, active noise reduction, car alternator noise, traffic noise and noise in ducts. A prize was awarded for the best presentation. The winner was a French student, Marie Poujol of CNRS, Marseille whose subject was entitled 'Methode d'Homogeneisation appliquees a la propagation acoustique dans les milieux inhomogenes'

All the participants are to be congratulated on their splendid efforts.

Conference Proceedings available from the Institute at £55 ❖

Contributions

Institute Makes Winning Bid for Inter-noise '96

Earlier this year the Institute was invited by the President of the International Institute of Noise Control Engineering (I-INCE) to put in a UK proposal to host Inter-noise in 1996.

A special sub-group of the Meetings Committee, led by Bernard Berry of NPL, considered the content of the bid and evaluated various venues. For a number of reasons, including meeting room capacities and the support of the civic authorities, the Britannia Adelphi Hotel in Liverpool emerged as the clear favourite. Bernard wrote a proposal dealing with every aspect of the planned event and with the help of a graphic design consultant, Philippa Steward of Graphix Ltd, produced a colour brochure, which was submitted to the Board of I-INCE. He made a presentation to the Board and answered questions on the proposal immediately prior to this year's Inter-noise in Leuven, Belgium. At this point we learnt that our competitors were Moscow and Budapest. At the Opening Ceremony of Inter-noise '93 it was announced that the Institute bid had won! So if you are planning ahead keep July 31 to August 2 1996 free and listen out for further details.

Tests in Concert Halls

Measurement programmes in concert halls are becoming the vogue, it seems. Plans are underway for a survey of French auditoria while in North America they have set up a Concert Hall Research Group, which started measurements last year. The American group is funded for expenses with contributions from professional sponsers (ie consultants), the ASA and corporate sponsers. Three groups have been conducting measurements: John Bradley from the National Research Council, Ottowa, Garry Siebein from the University of Florida and Anders-Christian Gade from the Technical University of Denmark. The first measurement series involved tests in nine unoccupied halls including Boston Symphony Hall.

With three independent sets of measurements, there have been several differences between results. Incompatibilities have now been ironed out; they were reported at the 125th meeting of the ASA in Ottawa in May. The latest development is the decision to conduct measurements in occupied halls. This is done with loudspeakers emitting relatively modest level signals; gun shots are out!

British unoccupied halls were subjected to this treatment in 1982-84 by Mike Barron and Lee-Jong Lee.

Noise Nuisance From Earthmoving Equipment

The construction industry has become recognised as one of the major noise nuisances in the Community and so a new proposal has been issued by the Commission to amend the 1986 Directive limiting noise from earthmoving machinery, defined, for the purposes of the legislation, as excavators, dozers, loaders and excavator-loaders.

Since the 1986 Directive requires a revised noise test method and new power limits to come into operation in December 1994, the Commission has taken the opportunity to introduce more stringent limits. From December 1995 (a year later than scheduled to allow for implementation), limit values of approximately four decibels less than at present will apply, with a further three decibel reduction from the year 2000. Limits vary according to the type of equipment, with excavators having a lower permissible limit than tracked machines. Present limits will probably continue to apply until 1995.

Needless to say, the UK has some reservations about the proposal, particularly with some of the noise level reductions, which it feels are too strict. It also thinks that the redesign costs for UK manufacturers of some machines may be higher than for companies in other Member States.

Because the Commisssion wants to see member States incorporating the changes into their legislation by December 1994, so that the Directive can come into force in 1995, it has asked the European Parliament and Economic and Social Committee to deliver their opinions in July with a view to its adoption in September. *(OJ C157, 9 June 1993 and COM (93) 154 final - SYN 458, 12 May 1993: proposal for a Council Directive to amend Council Directive 86/662/EEC on the limitation of noise emitted by earthmoving machinery; Department of Trade and Industry explanatory memorandum, 17 June 1993).*

Diane Welfare Case

Leicester City Council's Environmental Health Department received a complaint from a member of the public concerning an alleged noise nuisance in October 1992.

Later that month a noise nuisance was witnessed emanating from 11 Upper Temple Walk which resulted in the Council sending a warning letter to Miss Diane Welfare.

In January 1993, another noise nuisance was witnessed and an Abatement Notice under the Environmental Protection Act 1990 was served on 2 February 1993.

Environmental Health Officers from the Council's specialist domestic noise service subsequently witnessed a total of ten contraventions of the Abatement Notice between 23 February and 30 April 1993, resulting in Miss Welfare being prosecuted on 11 June 1993 at Leicester Magistrates' Court.

The Magistrates' Court on 11 June 1993 convicted Miss Welfare in her absence, on all ten contraventions of the Abatement Notice. However, because there was no means test form returned, the Court adjourned the case until 2 July 1993, for one to be provided.

On 2 July 1993 at the Magistrates' Court, Miss Welfare again failed to attend and therefore the Court decided to give sentence in her absence.

Miss Welfare was fined 25 units for each of the first five contraventions, no fine for the remaining five contraventions, which therefore resulted in a total of 125 units.

As no means test form was returned to show her disposable income, she was fined the maximum £100 per unit. This therefore gave a total of £12,500 which was publicised so widely in all the national press.

Miss Welfare has now appealed against the conviction and sentence.

Pop Code Revised

Even the most patient observers of standards committees will probably have begun to despair that the Health and Safety Executive's long heralded 'Pop Code' will ever appear. The document in chief, circulated in draft form for public comment in October 1991 and subsequently quite substantially revised, has been held up by the government's general review of regulations and their burden on industry. Informed sources at the moment suggest that it might appear this autumn.

One of the structural changes made to the draft was the removal of the controversial chapter on environmental noise control, with the intention that this would be reconstituted as a Code of Practice approved by the Secretary of State under the provision of section 71 of the Control of Pollution Act. The HSE document would incorporate the Code as an Appendix.

A Working Party was formed under the auspices of the Noise Council to draft the Code and the results of its deliberations, in the form of a Draft Code of Practice on Environmental Noise Control at Concerts, has been in circulation for public consultation since mid-July.

The Noise Council Code differs quite significantly from the original model proposed by the Health and Safety Executive. Essentially, the difference between frequently and infrequently used venues is recognised and the reasonable assumption made that a more adverse response might arise in a quiet rural area compared with a noisy urban area to a particular level of intruding noise. The most radical change in perspective is that the long established but awkward 'background noise level plus' principle is abandoned for infrequent events and a single number absolute limit substituted.

The limits, which apply where there are up to three events per calendar year, are 75 dB(A) for urban stadia/arenas and 65 dB(A) for other urban and all rural venues measured at 1m from the facade of any noise sensitive premises. The values refer to Music Noise Level (MNL), which is the $L_{Aeq,15\,minute}$ of the noise generated by activities on stage (whether concert, rehearsal or sound test) excluding contributions from other sources.

For more than three events a year at any venue, regardless of location, the old established principle of background noise plus an increment (15 dB(A) for twelve or less and 5 dB(A) for more than twelve events per year) is adopted.

Comments on the Draft Code are still invited and the closing date for submissions to the Noise Council is 30 November. Copies of the Draft are available from the Noise Council, 16 Great Guildford Street, London SE1 0ES. Comments and queries should be addressed to S W Turner the Noise Council Working Party Chair, at c/o Rendel Science and Environment, 30 Great Guildford Street, London SE1 0ES.

