Acoustics BULLETIN

VOL 28 No2 Mar/Apr 2003

Calibration and measurement in underwater acoustics - meeting report

Noise measurements in extreme cold
Approved Document E: Development of Robust Standard Details
The accuracy of noise maps using air quality source data

Institute of Acoustics

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Contents

Cover: The recent meeting of the underwater acoustics group at NPL turns our attention again to the oceans of the world. The Great Barrier Reef offshore Australia is an area of special interest to non-oceanographers too, because of the variety of wildlife on and around it.

Institute of Acoustics

The Institute of Acoustics was formed in 1974 through the amalgamation of the Acoustics Group of the Institute of Physics and the British Acoustical Society and is the premier organisation in the United Kingdom concerned with acoustics. The present membership is in excess of two thousand and since 1977 it has been a fully professional Institute. The Institute has representation in many major research, educational, planning and industrial establishments covering all aspects of acoustics including aerodynamic noise, environmental, industrial and architectural acoustics, audiology, building acoustics, hearing, electroacoustics, infrasonics, ultrasonics, noise, physical acoustics, speech, transportation noise, underwater acoustics and vibration. The Institute is a Registered Charity no 267026.

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Dear Members

This is a busy time for the Institute and its committees and I thought it appropriate to use this letter to tell you about some recent developments. Those members who attended the Autumn Conference know that we had to cancel the EGM intended to approve the changes to the by-laws covering the introduction of the 'Technician' grade. The operational rules of the Institute's Memorandum and Articles of Association are complex and we decided to get approval from the Charities Commission as well as the DTI. We expect to obtain this in time to ratify the changes at the Spring Conference. This membership grade is aimed primarily at young technicians doing occupational and environmental noise assessments, and those working in the electro-acoustic business and in technical acoustics everywhere. To qualify, applicants must be regularly engaged in the business and have one or more certificates of competence as well as a good general education.

Some other good news is that the Association of Noise Consultants (ANC) has donated £5000 to the Institute to assist with the setting up of an archive to house the papers of prominent UK acousticians. Council has agreed to match this donation and to set up an Archive Fund to allow the Institute to deal properly with the various archives that have been made available to us. These cannot be housed at the office because of lack of space, but in any case they require sorting and cataloguing. We intend to apply to other bodies for additional funds to set up a National Archive at an appropriate establishment. You will hear more on this from Professor Bridget Shields who has agreed to chair a new archive sub-committee.

In future, the Membership Committee will take on a more strategic role in setting standards for membership, providing guidance to those seeking admission or upgrade and setting a framework for the maintenance of competence through CPD. To do this Council has agreed that the Membership Committee's terms of reference will be extended to cover the activities previously covered by the Professional Development Committee. The extended committee will include members from both. It is intended that experience will be drawn from work already done by Engineering Division. However, generic statements of competence for all IOA members must reflect the very broad range of work undertaken. We have many environmental scientists, architects, planners and lawyers as well as engineers on the membership roll. Acousticians come from diverse professional backgrounds.

Yours sincerely

Geoff

Geoff Kerry
President

MEETING REPORT

Calibration and measurement in underwater acoustics

A sunny, but rather snowy scene, welcomed 45 delegates to the National Physical Laboratory (NPL) for the Underwater Acoustics Group conference on calibration and measurement. The meeting was held on 9 and 10 January 2003 in the splendid conference facilities that form part of the new buildings at NPL. The delegates came from a wide range of interests and organisations, with 13 international representatives and ten different countries represented.

Stephen Robinson of NPL started the meeting by talking about the CIPM key comparison of hydrophones that involves seven calibration laboratories from four continents. These have each calibrated three hydrophones using fundamental techniques. The provisional results were very encouraging, displaying generally good agreement (within ±0.5dB) and a significant improvement on a European comparison held previously.

The low frequency calibration of hydrophones using transfer coupler reciprocity formed the subject of Joseph Zalesak's talk. He described the different couplers and techniques being used at the Naval Undersea Warfare Centre(NUWC) in Newport, USA, and how these techniques could be used to calibrate hydrophones not specifically designed for use in a coupler to a very high precision.

Alexander Isaev from VNIIFTRI in Russia then proceeded to describe his work on the precise calibration of hydrophones in a laboratory water tank. His talk concentrated on a technique for identifying early multiple reflections from the hydrophone body and hydrophone support structure, and then went on to describe how the effect of these can be reduced.

After lunch, **Stephen Forsythe** (NUWC), revealed new measurement techniques in NUWC's Underwater Sound Reference division. These varied from techniques of measuring the acoustic performance of materials to an intriguing technique of generating a low frequency plane wave for testing the effect of high amplitude sound fields on divers.

Victor Humphrey presents his work

Wang Yuebing of the Hangzhou Acoustic Research Institute, China, presents his work on the optical calibration of hydrophones

The reverberant calibration of acoustic sources in laboratory tanks formed the subject of **Steven Everitt**'s talk (University of Bath). He described how reverberant calibration techniques, normally associated with airborne acoustics, could be applied to the calibration of high Q acoustic sources by driving them with random noise and making measurements of the reverberant field. He compared the results obtained in a wide range of different tanks.

Discussions in a coffee break

Dick Hazelwood of Sonardyne International discussed techniques for deep-ocean noise monitoring at depths in excess of 1 kilometre. A system has been developed for attachment to a ROV that enables sources of noise to be monitored at depths where acoustic positioning and telemetry systems may be required to operate. He described the particular care taken to ensure that the hydrophone measurements were not contaminated by noise from the ROV.

The afternoon session ended with **Mark Hodnett** of NPL describing a range of sensors being developed to monitor the occurrence of acoustic cavitation in ultrasonic systems. The sensors consist of a cylinder of piezoelectric polymer coated with a material that transmits low acoustic frequencies but attenuates high frequencies. This enables low frequencies to propagate within the cylinder and produce cavitation; this is monitored by the high frequencies that are generated and detected by the sensor.

The delegates were then taken on a tour of the underwater acoustic calibration facilities at NPL. These included the large open water calibration tank (5m in diameter) and the Acoustic Pressure Vessel (APV) used to perform calibrations and measurements at pressures up to 7.0MPa (equivalent to a water depth of 700m) and at temperatures from 2°C to 35°C. A range of new developments was also presented including optical techniques for the fundamental measurement of pressure fields in water and an acoustic coupler used to calibrate hydrophones below 1kHz. The delegates then retired for an aperitif and informal meal at a local restaurant, enabling them to engage in a range of discussions.

The second day started with a presentation on recent progress at NPL in the use of optical techniques for hydrophone calibration. **Peter Theobald** (NPL) discussed ongoing work to extend the optical techniques that are currently used to calibrate hydrophones at frequencies above 500kHz (and hence define the acoustic Pascal) to much lower frequencies. He outlined the proposed technique and illustrated the potential with preliminary results for a hydrophone calibration.

The optical theme continued with **Andy Harland** of Loughborough University, who talked about non-invasive measurements of spatially and temporally distributed underwater acoustic pressure fields using laser doppler velocimetry. He showed how a laser doppler system could be used to measure a projection of the acoustic field as a function of time and hence monitor the development of a pulsed field. This was illustrated with impressive animations of the development of the field for real devices.

Wang Yuebing of the Hangzhou Acoustic Research Institute, China, also discussed optical techniques in his presentation dealing with the application of optical interferometry in the measurement of hydrophones. He described the use of a laser interferometer to measure the velocity of a thin pellicle immersed in the water tank and hence measure the acoustic pressure at that point. The hydrophone to be calibrated was then placed at this location: the calibration results presented showed excellent agreement with reciprocity over the frequency range 10 - 500 kHz.

The three papers presented after the

Discussions in a coffee break. Steven Everitt, Paul Lepper and J Dunn

coffee break were all concerned with the measurement of the acoustic properties of materials for use in underwater systems. **Victor Humphrey** of the University of Bath started the session by describing the work he was performing at NPL, in collaboration with QinetiQ, while on sabbatical. His presentation, entitled *The acoustic characterisation of panel materials under simulated ocean conditions,* described the use of a parametric array in the acoustic pressure vessel to facilitate measurements in the confined space over a wide frequency range.

The wide range of facilities for making materials measurements at the Naval Physical and Oceanographic Laboratory (NPOL) in India were described by **Shri Vasudevan** as part of his presentation on the evaluation of metal powder imbedded passive acoustic materials using an impulse measurement technique. This described the use of impulse tubes and free-field measurement techniques. In the latter case improved results were obtained by spatial averaging of the transmitted and reflected fields.

The second presentation from the Hangzhou Acoustic Research Institute was given by **Li Shu**, who spoke about a method based on broadband compressed pulse to measure properties of underwater acoustic materials. He described how the drive to the transmitting transducer could be adapted in order to generate short impulse-like pressure pulses in the water for making material measurements.

In the final session **Alan Hart** (QinetiQ) discussed techniques in wideband target echo strength measurements. These covered a portable wideband target echo strength measurement system, the acoustic range at Bincleaves and the floating laboratory complex at Loch Goil. He also described a novel target rotator consisting of a 3m diameter motorised tray that can be filled with sediment and placed on the seabed in order to study the responses of targets as a function of angle.

Stephen Robinson (NPL) brought the meeting to a close in reporting the results of a study of the effect of pressure and temperature on the sensitivity of hydrophones. The measurements obtained in the NPL APV demonstrated that the sensitivity of hydrophones could vary significantly with pressure, and that the nature of the variation appeared to be related to the hydrophone construction. The variation also appeared to reflect changes in the hydrophone impedance with pressure. This brought the meeting to a close. The two days had promoted a good deal of discussion and were generally agreed to have been very useful. Grateful thanks are extended to Stephen Robinson for his hard work as the local organiser, and to NPL for hosting the meeting.

Victor Humphrey and Stephen Robinson

Photography by Andrew Brookes.

Lecture in progress

Editor's Notes

Ian F Bennett BSc CEng MIOA
Editor

Approved Document E of the Building Regulations is almost upon us. Judging by the attendance at the meeting late last year, there is a great deal of interest and concern about the ramifications of new, 'stricter' control of sound insulation in homes. It would not be appropriate for me to express an opinion here, but suffice it to say that in this consultant's experience of the building industry, PCT doesn't stand for 'pre-completion testing', or even 'post-construction testing' – it means 'please come tomorrow'! In any event, those active in this particular field of acoustics will find plenty to interest them in this issue.

Anyone who has ever attempted to conduct a noise survey in winter will empathise with Mark Derrick, whose technical contribution is about the problems faced by equipment and people working in temperatures 40 degrees below zero, and the novel solution they arrived at. I hope they remembered the Kendal mint cake.

Copy for the May/June issue of the Bulletin should reach me by 11 April at the latest. As ever, e-mail is the preferred medium for the transmission of words and pictures: I can be reached on ian@acia-acoustics.co.uk. News items and short submissions, as well as offers of more weighty contributions, are always welcome.

Ian Bennett

MEETING REPORT

Changes to the Building Regulations

Approved Document E

A new meeting venue, but what is becoming a rather familiar subject for members of the Building Acoustics Group: the much-trumpeted revised version of *Approved Document E* was discussed on a fine but windy day in central London. The headquarters of the Royal Institute of British Architects in Portland Place offered neo-classical architecture and excellent facilities for the one-day meeting, held on 28 November 2002, which attracted over 120 delegates to hear seven varied presentations by knowledgeable and interesting speakers.

Prof Bob Craik of Heriot-Watt University welcomed all to the meeting, explaining that the final published version of *Approved Document E* had been expected by that date, but it was actually at the proof stage and would not be out for another two weeks (it has now appeared, and can be found at www.safety.odpm.gov.uk/bregs/approvede/index.htm). Never one to miss the opportunity for visual aids, Bob produced three large knotted handkerchiefs, to remind him to tell us (1) to switch off all mobile phones; (2) not to tell any architect jokes, or make derogatory remarks about that august profession, in view of our surroundings; and (3) for another reason which escaped him!

The first presentation was given by **Les Fothergill** of the Office of the Deputy Prime Minister, Building Regulations Division, who gave an overview of the amended Part E and Approved Document E. These had three main aims: to raise the standards of acoustic insulation in buildings; improve the level of compliance with those standards; and extend the scope of the existing Part E of the regulations. Protection of dwellings from external noise was not included, mainly for legal reasons, because a conflict would have arisen with the Town and Country Planning Acts.

He explained the rationale behind the explicit performance target that had been set in requirement E1 of the new *Approved Document E*. Although at first sight the target was less severe than the existing guidance, it had been arrived at by taking the current limit of 49dB D_{nTw} – no measured value should fall below this at present – then adding 3dB to improve the standard of insulation, subtracting 5dB because the new limits are presented in terms of $D_{nTw} + C_{tr}$ and the typical C_{tr} value is around -5dB, then subtracting a further 2dB for measurement uncertainty. The result was a 45dB limit for $D_{nTw} + C_{tr}$.

There were new performance requirements in E2 for rooms within dwellings, but it should be noted that the requirements did not apply if there was a door in such a wall, nor did they apply to ensuite bathrooms or existing walls (in conversion projects).

RIBA from across Portland Place

Requirement E3, a new requirement, was aimed at reducing the noise from revellers returning home late at night to buildings in shared occupancy. It was not expressed in terms of reverberation time, but rather the minimum amount of absorption that had to be provided in common areas of buildings. Similarly, E4 covered noise in schools, which was previously the general responsibility of the DfES. No guidance was included in meeting these new limits, but *Building Bulletin 93* would be providing that guidance.

Section 1 of the document described pre-completion testing, which is seen as a quality control process for the builder. Guidance is provided on the number of tests needed, and what happens if a set of tests should fail.

> **'The risk of failure has to be considered early in the design process'**

It was noted that because of concern from housebuilders in particular, the House Builders' Federation had appointed Napier University to develop and test a number of standard structures with a view to publishing *Robust Standard Details* for noise control. This concept is already in use for matters such as fire protection, and basically means that if RSDs are followed, there is no need for testing. This would allow builders to spend money on good construction, rather than site testing.

Next, **Carl Hopkins** of BRE discussed the document in some detail. He particularly considered implications for the design process in view of the desire to improve compliance through pre-completion testing, often known to the building industry as post-construction testing. Either way, the term PCT is equally applicable. The requirement for this meant that the risk of failure has to be considered early in the design process, because it was possible either to adopt a high-risk strategy, then carry out remedial work afterwards in the event of failures, or a low-risk strategy which would seek to avoid performance failures by design.

Carl described a set of 30 test results that had been scrutinised in order to estimate the failure rate, so that the $D_{nTw} + C_{tr}$ plus standard deviation date could be compared with the new requirements and determine the probability of failures. This study revealed that poor workmanship meant the sound insulation distributions were skewed, not normal, with the results tailing off to lower values. He gave examples illustrating the importance of flanking transmission to final performance, and pointed out that more guidance is now given on avoiding problems of flanking transmission than was previously the case. Wall ties were capable of affecting low frequency sound transmission, and adding a wall lining could actually make matters worse at low frequencies because of the mass-spring resonances thus introduced. The typical resonant frequency was at about 80Hz so it was useful to have test data below 100Hz, the current low frequency limit.

Finally, Carl discussed the identification of the causes of failure, and how remedial measures could be formulated. In order to diagnose problems, sound intensity measurements were useful because the technique was good at identifying surfaces that were transmitting sound. Vibration measurements were also helpful. For prediction work, SEA-based models were potentially useful, because they could be used to assess the influence of many different transmission paths, but the technique was not well suited to concrete or masonry cavity walls.

Sean Smith of Napier University discussed a number of technical issues and their implications. He considered the spectrum correction terms C and C_{tr}, and which noise sources they should be used for. Interestingly, within Europe eleven countries used D_{nTw} (or R_w) whereas two used C (France and Sweden). None used C_{tr}. That spectrum adjustment was intended for noise sources such as trains and propeller aircraft, not for music! The main zone of influence of C_{tr} was around 100 to 315 Hz, which was not the range in which music in the home was most intrusive. He illustrated the point with some audience participation, in which we were asked to judge from the test results which of two walls would give rise to fewer complaints. Opinion was close to unanimity, but it soon became obvious that the more acceptable wall would not fulfil the new requirements, whilst the subjectively worse wall would.

Sean went on to compare failure rates for masonry walls and frame walls under the 'old' and 'new' regimes based on a large number of field tests, and showed that the failure rate would improve for masonry, but become rather worse for frame walls. However, as the result of the changes broadly similar failure rates would be experienced with both types. The point was made that in general, jumbo stud walls were not very good at providing sound insulation, unless resilient bars were used, in which case they performed very well. Floor constructions, whether concrete, heavy timber (in conversions) or lightweight timber would increasingly fail to meet the performance criteria under the new Approved Document E. He deduced that resilient ceiling bars do make a difference, and that plasterboard ceilings should not be attached directly to the undersides of joists.

Finally, the results of a questionnaire were presented and examined in order to determine how sound insulation performance correlated with dwellers' responses. Some 200 walls and 300 floors were tested, and 400 dwellers were interviewed. It was found that where partition walls exceeded 53dB D_{nTw} there were no complaints about noise disturbance. Where the performance was poorer than 44dB, the consensus was that the degree of sound insulation was intolerable. When the C_{tr} spectrum adaptation term was taken into account, a performance of 45dB was not really satisfactory: the results of the interviews suggested that only 10% would find this degree of insulation acceptable. In conclusion, the introduction of a spectrum adaptation term to take low frequency performance into account was a welcome revision, but in the longer term may lead to an increased incidence of complaints in some circumstances.

The lunch provided at RIBA headquarters was a stand-up affair, but for once the caterers had worked out that fork-only food was the best option. The quality was very high for this type of gathering, even if the afternoon restart had to be postponed by a few minutes to allow those of us so addicted to re-establish our caffeine levels.

The first post-prandial presentation was by **Nick Antonio** of Arup Acoustics, who spoke about the practicalities and dangers of on-site testing, and the possibility of addressing the performance question by the RSD route. Nick pointed out that the Building Regulations - and any subsidiary guidance - had to be reasonable, proportional (in terms of cost of implementation), practical, and precise, and suggested avenues of further thought for the audience to consider.

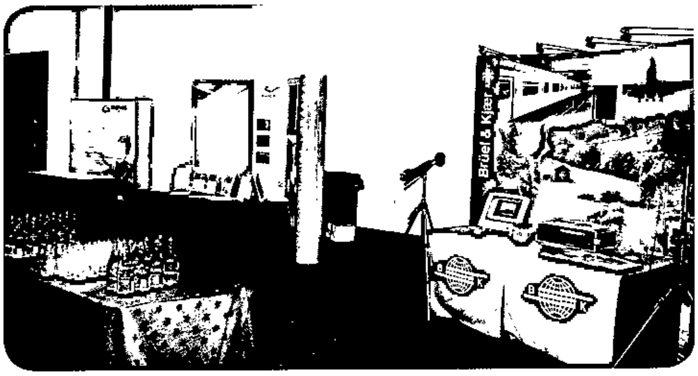
He illustrated his talk with the results of tests carried out on 344 domestic party walls, 40% of which had been found to be below standard according to current tests. If there were more testing, then the results might be expected to form a bell-shaped curve (even if it were skewed) so the more tests, the more outliers there would be - and so inevitably there would be failures. Was this reasonable? On the topic of proportionality, RSDs would be a less expensive way of securing improvements than PCT, and would probably have a better take-up by the construction industry. The advice would be better, and the technical knowledge required of the builder would be reduced.

Turning to the question of practicality, Nick asked whether tests carried out on a wet February morning on a site in Milton Keynes would necessarily produce reliable results (I don't know what that wonderful town has done to offend Mr Antonio), and pointed out that the question of liability would go back to the builder. It was a clumsy process to revise Building Regulations, and this could only happen every five to ten years, but RSDs could be revised more readily. The extent of detailing and the possibility of misapplication of details in the Approved Document were worthy of consideration, but he was still pleased to see that a performance requirement had been retained.

In terms of precision of the new *Approved Document E,* the details should be - and were - broadly applicable, and this would be reinforced by the use of RSDs. Consideration of flanking transmission was, however, vital to the resulting performance of a wall. Nick thought that the building control authority on a particular project should be able to require a test even if RSDs were used.

The question-and-answer session that

continued on page 8



Above: Phil Dunbavin single - mindedly seeking liquid refreshment

Top left and left: delegates could combine refreshment breaks with a look round the supporting exhibition - complete with mysterious spheres (Helmholtz?)

Changes to the Building Regulations
Approved Document E

continued from page 7

followed raised some interesting points. Nick was asked about a possible conflict between RSDs and the need for site testing, which he dealt with by suggesting that although the use of RSDs avoided the need for large-scale testing, some details were more reliable than others, so small-scale testing would sometimes be necessary. The further point was made that BB93 (for schools) did not consider the use of RSDs: many consultants in the audience agreed with the response that RSDs are not necessary if there was a competent professional on the project. The chairman wondered if testing was in fact mandatory under *Approved Document E:* Les Fothergill responded that it was, but that the amount of testing was subject to guidance. It was further mentioned that RSDs, if they are indeed brought in, will apply only to new build projects, not conversions. If there were no applicable RSD, testing was necessary in order to prove that the construction worked.

Delegates filter back into the lecture hall post - prandially

The *Robust Standard Details* already discussed were the subject of the presentation by **Dave Baker** of the House Builders' Federation. He began with a general introduction to the work of his organisation, and explained that it works with government, third parties, regulators and the NHBC. There are several 'shopping lists' for housing improvements, some already being in the trolley, but others - including sound insulation tests - remaining on the shelves for the present. Dave pointed out that the housing market in the UK at present is predominantly second-hand, and sound insulation is not normally an issue for buyers of non-new housing. The HBF would rather improve the building quality than pay for tests, using the same money. He went on to compare and contrast Part E with Part L of the Building Regulations: for example, wet trades are firmly discouraged by Part L, but are advocated for acoustic performance reasons. Skills shortages in the building industry, and the timetables to which new dwellings are constructed, were powerful inducements to the adoption of RSDs rather than PCT.

The 'mix' of new developments at present meant there were more apartments and brown field sites, and fewer newly-built detached houses, and there was a trend towards smaller sites with fewer dwellings on them. These prompted questions about capacity in the supply chain: put simply, were there enough acousticians to carry out the testing that might be necessary? Surely PCT was unnecessary if the control system was effective, and also for proven methods of construction? Nevertheless, it would be advantageous to prove that innovations actually worked. The HBF's view was that PCT set a dangerous precedent for other regulatory matters, and would cost two or three times the alternative route of RSDs. Data collection for statistical purposes would be difficult or impossible, making judgements unreliable. Conversely, the objectives of the RSD development programme were to produce guidance acceptable to the industry, include a margin of safety, a broad range of products and practices, and give cost-effective solutions. Finally, the RSD approach would be compatible with other regulations.

'Systematic checking will be needed'

The final presentation was by **Paul Wornell** of Housing Association Property Mutual, which is mutually owned by housing associations and social housing providers. He explained the steps taken since 1995 to track claims for poor sound insulation, *ie* failures to meet the requirements of the existing Building Regulations Part E. Based on a proper series of post-completion checks, he was able to look at deficiencies in performance and the reliability of the existing building control process. He cited several cases where there had been defects in construction, for example, a levelling screed was missing in 81% of the claims received for poor acoustic performance, a cavity wall closer was absent in 21%, and so on. Most industries accept a failure rate of something well below 1%, but we were dealing with a rate of 5% to 10% overall, and quite possibly more. Sound deficiencies accounted for about 10% of all claims, which included structural problems, damp and decay.

