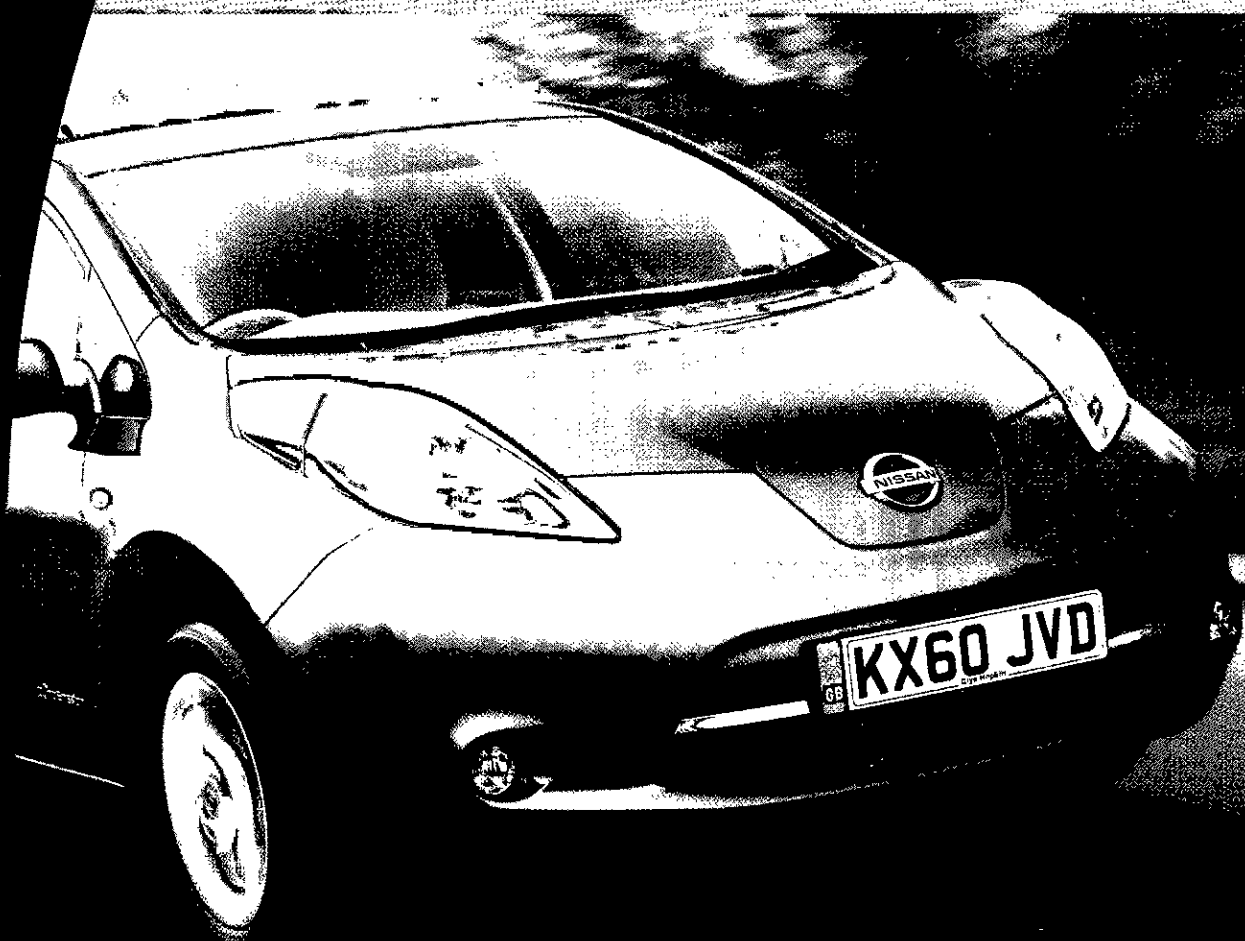


Vol 36 No 6 NOVEMBER/DECEMBER 2011

ACOUSTICS

BULLETIN



In this issue... Preparing for the roar
of electric vehicles

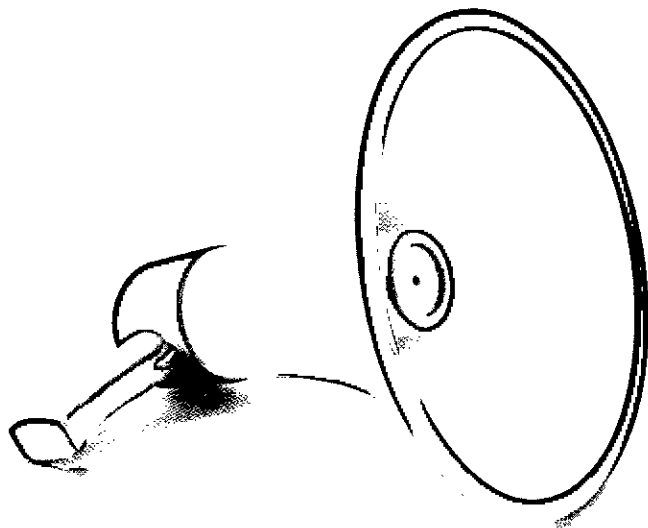
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Investigation of wind turbine amplitude modulation methodology

IOA consultation response to a sustainable framework for UK aviation

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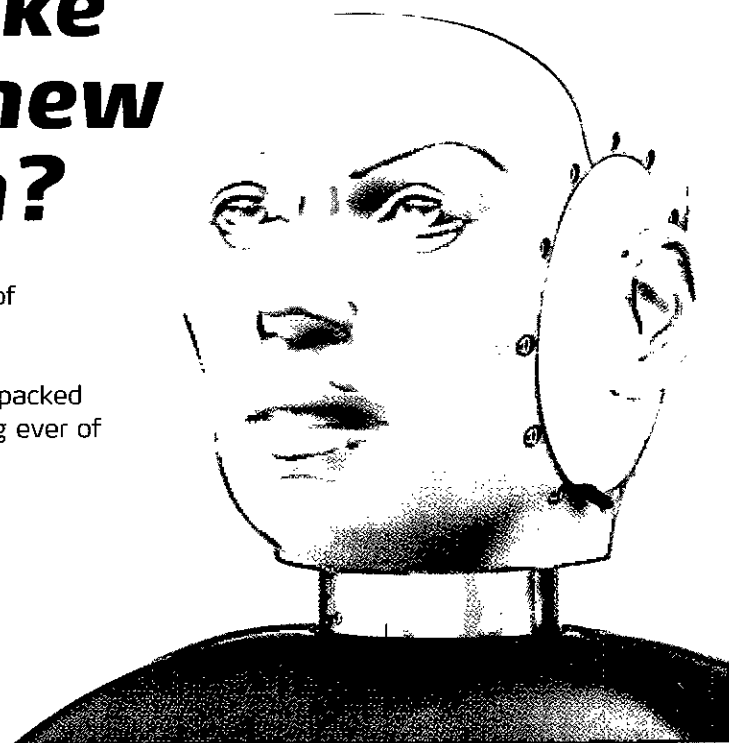
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Published and produced by:

The Institute of Acoustics,
77A St Peter's Street, St Albans,
Hertfordshire, AL1 3BN
tel: 01727 848195
fax: 01727 850553
e-mail: ioa@ioa.org.uk
web site: www.ioa.org.uk

Designed and printed by:

Point One (UK) Ltd.,
Stonehills House, Stonehills,
Welwyn Garden City, Herts, AL8 6NH
e-mail: talk2us@point-one.co.uk
web site: www.point-one.co.uk

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Annual subscription (6 issues) £120.00
Single copy £20.00

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ACOUSTICS

BULLETIN

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Front cover photograph: In this 'green' issue Eoin King looks at the use of artificial sounds for electric vehicles and how they might improve pedestrian safety. Of course, electric vehicles still have a significant carbon footprint unless the electricity is from renewable sources: noise from wind turbines is a current(!) hot potato which shows no sign of cooling down. Jeremy Bass looks at the problem of excessive amplitude modulation and asks if one detection method often postulated is fit for purpose, and Dani Fiumicelli considers noise-dose response in connection with wind farm noise in a literature review of recent European work.

The Institute of Acoustics is the UK's professional body for those working in acoustics, noise and vibration. It was formed in 1974 from the amalgamation of the Acoustics Group of the Institute of Physics and the British Acoustical Society.

The Institute of Acoustics is a nominated body of the Engineering Council, offering registration at Chartered and Incorporated Engineer levels.