There will be a presentation and discussion of the Draft Code at each of this year's IOA conferences at Windermere, with the object of formulating the Institute's response.

The Noise Council has determined that the Code will be published in time for next year's outdoor concert season whether or not the Secretary of State's endorsement is obtained, so study of this draft and the expenditure of some time in responding will not be in vain.

Bepac Acoustics Library Classification System

The Building Environmental Performance Analysis Club (BEPAC) Special Interest Group (SIG) 5 has been in existence now for over three years and is supported regularly by a small group of participants from both consultancy and industry.

At an early stage, the group recognised the need for a classification system which would assist organisations and individuals working in the area of building acoustics to file their literature. One of the group's first projects was, therefore, to devise such a system. The resulting document, the Building Acoustics Library Classification System, has recently been published by BEPAC.

The term 'building acoustics' has been interpreted widely and the system encompasses such diverse subjects as electro-acoustics, hearing and speech, environmental noise, sound insulation, building services, vibration, acoustics of spaces, legislation, standards, regulations and guidelines and professional practice. It is designed for use by anyone who collects books and papers in these subject areas such as consultants, environmental health officers, building services engineers, architects, specialist manufacturers, educators and researchers.

The document can be purchased from BEPAC Adminstration which is based at David Bartholomew Associates, 16 Nursery Gardens, Purley on Thames, Reading RG8 8AS (telephone/fax 0734 842861). The price is £6 to members and £12 to non-members.

Max Vuillermoz

Members will be saddened to learn that Max Vuillermoz, of South Bank University, died suddenly in August while on holiday at his house in Spain. Max, who was 59, had taken early retirement from South Bank last year but, as a visiting professor, continued to play a very active role in the Acoustics Group, lecturing on the MSc Environmental Acoustics course, supervising several research projects and doing consultancy work. Max was buried in Spain, but there will be a memorial service in London in the autumn. He will be deeply missed by his colleagues and friends. Our sympathy goes to his widow, Janice, and their family.

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News from BSI

New and Revised British Standards

BS 5775: Specifications for quantities, units and symbols Part 7: 1993 (equivalent to ISO 31-7) Acoustics. This supersedes BS 5775: Part 6: 1979.
BS 7643: Building construction – Expression of users' requirements. Part 3: 1993 (equivalent to ISO 6242-3) Acoustical requirements. No current standard is superseded.
BS 2750: Acoustics – Measurement of sound insulation in buildings and of building elements. Part 2: 1993 (equivalent to ISO 140-2 and also numbered as BS EN 20140-2: 1993).
BS 7594: 1993 Code of practice for audio-frequency induction-loop systems (AFILS). This provides recommended design and measurement methods for use by local authorities and administrators of public buildings and sports stadia, purchasers, designers, manufacturers and installers, for the correct installation of AFILS with an acceptable performance level and good reliability for use by persons who are hard of hearing. No current standard is superseded.
BS 7676: Acceptance codes for gears Part 1: 1993 (equivalent to ISO 8579-1) Determination of sound power levels emitted by gear units. No current standard is superseded.

Amendments

BS 6840: Sound system equipment Part 17: 1991 Methods of specifying and measuring the characteristics of standard volume indicators [IEC 268-17]. Amendment No 1. This amendment effects the implementation of Corrigendum: 1991 to IEC 268-17: 1990 and CENELEC HD 483.17 S1.
BS 7443: 1991 Specification for sound systems for emergency purposes. Amendment No 1.
BS 5228: Noise control on construction and open sites Part 4: 1992 Code of practice for noise and vibration control applicable to piling operations. Amendment No 1.
BS 5793: Part 8: Noise considerations Section 8.2: 1991 Methods for laboratory measurement of noise generated by hydrodynamic flow through control valves [IEC 534-8-2]. Amendment No 1. Note that this amendment implements EN 60534-8-2: 1993 and renumbers BS 5793: Section 8.2: 1991 as BS EN 60534-8-2: 1993.
BS 6840: Sound system equipment Part 15: 1992 Specification for matching values for the interconnection of sound system components [IEC 268-15]. Note that this amendment implements Amendment No 3: 1991 to IEC 268-15: 1987 and CENELEC HD 483.15 S4.
BS 6083: Hearing aids Part 0: 1984 [IEC 118-0] Methods for measurement of electroacoustical characteristics. Amendment No 2. This amendment implements EN 60118-0: 1993 as a British Standard and re-numbers BS 6083: Part 0: 1984 as BS EN 60118-0: 1993. Part 7: 1985 [IEC 118-7] Methods for measurement of the performance characteristics of hearing aids for quality inspection on delivery. This amendment implements EN 60118-7: 1993 as a British Standard and re-numbers BS 6083: Part 7: 1985 as BS EN 60118-7: 1993.

BS ENs Implemented by Amendment

The following BS ENs are implemented by amendment to existing documents:.
BS EN 60118: Hearing aids.
BS EN 60118-0: 1993 (equivalent to IEC 118-0) Methods for measurement of electroacoustical characteristics. Implemented as a European Standard by amendment to BS 6083: Part 0: 1984.
BS EN 60118-7: 1993 (equivalent to IEC 118-7) Methods for measurement of the performance characteristics of hearing aids for quality inspection on delivery. Implemented as a European Standard by amendment to BS 6083: Part 7: 1985.
BS EN 60534-8: Noise considerations.
BS EN 60534-8-2:1993 (equivalent IEC 534-8-2) Laboratory measurement of noise generated by hydrodynamic flow through control valves. Implemented as a European Standard by amendment to and renumbering BS 5793: Section 8.2:1991.
BS EN 60601: Medical electrical equipment.
BS EN 60601-2 Particular requirements for safety BS EN 60601-2-2: 1993 (equivalent to IEC 601-2-2).

British Standards Proposed for Confirmation

BS 5750: Quality systems.
Part 0: Principal concepts and applications.
Part 0: Section 0.1: 1987 Guide to selection and use.
Part 0: Section 0.2: 1987 Guide to quality management and quality system elements.
Part 1, 2, 3: 1987.
BS 5942: High fidelity audio equipment and systems; minimum performance requirements.
Part 2: 1987 Specification for FM tuners.
Part 7: 1987 Specification for loudspeakers.
Part 8: 1987 Specification for combination equipment.
BS 6686: Methods for determination of airborne acoustical noise emitted by household and similar electrical appliances.
Part 1: 1986 General requirements for testing.