Paul told the meeting about some of the typical sound control problems his organisation had uncovered during its investigations. In the case of walls these included: adjacent flues in cavity walls; aerated concrete blocks used in flanking walls; cavity walls which changed to solid walls in roof spaces; heavy gauge wall ties instead of those specified; thin plasterboard; substitution of the wrong type of blocks; and lightweight blocks used with narrow cavities. Floor problems often occurred because of gaps in beam and block construction, and he showed several lurid pictures of what can go wrong with the grouting - or what passes for grouting - in such a flooring system.

Finally he posed the question of whether or not the new *Approved Document E* will make a difference. He concluded that if there were to be 100% testing of completed buildings, the risk of failures would be greatly reduced. Having looked at the details of the document, he felt that systematic checking was going to be needed.

A lively question and answer session followed, with all six speakers on the platform in order to field comments or queries in their own particular area of interest. To illustrate the hundreds of unforeseen practicalities, one interesting question from the floor involved a hypothetical large project where 10% of the apartments were to be subject to PCT. The early completions such as the show flat would be tested, but the remainder of the units could then be 'thrown up' as the test programme would be complete already. Surely no reputable builder would allow this to happen?

Ian Bennett

ACOUSTICS BULLETIN ADVERTISING

New contact details for Dennis Baylis

The Bulletin's Advertising Manager, Dennis Baylis, has completed his relocation to France and can now be contacted (phone or fax) on 00 33 (0)5 62 70 99 25.
His postal address is now Peypouquet, 32320 Montesquiou, France and his e-mail address remains dbioa@hotmail.com.
The suggestion that snail-mail may be unreliable because of the hazards faced by the molluscs has been refuted by La Poste.

BS EN12354 MASTERCLASS

Introduction

R J M Craik,
Heriot-Watt University,

Background

During the last 40 years flanking transmission has come a long way.
In 1976 CIB W51 Group identified flanking transmission as the most important problem facing those working in building acoustics. They further identified Statistical Energy Analysis as the most likely tool to be useful for the study of flanking and they judged masonry buildings would be easier than any other type of structure. Within 10 years this prediction proved to be correct and currently SEA is the only general technique for predicting flanking transmission in buildings and is currently being extended from masonry buildings to other types of building such as timber framed constructions.
About ten years ago the European Community decided that as part of the harmonisation across Europe, a Standard was required to provide a general method for calculating sound transmission in buildings which could use measured data from laboratories across Europe as part of the input information. The first of these Standards, EN12354 Part 1, **(1)** concerns a method for calculating sound transmission between adjacent rooms both by the direct path and by the most important flanking transmission paths each of which crosses one structural junction.
The approach used is a simplified version of Statistical Energy Analysis (SEA) with a notation which is simpler to use when using measured data **(2)**. The Standard is restricted to the situation where the two rooms are adjacent unlike SEA which can solve general problems.
The method adopted is to break the very complex problem of sound transmission down into a number of individual transmission paths, see *Figure 1*, each of which can be calculated separately. Thus it can be seen that there is one direct path (Dd) and for each edge of the common wall there will be three flanking paths (Fd, Df, Ff). There are therefore 13 transmission paths that need to be considered when calculating flanking transmission between any two rooms. The actual calculation method is given in a later section and uses data that can be measured or calculated.

Structural damping

An important feature of the standard is that it recognises the importance of structural damping in sound transmission between rooms. Above the critical frequency, the only frequency region considered in this Standard, sound transmission is directly proportional to structural damping. The standard equation for predicting the sound reduction index (SRI) of a single leaf partition is given as

$$R = 20\log\frac{\omega\rho_s}{2\rho_0 c_0} + 10\log\frac{2f\eta}{\pi f_c \sigma^2}$$

where η is the structural damping. It can be seen that the SRI is directly proportional to damping and therefore a 2dB increase in the structural damping corresponds to the 2dB increase in the SRI. Differences in structural damping is one of the reasons why there are differences between laboratory measurements and field measurements and differences between one laboratory and another laboratory.
Structural damping occurs due to a number of different mechanisms. Part of the energy in a structure is dissipated as waves propagate through the material and this is known as the material loss, η_d, and is usually a constant for material typically with a value of 0.01 to 0.02. Losses will also occur due to radiation from the material which can be calculated using the equation

$$\eta = \frac{\rho_0 c_0 \sigma}{\omega \rho_s}$$

where s is the radiation efficiency. For masonry walls and floor this loss is negligible and the dominant loss is the edge losses given by

$$\eta_{edge} = \frac{c_0}{\pi^2\sqrt{ff_c}}\frac{\sum L\alpha}{S}$$

where a is the boundary absorption. This equation is analogous to the calculation of damping in a room which is a function of the surface area and is the surface absorption.
Expressing the structural damping in this form moves the problem from establishing the structural loss factor to determining the boundary absorption. Fortunately the boundary absorption can be readily calculated for most junctions and a typical value is 0.3 (see *Figure 2*). Therefore inserting typical values for the dimensions, thickness and critical frequency gives an approximation for the structural damping as

$$\eta = \frac{1}{\sqrt{f}} + 0.015$$

It can be seen that the structural damping varies little from one structure to another and explains why it has been possible to ignore structural damping for so long. Unfortunately, this equation cannot be used to estimate the structural damping in laboratories and the damping may vary significantly from one laboratory to another. The overall damping rarely exceeds the value given by equation (4) but a minimum value can be as small as 0.015 giving a variation of over 10dB at low frequencies.
An important feature of the Standard is the accounting for variations in damping.

Transmission along a single transmission path

Considering the path Ff in *Figure 1* it can be seen that transmission between the two rooms involves excitation of the flanking wall in the source room, transmission from one wall to another wall followed by radiation from the wall into the receiving room. The part associated with excitation of the wall in the first room and radiation from the wall in the second room is very similar to sound transmission through the flanking wall. It is therefore possible to write down the sound transmission by the flanking path **(1)** in terms of the SRI of the flanking wall and additional terms as

$$R_{Ff} = \frac{R_F}{2} + \frac{R_f}{2} + \overline{D_v} + 10\log\frac{S}{\sqrt{S_F S_f}}$$

It is assumed that the terms Rf and Rf can be readily found and therefore the only difficulty in calculating the SRI of the flanking path is the term D_v which is the flanking path is the term

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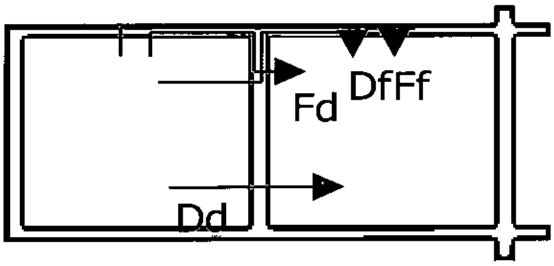


Fig 1 A section through a building showing the dominant flanking paths.

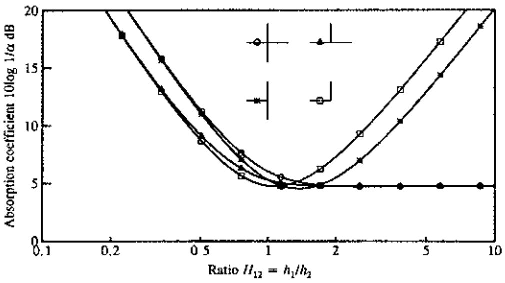


Fig 2 Boundary absorption for L, T and X junctions as a function of the thickness of the plate of interest (h_1) and the plate at right angles (h_2)

BS EN12354 MASTERCLASS

continued from page 9
average velocity level difference between the two walls which make up the flanking path. The actual value of D_v will vary from one situation to another and depends on a number of terms including the size of the wall and the common boundary length. Therefore within the standard a normalised value, K_{ij}, is used and is the same as D_v apart from some normalisation terms. A useful rule of thumb is that if all the walls are assumed to be the same size and to have the same general material properties, then the value for D_v is approximately equal to 10 log (1/number of connections). Typically each wall or floor will be connected to 10 other walls and floors and therefore the value of D_v equals 10 log 1/10 = 10dB. Thus typically there will be 10dB attenuation between any two walls. Note that this is calculated entirely from a typical geometry system and not on the dimensions or material properties. This is a useful rule of thumb for rigid masonry connections.

Putting it all together

Once the direct path and each of the 12 flanking paths have been computed, it is a straightforward matter to combine these to give the overall transmission. Although there are 12 flanking paths it will be found in practice that many of them are the same and therefore 12 calculations do not normally need to be carried out.

Calculation of flanking paths

S Chiles,
University of Bath

The calculation procedure for a flanking path is described in the Standard and its application to the example in Annex H. For clarity this was done with the 'first approximations', which remove the need to know the structural reverberation time of every element in the system (often a lengthy calculation). The calculation procedure can be expressed in the simple block diagram in *Table 1*.
The top three boxes are the input data for the calculation. Firstly, the sound reduction index is required for the separating element and each of the four possible flanking elements; an approximation can then be made that R_{situ} = R. Next the vibration loss factor, K_{ij}, for each of the 12 possible flanking routes is found with a simple calculation from Annex E. Finally, if there are any additional layers such as floating floors or plasterboard linings then the ΔR_{situ} value of these is needed, although it was noted that such data is quite scarce. Once these values have been entered into a spreadsheet, two straightforward formulae give the flanking sound reduction for each path and then the overall apparent sound reduction index.

Input Data for BS EN 12354

Carl Hopkins,
Acoustics Centre, BRE

The 'roots' of EN 12354 are based in the *Construction Products Directive*, hence EN 12354 was primarily intended to be used with measured data from transmission suites and flanking laboratories as well as data from laboratory measurements of material properties.
For transmission suite measurements, it is important to measure structural reverberation times with heavy concrete/masonry elements **(3).** An example is shown here for two nominally identical walls measured in two different laboratories. In order to compare SRI data from different laboratories using the total loss factor, transmission across the solid homogenous test element must be dominated by resonant transmission and both laboratories must not have significant power flow from any of the transmission suite walls/floors into the test element.
For a test element with different boundary conditions in laboratories A and B, the sound reduction indices are R(A) and R(B) and the measured total loss factors are η_A and η_B (linear values). Using the total loss factor data, R(A) can be converted to R(B) and is denoted R(A,B).

$$R(A,B) = R(A) + 10\lg\left(\frac{\eta_B}{\eta_A}\right)$$

The total loss factor (linear value) is calculated from the structural reverberation time, T_s in seconds.

$$\eta = \frac{2.2}{fT_s}$$

An example is shown for a 215mm masonry blockwork wall (2000kgm^{-3}) with 13mm plaster on both sides. The critical frequency of the test element was below 100Hz and it was assumed that resonant transmission was dominant above the critical frequency. The plaster on both sides of the test element effectively sealed the blocks and mortar joints to remove any non-resonant transmission through air paths. The direction average intensity sound reduction index, R_I (dB) for the nominally identical 215mm wall with plaster finish in laboratories A and B is shown on *Figure 3*. It also shows data that has been converted from laboratory A to laboratory B to give R(A,B). Good agreement exists between R(B) and R(A,B) in both the single number quantity and the third octave band data for 315Hz-3.15kHz. This shows that without the total loss factor, differences ≤3dB between masonry elements may not give an indication of better or worse performance. This confirms that the laboratory boundary conditions significantly affect the measured sound reduction index. (Note: a new part of the ISO 140 series is currently being written on measurement of the structural reverberation time.) Failure to correct for structural reverberation time can lead to significant errors, and information on the

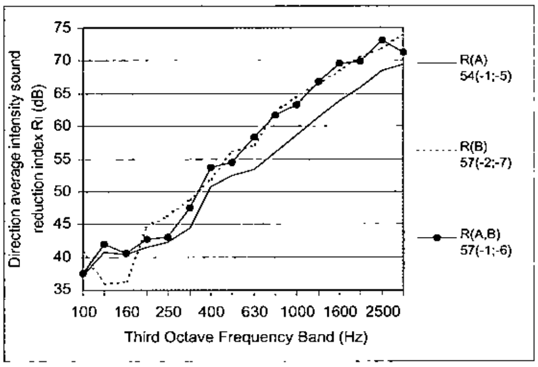
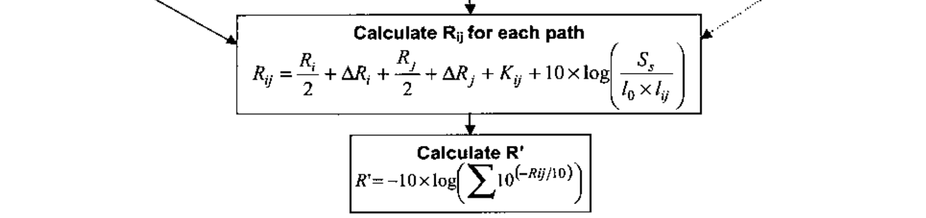


Fig 3: 215mm masonry wall (2000kgm^{-3}) with 13mm plaster both sides. $R_w(C;C_{tr})$

structural reverberation time is a crucial part of BS EN12354 calculations.
For BS EN12354 models it is intended that measured data from flanking laboratories of flanking parameters such as the vibration reduction index, K_{ij} can be used. Currently, a new set of four standards is being written (to be called EN ISO 10848) to determine K_{ij}, $D_{n,f}$ and $L_{n,f}$. It was noted that it was generally advantageous to measure flanking parameters on concrete/masonry constructions in a flanking laboratory (rather than on free-standing constructions) to ensure that the loss factors of the walls/floors were similar to the field situation. It should be noted that K_{ij} values for many constructions often show frequency dependence.
Laboratory measurement procedures to determine material properties such as longitudinal wave speed, internal damping and the dynamic stiffness of resilient

Table 1. Calculation procedure for calculating flanking transmission paths



materials can also be used to provide data for the BS EN12354 model.

Limitations of BS EN 12354

R J M Craik,
Heriot-Watt University,

When using BS EN 12354 to calculate sound transmission between adjacent rooms it is important to recognise that there are a number of limitations and assumptions which may affect the accuracy of the calculations. These limitations can be divided into two groups. There are those which are fundamental limitations of Statistical Energy Analysis (of which the Standard is an approximation) which cannot be readily overcome. There are others approximately which are a result of the way in which the Standard has been written and these limitations can be overcome by moving from the guidelines given in the Standard to a more general SEA model.
The most important of the fundamental limitations is that SEA requires all elements or subsystems to have resonant modes that determine response and it requires that the mean modal properties should be representative and meaningful.

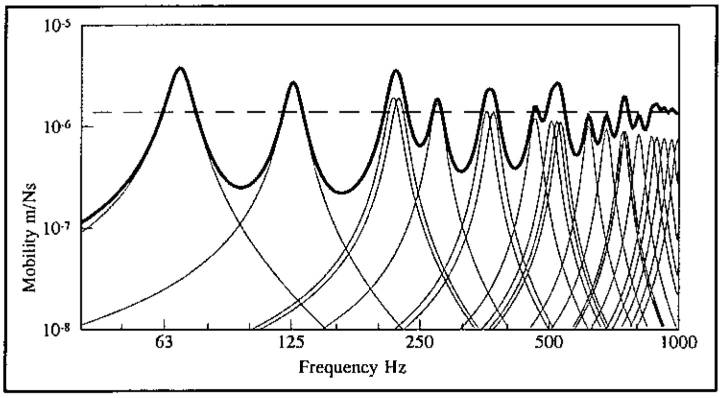


Figure 4 Structural mobility of a concrete floor. The thin lines show the mobility of the individual modes and the thick line the overall mobility being the sum of all modes. It can be seen that the mobility is highly dependent on frequency at low frequencies

Effectively this places a lower frequency limit as far as there is a minimum modal density and modal overlap factor.
The limitation at low frequencies can be seen by considering the point mobility of a concrete floor as shown in *Figure 4.* Mobility is the ratio of the velocity to the force for a point excitation and therefore shows the amount by which the floor moves for a given excitation. Each of the individual thin lines shows the response of an individual resonance or mode in the floor and it can be seen that this results in sharp peaks at 63 Hz, 125 Hz, 220 Hz etc. At high frequencies there are many modes present in the floor and the overall response tends to a straight line which is shown dashed. At these high frequencies the actual frequency of an individual mode is not important and there are sufficient modes for statistical analysis to be meaningful. At low frequencies the exact frequency of an individual mode becomes very important and it can be seen for example that there is a large difference between the response at 63 Hz and at 80 Hz as there is a resonance at 63 but not at 80 Hz. If there are insufficient modes at low frequencies then statistical analysis becomes unreliable and there will be large discrepancies between what is measured and what is calculated. This is the same reason why airborne sound transmission cannot be extended down to 50 Hz with any confidence.
The normal guidelines are that the third-octave band mode count should exceed 2 modes/band and that the modal overlap (defined as the ratio of the modal bandwidth to average modal spacing) should exceed unity.
A second fundamental limitation which cannot be overcome concerns the natural variation between different examples of the same type of structure. If a large number of nominally identical buildings are built and tested they will not all be the same, yet they will all have the same predicted SRI. Typically the standard deviation of a large number of measurements will be in the order of 2dB suggesting that any single example will only be within about 4dB of the mean. As a consequence of this ensemble variance it is unreasonable to expect that any theory will consistently better than within 4dB of any single measured example.
In addition to these fundamental limitations, there are some limitations due to the way in which the Standard has been structured. One of the obvious restrictions is that the Standard is restricted to examining the case of sound transmission between adjacent rooms. In principle the Standard could be extended to look at more general systems but calculating sound transmission by examining each individual path is only sensible when the total number of parts is small. If the rooms were further apart then many hundreds of paths may have to be considered which is impractical and alternative methods of calculation would be faster. For the same reason longer transmission paths between adjacent rooms which cross more than one structural junction are not included in the Standard even though more detailed calculations show that transmission along paths that cross two structural junctions can often be very important. Finally, there are restrictions on the type of system than can be measured. The Standard is restricted to a study of masonry type structures where the critical frequency is below the frequency range of interest. The Standard cannot be used for lightweight constructions where the critical frequency is high.

Application 1

D Fleming,
Fleming and Barron

Sound transmission has come full circle: from the 1950s when consultants calculated sound reduction index for want of data, through a period when data was fervently collected in laboratories and in buildings, to this standard published at the turn of the century which includes a method of calculation using SEA principles available 50 years ago. In BS EN12354 the calculation of R is complex, but flanking transmission is readily calculable and very useful. High precision is not necessary (or attainable) for diagnosis of faults and decision making in design. Two examples are given, one for adjacent rooms (diagnosis), the other for distant rooms (design).
The first example is of adjacent music teaching rooms of load-bearing dense blockwork walls on beam and block floors, with a plasterboard lining on one side of the party wall. When measured, this construction gave a disappointing D_w 50dB but (in retrospect) D_w 57dB was predicted by BS EN12354 for rigid junctions between the flanking and separating walls. Normal velocity measurements on these elements in the receiving room, were used to predict radiated sound power, which was found to be more consistent, in this case, with flanking transmission calculations of BS EN12354 for flexible rather than rigid wall junctions.
For non-adjacent rooms, there is no direct path only flanking transmission. For buildings with concrete walls and floors having low critical frequency (popular in Greek public buildings), a basic SEA model was described with equations derived from reference **(2)**. The model was: given source room reverberant SPLαvibrational energy in a wall →junction attenuations (as many as needed) →vibrational energy in receiving room wall →receiving room SPL. Thus the efficacy of 'buffer zones' could be tested.
The second example examines transmission between a conference room adjoining but diagonally below a concert hall and included discussion of the sound insulation targets and the need to calculate not only received reverberant sound levels but those close to radiating surfaces in large spaces. Because there are so many flanking paths, inaccuracies in the calculation for one path may not be important, approximate procedures for estimating the effect of many paths may be more appropriate.

Application 2

S Shilton,
Hepworth Acoustics

An example of the application of SEA is described showing the practical use of BS

continued on page 12

BS EN12354 MASTERCLASS

continued from page 11

EN12354 in consultancy. Using a recent refurbishment project as an example it was illustrated that even given the constraints of a commercial situation the standard can successfully be used to assist with design options.

Working on a project where an old warehouse building was being converted to residential accommodation, details of the building structure were obtained from a site visit, structural drawings and architects notes. The desired criterion for acoustic separation was then determined with reference to the Building Regulations, Planning Conditions and Landlords specification. The target chosen was Part E for new build plus 5dB as the developers wanted to offer high specification sound insulation as a sales feature.

The ideal project plan could be

1) *on-site tests of the basic structure – does it already meet the criteria?*
2) *calculations to BS EN12354 of the tested shell*
3) *calculations to assess various improvement schemes*
4) *submission of recommended scheme of works*
5) *construction of scheme designed*
6) *on-site tests of finished scheme to show compliance*

Unfortunately the client was only willing to pay for one on-site test, so the above plan was followed with the omission of step 1.

As the building structure consisted of solid brick external walls, timber joist floors and

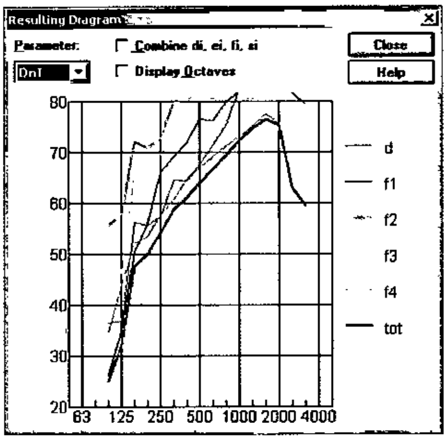


Figure 5. Calculated $D_{nT,w}$ showing total, separating element and main flanking paths

new lightweight internal partition walls we were confident that it would not meet the criterion without improvement works.

Calculations were carried out using the Bastian computer software which allowed for easy assessment of various 'what if' scenaria and the inclusion of detailed aspects of the standard such as structural reverberation corrections and allowance for windows and doors in flanking walls.

The recommended sound insulation scheme was then installed in a pair of new bedrooms, one above the other, and onsite testing was carried out to assess the room to room sound transmission. The target was set at 59dB $D_{nT,w}$ which was the total level calculated within Bastian, see *Figure 5.* The target was then achieved in the on-site test *(Figure 6)*.

This example gives a very good correlation between the BS EN12354 calculations and the on-site tests. *Figure 6* illustrates the comments within BS EN 12354 -1 regarding accuracy which suggests a standard deviation on detailed calculations in the region of 1.5 to 2.5 dB (Section 5 page 24) which means that 95% of results will be

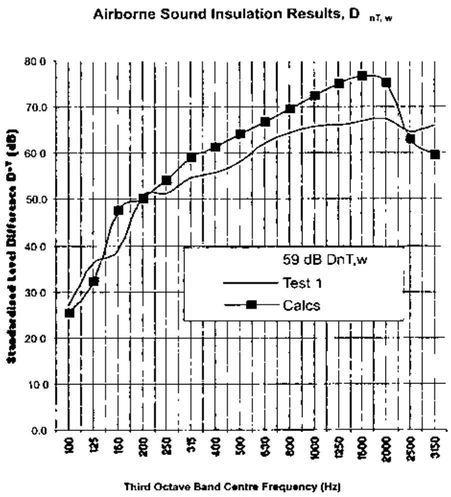


Figure 6. On-site measurements and calculations plotted against target of 59dB $D_{nT,w}$

Flanking transmission between adjacent apartments can be a particular problem on refurbishment projects

within 3 to 5 dB of the actual figures. The recent work on assessment of uncertainty in environmental measurements by Geoff Kerry should also be considered when assessing the 'absolute' nature of site measurements. With both of these uncertainties considered the third octave results in *Figure 6,* typically within approximately 5dB, could be considered a reasonable result and are in line with other sites. In conclusion it is suggested that BS EN 12354 can be used in the real world and can bring to a much wider audience SEA based calculations to calculate sound transmission within buildings. The standard is primarily applicable to high mass monolithic elements where the critical frequency of the elements is low and where the rooms under assessment are adjacent. Calculated octave bands can typically be expected to be within 5dB of measurements, whilst overall $D_{nT,w}$ levels should be typically within 3dB. More test data is required particularly for flanking elements and additional layers, and a forum for discussing experience with the standard will only help to promote quality in assessments.