The Institute has over 3000 members working in a diverse range of research, educational, governmental and industrial organisations. This multidisciplinary culture provides a productive environment for cross-fertilisation of ideas and initiatives. The range of interests of members within the world of acoustics is equally wide, embracing such aspects as aerodynamics, architectural acoustics, building acoustics, electroacoustics, engineering dynamics, noise and vibration, hearing, speech, physical acoustics, underwater acoustics, together with a variety of environmental aspects. The Institute is a Registered Charity no. 267026.

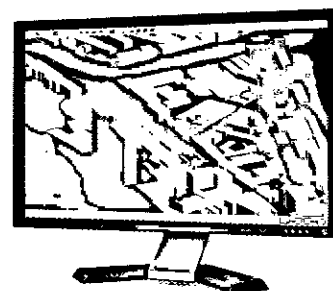
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Dear Members

After the conference dinner at Acoustics 2011 in Glasgow, I was chatting to two eminent members about the Institute's finances. I was amazed to find out that using a mobile phone app, it was possible from the hotel dining room to find out how much money the Institute had in the bank as declared in the last set of annual accounts (£657,183, since you ask). The questions I was being asked were: Why do we have so much money in the bank? And why has it doubled in the last five or six years? Adapting an old formula which has stood the test of time, that if two people ask a question there must be another 200 curious about the answer, here is the response for the more-or-less 10% of members who want to know.

As the Institute is a charity, the Charities Commission is often a useful source of information including guidance on prudent financial management. The commission did a large review of reserves held by thousands of charities and produced guidelines which can be found at <http://tinyurl.com/67dqm67>. Although the Commission does not publicly prescribe specific amounts, along the lines of 'a charity should hold x times its annual turnover in reserves', the Commission did write to the Institute at the start of the recession in 2008 to recommend the reserves be reviewed and possibly increased. To put our 2010 declared reserves (£677,932) in context, our total resources expended in the same year amounted to £785,709. This size of reserves is not unusual for a charity (see the table on <http://tinyurl.com/63thogo>), although there is a considerable variation.

We are seeing the usefulness of having healthy reserves during the recession. Currently, we are projecting a moderate loss for this financial year, and one reason to have reserves is to call upon them during difficult times. To take one budget line, some conferences which would have been expected to break even in the past are now making a loss. Having reserves means we can continue to run these meetings and conferences, which are, after all, a vital service to you, our members. Of course the Institute is also analysing the reasons for the losses and using that understanding to improve future budgeting.

But it was not all financial discussions at Acoustics 2011. As I mentioned in my last letter, the conference in Glasgow included a visit to the Hamilton Mausoleum, famed for its long echo which used to be in the Guinness Book of Records. It was indeed impressive, but the mid-frequency reverberation time of 1.1 second is probably not very different from many large cathedrals and certainly not the longest reverberation time in the world. I sloped off from the conference one afternoon and crossed Scotland to visit a disused underground water reservoir near Dundee. It used to hold one million gallons of water and is now an unused space underneath the back garden of someone's house. I was travelling light so measurements were done with balloon bursts. At 500Hz the reverberation time was 17s. Sounds like an ideal space to set up a Free School!

If you know of a more reverberant space, I'd be interested to know: president@ioa.org.uk or @ioa_president.



Trevor Cox

PRESIDENT



Conference report

Sue Dowson. Measurement and instrumentation group session at Acoustics 2011

The Acoustics 2011 session organised by the Measurement and instrumentation group was held on Wednesday afternoon, 14 September 2011, and was chaired by Ian Campbell. It consisted of five papers, all of which were very relevant to the title of the conference.