British Standards Reviewed and Confirmed

BS 2750: Measurement of sound insulation in buildings and of building elements.
Part 1: 1980 Recommendations for laboratories.
Part 2: 1980 Statement of precision requirements.
Part 3: 1980 Laboratory measurements of airborne sound insulation of building elements.
Part 4: 1980 Field measurements of airborne sound insulation between rooms.
Part 5: 1980 Field measurements of airborne sound insu-

lation of facade elements and facades.
Part 6: 1980 Laboratory measurements of impact sound insulation of floors.
Part 7: 1980 Field measurements of impact sound insulation of floors.
Part 8: 1980 Laboratory measurements of the reduction of transmitted impact noise by floor coverings on a standard floor.
BS 5363: 1976 Method for measurement for reverberation time in auditoria.
BS 5821: Methods for rating the sound insulation in buildings and of building elements.
Part 1: 1984 Method for rating the airborne sound insulation in buildings and of building elements.
Part 2: 1984 Method for rating the impact sound insulation.
Part 3: 1984 Method for rating the airborne sound insulation of facade elements and facades.
BS 6864: Laboratory tests on noise emission from appliances and equipment intended for use in water supply installations.
Part 1: 1987 Method for measurement.
BS 3045: 1981 Method of expression of physical and subjective magnitudes of sound or noise in air.
BS 3593: 1963 Recommendation on preferred frequencies for acoustical measurements.
BS 6288: Magnetic tape sound recording and reproducing systems.
Part 4: 1987 Methods for measuring the mechanical characteristics of magnetic tape for analogue recording.
Part 6: 1987 Specification for reel–to–reel systems.
Part 7: 1987 Specification for cassettes for commercial tape records and domestic use.
BS 6655: 1986 Specification for pure tone air conduction threshold audiometry for hearing conservation purposes.
BS 6840: Sound system equipment.
Part 1: 1987 Methods for specifying and measuring general characteristics used in equipment performance.
Part 4: 1987 Methods for specifying and measuring the characteristics of microphones.
Part 9: 1987 Methods for specifying and measuring the characteristics of artificial reverberation time, time delay and frequency shift equipment.
Part 11: 1988 Specification for application of connectors for the inter–connection of sound system components.
Part 12: 1987 Specification for applications of connectors for broadcast and similar use.
Part 13: 1987 Guide for listening tests on loudspeakers
Part 14: 1987 Guide for circular and elliptical loudspeaker; outer frame diameter and mounting dimensions.

British Standards Withdrawn

BS 2750: Acoustics – Measurement of sound insulation in buildings and of building elements. Part 2: 1980 Statement of precision requirements. Superseded by BS EN 20140–2: 1993 [BS 2750: Part 2: 1993].

BS EN Publications

The following are British Standard implementations of the English language versions of European Standards (EN's).
BS EN 20140: Acoustics – Measurement of sound insulation in buildings and of building elements, BS EN 20140–2: 1993 (equivalent to ISO 140–2).
BS EN 29053: 1993 Acoustics – Materials for acoustical applications – Determination of airflow resistance. This gives two methods for the determination of the airflow resistance of test specimens cut from products of porous materials. (Equivalent to ISO 9053). No current standard is superseded.
BS EN 61096: 1993 (equivalent to IEC 1096) Methods of measuring the characteristics of reproducing equipment for digital audio compact discs. This lists and defines characteristics affecting performance of CD players to establish their conditions and methods of measurement and to standardize result presentation. No current standard is superseded.
BS EN 61027: 1993 (equivalent to IEC 1027) Specification for instruments for the measurement of aural acoustic impedance/admittance. This defines the characteristics to be specified by the manufacturer and lays down performance specifications for four types of instrument. No current standard is superseded.

New Work Started

BS 7750: Environmental management systems. This will revise BS 7750: 1992 in the light of experience of use and of the EC Eco–management and Audit Regulation.

European New Work Started

EN 1030: Hand–arm vibration – Guidelines for vibration – Part 1: Engineering methods by design of machinery (prEN 1030–1).
EN 1031: Measurement and evaluation of whole body vibration – General requirements (prEN 1031).
EN 1032: Testing of machinery in order to measure the whole–body vibration emission value – General requirements (prEN 1032).
EN 1033: Laboratory measurement of vibrations at grip surface of hand–guided machinery – Part 1: General requirements (prEN 1033–1).
EN 30326: Mechanical vibration – Laboratory method for evaluating vehicle seat vibration – Part 1: General requirements (ISO 10326–1) (prEN 30326–1).
Measurement of noise emitted by railbound vehicles.
Ultrasonic examination equipment – Part 2: Probes. This will cover two methods (a) a large number of probes manufactured under a quality management system, and (b) small numbers of individual probes.
EN 50144: Safety of hand–held electric motor tools.
Part 1: General requirements – This will amend EN 50144–1 to provide new subclauses 13.2 and 13.3 covering noise and vibration measurements. BS EN 50144–1 will replace BS 2769: Part 1 as a British Standard if adopted as a European Standard.
Parts 2–1 to 2–16 This will amend the sixteen subordinate Parts of EN 50144–2 for noise and vibration measurements relating to particular tools. BS EN 50144–

2 and its subordinate Parts will replace the Sections of BS 2769: Part 2 as British Standards if adopted as European Standards.

International New Work Started

ISO 8662: Measurement of vibrations in hand–held power tools Parts 8 –17 (ISO/TC 118/SC 3 through MCE/8) Determination of fan sound power level under standardized laboratory conditions (ISO/TC 117 through MCE/17).

ISO 3822: Parts 1 to 4 Acoustics – Laboratory tests on noise emission from appliances and equipment used in water supply installations. This will revise ISO 3822 Parts 1 to 4 to cover all types of taps, valves etc. commonly used in the home.

ISO 10375: Non–destructive testing – Ultrasonic inspection – Characterization of search unit and sound field (ISO/DIS 10375).

ISO 12124: Acoustics – Procedures for the measurement of real–ear characteristics of hearing aids. This will specify methods and equipment for measuring electroacoustic characteristics of hearing aids when worn by the user. (ISO/TC 43 through EPC 1).

IEC 268: Sound system equipment.
Part 7: Headphones and earphones. This will revise IEC 268–7 to specify the characteristics and their methods of measurement for headphones, headsets, earphones and earsets intended to be used on, or in, the human ear, and to pre–amplifiers, passive networks and power supplies forming an integral part of the headphone system (3rd draft revision of 268–7). (IEC/TC 84(Sec)278 through EEL/32).

ISO 10124: Seamless and welded (except submerged arc–welded) steel tubes for pressure purposes – Part 2: Ultrasonic testing for detection of laminar imperfections (ISO/DIS 10124.2). This will specify the requirements for ultrasonic testing and welded (except submerged arc–welded) tubes, greater that 30mm outside diameter to four acceptance levels). (ISO/TC 17/SC 19 through ISM/73).

ISO 9000: Quality systems – Part 1: Guidelines for selection and use. This will revise ISO 9000–1: 1987. (ISO/TC 176/SC 2 through QMS/22).

ISO 9001: Quality systems – Model for quality assurance in design, development, production, installation and servicing. This will revise ISO 9001: 1987. (ISO/TC 176/SC 2 through QMS/22).

ISO 9002: Quality systems – Model for quality assurance in production and installation. This will revise ISO 9002: 1987. (ISO/TC 176/SC 2 through QMS/22).

ISO 9003: Quality systems – Model for quality assurance in final inspection and test. This will revise ISO 9003: 1987. (ISO/TC 176/SC 2 through QMS/22).

ISO 9004: Quality management and quality system elements.
Part 1: Guidelines. This will revise ISO 9004: 1987.
Part 8: Guidelines on quality principles and their application to management practices. (ISO/TC 176/SC 2 through QMS/22).

Test method of ultrasonic cleaning – Exposure of surface mounted devices. This will provide a test method to evaluate the endurance of surface mounting devices mounted on a printed circuit board when exposed to ultrasonic wave for cleaning.