Review of workshop

Stephen Chiles,
University of Bath

The delegates were split into groups to apply BS EN 12354 to real examples they had brought with them (the youngest member of each group was put in charge!). After the two hours allocated, and most groups having battled on for another hour during lunch, everyone was forced to stop and reassemble to report back to the meeting.

The first presenter was Mike Barron, who explained how Group 1 had struggled hard with an example involving cavity walls for both separating and flanking constructions but were then advised by a tutor, Carl Hopkins, that this is not an ideal application for BS EN 12354. The group then took an example with a solid brick separating wall from the 1960s BRE book of sound insulation tests. Ignoring the timber joist floor/ ceiling constructions and an external wall with large windows, the group calculated the transmission through the internal flanking wall and separating wall. The results matched the test data reasonably well at mid frequencies but substantial differences were observed at 2kHz.

Ian Critchley presented Group 2's findings for a calculation of a beam and block floor with lightweight concrete flanking walls. Initially the calculations came out 6dB lower than the measured values but then, by including the effects of plasterboard linings (on dabs), the results came out very close to measured data at mid frequencies. At high frequencies, a large discrepancy was partly attributed to a known defect in the construction.

Ann Emsley then described Group 3's example of a pot and beam floor with brick flanking walls. The predictions were overlaid on the test results graph and appeared to be suspiciously accurate at mid frequencies, although with slight deviations at mid and high frequencies. The group had found issues with a lack of input data and using a complex spreadsheet that becomes prone to errors.

Group 4 used a contrived example, which they had hoped would be relatively straightforward, but Terry Hallett explained that keeping tabs on each of the flanking paths in the calculation had been an issue. The calculation showed that a lightweight block flanking element controlled the apparent sound reduction index.

Group 5 had made a good start calculating the 13 transmission paths in their example only to have their spreadsheet collapse over lunch. Rhys Owen noted how the group had spent some time getting the ratio of surface masses the correct way round when calculating vibration loss factors.

Bob Peters admitted that for Group 6 it wasn't the spreadsheet that failed! The group was calculating the transmission between 1970s flats with concrete floors and masonry flanking walls. In the calculation the group had ignored the external leaf of the cavity flanking wall, all doors, windows, and service penetrations, and had assumed rigid ties at all joints. Sadly the group was beaten by the clock.

Geoff Scott then explained how Group 7 also ran out of time having struggled to find data for a perforated plasterboard ceiling below a flanking element.

Finally, Tony Woolf presented Group 8's calculation of transmission through a timber joist floor with masonry flanking walls. For the junction with the timber joist floor the group was unsure as to the correct junction type to apply and found the transmission into the floor to be negligible, thus managing to predict a negative junction loss along a flanking wall. Large windows in the external flanking wall were tackled by dividing up that element. The calculated level was lower than the measured data, which more closely matched the prediction taking just direct transmission through the floor.

References

1 BS EN 12354, *Estimation of acoustic performance of buildings from the performance of elements.* British Standards Institution, 2000.

2 R J M Craik, *Sound transmission through buildings using statistical energy analysis.* Gower, 1996.

3 C Hopkins. *Building acoustics measurements.* Institute of Acoustics 25th anniversary conference 13 May 1999 London. Proceedings of the Institute of Acoustics 21(3) 1999 9-16.

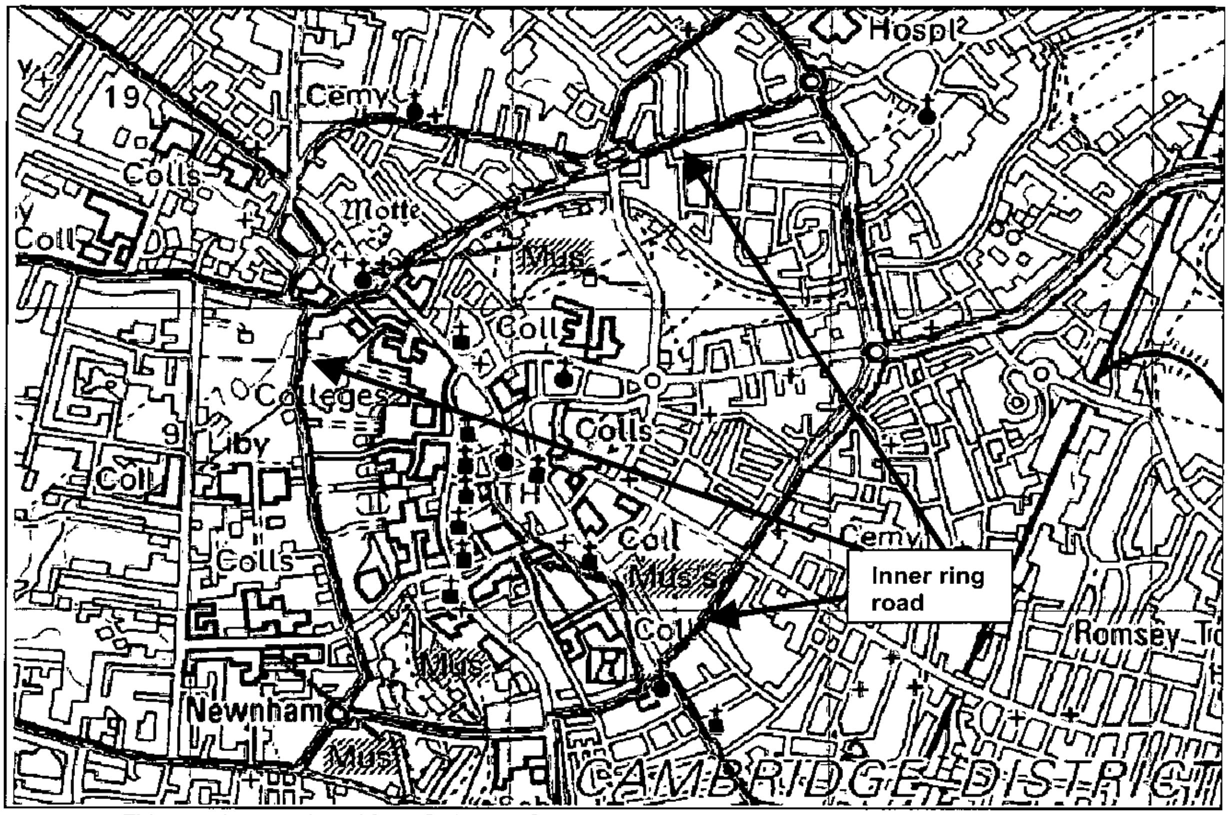


Figure 1 Region of Cambridge within the inner ring road (scale 1:50000)

How accurate is a noise map created using air quality source data?

Jenny Stocker and David Carruthers

Over the last few years, all local authorities in the UK have undertaken an Air Quality Review and Assessment **(1)** of their areas. These involved the collection of emissions data from all sources that emit certain toxic pollutants, including oxides of nitrogen and particulate matter. In regions where emissions of these pollutants are high, such as urban areas, motorways and some industrial sites, air dispersion modelling was used to predict ground level concentrations. Results from these modelling studies have been validated extensively using monitoring data. Where the predicted concentrations of these pollutants exceed the UK Air Quality Objectives, local authorities are obliged to take measures to reduce emissions, by declaring Air Quality Management Areas and compiling Air Quality Action Plans. Measures that can be taken to help reduce emissions include the introduction of Low Emission Zones, congestion charging and encouraging people to use public transport, walk or cycle.

The government's recent plans to develop a national ambient noise strategy, announced last year in the Rural White Paper **(2)**, include the commitment to produce noise maps of England. This is consistent with requirements of the EU Directive **(3)** on environmental (ambient) noise that will be adopted within UK law over the next few years. Sources of ambient noise are mainly road traffic, railways, aircraft and industry. These sources are the same as those emitting toxic air pollutants that have been under scrutiny during the air quality review and assessment procedure.

Huge quantities of source data were collected and processed during the air quality review and assessment procedure. There are several reasons why these data should also be used for the noise mapping studies. Their compilation and manipulation is expensive and time consuming. If the data already collected and validated can be re-used then it would save local authorities and the government time and money. Also, looking to the future, implementation of any traffic management schemes or other measures to reduce air pollution will affect noise levels, and vice versa, so at the planning stage of any such schemes the effects on both air quality and noise levels should be considered using a consistent set of data.

One argument against using the same data for noise mapping as for air quality is that noise source data are supposedly required to a higher degree of accuracy with respect to location. Also, noise studies usually consider roads with much lower traffic flows than do air quality studies. Conversely, vehicle emissions data (categorised by vehicle engine size and type) are required in more detail for air quality modelling than can be used in the present noise algorithms.

In this article we take as an example the road traffic data used for the air quality review and assessment procedure by Cambridge City Council (CCC) and create a noise map for Cambridge. The results from the noise mapping study are compared with the results of actual monitoring. The 2002, 18-hour L_{A10} noise levels were predicted using the implementation of the UK standard Calculation of Road Traffic Noise, CRTN (4), by the noise-mapping package CadnaA (5).

The ideas are then extended with the help of an example free-field noise map of London for road traffic sources, using the data from the London Atmospheric Emissions Inventory (6).

Source data

The area under consideration in this study was Cambridge city centre within the inner ring road, as indicated on *Figure 1*. The railway station is located 1.5km to the east of the city centre. There are no industrial sources within the inner ring road and no major flight paths over Cambridge. Therefore the only noise sources considered in this study were major roads.

Major road sources from a large region (approximately 64km^2) centred on Cambridge were considered in order to include background noise levels from outside the study area. That is, these roads were included as noise sources outside the output grid area. This extended region includes the A14 to the north of Cambridge, and the M11 to the west. Contributions from any rail, aircraft and industrial noise sources in this extended area were neglected.

Data available from the Air Quality Study

The original road source data were supplied by CCC in the form of a file used for input into the air quality model, ADMS-Urban. This file contained the following data relevant to this noise project for each modelled road:

- an hourly traffic flow with an accompanying 24-hour time-varying profile applicable to all roads (light and heavy vehicles);
- traffic speed (light and heavy vehicles);
- road location; and
- road width.

Additional data

Two types of additional data were required - noise source and geographical.

The only additional noise source data required by the study was road surface data for all roads within the study area.

The geographical data required included buildings data, in the form of closed polygons. As CCC did not have these data at a suitable resolution, the buildings within the Cambridge inner ring road were manually digitised using the 1:10000 Ordnance Survey map as a guide. In addition, buildings outside the inner ring road but adjacent to it were included. Building heights for approximately 25% of the buildings were supplied by CCC, and the remainder were assumed to be 8m high.

For many urban areas, although individual building heights were not used in the air dispersion modelling, street canyon heights were required. Therefore, these data should be consistent if both air quality and noise mapping studies of the same area are being considered.

Additional geographical data input into the model included location of the many green spaces in Cambridge, as these areas are absorbent in terms of noise propagation. In fact, these data could also be entered into the urban air dispersion model as surfaces of varying roughness.

Data manipulation

The manipulations required in order to convert the air quality data into data suitable for a noise mapping project are described below.

Traffic flows

The air quality traffic flow data consisted of an hourly traffic flow value for each road in addition to a 24-hour time-varying profile applicable to all roads representing the daily variation. *Figure 2* shows this time-varying profile. Note that the same profile was supplied for all days of the week. The CRTN standard uses an 18-hour average flow so an average of the factors in the 18-hour period between 06:00h and midnight was calculated, indicated by the red line in *Figure 2*. This

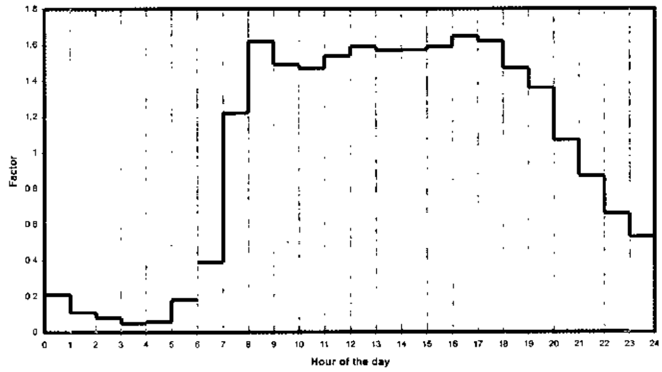


Figure 2 Time-varying profile for road traffic flow: hours 0-6 in blue (night time values, not used in the calculation of the scaling factor) and hours 7-24 in red (daytime values, used to calculate an average scaling factor applied to the traffic flows for each road)

factor, calculated as 1.283, was used to scale up all hourly traffic flows. The blue line indicates the night-time hours not considered in the road traffic noise calculations.

In addition, as the traffic flows supplied were for 1999, and the monitoring took place in April 2002, an increase in traffic of 2.5% per year was applied.

After these scalings, the traffic flows on the roads considered in the study ranged from 227 to 3369 vehicles per hour. These values correspond to a range from 4246 to 63021 for the Annual Average Daily Traffic flow (AADT).

Traffic speeds

The traffic speeds supplied were used in an air quality study where in order to consider the worst-case with respect to air pollution, traffic speeds appropriate to congestion were used. Most of the traffic speeds supplied varied between 5 and 25 km/h, with dual carriageways and motorways being assigned speeds of 45 to 50 km/h. For a noise study requiring the value of the L_{A10} (18-hour), the average speeds over the 18-hour period between 06:00h and midnight should be used. For this reason the assumed speeds were increased as shown in *Table 1*.

Speed supplied (km/h)	Speed used for noise modelling (km/h)	
	LGV	HGV
5	25	25
10	25	25
15	32	32
20	40	40
25	48	48
dual carriageways / motorways	110	90

Table 1 Increase in traffic speeds for noise modelling

continued on page 16

How accurate is a noise map created using air quality source data?

continued from page 15

Road location

When inspected on a 1:10000 Ordnance Survey map, positioning of the roads was seen to be insufficiently accurate: some of the roads appeared to pass through buildings. The roads within the area under consideration (within the inner ring road) were therefore re-digitised to align with the roads on the map. The positions of roads outside this area were not adjusted.

Road widths

As mentioned above, many road sources in urban areas are treated as 'street canyons' for the purposes of air dispersion modelling. Where this was the case, road widths were supplied as building-to-building distances rather than kerb-to-kerb carriageway widths as referred to in CRTN. The road width data was therefore modified to reduce this by 3m if the road was a street canyon, but no other alterations were made.

Modelling results

Validation of results

Results from the three noise monitors located within the study area are compared below with the 18-hour L_{A10} values predicted by the model.

CCC supplied results from noise monitors at three locations within the study area. The locations, heights and area classifications of these monitors are shown in *Table 2*.

location	easting	northing	height, m	character	date of measurements
Silver Street	544758	258121	4	busy road	10/04/02-11/04/02
Regent Street	545294	258114	4	busy road	16/04/02-17/04/02
Jesus Green	544907	259209	4	quiet area	17/04/02-18/04/02

Table 2 Monitor locations

The noise monitors were each activated for a 24-hour period, and the 18-hour L_{A10} values supplied by CCC are given in *Table 3*. The results of modelling with no reflections, and then with one reflection taken into account, are shown.

Within the scope of this study, there are a number of reasons why the predictions and the measured noise levels could be expected to differ:

- Noise measurement data were only recorded for one day at each site; usually noise measurements are recorded over a number of weeks in order to obtain a reliable average;
- The precise location of the Regent Street monitor was unknown. As noise levels close to roads can vary by several decibels over a short distance, the results would have been more reliable if more accurate location data were available; and
- Significant assumptions were made about the traffic flow and speed.

Taking all these points into account, the correlation between monitored and modelled results is very good.

location	measured, dB(A)	modelled, dB(A) no reflections	modelled, dB(A) 1 reflection
Silver Street	72	69.0	70.9
Regent Street	72	72 2	74.3
Jesus Green	58	57.1	58.5

Table 3 Comparison of modelled results with measured values as 18-hour L_{A10}

Noise map of Cambridge city centre

Figure 3 is a noise map of Cambridge city centre including *one* reflection in the calculation. The three monitoring locations are shown by black and white circles. Buildings are shown cross-hatched in grey, and open areas are outlined in black.

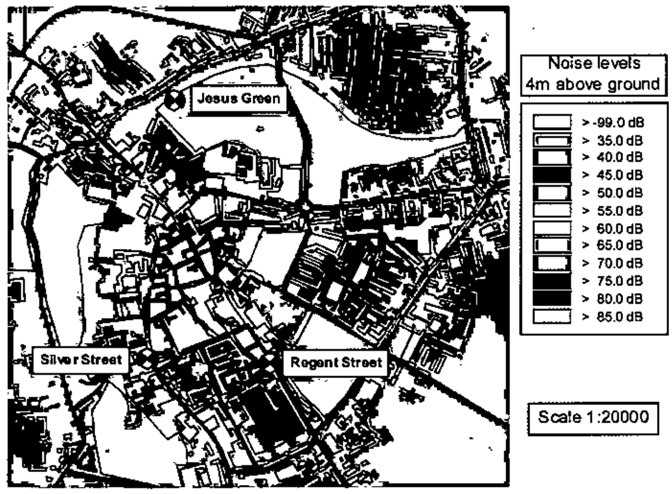


Figure 3 Noise map showing the 18-hour L_{A10} values in Cambridge City Centre within the inner ring road. One reflection included. Grid spacing: 10m. Buildings shown in grey hatching, open areas outlined in black, and monitoring points indicated

Discussion

For the Cambridge study, the comparison between modelled and monitored results is good, with the model predicting an average value 1.3dB higher than measured, when one reflection is included. This discrepancy is likely to be because noise levels were only measured for one 24-hour period, whereas noise measurements are usually recorded over a number of weeks in order to obtain a more reliable average.

A number of adjustments were made to the source data in order to make them suitable for use in the noise mapping study:

1. *one-hour traffic flow values* were converted into an 18-hour value. Other averages could have been considered, for example day, evening and night average traffic flows for calculation of the L_{den} noise indicator;
2. *speeds* were adjusted from congestion conditions to an 18-hour average value (again, other average speeds could be approximated for other limit values);
3. *road locations* were repositioned so that they were correctly aligned with the buildings considered in the study;
4. *road widths* were adjusted as necessary to represent kerb-to-kerb values.

Points 1, 2 and 4 were straightforward manipulations of the source data and did not take much time. Repositioning of the roads, however, was quite time-consuming.

More geographical data could be incorporated to improve the accuracy of the modelling process. Increasing numbers of datasets are becoming available for purchase which contain the outlines and heights of buildings in greater detail.

The EU guidance for air quality studies states that a minimum daily traffic flow of 20000 is needed before roads are included in a study but, in most cases, roads with around half that AADT are also considered. Which roads are actually considered depends on the area under consideration – when a smaller area is being modelled, the AADT criterion for a road being explicitly modelled should be reduced as a map of higher resolution is required. In the present study, the minimum value of AADT for any road within the study area was 4246. This minimum limit value is double the minimum value used in the Birmingham noise mapping study (7), but the comparison between modelled and measured values seems good. This suggests that it may not be necessary for a noise mapping study to include all the smaller roads when most of the noise comes from the major roads.

Results from the Cambridge noise mapping study using air quality road source data seem to indicate that the available air quality data are indeed sufficient for a noise mapping study, at least for road traffic noise sources. For other ambient noise sources, however, the air quality source data may not be quite so useful. For example, emissions of toxic pollutants from rail traffic are often modelled as a grid rather than as explicit sources. This is because rail traffic emits relatively small amounts of pollution compared with other transport sources. However, noise pollution from rail traffic is quite significant, and so the noise sources must be considered explicitly: in the UK these data can be difficult to find.

Parameters for industrial sources, such as source location and height, are available from air quality databases (for example, for Part A sources they are held by the Environment Agency) but the noise emissions are not directly related to the toxic emissions. Assumptions could perhaps be made if the process type were known. Finally, the data compiled for air quality studies around airports may be useful for noise mapping purposes, as the emissions from various aircraft types flying well-defined paths are considered in addition to other, ground related, traffic sources. Significant work has, of course, already been undertaken to assess the noise pollution from many UK airports.

As a logical extension to this work, the London Atmospheric Emissions Inventory was taken and a noise map for road traffic sources was produced for the 1999 data. The results are shown in *Figure 4*. Here, the source data was *not* manipulated in the manner described above, and because of computer time constraints, no buildings were included in this run.

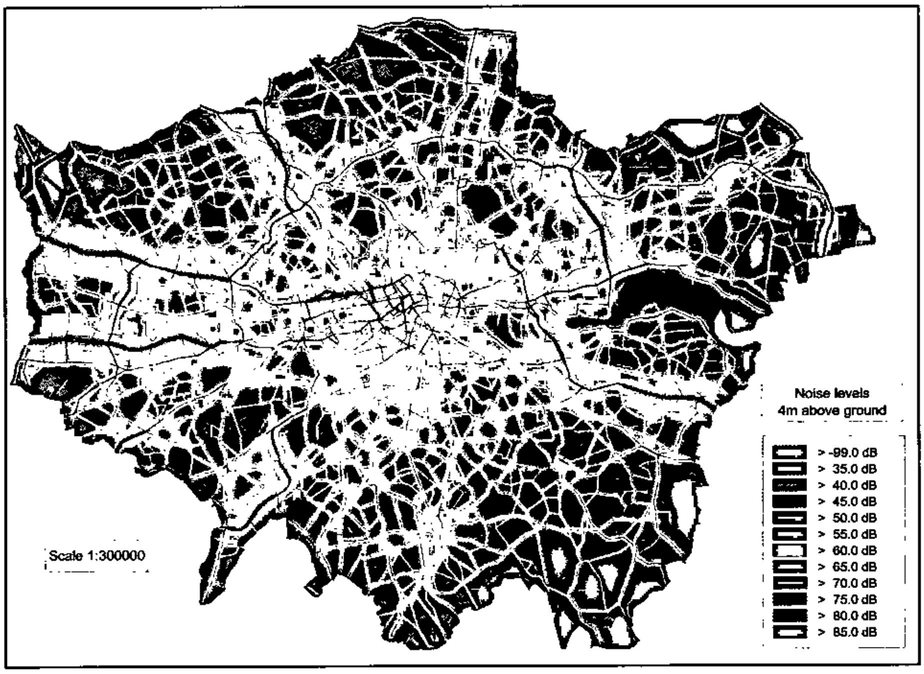


Figure 4 A free-field noise map of Greater London, using road traffic source data (1999) used for air quality studies. Results shown are the 18-hour L_{A10} values.