The session opened with a paper on *'Managed services for construction site noise and vibration'* by **Douglas Manvell** and **Phil Stollery** of Brüel and Kjær. It is well known that construction activities can be subject to operational restrictions, often due to local community concerns. Douglas explained how new technology (eg global positional systems, modern communication technologies, professional databases, cloud computing, GIS and aerial photography) has made it possible to develop an alternative, innovative approach to measurement. This approach together with the ability to supply information on a regular basis to local authorities and communities can alleviate some of those concerns, and so be beneficial to all parties. The approach relies on an active monitoring programme integrating both noise and vibration, using web-based systems to supply real time data to the client, with readily available reports. Douglas explained the advantages of this more holistic approach, allowing the constructor to interface better with the public in terms of activity, and also proactively to provide early mitigation of both noise and vibration, and so avoid penalty fines. He also examined the new skills required by suppliers: noise management system design, modern communications techniques, knowledge of IT infrastructure (supplier and customer), where it is essential to bear in mind the continuous updates of operating systems and embedded software to ensure smooth, continuous operation. Douglas also talked about financial implications, where systems such as the Brüel and Kjær 'Construction Sentinel', lend themselves to 'managed services' with a subscription-based format. In the current times he felt organisations were now routinely using 'Asset managed' services for noise measurement, where a monthly fee guaranteed access to operational facilities. The client specifies the information it wishes to receive and the supplier provides the hardware, the deployment, calibration and maintenance to meet these client specifications, so removing upfront capital expenditure for the client in these austere times.

A research paper from **Richard Barham** and **Dan Simmons** of the National Physical Laboratory followed, on 'MEMS microphone based measuring instruments and their role in innovative and cost-effective measurement solutions'. Richard explained that MEMS is an acronym for micro-electrical-mechanical-systems, with the ability to fabricate devices in silicon now spreading to many different applications. One of these is production of microphones, where it represents the first new microphone technology since the introduction of piezo devices in the 1960s. Miniaturisation has been vital for use in hearing aids and the advent of uses in mobile phones has aided rapid development. MEMS microphones have two key advantages: low cost (up to about £4 each) and small form factor. NPL saw a role for these microphones in measurement, an area that no manufacturer of these devices seemed to be considering. Richard outlined a recent collaborative TSB project (called DREAMSys) where a distributed array of MEMS sensors had been used for remote environmental noise monitoring in support of the European Noise Directive. Proof of concept was demonstrated by the completion of various field trials, which resulted in the production of real time noise maps superimposed on Google Maps. One, near London City Airport, demonstrated the advantage of continuous non-attended monitoring, with data available for the few days when the airport was closed due to the volcanic ash cloud. The MEMS system results showed good agreement with a conventional Class 1 sound level meter, excellent stability — in many cases better than the 0.1 dB resolution — and robustness to a variety of environmental conditions. Areas for improvement of the system were also identified: these include production of a MEMS microphone meeting the relevant Class 1 requirements of IEC 61672 Sound level meters, improved power supplies and telemetry, packaging and mounting for unobtrusive installation, and requirements for indoor operation, and NPL is now

investigating these. Richard concluded that this new affordable technology has the potential to revolutionise noise measurement in terms of cost via the new microphones and reduction in personnel time required, and it also opens up the possibilities for applications not previously considered owing to the expense of the instrumentation. Such applications vary from pubs and clubs through schools and hospitals, industrial and commercial premises monitoring, to soundscapes and personal dose meters.

Next **Gary Duffy** of Enfonc Ltd gave an interesting presentation 'The music plays on - innovative concert noise monitoring using modern instrumentation to improve efficiency'. With the increasing number of outdoor venues, this paper continued the theme of the benefits of using modern technology, this time to implement noise monitoring at such arenas. Gary cited some examples from Ireland of fines of up to 50,000 euro for noise exceedances, so there is a strong desire by promoters and artists alike to avoid such situations. Conventionally, noise monitoring around concert venues is undertaken by individuals monitoring about every 15 minutes at specific locations. When an agreed level is exceeded these individuals contact the sound engineer usually at the mixer desk, by text message, phone or email. This all takes valuable time, assumes the message will get through, and is inefficient and inconvenient, and hence frustrating for the EHO, promoter, sound engineer etc. The new capability described by Gary is a commercially available real-time system providing continuous displays of remote noise levels direct to the sound engineer. This allows an instant reduction in levels as soon as an exceedance is observed, resulting in avoidance of the costly fines and reducing the need to interface with the local authority. The system is based on a commercially available sound level meter, typically housed in an enclosure with sufficient battery power to cover the typical two to three days of monitoring required for such events. The meter is connected through a router and transmits either via a 3G fixed IP address or dedicated wireless network, and in some cases the latter is made a condition of the licence. The monitoring also includes audio so allowing off-line interrogation of particular events, for example those that are nothing to do with the concert. Gary gave examples of successful use at Croke Park, the Aviva Stadium, and at an Oxygene concert, where the equipment was also used to monitor overnight noise on the associated camp site!