IEC 601–2: Medical electrical equipment – Part 2: Particular requirements IEC 601–2–5: Particular requirements for the safety of ultrasonic therapy equipment. This will revise IEC 601–2–5.

Draft British Standards for Public Comment

93/300610 DC ISO 10124 Seamless and welded (except submerged arc–welded) steel tubes for pressure purposes – Ultrasonic testing for the detection of laminar imperfections (ISO/DIS 10124.2).

93/203591 DC Ultrasonics – Physiotherapy systems – Performance requirements and methods of measurement in the frequency range 0.5 MHz to 5 MHz (Possible new British Standard) [IEC 87/62D(Secretariat)48/100].

93/704699 DC ISO 10375 Non–destructive testing – Ultrasonic inspection – Characterization of search unit and sound field (ISO/DIS 10375).

93/705827 DC EN 1031 Measurement and evaluation of whole body vibration – General requirements (pr EN 1031).

93/705831 DC EN 1031 Hand–arm vibration – Guidelines for vibration hazards reduction – Part 1: Engineering methods by design of machinery (prEN 1031–1)

93/705832 DC EN 1032 Testing of machinery in order to measure the whole–body vibration emission value – General requirements (prEN 1032).

93/705835 DC EN 1033 Laboratory measurement of vibrations at the grip surface of hand–guided machinery (prEN 1033–1).

93/203886 DC Methods of measuring and specifying the performers of sounders (electroacoustic transducers for tone production) [IEC 84(Secretariat)284].

93/502132 DC Acoustics – Measurement of insertion loss of ducted silencers without flow – Laboratory survey method (ISO/DIS 11691 and prEN 31691).

93/502133 DC Acoustics – Noise emitted by machinery and equipment – Guidelines for the use of basic standards for the determination of emission sound pressure levels at the work station and at other specified positions (ISO/DIS 11200 and prEN 31200).

93/502149 DC Acoustics – Noise emitted by machinery and equipment – Rules for the drafting and presentation of a noise test code (ISO/DIS 12001 and prEN 32001).

93/502150 DC Acoustics – Noise emitted by machinery and equipment – Measurement of emission sound pressure levels at the work station and at other specified positions – Engineering method in an essentially free field over a reflecting plane (ISO/DIS 11201 and prEN 31201).

93/502151 DC Acoustics – Noise emitted by machinery and equipment – Measurement of emission sound pressure levels at the work station and at other specified positions – Survey method in situ (ISO/DIS 11202 and prEN 31202).

93/502152 DC Acoustics – Noise emitted by machinery and equipment – Measurement of emission sound pressure levels at the work station and at other specified positions (ISO/DIS 11203 and prEN 31203).
93/502153 DC Acoustics – Noise emitted by machinery and equipment – Measurement of emission sound pressure levels at the work station and at other specified positions – Method requiring environmental corrections (ISO/DIS 11204 and prEN 31204).
93/702700 DC ISO 6798 Acoustics – Test code for the measurement of airborne noise emitted by reciprocating internal combustion engines – Engineering and survey method (ISO/DIS 6798).
93/502127 DC ISO/DIS 3095 Acoustics – Measurement of noise emitted by railbound vehicles.
93/502128 DC Acoustics – Method for the measurement of airborne noise emitted by small air–moving devices.
93/205919 DC Amendment 2 to IEC 268 Sound system equipment – Part 12: Application data for connectors for amplifiers and loudspeakers, suitable for voltages above 34 V peak and currents above 4 A peak [IEC 84 (Secretariat)290].
93/206325 DC Amendment to EN 50144 Hand–held electric motor tools – Part 1: General requirements – Amendment: New subclauses 13.2 and 13.3 covering noise and vibration measurements (Possible amendment to future British Standard) [CLC/TC 61F (Secretariat) 128].
93/206326 DC Amendments to EN 50144 Hand–held electric motor tools – Part 2: Particular requirements – Amendment to the sixteen subordinate Parts of EN 50144–2 relating to noise and vibration measurements for particular tools (Possible amendment to future British Standards) [CLC/TC 61F(Secretariat)129].
93/206327 DC EN 50144 Hand–held electric motor tools – Parts 2–13: Particular requirements for planers – Proposal to update HD 400.3 Section MS2 into a European Standard (EN 50114–2–13) (Possible revision to BS 2769:Part 2.13: 1992) [CLC/TC 61F (Secretariat) 129].
93/206328 DC EN 50144 Hand–held electric motor operated tools – Parts 2–9: Particular requirements for circular saws and circular knives – Proposal to update HD 400.2 Section ES2 into a European Standard (EN 50114–2–9) (Possible revision to BS 2769: Part 2.5: 1991) [CLC/TC 61F(Secretariat) 131].
93/206329 DC EN 50144 Hand–held electric motor operated tools – Parts 2–12: Particular requirements for chain saws – Proposal to update HD 400.3 Section LS2 into a European Standard (EN 50114–2–12) (Possible revision to BS 2769: Part 2.12: 1991) [CLC/TC 61F (Secretariat)115].
93/504337 DC BS 5724 Medical electrical equipment. BS 5724: Part 2: Particular requirements for safety. New Section: Specification for ultrasonic diagnostic and monitoring equipment [IEC/SC 62B/87(Secretariat)199/53].
93/706301 DC ISO 10816 Mechanical vibration – Evaluation of machine vibration by measurements on non–rotating parts – Part 1: General guidelines (ISO/DIS 10816–1).
93/207637 DC Possible amendment to BS 6840 Sound system equipment. Part 5: 1990 Methods for specifying the characteristics of loudspeakers. Addition of a new subclause 23.4 to introduce a useful characteristic 'coverage angle' (Amendment to IEC 268–5: 1989) [IEC 84 (Secretariat)296].
93/207638 DC Possible amendment to BS 6840 Sound system equipment. Part 11: 1988 Specification for the application of connectors for interconnection of sound system components. Additional text on cordsets and screen continuity. (Amendment to IEC 268–11: 1987) [IEC 84(Secretariat) 297].
93/707619 DC ISO 8528–9 Reciprocating internal combustion engine driven a.c. generating sets – Part 9: Measurement and evaluation of mechanical vibrations (ISO/DIS 8528–9).
93/208222 DC Code of practice for the assessment, specification, preparation, maintenance and operation of sound systems for emergency purposes at sports grounds and stadia in pursuit of approval by licensing authorities.
93/208441 DC IEC 1019–2–3 Surface acoustic wave (SAW) resonators – Part 2: Guide to the use of surface acoustic wave (SAW) resonators (Section 3) [IEC 49 (Secretariat) 257].
93/208508 DC Electroacoustics – Instruments for measurement of aircraft noise – Performance requirements for systems to measure one–third–octave band sound pressure levels in noise certification of transport – category aeroplanes [IEC 29 (Secretariat) 239].
93/209124 DC Amendment to IEC 268–5 Sound system equipment – Part 5: Loudspeakers – Subclause 24: Harmonic distortion of the loudspeaker at the time limited input voltages higher than the rated sinusoidal voltage (Possible amendment to BS 6840: Part 5: 1990) [IEC 83 (Secretariat) 307].
93/505036 DC Revision of ISO 2923 Acoustics – Measurement of noise on board vessels (Possible new British Standard) (ISO/DIS 2923).
93/505037 DC Acoustics – Determination of sound insulation performance of cabins – Laboratory and in situ measurements (Possible new British Standard) (ISO/DIS 11957 and prEN 31957).