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House Builders' Federation

Robust Standard Details project

Sean Smith BSc PhD MIOA

On 5 July 2002 Chris Leslie MP, the Minister responsible for the Building Regulations (England and Wales) outlined measures to be included in the new Part E (Resistance to the passage of sound). These involved sound testing or pre-completion testing (PCT) for certain types of property. However, he revealed that following representations from the House Builders Federation (HBF), the house building industry would be given the chance to put forward an alternative to PCT called Robust Standard Details (RSDs) for new-build separating walls and floors for houses and apartments. The Robust Standard Details must provide consistently good performance and so would not require routine testing. The Building Regulations Advisory Committee (BRAC) will assess whether the RSDs have achieved this objective and it is then expected that the document will be released for public consultation prior to a final decision by the Minister.

Following the ministerial announcement one of the largest and most intensive projects ever undertaken by the construction industry was initiated. The Building Performance Centre at Napier University was chosen as the RSD Project Manager. The first stages of the project were to provide a boundary framework for submission of potential RSDs and to arrange a suitable structure and process to cater for all sectors of the industry. Five committees were formed which included a steering group to oversee the whole project, three working groups representing the industry sectors of masonry and concrete, timber, and steel, and a fourth working group to cover regulatory issues.

Objectives

The objectives of the RSDs are to:

- **Provide consistent levels of performance to exceed Part E**
- **Be acceptable to BRAC, HBF members and industry**
- **Provide industry choice to the homebuyer or dweller**
- **Include a safety margin to allow for standard workmanship variance**
- **Reduce design and materials weakness influencing the result**
- **Include a broad range of industry products and practice**
- **Provide choice in components and materials**
- **Provide sufficient clarity and instruction**
- **Be compatible with other regulations (eg Part L, and Health and Safety)**

Timeframe

Because test results and RSD construction details have to be submitted by the end of May 2003 the timeframe of the project is very short. Although the announcement was made in July 2002 the project did not start until mid-September. The timeframe was thus July 2002 to July 2003, but as the earliest possible dates for the working group meetings were in October 2002, and an earlier submission to BRAC by end of May 2003 became necessary, the already short timescale of 12 months was reduced to eight.

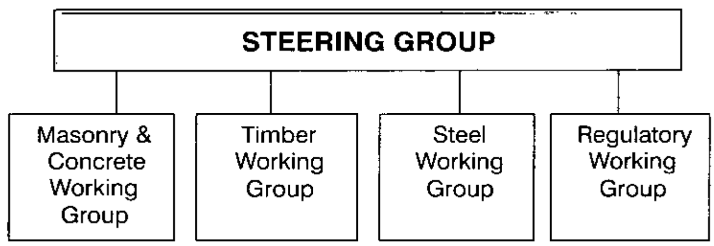

FIGURE 1
RSD Group Structure

Working groups

Following the steering group meeting in September to decide on the boundaries and framework for the project, the working groups met in October and November to submit potential Robust Standard Details for separating walls and floors, called Candidate RSDs (CRSDs). The working groups have 119 members including house builders, materials and manufacturing organisations, and acoustic experts. The working groups were charged with looking at submitted constructions and their ability to meet the RSDs, robustness, technical compatibility with other current regulations and new forthcoming regulations, and track records of construction and complaint issues.

When separating walls or floors are proposed for CRSD status the issue of 'robust analysis' should try to cater for:

Reproducibility – can the CRSD be repeatable on the same site and reproducible on other sites and what is the variation in performance?

System thinking – does it take account of a complete system and the importance of flanking conditions, junction factors and material substitution?

Direct or indirect workmanship – what are the strengths and weaknesses of the structure as a result of those building the structure directly and those who undertake important indirect works such as services, fixings and utilities?

At the early stages of the CRSD submissions over 60 candidates could meet the new Part E requirements. However, some would struggle to meet the RSD mean performance target, some had a track record of workmanship variances, and some were not robust enough or had a history of complaints. As a result the list was reduced to 36 CRSDs to go forward for testing and covered all sectors of the house building industry such as traditional, timber-frame and steel. Details of the 36 CRSDs are available on the project web site, www.rsd.napier.ac.uk.

Measurement contractors

In parallel with this the project managers invited expressions of interest from the organisations in the acoustics industry to be among the twelve appointed measurement contractors (AMCs). Decisions relating to the selection were based on test measurement experience, size of staff, geographic location, sets of test equipment, indemnity insurance, calibration certification and ability to meet the project programme. During the first call for expressions of interest over 60 companies applied, ranging from some of the largest consultancies in the UK to one person operations. The breadth and scale of the submissions was varied. Twelve measurement companies were appointed and a reserve list was also compiled. Because of the scale of the project some of the reserve test companies have since become involved.

Route 1 and Route 2 submissions of CRSDs

Submission of proposals for Candidate RSDs (CRSDs) could be undertaken in two ways. The Route 1 method involved submission of measured test data from sites or from full flanking laboratory testing, and had to be submitted by early November. The cut-off date was to allow collation of the first phase of CRSDs so that the working groups could make progress, house builders could initiate construction, and testing could begin as early as possible.

The Route 2 method would allow those current or new constructions which did not have measured data to enter the CRSD programme. Proposers of constructions through Route 2 are required to submit a maximum of eight measurements from PCT tests conducted after early November 2002. If these results meet the CRSD requirements they can count towards the final group of test results.

Boundary conditions for CRSD testing

Each CRSD is to be tested a minimum of 30 times. Measured data via Route 1 (existing data) would not be included in the group of 30 results. The eight tests carried out through Route 2 can count towards the 30 test results. All testing is to be undertaken by an appointed measurement contractor (AMC), but the maximum number of tests of any one CRSD from any one site is eight. Each batch of CRSD 30 tests must be spread over a minimum of three different appointed measurement contractors. The 30 test structures must be built by more than one house builder.

Risk to industry sectors

Of the 36 CRSDs that went forward only eight structures were being built on a regular basis by some house builders, the remaining 28 being either new constructions or improvements on existing constructions. The proposal of these 28 constructions

continued on page 20

House Builders' Federation

Robust Standard Details project

continued from page 19

has led to an increase in the complexity of the RSD project management, particularly in finding sites in time and dealing with all the other competing site priorities. Test sites have to be complete within the short time window of the project by certain key dates, and at the same time compete with winter construction delays and additional orders for new materials. Instructions have to arrive at sites in time, subcontractors must be found to carry out the building works, and the tests undertaken before pre-arranged early handover dates to clients. All this has to happen in a short time whilst catering for site agents and managers who have never had to deal with PCT before.

The high housing demand at present for new build dwellings meant that many handover dates had been arranged before work even started on site in some cases. Sites of traditional housing, with longer build times, had already been started and the significant construction changes required to meet the new Part E and RSDs resulted in some delays, particularly in the case of separating floors which influences all industry sectors.

In some cases where the CRSD structures are limited in their use or would not have many potential sites, owing to their embryonic status as new industry sectors, delays mean that the 30 target is not yet reached. It is hoped that the majority of separating CRSD walls that would be used if RSDs are accepted will reach their target of 30 tests by May 2003.

Encouraging innovation

The RSD process has initiated new areas of research and development into novel designs for possible future submissions if RSDs are accepted. It has also stimulated discussion into the possibility of proprietary RSDs. The attraction of a possible 'living document' that could be updated regularly (overseen by a RSD management board) is also encouraging future pan-industry research and development. Concepts such as a publishable performance mean each RSD also attracts manufacturing companies to achieve higher benchmarks in future product development.

Independence of test sites

To avoid accusations that house builders may try and 'fix' test sites each CRSD is being built by several house builders – in some cases up to nine different ones. Test sites are spread throughout the UK and each CRSD test site location, house builder and tester is only known to the project managers. In addition, sites are being constructed by HBF members, non-HBF members, independent contractors and developers using a wide range of subcontractors. It is hoped that the sound test results will provide a reflection of the possible industry variables.

Pan-industry involvement

The working group discussions have brought a tremendous range and quality of technical knowledge together at each monthly meeting. The open distribution of such knowledge and feedback is one of the most positive aspects about the whole RSD process. Whilst there are many examples of 'firsts' this project has achieved for bringing competing industry sectors and companies together, one of the largest virgin groups formed is PASM (proprietary acoustic system manufacturers). These eleven companies manufacture a wide range of floating floor treatments, wall linings and ceiling systems.

ISO 717 and C_{tr}

Floating floor treatments (FFTs) were formerly designed and used solely to meet impact sound transmission requirements, but nowadays the FFTs have to contribute not only to impact but also airborne performance. The new performance criteria and use of ISO 717-1 spectrum adaptation term C_{tr} prompts careful consideration when choosing an FFT. The system approach used by RSDs will clearly describe which FFTs can be used for the core floor treatment under construction.

The emphasis on low frequencies (100-315Hz) resulting from the use of C_{tr} has led to larger variances in test results than was seen when only $D_{nT,w}$ was specified. For measurements conducted by several different testers on the same site, between the same two plots, with exactly the same room dimensions on exactly the same separating wall, the $D_{nT,w}$ variance could typically be ±1dB. With $D_{nT,w}+C_{tr}$ these same measurements have a variance of ±2dB, a spread of 4 to 5 dB. There are other reasons for even greater variances as a result of the C_{tr} low frequency emphasis, including:

- the influence of room volume dimensions (particularly perpendicular to the separating test structure) and the area size of the test wall or floor;
- the influence of the wall or floor key stiffness properties; and
- because reverberation times below 0.5 seconds at low frequencies for small rooms result in a negative contribution on the D_{nT} value, there is a more pronounced effect when the result is converted to $D_{nT,w}+C_{tr}$.

In addition, testing of plots with lightweight facades near sources of fluctuating low frequency noise (such as busy city centre roads) can lead to variables in the recorded receiving room sound pressure level at low frequencies. These are interesting factors to consider in the light of the current trend towards more city centre living, and the increase in planning applications for dwellings next to major roads and railways.

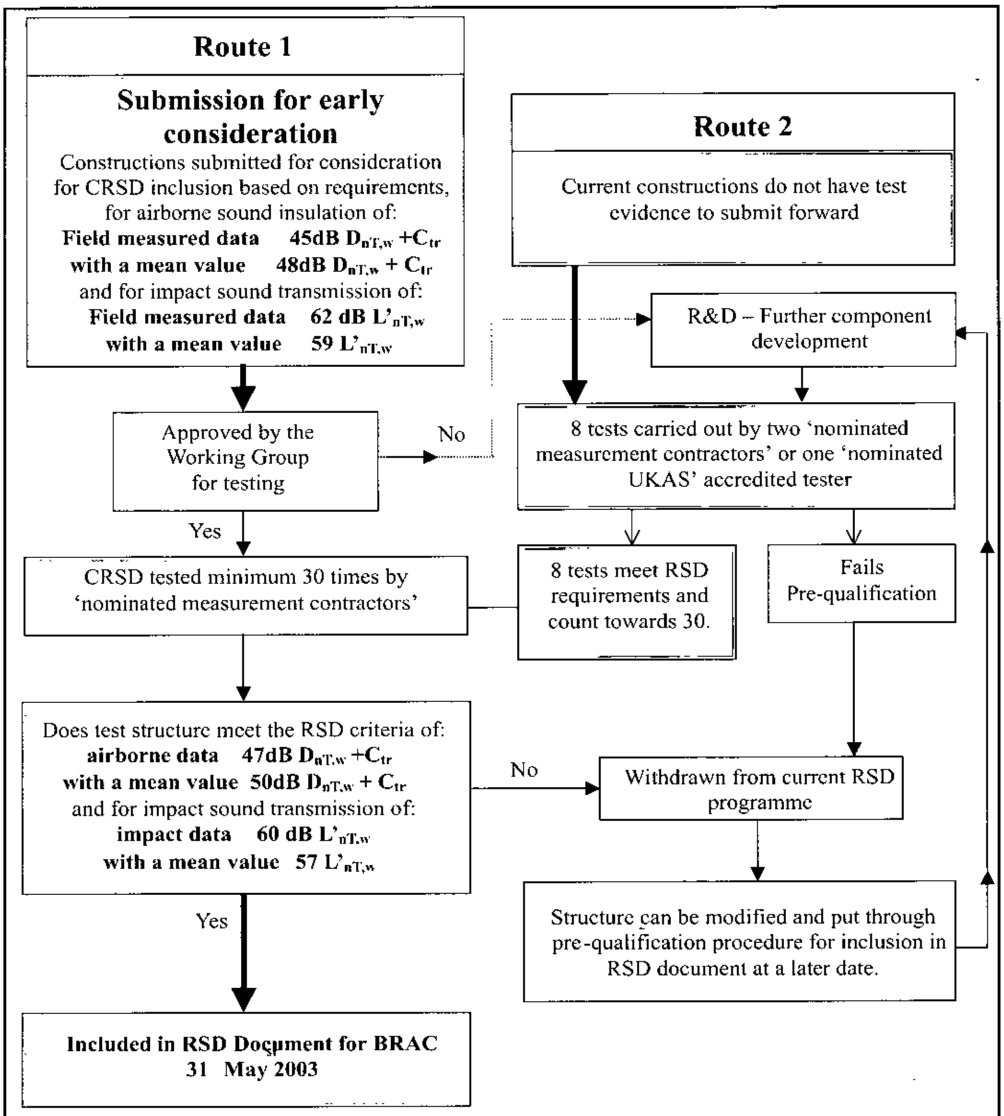

FIGURE 2 RSD measurement qualification process

QA procedures for the future of RSDs

The regulatory group has discussed at length the importance of how the RSDs could be monitored to ensure that the construction of these higher performing systems is maintained. As a result each RSD will have a checklist that the site agent or site manager would be required to sign. In addition the warranty providers and Building Control Bodies (BCBs) have discussed the inclusion of the RSD in their key stage inspections. To monitor the feedback from house builders, warranty providers, registered social landlords, housing associations, BCBs and dwellers a RSD management board would be formed. Should one or more RSDs be a source of complaints or build problems then the RSD management board would have the authority to remove these RSDs as part of the review process.

Size and scale of the RSD project

This is the largest research project ever carried out by the construction industry over such an intensive and short period of time. Over 350 organisations are involved, there are 119 committee members, and almost every sector of the industry has been actively involved. The web site receives over 2800 regular visitors. At the time of writing (February 2003) there are over 500 wall and floor structures requiring more than 1000 dwellings to be tested. The degree of cooperation between normally competing industry sectors is unprecedented.

Summary

Not all constructions can achieve RSD status and nor should they. Some of the sound insulation levels for airborne and impact so far recorded for the CRSDs are very high, giving subjective insulation levels of 'very good' or 'excellent'. The government has given the House Builders' Federation an opportunity to provide detailed direction on future house building design for all forms of dwelling construction, and to be a leading light for industry self-regulation. If accepted, the RSDs could have a crucial role in terms of the future construction process and designs to be adopted by the industry and leave a lasting footprint for new-build dwellings throughout the UK.

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Noise measurements up North

Mark Derrick

In assessing the existing environmental noise along the north shore of Canada's North West Territories, temperatures as low as -40°C are common. To obtain multi-day data sets a new environmental noise monitoring kit needed to be developed. This article looks at some of the problems and solutions devised to conduct relatively long-term noise monitoring in hard-to-access remote polar areas in the extreme cold.

At HFP we are used to monitoring in Alberta, where temperatures of -40°C are not uncommon. However, monitoring is normally only carried out in spring or autumn with temperatures only as low as -15°C. Such measurements are normally carried out adjacent to existing residences and hence a reliable power source is available to heat the environmental monitoring instrument pack. Where power is not available a bank of car batteries can be used, and these are changed out at regular intervals .

For a project in Northern Canada we were required to be able to monitor environmental noise levels for several days, with temperatures as low as -40°C. Access was by helicopter at the start and end of the period and weather may dictate that the equipment is inaccessible for several days. The helicopters could only fly in the daytime, and the anticipated length of available daylight during the survey period was two to three hours (late November). The total flight time needed to include the transit time from the helicopter base to the monitoring locations was about an hour. Hence we required a noise monitoring system that was relatively portable, could be assembled, calibrated and operational in about two hours, and would operate for several days at -40°C. Our experiences in carrying out noise data collection in Alberta identified the power supply as the major hurdle.

The basic parameter for the power supply was that it must be capable of running a redundant set of modern sound level meters and associated digital audio storage devices, both tape and solid state. In addition a small meteorological station had to be powered. Although current demands for the above were modest, those for the heater required to maintain the instrumentation at +15°C were significant. At modest temperatures, the calculated required lead acid gel cell battery was found to be approximately 150AH per 24-hour period at the anticipated lower temperatures and adding some reserve 3-4 150AH batteries were anticipated, each weighing 35kg. For a five day capable system we would require at least 20 batteries, the total weight being some 700kg. Operating in Alberta from a vehicle in an easily accessible location, maintaining a set of two to four batteries was problematic for the field crew, so 20 batteries from a helicopter would be impossible.

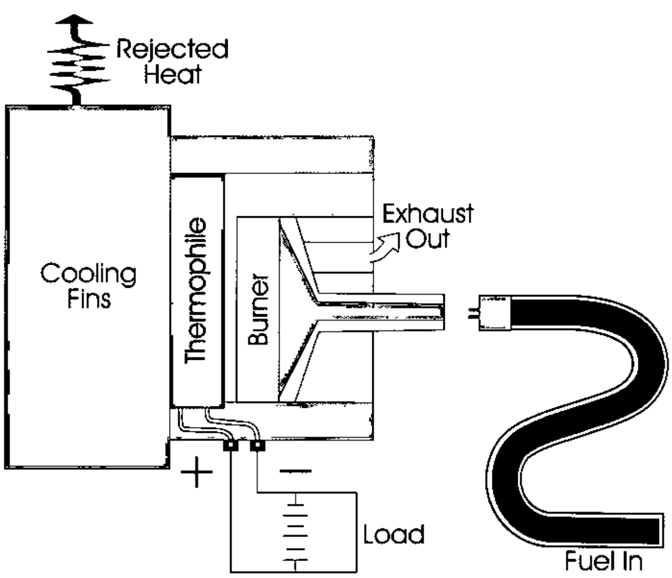

Figure 1 Thermopile (Global Thermoelectric)

How to keep the instruments warm

Powering the instruments themselves was not the issue. Keeping them warm was. We first investigated propane powered catalytic heaters to heat a tent in which the noise measuring instrumentation was stored. A hard framed enclosure was considered impractical. We even considered an igloo, but constructing one in the available two hour timeslot was impossible. The catalytic heater supplied enough heat for as long a period as we had a portable gas supply. A 5kg propane cylinder would last for several days. The modest electrical requirements could then be supplied by a pair of 12V gel cells. The tent offered other advantages in that the crew could shelter inside, calibrating the instruments and keeping the microphone cable warm. We were anticipating ambient noise levels below 20dBA, so the microphone would have to be located well away from the tent as the catalytic heater made significant noise and the potential for wind noise emanating from the tent fabric was considered significant. Problems were likely to be pitching a tent on ice, in a wind, transferring the equipment from the helicopter to the tent, warming the tent, the fire hazard of a tent with a heater and melting the ice.

The final solution involved the use of a thermopile, a large number of thermocouples connected in parallel. By heating a large number of dissimilar metal connections a significant amount of electrical porter can be generated. The thermopile power source was, fortunately, developed by a Calgary-based company and is used extensively in remote locations where modest electrical power is required, for example in communication repeater stations. The thermopile is powered by propane gas, and can generate electrical power from 15 to 500 W.

For every watt of electrical power generated the thermopile rejects about 20W of heat from the cooling fin array. The smallest thermopile, generating 15W of electrical power and over 300W of heat, weighs 20kg.

Having identified the ideal power source, a suitable instrumentation enclosure was fabricated. This has a suitable sized hole through which the heat sink from the thermopile penetrated the insulated instrumentation enclosure. The heat sink emissions were roughly controlled by a simple control vane placed above the fins, directing the heat into the enclosure. The instrument enclosure contained the propane cylinder, backup 12V batteries, all the sound level meters and audio data storage equipment, and the weather station controller. The package subassemblies were sized to the cargo bays on the available helicopters. In field proving tests the system maintained a 60C° temperature difference over the external ambient air temperature. This necessitated an additional internal temperature-controlled ventilation system that was regulated at +20°C, but unfortunately the ambient temperature during the proving tests never fell below -5°C.

Acoustic enclosure

The final component of the system was an acoustic enclosure around the thermopile. The combustion chamber and air inlet and exhaust systems were fairly noisy (41dBA at 1 metre) so a close-fitting acoustically insulated and baffled enclosure was fabricated. This reduced the noise emissions by over 15dB.

continued on page 25

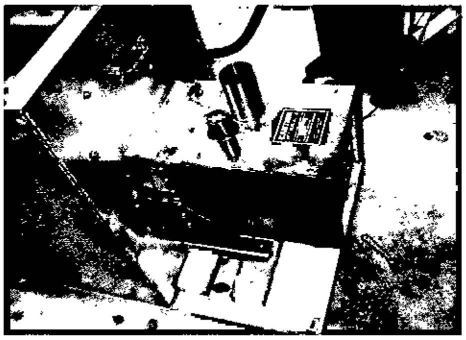

Figure 2 Thermopile and instrumentation enclosure

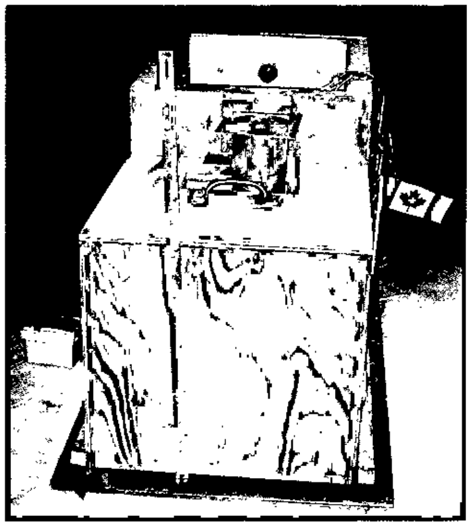

Figure 3 Complete equipment package

Figure 4 Equipment in the field

Noise measurements up North

continued from page 23

The thermopile and enclosure were mounted on a skid with ice runners and wheels to facilitate handling in the field. Three people could readily lift the entire assembly which weighed around 80kg.

The next issue to resolve related to performance of the microphone cables in the cold: they become stiff, and at -40°C it is impossible to roll up the cable. Imagine trying to roll up two 30m cables at -40°C in a timely manner so that they can be safely transported in a helicopter! In field trials a successful technique was developed by making a large 'slinky' type coil for the microphone cable. The cable memory was encouraged by preheating the cable in very hot water and wrapping it around a tapered rubbish bin.

Several training runs were conducted in the field with the crew wearing the clothing they would be using in the field, assembly and calibration activities being practised. We continuously played games of 'what if the ... failed' and details of the equipment arrangement were improved as a result. In addition, spare custom-built power supplies were prepared. Logistical and timescale constraints also complicated the project, specifically shipping the equipment batteries and propane gas cylinders using approved dangerous goods transportation methods.

In the field performance

During the field measurements, temperatures did not fall below -20°C, so the package was not tested to the design limits. On the first occasion that the system was used, assembly took just under three hours with two field crew, an aboriginal assistant and a pilot helping. Subsequent assemblies were accomplished in two hours. At one measurement location bad weather meant that the equipment could not be recovered for over three days. On retrieval it was found to be intact and operational.