Simon Bull and **Chris Gilbert** (Castle Group) then provided an entertaining and instructive talk on the austerity theme by considering 'What you can get away with for 90% of the time!'. Modern sound level meters are capable of measuring many parameters simultaneously, whilst sending the data to a web site or mobile phone. However, Simon explained that there is a cut-off, even with modern technology, where a leap is required in the processing and power required if frequency measurement or multiple statistical parameters are to be incorporated into a sound level meter, and this increases the cost. He therefore set out to investigate the basic requirements for environmental noise measurements in terms of features and parameters sound level meter users actually require in order to meet the majority of their needs. Simon and Chris undertook a review of standards, guidelines and regulations that specifically relate to the environment and how noise affects the public. Areas covered were: British Standards, WHO guidelines, town and country planning Acts, environmental Acts of Parliament, Noise and Statutory Nuisance Act, Noise Insulation Regulations, IPPC and Control guidance, EU Noise Directives, and entertainment licensing and guidance. For each of these documents they noted the key parameters required, and then analysed the results in order of simplicity. They devised a weighting system with three categories — weighting '1' when a document is rarely used, '2' for a moderately-used document and '3' for one that is heavily used. The results showed that for the weighted percentages the parameters occurring most often, in order of importance, were LAeq, LAMax and LA90, which covered 85% of the tasks. Without the weighting very

similar results were obtained. If LA10 was included in the weighted values, 88% of tasks were covered. Simon also took the opportunity to explain the key components in the design and construction of a sound level meter with a good animation of how percentile levels are calculated. Other citations, which add to the cost of a sound level meter, were third-octave and octave band filtering. Simon concluded that although there was a place for complex monitoring and instrumentation, in many cases a relatively simple system would be adequate depending on the documents being followed.

The final presentation of the session was from **Christian Freneat** and **Christine Aujard** of 01dB Metravib, and **Steve Thomas** of Acoustic1 on 'Innovative techniques for sound measurement based on a new concept: Smart Monitor DUO'. Christian also spoke about the benefits of real-time remote monitoring systems, such as the DUO, and the advantages to urban planners, industrial decision makers and construction site managers, as well as to the local residents. The system can use wi-fi for short range use and 3G modem for access anywhere in the world, incorporates GPS, and the operator has full control of all the units. He also cited audio files, in-built self-check and the ability to identify and then exclude interference signals not representative of the

local noise situation (such as a dog barking) as further advantages. He provided three case studies: first, a multi-source location with complaints from a food storage warehouse, where use of two smart noise monitors with GPS allowed accurate time stamping of data and identification of the noise sources. Second, he discussed a stadium where monitoring was performed not only during construction, but also using a permanent noise monitoring system. Live data — LAeq, sliding LAeq (including historical data), and 'dose' — were produced on a web site and exceedance could trigger a text message or email, so allowing rapid control of noise from PA systems and from concerts. Thirdly, the renovation of a TV channel headquarters was reviewed. Here Christian explained the dedicated web site, and an easy-to-understand 'hebdogram', with different levels in terms of 'quiet' to 'loudest' represented by different colours to show the time history, making it suitable for presentation to the general public. Real-time data allows the construction company to take early mitigating action if required, to update their schedule and keep the public informed on an ongoing basis. The DUO system provides capital and financial flexibility, with the user having a choice of direct purchase or subscription services, covering both noise and vibration.

IOA Consultation Response

Department for Transport's paper on developing a sustainable framework from UK aviation, Scoping Document, March 2011

Wednesday 19 October 2011

Background

The Institute of Acoustics represents professionals involved in the management of environmental noise across the UK. Whilst some of our members will be responding to this consultation in their own professional and local capacity, this response represents the Institute's views. It has been prepared by discussion amongst our members on the Scoping Documents and in particular the questions on local impacts outlined in paragraphs 5.40 to 5.48.

General

The IOA acknowledges existing government policies that aim to support the sustainable growth of the UK aviation sector and supports the view that in pursuing such policies it is necessary to strike a balance between economic, social and environmental factors. Nevertheless, it is our opinion that there should be a presumption not to expand airports that are in the most densely populated areas in order to manage the strategic health impact of aviation noise when meeting future demand. In addition we feel that greater attention should be paid to protecting the special acoustic environment of tranquil areas when developing future aviation policy. In our view, such policies would meet the wider aims contained in the government's Noise Policy Statement for England. One possible way forward may be in the provision of improved and more transparent information on aviation noise impacts for local people in order to improve community engagement and local relations.