CEN European Standards
EN 20140–2: 1993 Acoustics – Measurement of sound insulation in buildings and of building elements – Part 2: Determination, verification, and application of precision data (ISO 140–2: 1991). Implemented as BS EN 20140–2: 1993 [BS 2750: part 2: 1993].

European Pre–standards
The following European pre–standard (ENV) has been approved by CEN:.
ENV 28041: 1993 Human response to vibration – Measuring instrumentation (ISO 8041: 1990).

CENELEC Publications
European Standards:.
EN 60118: Hearing aids.

EN 60118–0 January 1993 Measurement of electro-acoustical characteristics. This supersedes HD 450.0 S1:1984.
EN 60118–7 January 1993 Measurement of performance characteristics of hearing aids for quality inspection for delivery purposes. This supersedes HD 450.7 S1:1985. Corrigendum: June 1993 to EN 60335 –2–27.
EN 61027: February 1993 Instruments for the measurement of aural acoustic impedance/admittance.

ISO and IEC Draft Standards

The following has been issued as British Standard draft for public comment: Electroacoustics – Aircraft noise – 93/208508 DC.

IEC Publications

IEC 118–2: Hearing aids – Part 2: Hearing aids with automatic gain control circuits. Amendment 1: 1993 to IEC 118–2: 1983. This will be implemented when harmonised by CENELEC.
IEC 645–1: 1992 Audiometers – Part 1: Pure tone audiometers. Corrigendum to IEC 645–1: 1992.
IEC 1094: Measurement microphones.
IEC 1094–1: 1992 Specification for laboratory standard microphones.
Corrigendum to IEC 1094–1: 1992.
IEC 1094–2: 1992 Primary method for pressure calibration of laboratory standard microphones by the reciprocity technique.
IEC 268–5 Sound system equipment – Part 5: Loudspeakers. Amendment No.1: 1993 to IEC 268–5: 1989. This will be implemented when harmonised by CENELEC.
IEC 1206: 1993 Technical Report. Ultrasonics – Continuous-wave Doppler systems test procedures. This will be implemented as a British Standard.
IEC 1119–5: May 1993 Digital audio tape cassette system (DAT) – Part 5: DAT for professional use. This will be implemented when harmonised by CENELEC.
IEC 1220: 1993 Technical Report. Ultrasonics – Fields - Guidance for measurement and characterisation of ultrasonic fields generated by medical ultrasonic equipment using headphones in a frequency range 0.5 MHz to 15 MHz.

ISO Standards

ISO 9578: 1993 Cinematography – Background acoustic noise levels in theatres, review rooms and dubbing rooms.
ISO 8579: Acceptance codes for gears.
ISO 8579–1:1993 Determination of airborne sound power levels emitted by gear units. This will be implemented dual-numbered as a British Standard.
ISO 8041: Human response to vibration – Measuring instrumentation. Technical Corrigendum 1: 1993 to ISO 8041:1990. ISO 8041 is shortly to be implemented as DD ENV 28041 and if CEN adopt this corrigendum it will be issued as an amendment to DD ENV 28041.
ISO 9613–1: 1993 Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of the absorption of sound absorption by the atmosphere. This will not be implemented as a British Standard because of absence of UK interest.
ISO 9614–1: 1993 Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 1: Measurement at discrete points. This will not be implemented as a British Standard because of absence of UK interest.

Documents Issued Under CEN Primary Questionnaire (PQ) Procedure

CEN is conducting enquiries to assess the acceptability as European Standards of the following Reference Documents (standards issued by other organizations). If, as a results of any enquiry, a Reference Document accepted as a European Standard has already been adopted as a dual-numbered BS, the BS will be amended to indicate its status as an EN. In all other cases, the resulting EN will be implemented as a new revised BS under the BS EN numbering system and any existing BS on the subject will be withdrawn.
ISO 7235: 1991 Acoustics – Measurement for ducted silencers – Insertion loss, flow noise and total pressure loss. No equivalent British Standard is superseded.
ISO 9614–1: Acoustics – Determination of sound power levels of noise sources using sound intensity – Part 1: Measurement at discrete points.

Special announcements

Hearing aids.
CENELEC has adopted the International Standards listed below without any modifications as EN 60118–1/7 respectively.
IEC 118–0: Hearing aids – Part 0: Measurement of electroacoustical properties (United Kingdom did not approve the EN).
IEC 118–7: Measurement of performance characteristics of hearing aids for quality inspection for delivery purposes (United Kingdom did not approve the EN).

This information was provided by Nicole Porter MIOA of NPL from the March to August issues of BSI News.

Hansard

8 June 1993
Noise
Mr Dafis: To ask the Secretary of State for the Environment what proportion of the United Kingdom population is estimated to be exposed to night-time noise levels in excess of 65 dB(A); what assessment he has made of the health effects of such exposure; and what plans he has to meet the targets for noise reduction contained in the European Community's fifth environmental action programme.
Mr Yeo: Results from a noise incidence study of England and Wales carried out as part of my Department's noise research programme indicate that under 1 per cent. of the population is exposed to night-time noise levels above

65 dB(A). Research in this area has not so far shown scientifically demonstrable links between night-time noise levels, loss of sleep and effects on health, but this area is being kept under review.

The importance of a quieter night-time noise environment is recognised in my Department's draft planning policy guidance note on planning and noise. It suggests a group of four noise exposure categories, in which different planning constraints on noise sensitive development are appropriate. Recommended noise levels for each category are set out in the draft guidance for both day-time exposure - 07.00 to 23.00 - and night-time exposure - 23.00 to 07.00. Where relevant, the suggested noise level figures take account of, and broadly reflect, the EC fifth environment action programme. The draft guidance, a copy of which is in the Library, also offers more general advice on night-time noise exposure issues.

1 July 1993

Noise Abatement Zones

Mr Pike: To ask the Secretary of State for the Environment what recent representations his Department has received on noise abatement zones; and if he will make a statement.

Mr Yeo: I have received no recent representations, apart from those from the hon. Member.

The report of the Noise Review Working Party 1990, copies of which are in the Library, found that the application of NAZs was limited by their complexity and the demands on local authority resources. Subsequent research by the Building Research Establishment considered this further and demonstrated that the principal problems are the complexity of the regulations for setting up NAZs and the intensive use of manpower in monitoring the statutorily required noise level registers. My Department is considering these findings.

13 July 1993

Noise and Statutory Nuisance Bill

The Earl of Shrewsbury: My Lords, I beg to move that this Bill be now read a second time.

It gives me great pleasure to help in bringing forward this extremely useful legislation. I am sure that we are all deeply grateful to the honourable Member for Basingstoke who picked up on some of the major recommendations put forward by the Noise Review Working Party in 1990 and who has drafted a Bill which I believe responds admirably to them....

I turn now to the main elements of the Bill, of which there are four. First, there is noise in the street; secondly, loudspeakers in the street; thirdly, burglar alarms; and, fourthly, a more certain way for local authorities to recover the cost of abating statutory nuisances....