The team was well aware that the noise floor of the sound level meter system (Larson Davis 824, PRM902 and 40AE half-inch microphone) would likely be attained: previous experience indicated that the noise floor is approximately 16dBA; the microphone has a thermal noise floor or 14dBA, and the 824 has a noise floor of 8dBA in the functional mode used. To reduce the noise floor to 10dBA would require the use of a different (1inch) microphone and preamplifier. Another concern was with the effect of humidity on the microphone diaphragms, so the microphones were stored with desiccant to ensure that on exposure to -40°C there would be no condensation. Standard 90mm diameter microphone windscreens were used.

The captured data was analysed and indeed during periods of no wind the noise floor of the instrumentation was reached.

At one of the monitored locations sited 24km

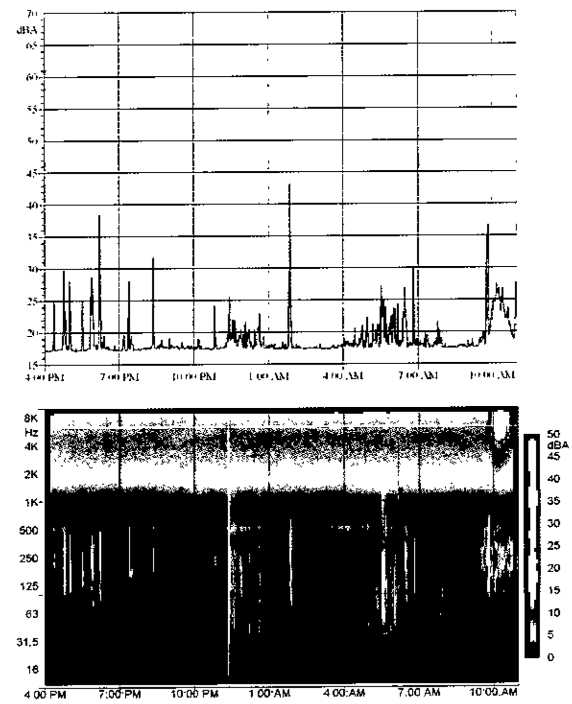

Figure 5 1-minute L_{eq} time history and third-octave band sonogram

from a major city a typical 1-minute data set is presented, both as an overall L_{eq} plot and an A-weighted sonogram. The noise events include aircraft movements and local people travelling on ski-doos.

In conclusion, with sufficient design, construction and testing time a successful long term environmental noise monitoring system was developed that met the required operational and performance parameters. The system is capable of operating for over a month with a suitably large propane tank, ideal for use in remote areas, will operate at temperatures as low as -40°C, is robust enough and sized to be transportable by helicopter.

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Hermann von Helmholtz

1821 - 1894

Hermann Ludwig Ferdinand von Helmholtz's father was August Ferdinand Julius Helmholtz. The eldest of four children, Hermann was born in Potsdam, Prussia on 31 August 1821, a part of Europe later to be absorbed into the new German empire. The circumstances of his childhood had a strong influence on his character and later career, and in particular the philosophical views of his father restricted the young Helmholtz's own opinions.

Ferdinand Helmholtz had served in the Prussian army in the wars against Napoleon. Despite having a good university education in philosophy and philology, he became a teacher at the Potsdam Gymnasium. The position was poorly paid and the family was brought up in difficult financial circumstances. His father was very artistic and this influence meant that Hermann grew up with a strong love of music and painting. His mother, born Caroline Penn, was the daughter of an artillery officer. Hermann inherited from her the placidity and reserve which were noticeable facets of his character in later life.

Hermann attended Potsdam Gymnasium where his father taught philology and classical literature. His interests at school were mainly in physics, and he would have liked to study these further at university, but the family's financial position meant that this would only be possible if he received a scholarship. As this sort of financial support was only available for particular subjects, Hermann's father persuaded him to study medicine, which enjoyed financial support from the government.

In 1837 Helmholtz was awarded such a grant to enable him to study medicine at the Royal Friedrich-Wilhelm Institute of Medicine and Surgery in Berlin. He did not receive the money without strings, however, and had to agree in advance that he would work for ten years as a doctor in the Prussian army after graduation. In 1838 he began his studies in Berlin. Although officially studying at the Institute of Medicine and Surgery, he had the opportunity to attend courses at Berlin University, availing himself of the possibilities, by attending lectures in chemistry and physiology.

Given Helmholtz's contributions to mathematics later in his career it would be reasonable to have expected him to attend such courses at the University of Berlin. However he did not, but studied mathematics on his own, reading works by Biot, Laplace, and Bernoulli. He also read philosophical works, particularly those of Kant. His research career began in 1841 when he began his dissertation. He rejected the direction which physiology had been taking, one based on 'vital forces' rather than those which were physical in nature. Helmholtz argued vehemently that physiology should be completely founded on the principles of chemistry and physics.

After graduating from the Medical Institute in Berlin in 1843, he was assigned to a military regiment at Potsdam, but spent all his spare time in research. He continued to concentrate on demonstrating that muscle force was derived from chemical and physical principles. If some vital force were present, he argued, then perpetual motion would become possible. In 1847 he published his ideas in the important paper *Uber die Erhaltung der Kraft* which discussed the mathematical principles behind the conservation of energy.

Helmholtz argued in favour of the conservation of energy using both philosophical and physical arguments. His ideas were frequently based on earlier work by Clapeyron, Joule, Sadi Carnot, and others. That the driving force came mainly from philosophical arguments was typical of all Helmholtz's published works. He argued that in order to find general laws, physical scientists had to conduct experiments. Theoretical argument would then '...endeavour to ascertain the unknown causes of processes from their visible effects, and seek to comprehend them according to the laws of causality. Theoretical natural science must, therefore, if it is not to rest content with a partial view of the nature of things, take a position in harmony with the present conception of the nature of simple forces and the consequences of this conception. Its task will be completed when the reduction of phenomena to simple forces is completed, and when it can at the same time be proved that the reduction given is the only one possible which the phenomena will permit'.

He showed that the assumption work could not continually be produced from nothing led to the conservation of kinetic energy. He then applied the principle to a variety of different fields. He demonstrated that often where energy appears to be lost it is in fact converted into heat energy. This happens for example in collisions, the expansion of gases, and muscle contraction. The paper looked at several broad applications including electrostatics, galvanic phenomena and electrodynamics. It was an important contribution and quickly recognised as such. It played such a large part in Helmholtz's career during the following year that he was released from his obligation to serve as an army doctor so that he could accept the vacant chair of physiology at Königsberg. On 26 August 1849 he married Olga von Velten and settled down to an academic career.

His career progressed rapidly in Königsberg. He published important work on physiological optics and physiological acoustics. He received great acclaim for his invention of the ophthalmoscope in 1851 and rapidly gained a strong international reputation. In 1852 he published important work on physiological optics with his theory of colour vision. However, experiments he carried out led him to reject Newton's theory of colour. The paper was roundly (and correctly) criticised by Grassmann and Maxwell. Helmholtz was always prepared to admit his mistakes and he did so three years later when he published new experimental results showing those of his 1852 paper to be incorrect. During a visit to Britain in 1853 he formed an important friendship with William Thomson.

Unfortunately, there were problems in Königsberg. Franz Neumann, the professor of physics there was involved in disputes with Helmholtz about priority, and the city's cold weather had a deleterious effect on his wife's delicate health. He requested a move, and in 1855 was appointed to the vacant chair of anatomy and physiology in Bonn.

In 1856 he published the first volume of his *Handbook of Physiological Optics,* and in 1858 his important paper appeared in *Crelle's Journal* on the motion of a perfect fluid. The paper *Uber Integrale der hydrodynamischen Gleichungen, welche den Wirbelbewegungen entsprechen* began by decomposing the motion of a perfect fluid into translation, rotation and deformation. Helmholtz defined vortex lines as lines coinciding with the local direction of the axis of rotation of the fluid, and vortex tubes as bundles of vortex lines through an infinitesimal element of area. He showed that the vortex tubes had to close up and also that the particles in a vortex tube at any given instant would remain in the tube indefinitely, so that no matter how much the tube was distorted it would retain its shape.

Helmholtz was aware of the topological ideas in his paper, particularly the fact that the region outside a vortex tube was multiply connected, which led him to consider many-valued potential functions. He described his theoretical conclusions regarding two circular vortex rings with a common axis of symmetry in the following way.

'...If they both have the same direction of rotation they will proceed in the same sense, and the ring in front will enlarge itself and move slower, while the second one will shrink and move faster, if the velocities of translation are not too different, the second will finally reach the first and pass through it. Then the same game will be repeated with the other ring, so the rings will pass alternately one through the other'.

This paper, highly rigorous in its mathematical approach, did not attract much attention at the time but its impact on future work by Tait and Thomson was very marked.

Before the publication of this paper Helmholtz

continued on page 28

Hermann von Helmholtz

continued from page 27

had become unhappy in his new position in Bonn. Part of the problem seems to have been that the chair included the subject of anatomy, and complaints were made to the Minister of Education that his lectures on this topic were incompetent. Helmholtz reacted strongly to these criticisms which, he felt, were made by traditionalists who did not understand his new mechanical approach to the subject. It was a strange position for Helmholtz, for he had earned a very strong reputation as a leading world scientist. Nevertheless, when he was offered the chair in Heidelberg in 1857, he did not accept straight away. Further sweeteners were offered in 1858 in an attempt to entice him to accept, such as the promise of setting up a new Physiology Institute, and at last Helmholtz agreed.

Hermann Helmholtz suffered some personal problems. His father died in 1858, then at the end of 1859 his wife, whose health had never been good, also died. He was left to bring up two young children, and within eighteen months he married again. On 16 May 1861 he married Anna von Mohl, the daughter of another professor at Heidelberg. Anna was an attractive, sophisticated woman considerably younger than her husband, and the couple were to have another three children. The marriage opened a period of broader social contacts for Helmholtz.

Helmholtz was probably the last great scholar whose work embraced all the sciences as well as philosophy and the fine arts

Some of his most important work was carried out while he held the post in Heidelberg. He studied mathematical physics and acoustics, producing a major study in 1862 which looked at musical theory and the perception of sound. In mathematical appendices he advocated the use of Fourier series. In 1843 Ohm had stated the fundamental principles of physiological acoustics, which was concerned with the way in which combination tones are heard. Helmholtz explained the origin of music on the basis of his fundamental physiological hypotheses. He formulated a resonance theory of hearing which provided a physiological explanation of Ohm's principle, and made original and valuable contributions to the theory of music.

From around 1866 Helmholtz began to move away from physiology and more towards physics. When the chair of physics in Berlin became vacant in 1870 he indicated his interest in the position. Kirchhoff was the other main candidate and because his teaching was considered superior to Helmholtz's he was offered the post. However, when he decided not to accept Helmholtz was in a strong position. He was able to negotiate a high salary when taking up the post in 1871, as well as having Prussia agree to build a new physics institute in Berlin under Helmholtz's own control.

He had begun to investigate the properties of non-Euclidean space around the time his interests were turning towards physics in 1867. In the second half of the 19th century, scientists and philosophers were involved in a heated discussion on the principles of geometry and on the validity of so-called non-Euclidean geometry. Helmholtz's research into the subject began in about 1867. Starting with the observation that our geometric faculties depend on the existence of rigid bodies in nature, he presumed he had given a proof that Euclidean geometry was the only one compatible with these bodies, maintaining at the same time the empirical, not *a priori*, origin of geometry. In 1869 he realised he had made a mistake: the empirical concept of a rigid body and mathematics alone were insufficient to characterise Euclidean geometry. The following year, fully sharing the mathematical itinerary that led to the creation of the new geometry through Gauss, Riemann, Lobachevsky and Beltrami, he proposed spreading this knowledge among philosophers while at the same time criticising the Kantian system. This marked the beginning of a heated philosophical discussion that lasted nearly ten years.

Electrodynamics was a major topic which occupied Helmholtz after his appointment to Berlin. He discussed with Weber the compatibility of the latter's electrodynamics with the principle of the conservation of energy. This argument was also heated, and lasted throughout the 1870s. Neither party really won, and the 1880s saw the acceptance of Maxwell's theory. Helmholtz attempted to give a mechanical foundation to thermodynamics, and also tried to derive Maxwell's electromagnetic field equations from the least action principle.

Helmholtz devoted his life to seeking the great unifying principles underlying nature. His career began with one such principle, that of energy, and concluded with another, that of least action. He longed to understand the ultimate, subjective sources of knowledge just as had the generations of scientists before him. His longing found expression in the determination to understand the role of the sense organs in the synthesis of knowledge, as mediators of experience. Helmholtz and his generation brought in two new elements: a profound distaste for metaphysics, and an unwavering reliance on mechanism and mathematics. The scope and depth which were characteristic of his greatest work were owed largely to the mathematical and experimental expertise which Helmholtz brought to science.

He was probably the last great scholar whose work, in the tradition of Leibniz, embraced all the sciences as well as philosophy and the fine arts. He was elected a Fellow of the Royal Society in 1860, and in 1873 was awarded the Royal Society's Copley Medal. He died on 8 September 1894 in Berlin.

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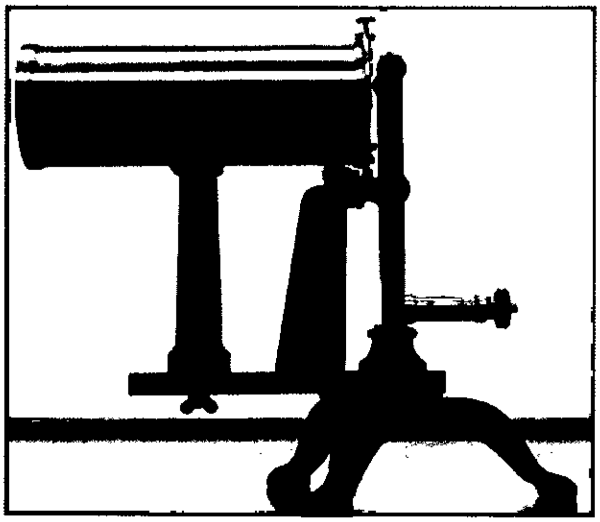


Helmholtz resonators explained

A Helmholtz resonator or Helmholtz oscillator is a gas-filled vessel with an open neck (the gas usually being air). A volume of air in and near the open hole vibrates because of the resilience of the air inside. A common example is an empty bottle: the air inside vibrates as a result of blowing across the top, as shown in *Figure 1*.

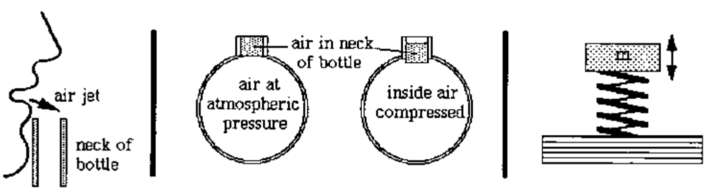


Figure 1

Some small whistles are Helmholtz oscillators. The air in the body of a stringed instrument such as a guitar acts almost like a Helmholtz resonator. An ocarina is a slightly more complicated example. Loudspeaker enclosures often use the Helmholtz resonance of the enclosure to boost the low frequency response.

The vibration here is due to the 'springiness' of air: when it is compressed, its pressure increases and it tends to expand back to its original volume. Consider a 'lump' of air at the neck of the bottle (shaded in the *Figure 2* diagrams). The air jet can force this lump of air a little way down the neck,

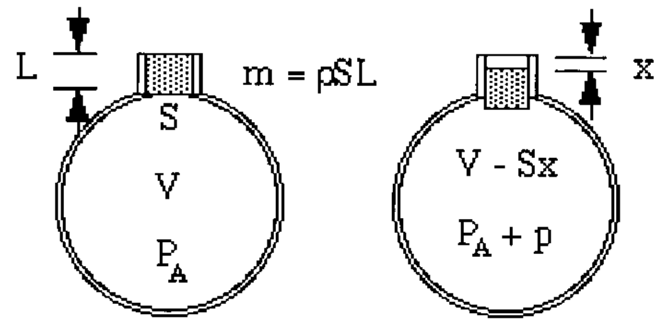


Figure 2

thereby compressing the air inside. That pressure then drives the 'lump' of air out, but when it reaches its original position, its momentum takes it on outside the body a small distance. This rarefies the air inside the body, which then sucks the 'lump' of air back in. It can thus vibrate like a mass on a spring. The jet of air from the blower's lips is capable of deflecting alternately into the bottle and outside, and that provides the power to keep the oscillation going.

The quantitative explanation is as follows. First of all, let us assume that the wavelength of the sound produced is much longer than the dimensions of the resonator. For a typical bottle, the sound produced has a wavelength of a few metres, so this is a reasonable approximation, but it is worth checking whenever starting to describe something as a Helmholtz oscillator. The consequence of this approximation is that pressure variations inside the volume of the container can be neglected: the pressure oscillation will have the same phase everywhere inside the container *(Figure 2)*.

Let the air in the neck have an effective length L and cross-sectional area S. Its mass is then SL times the density of air ρ. (Some complications about the effective length are discussed later). If the 'plug' of air descends a small distance x into the bottle, it compresses the air in the container so that whereas it previously occupied volume V it now has volume $V - Sx$. Consequently, the pressure of the air increases from atmospheric pressure P_A to a higher value $P_A + p$.

Now it might be expected that the pressure increase would be proportional to the volume decrease. That would be the case if the compression happened so slowly that the temperature did not change. In the vibrations that give rise to sound, however, the changes are fast and so the temperature increases on compression, giving a larger change in pressure. Technically the changes are adiabatic, meaning that heat has no time to move, and the resulting equation involves the constant γ, the ratio of specific heats. As a result, the pressure change p produced by a small volume change ΔV is just

$$\frac{p}{P_A} = -\gamma\frac{\Delta V}{V} = -\gamma\frac{Sx}{V}$$

Now the mass m is moved by the difference in pressure between the top and bottom of the neck, a net force pS, so Newton's law for the acceleration applies:

$$F = ma \text{ or } \frac{d^2x}{dt^2} = \frac{F}{m}$$

substituting for F and m gives:

$$\frac{d^2x}{dt^2} = \frac{pS}{pSL} = -\frac{\gamma SP_A}{2}x$$

so the restoring force is proportional to the displacement. This is the condition for simple harmonic motion, whose frequency is $1/2\pi$ times the square root of the constant of proportionality, so

$$f = \frac{c}{2\pi}\sqrt{\frac{S}{VL}}$$

Now the speed *c* of sound in air is determined by the density, the pressure and ratio of specific heats, so:

$$f = \frac{1}{2\pi}\sqrt{\frac{\gamma S P_A}{\rho V L}}$$

To give a numerical example, assume a 1 litre bottle, with $S = 3\text{cm}^2$ and $L = 5\text{cm}$, then the frequency is 130Hz, which is about the C below middle C. It follows that the wavelength is 2.6 metres, which is much bigger than the bottle, thus justifying the assumption made at the top of this article.

Complications can arise involving the effective length of the vessel's neck. *Figure 1* shows the 'plug' of air as though it were a cylinder terminating neatly at either end of the neck of the bottle, but this is an oversimplification. In practice, an extra volume both inside and outside moves with the air in the neck. The extra length that should be added to the geometrical length of the neck is very approximately 0.6 times the radius at the outside end, and one radius at the inside end).

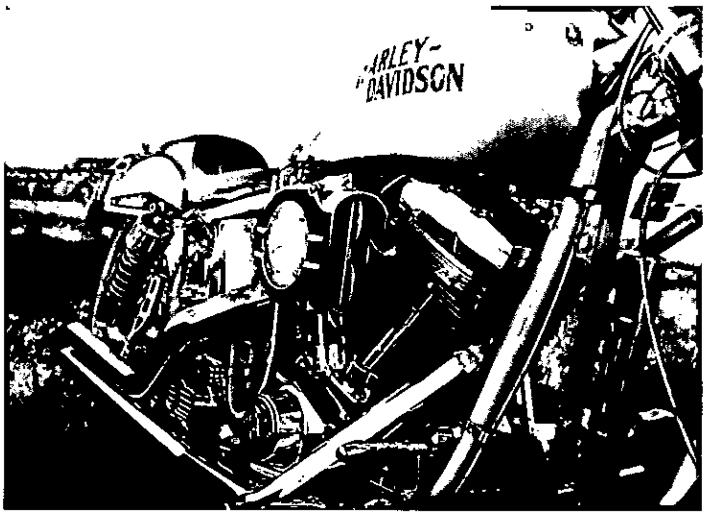
Is the guitar body akin to a Helmholtz oscillator?

It was stated above that the air in the body of a guitar acts almost like a Helmholtz oscillator. The case is complicated, because the body can swell slightly when the air pressure inside it increases, and also because the air within the soundhole of the guitar has a geometry less easily visualised than, say, the neck of a bottle. In the case of the guitar body, the length of the plug of the air is only a couple of millimetres thick, but the 'end effects' are related to, and similarly sized to, the radius of the hole: the mass of the air to be considered is substantial. The length of the end effect of a cylindrical pipe opening onto an infinite plane baffle. is 0.85 times the radius of the pipe. Although the soundboard of a guitar is not infinite, but a similar end effect would be expected, so the effective length of the 'plug' of air is about 1.7 times the radius of the hole.

Damp the strings on a guitar so that they cannot vibrate, by placing a cloth between the strings and the fingerboard. Hold the palm of the right hand above the soundhole, and close to it. With a finger of the other hand, strike the soundboard a sharp blow near the soundhole and close to the first string. A pulse of air will be felt on the palm of the hand. The finger blow pushes the soundboard in and squeezes some air out of the body. If the right hand is gradually moved further away from the hole, whilst still tapping with a finger of the left hand, at some stage the movement of the air will no longer be felt. This will gives a rough estimate of the length of the 'end effect' in the case of the sound hole.

Harley - Davidson

the sound of a legend



Noise, vibration and harshness are critical to the feel of a Harley-Davidson motorcycle. Before seeing it, an onlooker can tell a Harley is coming. The off-centred drumming beat and throaty pounding are part of the signature sound that defines the character of the machine and differentiates it from competitors. Riders expect thunder, rumble and roar when they gun the engine. The manager of the company's noise, vibration and harshness (NVH) development facility says that the product is identified by how it sounds as much as how it looks.

Sound quality is critical in establishing the image of a Harley-Davidson motorcycle, and gives immense satisfaction to riders through their perception of quality. The experienced Harley-Davidson community demands a distinctive and unmistakable sound which is a major part of the brand value of the company's products. NVH must preserve and enhance the sound, but must also meet strict US and international noise regulations. Cowlings or covers could easily be put over the power train to reduce mechanical noise, and the intake and exhaust system could readily be modified to meet regulatory noise requirements: car and motorcycle manufacturers do just that in their new vehicle designs.

However, hiding the engine and other mechanical bits and pieces would detract from the all-important look of a Harley. Instead, the distinctive sound is engineered into the machine with the right balance of pitch, engine tone, and beat from the drive train, induction and exhaust systems, and the engine block. The desirable sounds are deliberately left there, but whines, ticks, knocks, and other unwanted mechanical noises are all but eliminated. The NVH group is also responsible for the 'feel' of each model on the road. Vibration through the seat, footrests and handlebars is an important contributor to the overall riding experience, so the engineers pay close attention to the frequency and amplitude of excitation wherever the rider is in contact with the machine.

Development centre - the core

At the core of Harley-Davidson's NVH capabilities is the Development Centre just outside Milwaukee, Wisconsin, which is closed to the public and to most of the non-engineering company personnel. It was completed in 1997 and includes a fully anechoic chamber for engine and transmission studies as well as a semi-anechoic chamber with a chassis dynamometer for full vehicle testing. The test cells are equipped with automated-sequence, remotely-controlled arrays of microphones for gathering acoustic intensity and acoustic holography data, while sensors record engine performance parameters and vibration levels.

There is also a jury listening chamber where people from across the company are selected to judge the sound quality of proposed designs, in an attempt to provide correlation between rider preferences and product performance. The jurors tend to include people from senior management as well as accounting, marketing, sales and engineering, as a good cross-section is needed to reflect a range of opinions and preferences. Off-site jury tests are also carried out with customers to validate the process.

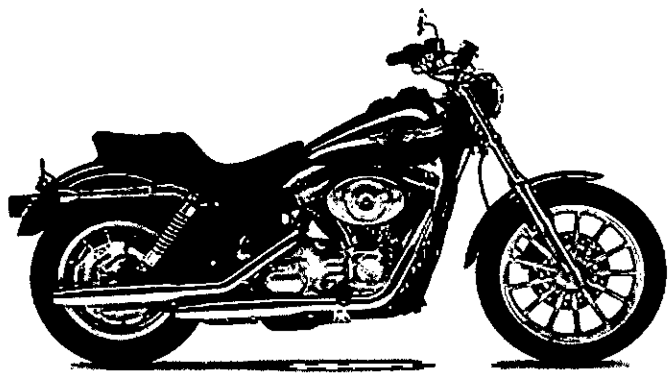
With NVH being such a vital part of the Harley-Davidson ethos it is an integral part of every new product development project from the start. There is NVH representation at the inception of every new project team so that the design, predictive analysis, and development can all benefit. Rather than attempting to rectify problems at the end of development, the NVH facility contributes throughout, especially early in the conceptual design when decisions are made about the bike's configuration. The engineers also work with suppliers on the development of many individual components. The sound quality can change noticeably as a consequence of clearances in power train components varying by a few micrometres.

Acoustic and vibration software

Throughout the development process the NVH team uses LMS CADA-X acoustic and vibration testing software. The software modules run on a bay of workstations, and high-speed multichannel front ends perform data acquisition analysis including signature analysis, modal analysis and time wave replication. The software is used to predict and visualise sound envelopes around individual components and subassemblies, as well as entire bikes. Advanced techniques such as Kalman filtering, synchronous resampling, time-frequency analysis and acoustic holography can also be used.

Some of the software has been customised to include standard processes and routine procedures, to save time and standardise operations from one project to another. Embedding the procedures in software captures a knowledge base for later use, and provides easily identifiable results that can be shared throughout the organisation. These solutions are central to the company's strategy of maintaining the classic sound of a Harley while improving performance, and respecting the legendary look of the machine while meeting strict noise regulations.

Few products have such a loyal following as Harley-Davidson. The Harley Owners Group (HOG) has more than 600,000 members internationally, making it the largest motorcycle enthusiasts' club in the world. William Harley and Arthur Davidson built their first motorcycle in 1903. The company went public in 1986, and now builds more than 200,000 bikes annually. The new V-Rod, their first liquid cooled production model, has been named **Bike of the Year** by *Motorcycle News* magazine.



Commons Debates

FROM HANSARD

Extracts are provided by Rupert Taylor FIOA

7 January 2003

Road noise

Colin Burgon (Elmet): This debate enables me to deal with two motorway issues in my constituency. First, there is the M1-A1 link, which cuts through my constituency and that of my hon. Friend the Member for Leeds, East (Mr Mudie). As the Under-Secretary of State for Transport, my hon. Friend the Member for Plymouth, Devonport will know that road was built under a design, build, finance and operate contract during the previous Conservative government. Although the audit report indicated savings of £80 million compared to more conventional funding, I was roughly correct when I said that success of that commercially driven project should not be achieved at the expense of local people's quality of life.

As soon as the road opened in February 1999, it was clear that the noise levels were unacceptable to many of my constituents in places such as Garforth, Swillington and Aberford. According to research produced by the Library in April 1999, the noise on the newly opened road was about 3 to 4 dB higher than had been estimated at the public inquiry.

It was predicted that, by 2012, the average number of vehicles passing Garforth every day would be between 49,000 and 59,800. In fact, according to Highways Agency figures, the number of vehicles had already reached 59,600 by 2001. What local residents and I find so appalling is that the previous Conservative government had what can only be classed as a very relaxed attitude - I nearly said 'cavalier' but, as we are talking about roads, I changed my adjective - to the impact of road noise on my constituents and those of my hon. Friend the Member for Leeds, East.

At the public inquiry in 1993, the independent inspector recommended the use of quieter road surfaces and appropriate sound barriers to minimise noise problems near the sensitive locations of Garforth, Aberford and Austhorpe. As a local person, I would have added Colton and Swillington to that list. Unfortunately, his recommendations were not included by the Conservative Secretary of State when the orders were made, so the contractors were allowed to build a virtually maintenance-free carriageway that would see out the 30 years of the contract and, therefore, maximise their profits.

I am pleased to say that, as a result of the pressure exerted by my hon. Friend the Member for Leeds, East and me, the Highways Agency announced within a few months of the opening of the link that a 2.6 km stretch of the concrete surface adjacent to Garforth would be treated with noise reduction blacktop. I am not quite sure what the technical term is, but I think that description fits the bill for most people. Although this concrete surface, which constitutes the backbone of the M1 link, seems to make good business sense, it does not make good sense for those who have to live near it.

I am glad that this government has given a target for the resurfacing of all concrete surfaces on trunk roads by 2010, according to *Transport 2010*, the 10-year plan published in July 2000. In the light of that target, may I ask the Minister when my hon. Friend the Member for Leeds, East and I can look forward to the patchwork quilt surface of the M1-A1 link being uniformly covered with a quieter surface?

'noise.... is a central issue in the construction of new roads'

In my discussions with the Highways Agency, I was pleased to hear it confirmed that attention is being paid to the problem of road noise. It is a central issue in the construction of new roads. Many of the village communities and Wetherby town residents have expressed their concerns on this issue. The mistakes that were made by the previous government on the M1-A1 link road look likely, as things stand, to be avoided. However, being sometimes the pessimist that I am, I would like some reassurance on what I consider to be a very important issue. Can the Minister confirm that a low-noise asphalt will be used? Are there to be any stretches where low-noise asphalt will not be specified?

The public consultation document on the Bramham to Wetherby upgrade indicates that mounding, noise fencing and tree barriers will be used to reduce the noise where appropriate. That is welcome, but similar barriers have not been that effective on the M1-A1 link. When it comes to trees, we seem to be planting the smallest that we can get our hands on. Many of us will not be here to see them when they grow to their full size. David Evans, chair of Bramham parish council, was in touch with my office only yesterday to stress the council's view that, without about a 4m high mounding from Bramham crossroads to the Grange Moor interchange, the noise levels will not be reduced to a desirable and tolerable level. I realise - I think that most sensible people realise - that noise can never be eradicated completely, but the upgrading is an opportunity to minimise the problem of road noise. I hope that we can take the opportunity with both hands. Will the Minister therefore agree that noise barriers need to be commensurate to the problem in each locality, and that some flexibility should be built into the specification to allow for any necessary adjustments that should arise during the 30-year period of the contract? There should be no off-the-shelf solution to what could well be difficult and complex problems along the route of the A1 and the upgrading area.

The Parliamentary Under-Secretary of State for Transport (Mr David Jamieson): As my hon. Friend has said, the M1 and the A1 in his constituency to the east of Leeds are vital links in the strategic highway network. Together with the connections to the north along the A1 and to the south along the A1, M1 and M62, they form the key north-south routes between Scotland and the north-east of England and the rest of the country. At a regional level they represent an important artery providing access between the more rural parts of North Yorkshire and the major towns and cities of West and South Yorkshire. At a local level they perform an essential function in keeping long-distance, strategic traffic away from market towns such as Wetherby and neighbouring villages, and hence minimising environmental impacts. The volume of traffic using those roads demonstrates their importance. For example, the A1 south of Wetherby is currently used by about 74,000 vehicles a day, and the A1(M) south of Bramham is used by more than 100,000 vehicles a day. We face a major challenge in maintaining the quality of service provided by those key routes in the face of steadily rising volumes of traffic. That is a reflection of economic growth - one of the problems of economic success resulting from our careful and prudent management of the economy is extra traffic wanting to use the roads. However, the government is committed to an unprecedented programme of investment to upgrade the A1 in Yorkshire to a motorway, which will ensure that that route continues to function effectively in meeting national, regional and local needs. That is essential if we are to support continued growth of the economy and, at the same time, ensure that the impacts on local communities of traffic growth are minimised, as my hon. Friend poignantly pointed out.

My hon. Friend asked a number of specific questions in our debate, which it would be appropriate to address in the order in which he asked them. I am pleased that he recognises the benefits of the M1 scheme and the use of private finance. I know that the use of concrete carriageways has resulted in noise levels higher than those originally predicted. My hon. Friend will be aware that one section of the route was identified as needing sensitive treatment close to Garforth, and was resurfaced shortly after opening. On the general subject of concrete roads, in October 2001 I announced the first list of concrete roads to be resurfaced as part of the 10-year plan. At the same time, I commissioned studies of 17 routes to establish the actual noise levels against those predicted. Once I have the results of those studies, I can further consider the programme for resurfacing. I hope to make an announcement on that in the next few months.

My hon. Friend asked about low-noise asphalt. All new sections of road on the A1 will be constructed with low-noise asphalt surfacing. I am sure he will be interested to know that the contract currently being negotiated for the A1 DBFO project will ensure that is the case. The draft contract that is being prepared states: 'the DBFO company shall ensure that all new and resurfaced carriageways on motorways and trunk roads forming part of the project road shall have quieter road surfaces'.

In addition, it states: "Concrete running surfacing shall not be permitted for new construction on trunk roads or motorways". I am sure that that will bring considerable relief to him and his constituents who have to live near the roads.

Under current proposals, the existing carriageway of the Bramham to Wetherby section of the A1 will be retained and become the new motorway. It will, of course, be resurfaced with low-noise surfacing when maintenance is due. Its current condition suggests that will occur between seven and 10 years from now.

My hon. Friend referred to noise barriers, which will be designed to suit the conditions at each locality. They may not always meet the aspirations of local residents, but we will consult further with interested parties on such matters as part of the consideration of order preparation. I believe that our approach of identifying the most serious problems and directing resources to them is the better way forward. I am sure he will agree that, overall, the A1 upgrading proposals will bring very considerable benefits to his constituents.

'Overall, the A1 upgrading proposals will bring very considerable benefits'

Finally, I can confirm that if my hon. Friend thinks it is appropriate for me to meet local representatives, I shall, of course, be delighted to meet him and local residents to discuss any of the matters that have been raised.

I again congratulate my hon. Friend, not only on raising such important matters for his constituents, but on the way in which he has done so and the powerful way in which he has represented them here tonight.

Written Answers

10 December 2002

Aviation standards

Tom Brake: To ask the Secretary of State for Transport what changes there have been to the standards for (a) noise limits, (b) minimum flying heights and (c) monitoring of noise levels for aircraft departing (i) Heathrow, (ii) Gatwick and (iii) Stansted airports since December 2000; and what assessment has been made of the effect of the changes.

Mr Jamieson: On 18 December 2000 my hon. friend (the Member for Sunderland South) (Chris Mullin) announced new departure noise limits for aircraft departing from Heathrow, Gatwick and Stansted and improved noise monitoring arrangements (*Official Report* columns 11–12W). In accordance with that decision, the new night-time noise limit of 87dBA came into effect during the night quota period (2330-0600 hours) from 25 March 2001; all other aspects of the decision, including the new daytime (0700-2300 hours) noise limit of 94dBA and the requirement for aircraft to be at a height of 1000 feet aal (above airport level) at 6.5 km from start of roll, came into effect from 25 February 2001.

The noise limits (including the old night-time noise limit of 89dBA which continues to apply 2300-2330 and 0600-0700 hours) apply at the fixed noise monitor positions as determined by my hon. friend.

Included in the announcement of 18 December 2000 was the decision to commence a further review of the departure noise limits and associated noise monitors. The technical work is being carried out by the Environmental Research and Consultancy Department (ERCD) of the Civil Aviation Authority. It is examining a method for assessing the effectiveness of the current monitoring arrangements and any possible improvements, as well as the scope for any further reductions in the departure noise limits. Our conclusions on the way forward in the light of that study will be announced in due course.

18 December 2002

Noise pollution

Mr Heath: To ask the Secretary of State for Culture, Media and Sport what assessment of the noise pollution caused by (a) amplified music and (b) television sets was made by her Department when considering licensing reform.

Dr Howells: [holding answer 16 December 2002]: We consulted local authorities and local residents groups, as well as representatives of the music industry, following the publication of our proposals for reform of the licensing laws, and considered views on public nuisance and the impact of various forms of entertainment on the community. The comments that were received during the initial review and in response to the publication of the White Paper led to our making the prevention of public nuisance one of the four primary licensing objectives of the Bill.

During the consultation, no organisation or individual commented on the issue of noise from television sets. Subsequently, we have considered whether the live broadcast of television in public venues should be brought within the proposed licensing regime and concluded that this is not necessary.

13 January 2003

Licensing

Mr Dobson: To ask the Secretary of State for Environment, Food and Rural Affairs whether her Department knew that drinks and entertainment organisations were clients of MCM Research Ltd when it was commissioned by her Department to advise on proposed changes in the arrangements for alcohol and entertainment licensing.

'The prevention of public nuisance is one of four licensing objectives'

Alun Michael: The research MCM is carrying out on behalf of DEFRA is to assist with the provision of best practice guidance for addressing potential noise from pubs and clubs. It is not to comment on proposed changes in the arrangements for alcohol and entertainment licensing. The intention is to support local authorities and the licensing trade both when working under the current licensing rules and in implementing changes under the arrangements currently proposed within the Licensing Bill.

All applicants to the competitive tender for this research project were asked to

continued on page 36

continued from page 35
give details of their relevant experience in this area. A number of drinks and entertainment organisations have been clients of MCM Research Ltd as a result of its specialisation in the application of social science to alcohol-related problems. MCM Research Ltd was appointed partly as a result of its knowledge and experience of the licensed trade.
This research will be made publicly available and is expected to be published in spring 2003.

15 January 2003
Low-noise tarmac

Tony Wright: To ask the Secretary of State for Transport whether low-noise tarmac is being used in the construction of the Birmingham Northern Relief Road.
Mr Jamieson: Yes. Responsibility for deciding on the surfacing treatment for the M6 Toll rests with Midlands Expressway Ltd (MEL) the commissioning contractor. Their intention is to use low noise surfacing along the entire length of the route.

16 January 2003
Fireworks

John Mann: To ask the Secretary of State for the Home Department if he will make the use of fireworks at certain times of the night a criminal offence.
Mr Denham: We are aware of the noise and nuisance caused by fireworks. There is already legislative provision through the Noise Act 1996 to deal with noise nuisance, including fireworks, between 11pm and 7am. This legislation is adoptive. We are considering how best to encourage local authorities to make greater use of it.
We are also considering as part of the development of the Anti-Social Behaviour White Paper what more needs to be done to tackle this nuisance which is blighting so many neighbourhoods.

29 January 2003
Light aircraft

Mr Key: To ask the Secretary of State for Transport what plans he has to reduce noise from light aircraft using grass airstrips in rural England.
Mr Jamieson: Light aircraft have to comply with an internationally agreed noise certification standard, unless they were on the UK register prior to 1980. This standard was tightened for aircraft certificated after 1999. There are currently no plans for additional measures to reduce aircraft noise from light aircraft using grass airstrips in rural England. It is the responsibility of all aerodromes to ensure that appropriate rules are set and enforced to minimise noise nuisance.

Written Ministerial Statements

12 December 2002
Ambient noise strategy

The Minister for Rural Affairs (Alun Michael): I am pleased to announce that today we have published a summary of the results of the consultation, Towards a National Ambient Noise Strategy.
There was very clear support for the government's proposals for the development of an ambient noise strategy and I am pleased to confirm that we are taking the next steps to develop the strategy. These include: continuing the mapping already underway across England; the establishment of an expert working group to address the effects of noise; and to establish cost-effective techniques to take action to improve or preserve noise levels, as appropriate.
A significant number of respondents indicated a need for a more strategic approach to neighbour noise. I agree that there is a need for a separate *Neighbour Noise Strategy* and as a first steps towards developing this I am pleased to launch a study to examine neighbour noise, both from the point of view of the noise makers and their victims. The research will generate appropriate and realistic options for action to both raise awareness and influence behaviour and, with many of the proposals identified during the consultation, should provide us with a solid basis to also develop a more strategic approach to the control of neighbourhood noise.

BOOK REVIEWS

Noise and Vibration from High Speed Trains

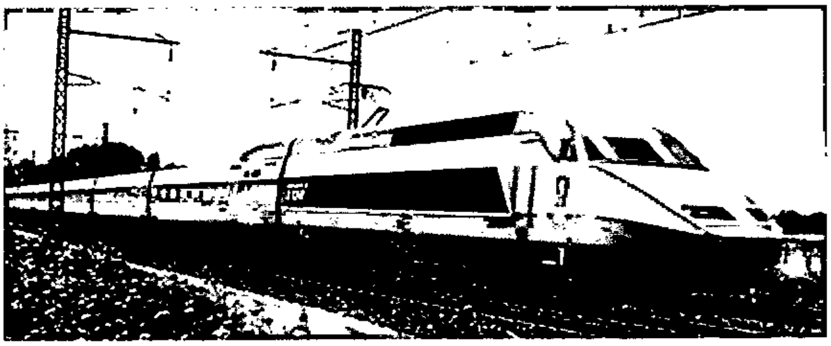
edited by Victor V Krylov
published by Thomas Telford
ISBN 0 7277 29673 2

A compendium text, drawing upon the expertise and experience of many authors recognised as academic or practitioner experts in their field, this book does what it 'says on the tin' – without hesitation, deviation and only the slightest repetition – in that it covers well and systematically noise and vibration issues relating to the specific application of high-speed trains, but nonetheless also contains material that is applicable to trains operating at any speed. Addressed primarily to the engineer, scientist and academic within the railway noise field, a degree level understanding is needed to make detailed use of the book. Apart from a few pages on effects internal to a train the book is entirely devoted to external behaviour. Comprising 14 chapters, each with copious references, it is set into five parts arranged in an organised fashion. The first two parts entitled, *Generation and Propagation* and *Measurement and Control* (which together constitute about half of the book) have the wider scope for readership, and can be approached as an excellent overview of the body of knowledge in this particular field. They deal with the theory and modelling of that fascinating microscopic world at the wheel-rail interface, where all noise and vibration for moving rolling stock starts its energetic life. Prediction, propagation, measurement and control are then covered comprehensively. It would perhaps be instructive in any further edition to consider a contribution from train manufacturers and consultants on the pragmatic management of testing rigour within the constraints of time, cost, and logistics.

The subsequent three parts of the text (eight chapters) move onto the specifics, both in application and in their concentration on high-speed issues, and also epitomise more the overall advanced-level thrust of the book. Part 3 deals with tunnel pressure generation and control, and Parts 4 and 5 with ground vibration from surface and underground trains respectively. These are complex topics dependent on many variables for which it is difficult to establish a generalised reference, and the approach here is to mix the general with detailed reportage of particular situations. This succeeds in covering theory, prediction and control for the assiduous reader.

The hard-bound book has clear script, with sharp pictures and figures printed on high quality paper. Overall it is an excellent, focussed reference for those directly working and interested in the specific noise and vibration applications associated with trains operating at high-speed. Such an audience is likely to adopt the book readily. The readership drawn from those working in railway noise in a wider and more general sense might hesitate, partly in view of the cost of £95, but books devoted to railway noise (albeit external behaviour only) are few, and there is much here to provide a substantive reference.

Alan Bateman MIOA



'Books devoted to railway noise are few and there is much here to provide a substantive reference'

Noise control: The law and its enforcement

Christopher N Penn
(3rd edition, Shaw & Sons, November 2002: 478pp)
ISBN 0 7219 0832 2

This well-written and informative soft-back book, aimed principally at environmental practitioners, also contains valuable reference material for health and safety professionals. There are ten chapters in all, covering Noise Control and the basics of acoustics; Noise Nuisance; Noise in Public Places; Noise Abatement Zones; Construction Site Noise; Road Traffic Noise; Integrated Pollution Prevention and Control (IPPC); Aircraft Noise; Planning and Development; and Occupational Noise Exposure. For safety professionals also have some responsibility for environmental matters, and for anyone involved with environmental monitoring and control, the book provides excellent reference and study material.

The introductory material on noise control skips through the basics of sound generation mechanisms, but is more informative about the effects of noise on health, sleep disturbance, communications and working efficiency. The basics of noise measurement practice are covered in a few pages, and a section on noise reduction includes a step-by-step approach some consultants would be well-advised to follow! Vibration is then discussed as a physical phenomenon and a health hazard, which is particularly welcome in view of the EU *Physical Agents Directive* which is engaging particular attention at present.

Chapter 2 describes public, private and statutory nuisance, and includes case notes for illustrative purposes, before detailing the practical steps to be taken in cases of noise nuisance. *Chapter 3* is a logical progression from this material, as it examines the legal position regarding noise in public places from a wide variety of sources including industrial, entertainment and leisure noise from railway traffic to raves.

Noise Abatement Zones are described in *Chapter 5*, although the reasons they are given their own chapter are probably historical: this is, after all, the third edition of a well-established textbook, and NAZ's are rarely encountered these days.

Other useful information is interwoven, including the measurement of noise in the environment and the definition of noise measurement locations on a site boundary. *Chapter 6* covers road traffic noise and the insulation of buildings against it.

IPPC and noise control

The application of IPPC to noise control in *Chapter 7* quotes a lengthy extract from the Environment Agency's technical guidance and discusses the concept of Best Available Technique (BAT) in relation to noise matters. The 50 pages of *Chapter 8* deal concisely but thoroughly with aspects of aircraft noise, and the even longer *Chapter 9* covers the planning system in the UK and how it is used to regulate and control noise emissions and immissions.

Finally, *Chapter 10's* valuable reference text on occupational noise exposure covers the relationship between noise exposure and hearing loss, and how common law relates to occupational deafness. How to identify and assess an occupational health problem, the statutory duties of the employer, and the introduction of a hearing conservation scheme, are discussed in a readily-digestible form, and the functions of safety representatives and safety committees - especially their roles in education and training - are considered. A small section deals with the problems of vibration at work.

There is an extensive bibliography, both general and specific to each chapter, and a reasonably comprehensive index. This is a valuable and useful reference text: if it does not have the solution to every noise problem, it will at least take the reader to a place where the solution may be found.

Ian Bennett BSc CEng MIOA

Consulting on BB93

Acoustic Design of Schools

The DfES consultation period for the new BB93 Acoustic Design of Schools has now ended, with several interesting points being raised by correspondents to the web site and bulletin board. Many IOA members made comments, and these together with the responses are set out below.

Q: *The use of D_w (weighted sound level difference) for sound insulation is inconsistent with the rest of the Approved Document E, which uses $D_{nT,w}$.*
A: BB93 is not part of the Approved Document (ADE). It is a separate publication which sets out the acoustic requirements for schools which are not addressed elsewhere in ADE. There is no fundamental requirement for BB93 to be consistent with all aspects of the ADE, any more than there is for ADE to be consistent with BS 8233 – or indeed than it was for ADE to be consistent with BB87, which used D_w.
It is not inconsistent to use different descriptors for different purposes.
It would be tidier if all documents concerning sound insulation used the same descriptors but it would not necessarily be correct. There is no reason why the criteria and descriptors developed for dwellings should be appropriate to schools, and there is no evidence that the use of D_w (which has, after all, been used for schools for many years) is unsatisfactory.