Currently the Environmental Protection Act 1990 gives local authorities powers to deal with noise that is emitted from premises. Where noise arises on the street, however, the provisions of the Act do not apply....

Perhaps I may give your Lordships an illustration of how the Bill's street noise provisions would work. Let us say that a car alarm has been sounding for some time in a residential street. The Bill gives environmental health officers (EHOs) a new power to affix an abatement notice onto the vehicle, machinery or equipment rather than having to serve it on the person responsible. This is a most sensible provision which will serve the dual purpose of allowing local authorities to procede to take action where it proves impossible to trace the person responsible and of alerting that person, should he return in the meantime, that his alarm is causing a nuisance and that the local authority is taking steps to trace him....

Loudspeakers in the street can be a great source of noise and annoyance. They are currently controlled by Section 62 of the Control of Pollution Act 1974 (COPA), but there is room for improvement. Loudspeakers can currently be used in the street (although not for advertising purposes) between 8 am and 9 pm. Clause 7 of the Bill would give the Secretary of State the power to amend that time band....

The third element of the Bill deals with audible intruder alarms. We are all familiar with the deafening nuisance of intruder alarms which invariably seem to go off in the early hours of the morning, mine especially. These 'false alarms' have become so commonplace as to make alarm systems far less effective for their proper purpose. Alarms do, of course, have an important security role. I am, however, anxious that something should be done to reduce the noise nuisance alarms can cause when they sound for no apparent reason. If this nuisance could be reduced, I am sure that the credibility of alarm systems in general could be improved....

The fourth element of the Bill is a small but important provision concerned directly with statutory nuisance law as enshrined in the Environmental Protection Act 1990. Clause 10 in effect re-instates a power which local authorities used to have under the Public Health Act 1936. It allows them to recover costs incurred in abating a statutory nuisance by putting a charge on the premises where it is the owner of the premises who is, or was, responsible for the nuisance. In the past it has sometimes proved difficult for local authorities to trace the owners of premises in order to recover their costs after they have taken abatement action....

Moved, That the Bill be now read a second time. (The Earl of Shrewsbury.)

Lord Brougham and Vaux: This is a very welcome measure, but I do not believe it goes far enough, as the noble Viscount said. It does nothing to address the question of enforcement of emission standards and prevention of noise nuisance from moving vehicles....

Lord Meston: My Lords, I join in expressing gratitude to the noble Earl for his introduction of the Bill. In principle, it is a valuable measure which we should support. However, it has to be said that the Bill is a further illustration of the piecemeal and ad hoc manner in which our environmental protection legislation develops. But at least it can be said that it does develop. Noise alone is covered by several Acts of Parliament dealing with noise in general from aircraft, and from motor cycles to which my noble friend referred. In addition, there is a substantial body of secondary legislation and codes of practice such as those introduced in 1981 relating to intruder alarms and ice cream van chimes. Inevitably, there are also new European directives and initiatives. Indeed, I read that a Minister recently had said with some pride, that he had addressed something called Euro-Noise — which I assume is nothing to do with what we have been enduring for the past few weeks....

I should like to see some further encouragement given to insurers to give discounts for those who have properly maintained alarms, and encouragement to landlords to stipulate within leases for the proper maintenance of alarms. That is all in the hope that prevention is better than the remedies provided by the Bill....

The Parliamentary Under-Secretary of State, Department of the Environment (Lord Strathclyde): The noble Viscount and indeed my noble friend Lord Oxfuird asked an important question on the law preventing people from playing very loud music in their cars. I can tell the House that, although the Road Vehicles (Construction and Use) Regulations 1986 contain no specific reference to car stereos, Regulation 97 makes it an offence to use a vehicle on a road in such a manner as to cause any excessive noise which could have been avoided by the exercise of reasonable care on the part of the driver. I understand that Essex police have been serving fixed penalty notices on those who operate car stereos so as to create excessive noise. The penalty is currently £20 and the driver's licence is not endorsed. In addition the Control of Pollution Act 1974 makes it an offence to operate a loudspeaker in a car for certain purposes between the hours of 9 pm and 8 am if the loudspeaker gives reasonable cause for annoyance to persons in the vicinity.

The noble Viscount also asked a question on motorcycle exhausts. Perhaps I may draw his attention to the requirements of EC Directive 89/235 and the latest British Standard, both dealing with replacement exhaust systems. Under our Community obligations these two provisions, appearing soon after the 1987 Act, introduced unavoidable delays in completing the regulations. In addition, the requirements do not easily fit into the corpus of British road traffic law. Consequently, drafting has been a long and involved process. The amendment to the 1986 regulations is to all intents and purposes now complete. We propose to press ahead with the regulations to be made under the 1987 Act....

The Government consulted the insurance industry on its own proposals in June 1992. The industry was broadly supportive of the proposals that have now been introduced in the Bill. We will of course consult the industry again before this part of the Bill comes into force to make sure that the industry and Parliament are in agreement.

Turning to the Bill, I am sure that those who spoke and indeed the whole House will regard the Bill as extremely good news to all those who have suffered from the problems that are caused by noise in the street and noise from burglar alarms....

I am particularly delighted that the Bill addresses the problems caused by vehicle alarms, because I know that they can cause considerable annoyance to all those unfortunate enough to be in the vicinity. We should also recognise the care that has been taken in the Bill to balance the rights of owners of vehicles left unattended in the street against the reasonable expectations of those living and working in the vicinity that a noise nuisance should be stopped as quickly as possible.

Modern sound equipment is capable of creating a deafening and ear-damaging effect. I am therefore delighted that the Bill also addresses the question of loudspeakers in the street. I think that the provisions introduced by my noble friend strike just the right balance between being flexible and ensuring greater control....

My noble friend and other noble Lords mentioned the considerable problem that can be caused by burglar alarms that misfire in the small hours. Quite apart from the aggravation their misfiring creates, it also defeats their purpose. It is therefore in the interests of the owners of premises, the manufacturers and installers of alarms and residents at large that all is done that can be done to ensure that intruder alarms disturb people only when a crime is being committed. As with the loudspeaker proposals, the powers in the Bill relating to burglar alarms will also be subject to adoption procedures; and that, I am sure, is a sensible way of ensuring that only those authorities who feel that they can usefully use these powers need apply them.

Clause 10 of the Bill will, I am sure, be welcomed by local authorities. It will provide them with a more certain way of recovering the expenses that they have incurred in the course of their duty to abate statutory nuisances, I thoroughly welcome this proposal....

I commend the Bill to the House. I can assure noble Lords that it will receive full government support in its implementation....

On Question, Bill read a second time and committed to a Committee of the Whole House.

The Hansard extracts were provided by Rupert Taylor FIOA.

Book Reviews

Sound Control for Homes. Building Research Establishment and Construction Industry Research and Information Association Published 1993. £40.00

This book contains practical information relating to the control of noise within dwellings. It is in four parts which take the reader through the fundamental principles, design and detailing theory and worked examples of how these relate in practice.

The section on basic principles of acoustics is useful for those unfamiliar with acoustics or those who need reminding of the theory involved in noise control. The section on Scheme Design informs the reader how, at the design stage, to plan against noise sources by ensuring that appropriate construction methods and techniques are used. This is continued in the subsequent chapter by examining specific detailing within dwellings, relevant to sound insulation, which conform with the current Building Regulations. The main section of the text contains worked examples of how the digest should be used. It sums up the principles previously described and gives examples of how to apply them in practice. It includes details of the following: noise assessment used in the planning of a site and the design of the building envelope, noise control techniques used in the design of new houses and the selection of the form of construction, design methods used to ensure sound insulation in converted properties and methods used to alleviate noise problems in existing dwellings.