Q: *Although $D_{nT,w}$ is normalised to 0.5 seconds, most of the room types under BB93 encompass 0.5s in their range. Those larger rooms significantly in excess of 0.5s would be used as a source room anyway (ref BS EN ISO 717 and 140)*
A: There seems to be a fundamental misunderstanding here. We are interested in specifying and measuring what will actually occur in the completed school, ie the actual difference in sound levels between two rooms when the rooms are completed and furnished. That is the figure that will determine whether activity in one room will cause noise disturbance in another room. There is little point in using a descriptor that tells what the level difference would be if the RT of the receiving room was 0.5s at all frequencies. To calculate $D_{nT,w}$ the D_w values have to be measured anyway. EN ISO 140-4:1998 states:
"if the rooms are of different volumes, the larger one should be chosen as the source room where the standardised level difference is to be evaluated and no contradictory procedure is agreed upon. In order to evaluate the apparent sound reduction index measurement (sic) results from one measurement direction or from both directions may be used. "
It is worth remembering that EN-ISO 140 is primarily about determining standardised level difference and sound reduction index from measured level differences. EN ISO 12354 is concerned with the estimation of acoustic performance on site from the performance of building elements. BB93 is concerned with the performance achieved on site, rather than the performance of the building elements used, and therefore has more in common with EN ISO 12354 than with EN ISO 140.
As a matter of common sense, if there were a small noise-sensitive room alongside a larger, noisy (but not noise-sensitive) room, it would be ridiculous only to measure from the larger room to the smaller one. To avoid confusion, more explanation of this could be included in Section 1.

Q: *DW is not defined in BS EN ISO 717 and 140, but is merely a hybrid of D and $D_{nT,w}$*
A: This is correct, and is explained in Section 1.1B of the *Building Bulletin.* The fact that a standard does not specifically define a descriptor does not prevent us from using that quantity, provided that it is appropriate, easily understood and defined clearly in relation to standardised descriptors. D_w has been used by many consultants in the past and indeed was used in the old BB87.
The new table specifying sound insulation criteria gives identical D_w criteria regardless of the direction of transmission. Thus 55dB needs to be achieved when sound is transmitted from a music room to a toilet, as well as from a toilet to a music room. One might think that performance will be the same in both directions, but since D_w takes into account sound absorption in the receiving room, this is not the case. BB87 differentiated between the source and receiver rooms and set criteria accordingly. The point was discussed at the recent IOA meeting and discussed there. There are several possibilities for dealing with it: either revert to 2-stage tables, probably a 4×4 matrix similar to the 3×3 matrix used in BB87, or keep the current Table 1.2, filling in all the spaces and adding 'to' and 'from' headings.
Another possibility would be to write software that only requires the two room types to be added and outputs the D_w of the wall. It could perhaps simultaneously calculate $D_{nT,w}$ and R_w values.

Q: *Various commentators have asked why the C_{tr} adaptation terms as defined in EN ISO 717-1 : 1996 is not used*
A: C_{tr} is appropriate only for noise sources with a large amount of energy at low frequencies, such as urban road traffic (not, incidentally, highway road traffic), low-speed railway traffic, disco music and so on. Table A.1 of EN ISO 717-1 makes it clear that the 'C' spectrum, not the 'C_{tr}' spectrum, is appropriate for living activities (talking, music, radio, TV) and children playing. As we are using airborne sound insulation assessment only between rooms, where sources are children, speech and live music, the C_{tr} correction is inappropriate.

Q: *When sound absorption is required in buildings, a simple method of assessing the performance of a sound absorbing panel or tile should be used. At the moment the new BB93 is talking about different classes A, B ,C etc depending on the performance of the sound absorbing material. However, this is not easy for architects and non-acousticians to calculate. If the Noise Reduction Coefficient (NRC) were used instead it would be simpler for most lay people to understand, thus enabling them to feel comfortable specifying acoustic materials and getting a building designed which provides good acoustics.*
A: Noise Reduction Coefficient (NRC) is defined as the arithmetic average of the absorption coefficients in octave bands from 250Hz to 2kHz. This is simple to derive from the absorption coefficients but can be very misleading in the event where an absorber has a very uneven performance. Panel absorbers and some tuned absorbers fall into this category. This is presumably why the absorption category classes were introduced and defined in BS EN ISO 11654 : 1997.
NRC is indeed easier to derive from the absorption coefficients than are the absorption classes, but suppliers of absorbent material will normally calculate it and state what absorption class their materials fall into. This is very similar to the use of weighted sound reduction index R_w, which has entirely replaced the average sound reduction index in sound insulation definitions.

Q: *BB93 reduces the lower reverberation guideline from 0.5s to 0.4s in classrooms. Regular acoustic testing in schools has determined that many staff prefer shorter reverberation times: for example, T_{mf} values of 0.35s have been measured and the staff still liked the acoustic environment. The question therefore arises as to whether the lower limit could be reduced further. Note 2 on Page 19 states that where hearing impaired children are integrated into mainstream classes, the reverberation time should be 0.4s or less from 125Hz to 4kHz. This is at odds with the main table which indicates that reverberation times below 0.4s should be avoided in classrooms.*
A: The DfES admits that there was an inconsistency in the draft. There seems to be a good case for the lower limit to be less than 0.4 seconds and this change will probably be made in the final version.

BSI NEWS

New standards

BS EN 12736:2001 Electrically propelled road vehicles: Airborne acoustical noise of vehicle during charging with on-board chargers – Determination of sound power level
BS EN 13819-2:2002 Hearing protectors: Testing – Acoustic test methods
BS EN 352-5:2002 Hearing protectors: Safety requirements and testing – Active noise reduction ear-muffs
BS EN ISO 11904-1:2002 Acoustics: Determination of sound immission from sound sources placed close to the car – Technique using a microphone in a real car (MIRE technique)
BS ISO 15186-3:2002 Acoustics: Measurement of sound insulation in buildings and of building elements using sound intensity – Laboratory measurements at low frequencies

BS EN Publications and amendments

BS EN 12053:2001 Safety of industrial trucks – Test methods for measuring noise emissions
BS EN 61260:1996, IEC 61260:1995 Electroacoustics: Octave-band and fractional-octave-band filters
BS EN ISO 3741:2000 Acoustics: Determination of sound power levels of noise sources using sound pressure – Precision methods for reverberation rooms
BS EN ISO 9614-3:2002 Acoustics: Determination of sound power levels of noise sources using sound intensity – Precision method for measurement by scanning

Drafts for public comment

02/208062 DC IEC 60704-2-10 Ed.1.0 Household and similar electrical appliances: Test code for the determination of airborne acoustical noise, Part 2-10 – Particular requirements for electric cooking ranges, hobs, ovens, grills, microwave ovens and any combination of
02/563796 DC BS EN ISO 140-14 Acoustics: Measurement of sound insulation in buildings and of building elements, Part 14 – Additional requirements and guidelines for special situations in the field
02/705995 DC ISO 22868 Portable hand-held forestry machines with an internal combustion engine: Determination of A-weighted sound pressure levels at the operator's ears, and the sound power level – Engineering method (grade 2)
02/706364 DC EN 14462 Surface treatment equipment: Noise test code for surface treatment equipment including its ancillary handling equipment – Accuracy grades 2 and 3
03/101986 DC BS EN ISO 17201-1 Acoustics: Noise from shooting ranges, Part 1 – Sound source energy determination of muzzle blast
03/300069 DC IEC 60534-8-4 Ed.2 Industrial process control valves, Part 8-4: Noise considerations – Prediction of noise generated by hydrodynamic flow

New British Standard guidelines for environmental noise management

'Expressions of interest' invited

BSI Technical Committee EH/1/3 'Residential and industrial noise' is responsible for the widely used standard BS4142:1997 *Method for rating industrial noise affecting mixed residential and industrial area.*

The Committee has decided to produce a complementary guidance document dealing with environmental noise management.

It will be produced under the BSI/DTI Consultancy Drafting Scheme, under which a contract is awarded to cover the cost of writing the first draft of a document, and of developing that document through subsequent drafts up to the stage at which it is published for public comment.

The outline specification for the work in the form of a Consultant's Brief, together with further information, is available from Tim Newins, BSI, 389 Chiswick High Road, London W4 4AL,
e-mail tim.newins@bsi-global.com

Organisations or consortia wishing to be considered for the shortlist to tender for the work are invited to submit brief expressions of interest. The work is expected to start in May, and the 'guide price' is £30,000.

Applicants should be able to demonstrate the following attributes:

1. a thorough understanding of the subject of noise assessment and management;
2. a thorough understanding of relevant national and international standards and legislation;
3. proven track record of writing documents of the kind planned;
4. adequate staff resources to complete the project within 12 months;
5. robustness as a contractor; and
6. necessary quality assurance procedures.

The submission should include evidence of the above attributes. Expressions of Interest must be submitted by 17.00h on 15 April 2003.

Managing neighbour and neighbourhood noise

Phase 2 research seeks practical options

A team of researchers has been commissioned to undertake an in-depth national review of the management of neighbour and neighbourhood noise on behalf of the Department for Environment, Food and Rural Affairs (DEFRA). The eight-month study builds on earlier work that reviewed legislation and practice elsewhere in Europe, as reported to the UK Noise Forum in May 2002.

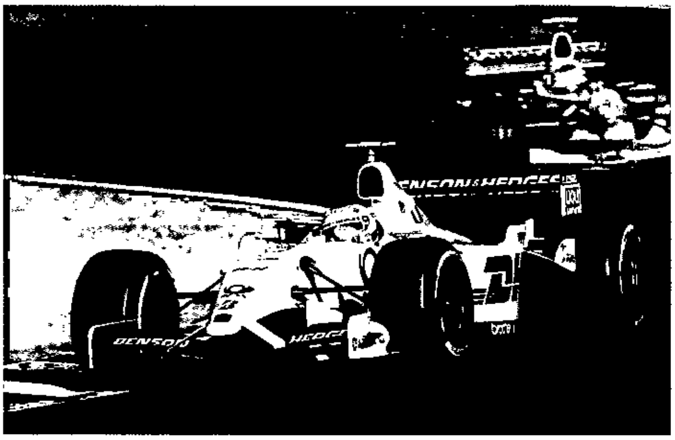
Phase 2 of the research brings the focus firmly back to the UK and aims to provide DEFRA with realistic and practical options to improve the management of neighbour and neighbourhood noise. Ideas from the rest of Europe uncovered in Phase 1 will be considered further, along with the many new ideas and practices already in use within the UK. It is recognised that the management of neighbour and neighbourhood noise is complex and labour intensive. This study aims to delve deeply into some of the obstacles to improvement. A key element of the work is therefore consultation, and the researchers would welcome ideas from interested parties.

The study is being led by Steve Mitchell at Environmental Resources Management Ltd (ERM) with support from Bernard Berry of Berry Environmental Ltd, Nicole Porter (independent consultant), Colin Grimwood at the Building Research Establishment, Peter Carey of the London Borough of Camden, Tim Clarke of Bristol City Council, and Neil Baker of Clarke Willmott & Clarke.

Steve Mitchell can be contacted on Tel 020 7465 7210 or
e-mail: Steve.Mitchell@ERM.com

All Creatures Great and Small?

Has any member come across research, or useful guidance, on the effects of environmental noise and vibration on other animal species (birds, fish, etc)? If so, could they please e-mail a quick note to jim.mcintyre@sepa.org.uk.



Jordan team enhances its Grand Prix communications

The Jordan Grand Prix team is using advanced noise reduction technology developed by Lucent's world-famous research and development division, **Bell Laboratories**. The team's drivers are using helmets fitted with advanced noise-cancelling microphones, specially adapted for use in Formula 1 cockpits by the laboratory's acoustic engineers, enabling them to communicate more clearly with their pit crews during a race. In addition, each car is equipped with electronics that filter the voice signal to make it more intelligible.

A Formula 1 driving seat is one of the noisiest places in the world, but even in this extreme environment, drivers must maintain a vital link with their pit crews. In addition to the scream of a 600kW engine directly behind the driver, the cockpit is subjected to high levels of vibration, extremes of temperature, and very high humidity.

With a noise-cancelling microphone the sound coming from a distance is cancelled, but sound originating very close to the microphone is enhanced, according to the Bell Laboratories research team that adapted the technology for Jordan.

The tiny microphone is about 8mm in diameter and 4mm deep, and replaces a much larger design which was far more sensitive to vibration and environmental elements. The new microphone is based on the high-performance foil-electret design known for providing high quality at low cost.

Controlling noise from sport and leisure

Symonds Group has been awarded a contract by the Department of Environment, Food and Rural Affairs (DEFRA) to compile a guide to the controls on noise from sport and leisure pursuits that are currently available to enforcement agencies. The aim is to produce a guide suitable for publication to a wide range of user groups, including enforcement agencies, sporting bodies and leisure groups, in order to help develop a common understanding.

It is intended that this will lead to more consistent enforcement and a reduction in the number of cases where such action becomes necessary.

The project will seek to consult with local authorities, government agencies, sport bodies, the leisure industries and consultancies, in fact anyone who can help, in order to make the review as comprehensive as possible.

If any members would like to share their experiences of noise from sports and leisure, please contact the project manager, Mike Fillery, by e-mail on mike.fillery@symonds-group.com.

Wanted

A used B & K Standing Wave Tube is sought by Acoustic Design Consultants Ltd in Ipswich. If you can help please contact Elaine Stewart.
e-mail: elaine.stewart@acoustic.co.uk
Tel: 01473 824452 Fax: 01473 824408

Air transport and environmental pollution

Royal Commission impact study focuses on global warming but side steps noise issues

On 1 July 2002, the Royal Commission announced a limited study into the environmental effects of air transport, focusing on civil aircraft in flight. The study was published on 29 November 2002, in advance of the government's White Paper on air transport.

The Commission re-examined its previous work in this area and considered some new areas, building also on the report of the Intergovernmental Panel on Climate Change - *Aviation and the Global Climate*. The study concentrated on the environmental problems associated with aircraft in flight. Specific questions for consultation were posed in the invitation to submit information for the study. The invitation was sent to over 20 organisations particularly likely to have useful experience, but the Commission was also pleased to receive responses from other bodies. The evidence received will shortly be posted on the web site.

Study urges shift from air to rail for short-haul travel in UK and Europe

The special report, *The environmental effects of aircraft in flight* was published on 29 November 2002. At the same time, the Commission issued its response to the government's consultation on the future development of air transport.

In the special report, the Royal Commission on Environmental Pollution expresses deep concern about the global impacts of the rapid growth in air travel. Air transport operates globally and its impacts on the atmosphere, particularly those that could result in climate change, could have worldwide consequences.

The Chairman, Sir Tom Blundell said: "Emissions from aircraft are likely to be a major contributor to global warming if the present increase in air traffic continues unabated. The government shows little sign of having recognised that action to reduce the impacts of air transport is just as important as action in other sectors contributing to climate change. The problems are challenging but it is imperative that environmental priorities are not simply sidelined as being too difficult. If no limiting action is taken, the rapid growth in air transport will proceed in fundamental contradiction to the government's stated goal of sustainable development.

"Short-haul passenger flights, such as UK domestic and European journeys, make a disproportionately large contribution to the global environmental impacts of air transport and these impacts are very much larger than those from rail transport over the same point-to-point journey.

He continued: "A shift away from the use of air transport over such distances could reap considerable environmental benefits as well as relieving pressure on major airports. Rail transport is demonstrably more sustainable than air transport. The fact that rail transport cannot compete at present, at least in the UK, is a consequence of several factors, but these certainly include a failure to invest in a rail infrastructure and a failure to reflect environmental externalities in the cost of air transport. Instead of encouraging airport expansion and proliferation, it is essential that the government should divert resources into encouraging and facilitating a modal shift from air to high-speed rail for internal UK travel and some intra European journeys."

The Royal Commission notes the ambitious targets for technological improvement - such as new airframe and engine designs and alternative fuels - and considers the potential for such developments to mitigate environmental effects. However, the report concludes that the projected increase in demand will easily outstrip any such technological developments for several decades.

The Royal Commission expresses disappointment that international aviation emissions were left out of the *Kyoto Protocol* and recommends they are included in the emissions trading scheme envisaged as one of the *Kyoto Protocol's* implementing mechanisms. In the meantime a charge on aircraft movements to reflect environmental impacts would send an important signal to travellers about the environmental implications of flying, and the revenue generated should be used to develop more environmentally benign transport modes.

The continued growth in air freight is also a major concern. It is so much more environmentally damaging than other freight transport modes that it must be reserved for very high value, and usually perishable, goods. The Royal Commission argues that any proposal to expand air freight movements must be examined with particular care.

In summing up, the Chairman said: "With respect to the expansion of airports across the country, the government has said that doing nothing is not an option. This may be so, but it does not mean that the only option is airport expansion. Emphasis should shift towards providing reliable, efficient and more sustainable alternatives to air flight. We urge the government to seize the opportunity presented by its forthcoming White Paper to implement our recommendations at the domestic level, and to argue for their adoption by the EU, and globally, where necessary and appropriate."

The Sustainable Development Commission (SDC) has prepared its own response to the consultation on air transport policy. In it, the SDC argues for a much wider-ranging public debate on the objectives of a sustainable policy for aviation and airport development. SDC member Charles Secrett presented the response at the same press conference as the Royal Commission's report.

Disappointingly, the announcement paid little direct attention to the problem of noise from civil aircraft movements. Whilst the problems may not be as potentially devastating as those of global warming, public attention and demands for action are surely more likely to receive a favourable reception if they are of immediate and obvious relevance to people in their homes. The root causes of noise and atmospheric pollution are the same: there are too many aircraft flights, especially on short-haul feeder routes, which could be replaced by railway movements under an integrated transport policy.

Wisdom from above

A man is flying in a hot air balloon and realises he is lost. He reduces height and spots someone down below. He lowers the balloon further and shouts: "Excuse me, can you tell me where I am?"

The man below says, "Yes, you're in a hot air balloon, hovering ten metres above this field."

"You must be an engineer," says the balloonist.

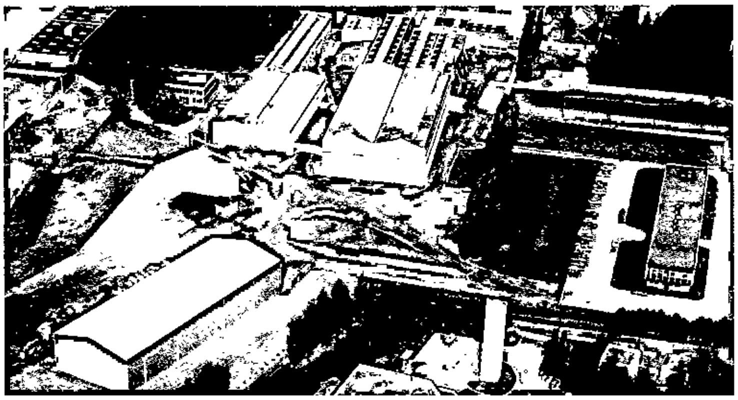
"Yes, I am," comes the reply. "How did you know?"

"Well," says the balloonist, "everything you have told me is technically correct, but none of it is any use to anyone."

The man below says, "Ah, you must be in management."

"Yes, I am," replies the balloonist, "but how did you know?"

"Well," says the engineer, "you don't know where you are, or where you're going, but you expect me to be able to help. You're in the same position you were before we met, but now it's my fault".



Boët Stopson's modern research centre in Lille

IAC

Major European acquisition

One of Europe's largest noise control product manufacturers, **Boët Stopson**, has been acquired by **IAC**, increasing by almost 70% the company's presence in mainland Europe. With major sales and production centres in France, Italy and Spain, the move adds to IAC's established operations in the UK, Germany and Denmark.
As the product ranges of the two businesses are substantially different and complement each other, IAC believes that its acquisition will offer tangible benefits to many customers throughout western Europe. IAC concentrates on products and structures for the building industry – audiology rooms, acoustic doors, broadcasting studios, anechoic chambers, acoustic louvres – and also produces automotive and aero-engine test facilities. Boët is strongest in the industrial and power generation sectors, particularly hot gas silencers and acoustic enclosures and containers.
Included in the acquisition is a production facility of over 9300m^2 and a modern research centre in Lille, France. The manufacturing base in mainland Europe is expected to make the organisation more responsive and competitive in local markets. Having a proper research and development facility in France should in the long term yield a new generation of acoustic products and materials for European customers.
Noise legislation and product specifications vary tremendously from one nation to another, even within Europe. Customers in France, Spain and Italy want advice from trained, experienced engineers familiar with the local market, and IAC can now provide this, so improving its service to customers outside the UK.
The Boët Stopson acquisition increases the total number of people now working for the IAC group to well over 600. IAC's European HQ is at Winchester (UK) and the European group companies are in Lille (France), Niederkrüchten (Germany), Milan (Italy), Barcelona (Spain) and Copenhagen (Denmark). There is also a sister company in the USA.

AHU no.500 shipped to Canary Wharf

IAC has just notched up sales of 500 packaged air handling units (AHU's) to London's Canary Wharf development. The special low-noise, on-floor units have been installed in eight different buildings on the 10 million ft^2 estate, the first having been delivered in 1998. Over 170 IAC units were installed in the two 42-storey office towers in Canada Square.
The units supplied range in duty from 3.5 to 17.5 m^{3}s^{-1}, all having a compact, space-saving footprint coupled with low noise emissions and energy-efficient operation.

Details of these and many other AHU designs developed by IAC for major building projects throughout the UK can be found at www.iaci.co.uk. A printed catalogue is also available from the company on 01962 873050.

IAC is a Sponsor Member of the Institute

CALL FOR PAPERS

Organised by the Building Acoustics Group

Autumn Conference 2003

sound-bite

5 - 6 November

The Oxford Hotel, Oxford

For the first time in many years the Institute's Autumn Conference will be devoted to the theory and practice of building acoustics. This will be an opportunity to address a broad range of current building acoustics issues by consultants, local authority officers, product manufacturers and academics. It is intended that the following topics will be included:

- ❑ Acoustic 'comfort' in buildings
- ❑ Domestic sound insulation
- ❑ Building acoustics Standards
- ❑ Approved Document E 2003 / Building Bulletin 93
- ❑ Sound insulation prediction methods
- ❑ Natural ventilation / façade sound insulation / PPG24
- ❑ Acoustics of atria and connected spaces
- ❑ Recording studio acoustics

Offers of contributions are invited on these or other aspects of building acoustics in the form of a brief abstract to be emailed to **Stephen Chiles**, s.chiles@bath.ac.uk, by 31 May 2003.

Contributions from students are encouraged; it is hoped there will be a dedicated student presentation session and a heavily discounted student delegate fee.

Casella CEL

Noise monitoring in the press room

Portsmouth Publishing and Printing is using **Casella** *CEL-440* sound level meters to help it comply with current and future workplace noise legislation. Inside the press room noise levels can exceed 105dBA, and, health issues apart, there is a risk that some local residents could be disturbed.

Hundreds of different titles are printed for the Johnston Press Group, owner of PPP, including the local evening newspaper *The News*. The presses run seven days a week, and nearly 20% of the 600-strong workforce work within the immediate area. Tom Anderson, the company's safety and environmental manager, wished to carry out octave band analyses to tailor available hearing protection to the noise emitted by the presses. He also wanted to conduct environmental noise monitoring in the immediate vicinity of the premises, in this predominantly residential area.