The text is primarily aimed at architects but would be beneficial to anyone involved in the procurement of homes from the initial planning stages, through the design stage, the construction process and any ensuing maintenance. It is very clearly written, well presented and contains excellent visual aids to assist the readers' understanding of the subject. The documentation is cross-referenced to similar areas of interest within the book. My only criticism of the book is the cost. At £40.00 it would be available to most professionals involved in the design and construction of houses. Sadly, it will be out of reach for most students of these disciplines where I feel its use would be valuable. Criticisms aside, I found the book an excellent guide to noise control and would recommend it to anyone as the definitive guide on this specialist area of noise control.

Stephen Pretlove

The Physics of Vibrations and Waves (4th edition)
H J Pain, J Wiley Chichester (1993)
ISBN 0471 937428: Price £39.95

This text, aimed at first year undergraduates, commences with the 'introductions' to each of the four editions through which it is has passed. It thus aims to assume 'no more than school-learning mathematics' (although the highest common factor in this may have reduced significantly since the first edition was published in 1968). It is concerned to produce 'a concise text amplified by many problems over a wide range of content and sophistication'. The initial concept that a medium through which energy is transmitted via wave propagation behaves essentially as a continuum of coupled oscillators, leads naturally to the behaviour of transverse waves on a string, longitudinal waves in a gas and a solid, voltage and current waves on a transmission line, and electromagnetic waves in a dielectric conductor. Through successive editions the author has added an extra chapter on Wave Mechanics to illustrate the application of classical principles to modern physics, the basis of an introductory course on optics, and most recently, extension of the chapter on non-linear oscillators to include elements of the application of chaos theory to problems in a variety of disciplines. Thus one finds a text of almost 500 pages, which may be rather large for a single introductory first year course.

However, on closer inspection, one discovers that the textual physics is augmented at the end of each chapter by a series of problems and a summary of important results. At appropriate points in the text the problems relevant to the preceding sections are indicated in bold type. Furthermore there are sections which introduce the appropriate mathematics as needed, eg complex numbers, partial differentiation, Fourier Series, etc.

Whereas the first chapter on simple and damped simple harmonic motion is all valuable (and the quantity Q is more clearly introduced than in many rival texts), the second chapter on the forced oscillator may not be included in all introductory waves courses. It is necessary in the present text for the introduction of impedance via the AC circuit approach. The third chapter starts with two spring-coupled oscillators and having introduced normal coordinates and modes, proceeds to the continuum limit which yields the wave equation. The more conventional derivation of the wave equation for transverse waves on a string follows in chapter 4 and the concepts developed in earlier chapters are marshalled to permit the rapid development of a number of new concepts, including phase and group velocities.

The next three chapters deal with longitudinal waves, waves on transmission lines and electromagnetic waves. Although waves in more than one dimension are discussed in chapter 8, the author - sensibly - continues to restrict himself to plane waves. The derivation of the number of normal modes in a given frequency range per unit volume of the enclosure is exemplified by its application to Planck's law of hot body radiation and to the Debye theory of specific heats.

Chapter 10 on waves in optical systems includes a small amount of classical geometrical optics as well as the interferometric and diffractive aspects of phenomena and measurements. It is a pleasure to see Fermat's principle included. The chapter on wave mechanics is an excellent brief introduction to the subject, as, indeed, is the final chapter on non-linear oscillators and chaos. The latter starts with the free vibrations of an anharmonic oscillator and forced oscillations with a non-linear restoring force, and proceeds on to concepts of chaos and phase space. After a brief look at fractals and strange chaotic attractors, the chapter concludes with a brief section on non-linear effects in acoustic waves.

With limited time available this text probably contains much more than will fit a single introductory first year course. Indeed the final chapter could easily form the basis of a more advanced course in its own right. The text is clearly written and, with typography that eases passage through the book, fulfils the aim of a working text. While the range of physical applications introduced is significant and illuminating, the acoustician (or physicist) who wishes to use the text selectively will need to beware that his or her selection has not inadvertently omitted preparatory concepts because of the careful and logical structure of the book.

For lecturers it is likely to be a valuable text on which to base a lecture course, while it will almost certainly have a longer term value for the students who wish to purchase it.

R C Chivers FIOA

Books for reviewing should be sent to Dr A J Pretlove FIOA, Engineering Department, University of Reading, Whiteknights, Reading RG6 2AY. ❖

New Products

CIRRUS RESEARCH plc

Data Logging Sound Level Meter CRL 236A

The CRL 236A shares all the data logging features of the CRL 236, but includes the following additional power:

- Vastly increased memory capacity of 987,000 short L_{eq} elements
- Real Time Clock
- Improved data transfer software
- Specialist 5 ms short L_{eq} variant CRL 236AF for impulsive noise.

The CRL 236A faithfully records actual integration period energy as a series of integrated or 'Short L_{eq}' measurements at periods such as 0.125 s, 1 s, or 10 s, and can store 8 values a second for 34 hours. During data acquisition noise sources can also be coded for identification. Stored data can be downloaded to an MS-DOS compatible computer. Once downloaded to a computer any noise index can be computed over any period or the level of a single event noise can be computed.

For further detail contact Andy Maslin on 0723 891655. Cirrus Research plc, Acoustic House, Hunmanby, North Yorkshire YO14 0PH.

Cirrus Research is a Key Sponsor of the Institute

ECOPHON PILKINGTON

TONGA Acoustic Ceiling System

Ceiling specialists, Ecophon Pilkington, have launched their TONGA range, a new colour-coordinated acoustic ceiling system which gives endless scope for unusual and attractive ceiling designs. Available in fourteen colours plus white, Tonga tiles are manufactured from 25mm, 40mm and 80mm high density rockwool finished with decorative glass tissue facing. As well as its excellent sound absorption properties Tonga meets TMR class 1 standard for moisture resistance by withstanding a permanent relative humidity of up to 95% at 40°C without warping or sagging and achieves 30 minutes fire resistance to BS 476:Part 23:1987. The tiles are fully demountable, can be handled frequently, dusted, vacuumed or wiped clean with a damp cloth without damage or deterioration.

For further details contact Ecophon Pilkington Ltd, Ramsdell, Basingstoke RG26 5PP. Tel: 0256 850977, Fax: 0256 850600.

Ecophon Pilkington is a Sponsor Member of the Institute

DIAGNOSTIC INSTRUMENTS LTD

SL 3000 on-line condition monitoring system.

Diagnostic Instruments Ltd announce the launch of their first 'on-line' system for fully automated data collection within a Predictive Maintenance program. DI's SL3000 system is designed specifically to provide a data harvesting facility which integrates completely with a full range of portable data collectors and on-line static monitoring pods.

The SL3000 can collect many different types of dynamic signals from Time and Frequency domain overalls and signatures to Enveloped Spectra and Dynamic Speed-measurements.

The introduction of the SL3000 into DI's solutions portfolio provides customers with a phased, fully integrated growth path from simple data collectors to on-line, fully automated Predictive Maintenance.

The SL3000 system was designed to incorporate many practical customer driven features to simplify installation, commissioning and debug.

For further information contact Donald Howieson, Product Engineer, Diagnostic Instruments Ltd, 264 West Main Street, Whitburn, West Lothian EH47 0LB, Tel: 0501 743031, Fax: 0501 743933.

HHB COMMUNICATIONS

CEDAR CR-1 De-Crackler

HHB announce the launch of the new CEDAR CR-1 De-crackler, the latest unique real-time audio restoration tool from CEDAR Audio Ltd, based in Cambridge, England. The CR-1 de-crackler is a 2U rack-mounted device which powerfully performs a number of functions utilising CEDAR's 'Split and Recombine' signal processing technology. The main features of the CR-1 are as follows :-

- Crackle Removal
- Buzz Removal
- Distortion reduction.

For further details please contact HHB Communications Ltd, 73-75 Scrubs Lane, London NW10 6QU. Tel: 081 960 2144, Telex: 923393. Fax: 081 960 1160.

News Items

Livingston Hire

New Availability

Now available from Livingston Hire is Bruel & Kjær's new measurement system providing portable facilities for evaluating the potential for annoyance and structural damage of building and ground vibrations. B & K's new system, using their versatile battery powered Type 2231 Modular Sound Level Meter equipped with a vibration event software module which controls the measurement, measures acceleration and velocity for monitoring of impulsive, intermittent and continous vibrations, in compliance with ISO 2631, BS 6472:1992 and DIN 4150. Stored results can be recalled for examination or downloaded via a serial interface to B & K's portable documentation printer or to a personal computer.

For further information contact Graham Harris, Livingston Hire Ltd, Livingston House, Queen's Road, Teddington, Middlesex TW11 0LR. Tel: 081 943 5151.

Anthony Best Dynamics

Analysis system on a portable PC

Anthony Best Dynamics Ltd (ABD) has launched what they claim to be the first truly cost effective octave and third octave analysis system on a portable PC, offering real time data capture up to 22.6 kHz through a slave digital signal processor (DSP). The third octave analyser is a new extension to the RAMS system from ABD, employing digital filters to remove the processing time lag inherent in Fast Fourier Transform techniques. Complete

spectra update rates are in excess of 500 per second with data storage direct to hard disc on the PC in excess of 100 per second. ABD can supply complete systems together with training.
For further information contact Andy Rumble, Systems Director, Anthony Best Dynamics, Holt Road, Bradford on Avon, Wilts BA15 1AJ, Tel: 0225 867575.

Travers Morgan Ltd

Travers Morgan Ltd enters the US acoustic market

MLM Promotions, an Anglo-American organisation, has appointed Travers Morgan Ltd to design the 200,000 watt temporary sound system for the 'Trance-Atlantic' dance party event at the 100 acre sound and laser park just south west of the Disney complex in Orlando.

This event will feature the world premiere of Laser Fantasy's 40 watt high resolution lasers capable of sending green argon beams over ten miles into the Orlando night sky.

There will be safeguards against excessive environmental noise over-spill and particular emphasis on speaker location and orientation to minimise any risk of hearing damage to the participants.

Diagnostics Instruments

FFT analysis at work: a training seminar.

Eight training seminars on FFT analysis will be held in different towns from 4 October 1993 to 11 March 1994. For more information contact Valerie Oliver, Diagnostic Instruments Ltd, 264 Main St, Whitburn, West Lothian EH47 0LB. Tel: 0501 743933.

Bruel & Kjær UK

Seminar on data acquisition

A one day seminar by Bruel & Kjær is designed to help engineers make the most of existing systems and looks at the most recent developments in this area.

Subjects covered will include signal conditioning, optimising dynamic range, data rates, data bandwidth, sampling rates, aliasing, communication, interface and media standards. The seminar will be held on 1 December at the Edgewarebury Hotel, Elstree. It is free of charge and lunch will be provided. For further information contact Sue Katic, Bruel & Kjær (UK) Ltd, 92 Uxbridge Road, Harrow HA3 6BZ, Tel: 081 954 2366.

Bruel & Kjær UK is a Key Sponsor of the Institute

SAVE ACOUSTICS

On 13 August 1993 Witt & Sohn GmbH of Pinneberg, Germany, acquired Fan Systems Group Ltd of Halifax, West Yorkshire, a manufacturer of fans and acoustical equipment. This includes Sound & Vibration Equipment Ltd, known as SAVE Acoustics.

At present only Witt & Sohn are certified to DIN ISO 9001; Fan Systems are stated to be in the final stages of achieving this. When the two companies have merged they will generate an annual turnover in excess of £50 million.

Items for the New Products section should be sent to John Sargent MIOA at BRE. ❖

Views expressed in Letters to the Editor are not necessarily shared by the Editor or the Institute. Letters may be edited for space reasons

From L F Moore FIOA, Leslie F Moore Associates

Dear Sir

In the August 1993 issue of BSI News I noticed the following entry under the section 'ISO Standards'

> ISO 9613-1: 1993 Acoustics - Attenuation of sound during propagation outdoors - Part 1: Calculation of the absorption of sound by the atmosphere. *Will not be implemented as a British Standard because of absence of UK interest (my italics).*

When BSI send out their 'Drafts for Public Comment' the cover sheet generally states 'If you have no specific comments to make but find it generally acceptable it would be helpful if you would notify us accordingly'. I must plead guilty to the fact that I sent off for and received the DPC for this particular ISO standard but because of the usual pressures of time did not communicate with BSI as I did not have any specific comments to make. I now wonder how many other IOA members (some of whom would have more interest in this standard than myself) took the same attitude with the above result.

Because of the high rates charged to be a full member of BSI I am only a member of its offshoot 'The British Standards Society' which is for individuals only with an annual subscription of £25 plus VAT. Two of the benefits of membership are free copies of BSI News and the annual standards catalogue at a reduced rate. For most of us who cannot afford the normal price of £12.50 for the handful of pages comprising a draft standard (more for the thicker ones) BSS membership has the added advantage - not well publicized - of free copies of DPCs. With the increasing complexity of International, European and British standards as overviewed so well in John Woodgate's article in the May/June 1993 Acoustics Bulletin I feel strongly that more of us should acquire these draft standards (possibly by becoming involved in at least one BSI committee) and make our views known instead of moaning later about the content of a published standard. I suppose the exception to this is, as far as IOA members are concerned, BS 4142 where a large number of us participated in the drafting stage and we are still moaning now that the revision has been published! The secretary of BSS is Mrs Pam Hall on 0923 252361 (telephone and fax).

I was recently at a BSI committee meeting in London to discuss some acoustic standards and we had an apology for absence from a senior staff member of a Government sponsored body in Glasgow who could not come to the meeting because of new time and expense restrictions. Only four of us attended the meeting instead of about ten and I understand this is not unusual for BSI meetings these days. I know that these meetings can be a bit boring but if only those with an axe (possibly commercial) to grind come along we must be prepared for the consequences.

Please do not forget that the lead time for these standards is now considerably shorter (see John Woodgate's article) and therefore we cannot afford to procrastinate if we want to influence the content of these standards.

Yours sincerely ❖