The Casella CEL-440 is able to operate in broadband and frequency analysis modes, manually or automatically and, because it stores its results on-board for later download to a computer or printer, the need for hand-written reports is largely eliminated.

Tom Anderson, safety environment manager at Portsmouth Publishing using a Casella CEL-440

Waste management company to undertake nationwide sound monitoring

A nationwide waste management company is planning to monitor sound levels on all its sites, and probably its fleet of vehicles. Taunton-based **Viridor Waste Management**, which operates 19 landfill sites and over 60 waste recycling and processing facilities across the UK, has used two **Casella** *CEL 360* sound level meters to undertake survey work at material recycling sites in Suffolk and Manchester. The instruments are being used to monitor the noise levels experienced by operators working alongside a conveyor belt where materials are selected for recycling.

A company spokesperson said that the meters will be used at all their sites and next year will probably be used to undertake a survey on the fleet of waste collection vehicles.

The CEL-360 meter is ideal for personal workplace monitoring and complies with all the current requirements of the ISO standard. Its features include seven pre-programmed measurement set-ups, and other functions that use the real-time calendar clock for automatic measurements, allowing runs to be made unattended.

Further details from: David Billington tel: 01234 844100 fax: 01234 841490

Left: Melanie Huggins and Nigel Steward of Viridor Waste preparing to use the Casella CEL360 sound level meter at Masons landfill site near Ipswich

Casella CEL is a Key Sponsor of the Institute

Eckel Noise Control Technologies

New hemi-anechoic test chamber for GDA

A metal wedge hemi-anechoic chamber, designed and manufactured by **Eckel Noise Control Technologies** using the new *Supersoft* acoustic wedges, has been supplied to the Blythe Bridge facility of General Domestic Appliances (GDA). The chamber is used to test white goods from Hotpoint, Credo and Cannon ranges. Measuring internally 5.8m wide, 5.8m deep and 3.2m high, it has an internal ambient measured sound pressure level of 18dBA and conforms to ISO 3745.

The wedges have a perforated metal profile and the acoustically absorptive material within them is encapsulated in an acoustically transparent non-woven fabric, which is chemically resistant and has a Class 1 fire rating. This eliminates fibre migration from the wedge without reducing its acoustic performance. The metal profile makes the wedges robust and hard-wearing, ideal for facilities in everyday use. The structure was built using high

performance modular acoustic panels with a modular floating floor designed for vibration isolation down to 5Hz. The inner ceiling and walls are lined with metal Supersoft wedges painted white. An independently isolated inertia block was also installed for mounting test products, in order to eliminate vibration into the host structure. Access into the chamber is through a double leaf acoustic door.

Eckel also supplied and installed all the ventilation, power, lighting and plumbing in a true 'turnkey' installation. Because the chamber is constructed from modular components it can be relocated or expanded relatively easily as required. GDA commented that the disruption caused by the installation was kept to a minimum: within eight weeks of arrival on site the high performance test chamber had been finished on time and within budget and is now in daily use as a benchmark tool.

For more information contact: Brian Harris tel: 01252 375000 fax: 01252 371351 e-mail: Brian@eckeleurope.co.uk

Eckel Noise Control Technologies is a Sponsor Member of the Institute

MRI-Polytech

Acoustic spray foam

Acoustic products manufacturer, **MRI-Polytech**, has patented a multi-purpose acoustic spray foam which has been tested under laboratory conditions to determine its sound absorption characteristics. The foam also acts as a thermal insulator, as it is fairly solid once applied, and shares the same components as a rigid spray specifically used for thermal insulation.

Independent analysis of tests recently carried out using two houses near Manchester Airport showed a 10dB reduction in noise where the foam was applied to the underside of roof tiles, compared with the house without foam.

MRI-Polytech is a member of the British Urethane Foam Contractors Association, BUFCA, and is a major supplier of rigid insulation foam as well as the patented acoustic foam. The company also produces a premium product, *Coustone*, which is a noise reduction tile system combining significant absorption capabilities with long life and an aesthetically pleasing appearance.

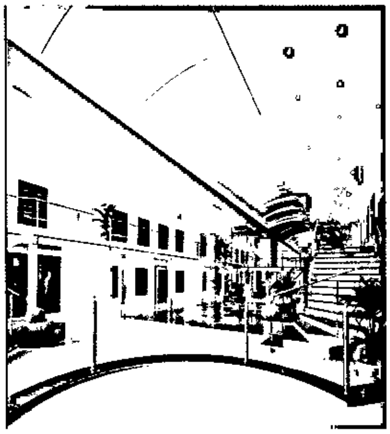
The acoustic foam and Coustone tiles have several applications apart from insulating houses under airport flight paths, and have been used to reduce and absorb noise in police stations, recording studios, kennels and gun clubs.

For more information contact: Martin Oakes tel: 01625 560 160 fax: 01625 560 180 www.mri-polytech.com

Barrisol

Innovative acoustic absorption fabric

Barrisol-Microsorberâ is an innovative new product from **Barrisol**, a world leader in stretch ceiling systems. The fabric is a special material, absorbing sound by resonance, which is also known as micro perforated acoustic absorption material. Its small micro-perforations transform acoustic energy into thermal energy. In fact, the volume of air enclosed between the material and its backing surface heightens the resonance of the air's viscous friction through the holes in the material, creating an impressive acoustic absorption performance.
The Barrisol-Microsorberâ fabric has a thickness of 0.18mm and is perforated with around 250,000 tiny holes per square metre, although the micro-perforations only represent around 0.8% of the fabric surface area. The structure of the holes is optimised to meet auditorium acoustic material requirements. The fabric has an Class 0 fire rating in the UK, as do all the fabrics available from this manufacturer.
In order to achieve the desired acoustic levels, the fabric can be stretched over hidden aluminium profiles at a predetermined height. The acoustic effects can be adapted to each individual room, thus offering major advantages in terms of being tailored and adapted to all types of surfaces, shapes, locations and sites.
Barrisol-Microsorber® offers a combination of aesthetic appearance and acoustic performance. The fabric is the result of a partnership between Barrisol-Normalu , a Barrisol licensee, and Kaeffer, a German construction and public works company. It is the fruit of their research into acoustics resulting in the granting of patents by the Stuttgart Fraunhofer Institute.



For further information contact : French Technology Press Bureau, 21 Grosvenor Place, London SW1X 7TB tel: +44 (0) 207 235 5330 fax: +44 (0) 207 235 2773

Omega Doors

Range consolidated

Specialist supplier, **Omega Doors Ltd** has consolidated its range of steel personnel doors. The new core range includes *OmegaGP* (general purpose), *OmegaFR* (fire resistant), and *OmegaTI* (thermally insulated) doorsets. Several enhancements are available for applications such as acoustic doors, clean rooms, gas-tightness, and high security.
The prime design considerations were ease and flexibility of installation, and all doorsets use the company's *Adaptabase, Adaptaframe* and *Varifit* systems so that they can be fitted into all common sizes of

structural aperture.
Through a national network of distributors the company operates a fast track service across the UK and Ireland covering all aspects of an order, from quotations through approval drawings and manufacture to delivery. All products are tested to meet current BS and EN standards. For example, the OmegaFR system has undergone 21 different fire tests in a range of configurations, including single and double swing and latchless designs using Assa, Exidor and Dorma hardware. The company is ISO9002 registered and is part of Allmar International Ltd, one of the largest door and hardware manufacturers in North America.
Further information from: Barry Gregson tel: 01772 696351 fax: 01772 696412 e-mail: info@allmarinternational.com www.omegadoors.com

Soundcheck™

Ancient & Modern

Two recently-completed landmark projects in London demonstrate the acoustic fit-out versatility of Soundcheck™.

St Luke's in Old Street, a Grade 1 listed church designed by Hawksmoor and completed in 1733, has been successfully refurbished, extended and converted to provide a music venue for the London Symphony Orchestra. With stringent design requirements – the Church is under a flight path for Heathrow – the acousticians Kirkegaard Associates of Chicago, working with architects Levitt Bernstein Associates, specified an acoustic ceiling as part of the integral roof design.

Soundcheck™ was selected to manufacture and install this high performance composite acoustic ceiling weighing some 30 tonnes. To satisfy the internal acoustic criteria, and ensure a standing wave could not build up within the auditorium, the plane of the new church ceiling was broken up into ten bays. All ten were made up of interlocking panels with cellular cores encapsulated by multiple layers of plywood, with the soffit facing finished in a polished cedar of Lebanon veneer.

Each interlocking panel section was isolated from the building structure by a grid of Mason resilient hangers, together with critical perimeter detailing and careful installation. As acoustic control was a critical element throughout the construction, the company used its own in-house manufacturing capabilities to produce the deep section panels, which were then transported to site, and installed within six weeks, using its own installation crews.

Across London in Deptford, Herzog de Meuron, Swiss architects of the Tate Modern have just completed their first 'new build' project in Britain, for which the company secured the contract to provide acoustic linings to studios. The Laban Centre is a £25 million dance centre providing 13 dance studios, a performance space, a theatre and associated facilities. With Arup Acoustics defining the acoustic performance, the architects specified an unusual fabric facing to provide the architectural finish to acoustic infills.

The Soundcheck™ standard acoustic lining system was easily adapted to accommodate all of these requirements, and to ensure that the specified fabric complied with current Building Control requirements, it underwent various fire tests. This success led to orders for further identical finishes to the offices, staff room, conference rooms and cafe bar.

For further details tel: 020 8789 4063 fax: 020 87135 4191 e-mail: info@soundcheck-uk.com

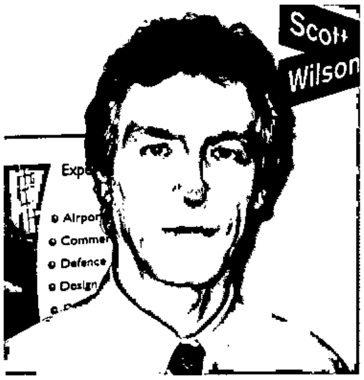
Soundcheck™ is a sponsor member of the Institute of Acoustics

People

New faces at Scott Wilson

Following a summer and autumn recruitment drive Scott Wilson has appointed Alf Maneylaws, Dan Atkinson and Paul Shields as noise and vibration consultants at the Chesterfield and Derby offices. The recruitment programme is ongoing.

Alf Maneylaws joined Scott Wilson in summer 2002, having previously worked for IMC Consulting Engineers and British Coal, and has over 15 years of experience in environmental and industrial noise and vibration work. He gained a first degree in



Alf Maneylaws

Mechanical Engineering from Nottingham University, and an MSc in Applied Acoustics from Salford University, and is a Member of the Institute of Acoustics.

Alf provides consultancy advice on a broad range of topics including environmental noise impact assessments, industrial noise and vibration control, and building and architectural acoustics. He has recently been getting to grips with the Environmental Statement for the proposed 21km Stirling-Alloa-Kincardine railway line reinstatement and will shortly commence work on the proposed Thames Gateway road traffic river crossing from Newham to Greenwich.

Outside work Alf's main interests are books, cinema, photography and the outdoors.

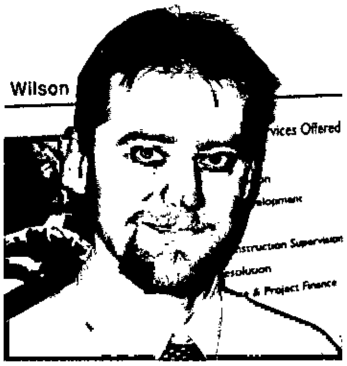
Paul Shields joins from Alstom where he was responsible for the acoustic performance of the new 'Pendolino' 140mph tilting train for Virgin Trains, having previously worked with British Rail Research (now AEAT), Adtranz (now Bombardier) and London Underground. Paul gained a BSc degree in Applied Physics at de Montford, Leicester and a Diploma in Acoustics and Noise Control at Derby. He is a Member of the Institute of Acoustics and is currently working on the final year of an MSc in Applied Acoustics at Derby.

Paul's main interest is railway-related acoustics. He is currently working for Scott Wilson on a number of railway related projects including a study into the possible reinstatement of the Buxton-Matlock railway line, the proposed 80km extension of the Birmingham Centro tram system, and the upgrading of the East Coast main line.

Outside work Paul enjoys travel and cycling, which he recently combined by cycling from Canada to Mexico, plus hill walking and eating curry, which he has achieved together during several trips to Nepal!

Dan Atkinson joins from Bolsover District Council where he was employed for four years as an environmental health technical officer within the Pollution Control Section. He gained a BSc degree in Chemistry and an MPhil in Environmental Chemistry at the University of Birmingham and is an Associate

Paul Shields



Dan Atkinson

Member of the Institute of Acoustics.

Dan brings with him a good understanding of noise legislation and the planning process, supplemented by completing the Diploma in Acoustics and Noise Control at Derby University. The project he submitted as part of the Diploma was short-listed for the student prize and a paper was presented at Liverpool University in the *Acoustics 2000: Research into Practice* conference.

Dan's experience has included the assessment of major planning applications including quarrying, open cast coal mining, supermarkets, industrial and retail park developments; he has worked on IPPC applications and is currently commencing the preparation of a Draft Code of Practice for Noise from Speedway. He has recently been involved in housing and residential development of various colliery and reclamation sites, including Cinderhill, Dinnington, Littlebrook Power Station and Thamesmead.

In addition, he has significant experience in statutory nuisance legislation and has successfully resolved a large number of noise complaints resulting from industrial, commercial and domestic premises using both mediation and legal enforcement, gaining expert witness experience in Magistrates Courts and the Crown Court. When not in Court Dan enjoys abseiling, cooking and playing his guitar.

A home for Raymond Stephens' library and papers

It was a pleasure to see the tributes to Dr Raymond Stephens *(Acoustics Bulletin,* November/December 2002). However, could I please clarify two inaccuracies in the text?

It was, of course, the legacy of Rayleigh's activity (not Stephens') that is to be found in his voluminous published works. Rayleigh's papers ran to several hundred which were published in five volumes, edited by his son, in addition to the seminal *Theory of Sound*. In comparison, Raymond Stephens' collection of about 70 papers and nine books is relatively modest. This is no doubt due in part to the fact that his students often published work done under his supervision, with Raymond modestly abstaining from co-authorship. Raymond's contribution to science was as great as that of Rayleigh, but of a different kind as the development of the age permitted.

The last paragraph of the main article is misleading. The books (only) from Raymond's library were offered to the ISVR at one time, but the conditions suggested were not considered acceptable to Victor, Raymond's brother. Since that time I have housed all the books and most of the papers in my own (small) house. Attempts to engage the Institute in their accommodation, even in part, have proved unproductive for the last 12 years.

To date approximately one quarter of the books have been taken to the new Physical Sciences Library in Cambridge. Negotiations have been successful for housing some of the remainder with the British Institute for Non-Destructive Testing and the Institute of Physical Sciences in Medicine. A small quantity has been welcomed by the Polish Acoustical Society (of which Raymond was the first British Honorary Member) which is actively establishing a national archive in acoustics. The papers are still in the process of being sorted. So far a home has been found for some of them at the NPL, Imperial College, the British Society for Audiology, and the Science Museum. The more personal memorabilia associated with Raymond's career have, of course, been returned to his family.

I apologise for what may appear to be a critical letter, but I still retain the illusion that scientists are concerned about the truth!!

Robert Chivers

Editor's note

We apologise for any errors or misleading statements in the R W B Stephens biography. The position with Dr Stephens' extensive papers was that although the Institute was unable to take any of the archive on this occasion, owing to the limited facilities at its disposal, the Publications Committee had been given the task of considering how best to deal with the growing number of archives that had become available over the past few years, and open them to researchers. The committee has reported back to Council through the library sub-committee, and the recommendations are being followed up. A progress report will be published shortly.

REGISTER OF MEMBERS

Quite a number of Register Entry Forms that were sent out at the beginning of February are still outstanding. An early response would be appreciated.

The Editor welcomes letters for publication

**Please send them to: Ian Bennett, Editor,
99 Wellington Road North, Stockport SK4 2LP
Tel: 0161 476 0919 Fax: 0161 476 0929
email ian@acia-acoustics.co.uk**

Peter Barnett Memorial Award

Nominations invited for 2003

The Peter Barnett Memorial Award was inaugurated in 2001 by the IOA Electroacoustics Group in memory of Peter Barnett. The concept of the award is to recognise advancements and technical excellence in the fields of electroacoustics, speech intelligibility, and education in acoustics and electroacoustics.

Few working in these fields would not have come across Peter Barnett at some time or other. Peter had a wide range of interests in acoustics but primarily in the fields of electroacoustics and speech intelligibility. He was known for his mathematical approach to problems and razor-sharp mind, as several presenters at IOA conferences found to their cost: if Peter felt that they did not come up to scratch, or gave poorly researched presentations, they were likely to be grilled!

The first recipient of the award - in 2001 - was Dr Herman Steeneken from TNO for his work on speech intelligibility and STI. Last year, the award was presented to Dr Wolfgang Ahnert for his contributions to sound system computer modelling, delta stereophony and education. Although the award sets out to recognise those working at the highest level, it is open to all and particularly seeks to recognise individual contributions in the field. The award is also open to students whose research or project work achieves a suitable level of excellence, or where it is felt the work could lead to advances in the field.

This year, the award has become an official award of the IOA as opposed to that of a member group, further elevating its status and the kudos to be gained.

Nominations are invited, and the award will be presented at Reproduced Sound 19 in Oxford in November. Nominations may be put forward by any corporate member of the institute and must include a 200 to 300 word summary of the nominee's career, and their contributions to the science of electroacoustics, speech intelligibility or education in acoustics. Student supervisors are also invited to put forward suitable candidates.

Nominations must be in writing, addressed to the President of the Institute of Acoustics, and arrive at the St Albans office no later than Friday 13 June 2003.

Acoustical Society of America honours IOA Past President

with a special session in memory of Dr David Weston

A central feature of the December 2002 meeting of our sister body, the Acoustical Society of America, was a highly successful special session in memory of David Weston, a distinguished Past President (1982-84) of the Institute of Acoustics, who died in 2001. David was honoured by the ASA with its interdisciplinary Helmholtz-Rayleigh Medal in 1998, having been awarded the (then) British Acoustical Society's Rayleigh Medal some 28 years previously.

Over 30 papers were presented, all related in different ways to research by David, who spent his professional career within the Royal Navy Scientific Service and was well known for the range of his interests in underwater and musical acoustics. So much interest was aroused that the planned single session was expanded to two half-days, and in a meeting where ten parallel sessions is the norm, there were audiences in excess of sixty throughout each.

Former colleagues and friends from his native Britain, Canada, Australia, New Zealand, Norway and Italy, as well as the host countries USA and Mexico, covered a wide spectrum of underwater acoustics: explosive sources; invariant techniques in propagation modelling; shallow water reverberation; scattering and sea-bed properties; and long-range shallow water transmissions, all topics from his earlier studies.

But the main focus, attracting papers from the younger generation of ocean acousticians around the world, was the topic which he introduced and named - *Sonar Ichthyology*. As he himself explained, he started by studying the impact of fish on long-range active sonar, and ended by defining how to use sonar to study fish behaviour. David would have been delighted by the way this topic has flowered in non-military use, and would probably have been somewhat surprised that the simple semi-empirical models of scattering he developed remain current today. Perhaps not so very surprised, however, as the methods were firmly rooted in measurements: a common theme throughout the sessions was the recognition that David's data obtained forty or fifty years ago with simple instruments are still the benchmark in many areas.

A pleasing consequence of the spread into two sessions was that each had a co-chair who was a British colleague of David in government research laboratories: Ian Roebuck, now with DSTL, the residual government part of the former DERA, and Mike Buckingham, now at the Marine Physics Laboratory of Scripps Institute of Oceanography. We are sure David Weston would have appreciated an Institute of Acoustics connection which made this particularly appropriate. David's early work at Teddington was with A B Wood, who is commemorated in the Institute's Medal: Ian and Mike are both holders of this medal, and in fact were the first two government scientists to receive the award, some considerable time after it was first instituted.

DIPLOMA AND CERTIFICATE EXAMINATION DATES 2003

Diploma in Acoustics and Noise Control
12 and 13 June

Certificate in the Management of Exposure to Occupational Hand Arm Vibration
11 April and 14 November

Certificate of Competence in Workplace Noise Assessment
16 May and 7 November

Certificate in the Measurement of Environmental Noise
2 May and 17 October

MEMBERSHIP FEES

A large number of members have already paid their membership fees for the current year. It would be appreciated if those members who have not yet forwarded their payment could do so within the next few days. Members are reminded that Membership Fees are tax allowable for members with an earned income relevant to the qualification. If you have any queries or wish to pay by credit card tel: 01727 848195.

ADVERTISERS INDEX

Institute Diary 2003

26 March
Venues for Sport and Entertainment,
Manchester

8 April
Diploma Examiners Meeting,
St Albans

8 April
Workshop, Design & Build: Unplugged,
London

8 May
CMOHAV Examiners & Committee,
St Albans

15 May
Annual General Meeting

15-16 May
Spring Conference, IPPC, PAD(NAWR), NCE & NVH:
The ' initial' conference of the Noise and Noise & Vibration Engineering group,
Coventry

2 June
CCENM Examiners & Committee,
St Albans

5 June
Membership Committee,
St Albans

10 June
Meetings Committee,
St Albans

10 June
Research Co-ordination,
London

17 June
CCWPNA Examiners & Committee,
St Albans

19 June
Distance Learning Tutors WG & Education,
St Albans

24 June
Engineering Division,
St Albans

26 June
Publications Committee,
St Albans

3 July
Executive,
St Albans

17 July
Medals & Awards & Council,
St Albans

5 August
Diploma Moderators Meeting,
St Albans

16 September
Meetings Committee,
St Albans

18 September
Membership Committee,
St Albans

18 September
Research Symposium,
University of Salford

25 September
Executive Committee,
St Albans

30 September
Diploma Tutors and Examiners & Education,
St Albans

9 October
Medals & Awards, and Council,
St Albans

14 October
Engineering Division,
St Albans

23 October
Publications,
St Albans

4 November
Research Coordination,
London

5 - 6 November
Building Acoustics Group: Autumn Conference, Sound-bite,
The Oxford Hotel, Oxford

6 November
Membership Committee,
St Albans

7 - 9 November
Electroacoustics Group: Reproduced Sound 19,
The Oxford Hotel, Oxford

18 November
CCENM Examiners and Committee,
St Albans

Spring Conference

IPPC, PA(N)D, NCE, NVH

Village Hotel, Coventry,
15-16 May 2003

The Noise and Vibration Engineering Group (formerly the Industrial Noise Group) of the Institute of Acoustics is holding its inaugural meeting in Coventry on 15 and 16 May 2003.

The meeting will review the implications of new legislation for Integrated Pollution Prevention and Control – IPPC – and the Physical Agents (Noise) Directive – PA(N)D– as well as providing a forum for new topics in noise control engineering – NCE – and Noise Vibration and Harshness – NVH.

Several people involved in the implementation of the new legislation have agreed to present papers. Others will discuss noise in the workplace and environmental noise prediction, as well as the prediction and control of noise in industrial and automotive applications. The Institute's Rayleigh Medal will be presented at this meeting to Prof Dr Ing Hugo Fastl, who will give a lecture on the subject of Sound Quality.

For further details contact the Institute office on 01727 848195 or e-mail ioa@ioa.org.uk

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Hann Tucker Associates

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