Question 5.40

What do you consider to be the most significant impacts – positive and negative – of aviation for local communities? Can more be done to enhance and/or mitigate those impacts? If so, what and by whom?

The main impact on local communities is a reduced quality of life through speech interference, annoyance, enjoyment of outdoor spaces, sleep disturbance particularly in the early mornings. Unless the air traffic is severely reduced, the extent of the perceived impacts on quality of life cannot really be reduced. However, by increasing the trust and communication between the communities and stakeholder, this may help to reduce perceived impacts on quality of life for those who are not very severely affected.

Question 5.41

Do you think that current arrangements for local engagement on aviation issues, eg through airport consultative committees and the development of airport master plans, are effective? Could more be done to improve community engagement on issues such as noise and air quality? If so, what and by whom?

Local engagement on aviation issues can always be improved, but it may be better to focus efforts more on improving the way in which the actual information is presented ie in a format which is more easily understandable for the locals. Recent research work this year again has suggested that the aviation industry produces information that is often viewed as misleading and underhand. Improving the transparency of information and in particular providing better basic information on air traffic movements (when and where the aircraft fly) could help to improve community relations and the success of local engagement.

Question 5.42

Do you think that current arrangements for ensuring sustainable access to and from airports, eg Airport Transport Forums and airport surface access strategies, are effective? Could more be done to improve surface access and reduce its environmental impacts? If so, what and by whom?

No response

Question 5.43

What are your views on the idea of setting a 'noise envelope' within which aviation growth would be possible, as technology and operations reduce noise impacts per plane? What do you consider to be the advantages and disadvantages of such an approach?

Details of this suggested 'noise envelope' are not really provided. If this is about providing noise contours in a given measure such as Leq, Lmax (energy based) and setting a noise envelope limit based on restricting the size, or area, population within etc, then there are many

continued on page 8

IOA Consultation Response - continued from page 7

drawbacks including which measure is used, how to deal with time averaging (a 16-hour Leq for instance does not reflect an individual's exposure with short term noise variations), weekday and weekend variations, and how such an energy based measure reliably predicts the actual degree of adverse response etc. However, if such an approach were adopted then any 'envelope' would also have to take into account number of individual events (above a given Lmax). However, by using a contour on a map as an envelope – the age-old problem arises of drawing a line and implying that those on the outside of the line (envelope) are not affected and also means that the noise outside the contour is not as effectively controlled.

Question 5.44

Is it better to minimise the total number of people affected by aircraft noise (eg through noise preferential routes) or to share the burden more evenly (eg through wider path dispersion) so that a greater number of people are affected by noise less frequently?

Obviously if you ask the locals, it will be dependent on where you live, there will always be winners and losers. What may be important in the short term is the change in exposure when such a change is made. Wider dispersion will mean that noise will affect communities who previously have not been affected significantly and a new noise can give rise to more adverse response (although this will decrease as the residents habituate over time). Consideration would need to be taken of how to deal with tranquil areas – should these be protected or would wider dispersion ruin these areas? Recent research has shown that when predicting an adverse response more importance should be placed on numbers of events (not just the noise level energy). This needs to be taken into account. What is also important is to consider the number of people exposed to a number of events above a certain noise level. It may therefore follow that one should minimise the total number of people affected by aircraft noise (above a given level) and provide noise insulation measures and compensation for loss of amenity.

Question 5.45

What is the best way to encourage aircraft manufacturers and airlines to continue to strive to achieve further reductions in noise and air pollutant emissions (notably particulate matter and NOx) through the implementation of new technology?

The aircraft manufacturers and airlines are already striving to achieve this anyway and do not really need encouraging. However, without a step change in technology advancement, any really large or significant reduction in noise emissions is unlikely.

IOA attends PLASA

The interface between pro-sound and acoustics

The IOA had a stand again at this year's PLASA exhibition at Earl's Court between 11 and 15 September. Here, Kevin Macan-Lind extols the virtues of attending the Reproduced Sound conference to a Mr William Wilson.

Other members of the team 'manning' the stand included Nezi Yusuf, Hazel Traynor, Hansa Parmar and Sue Omasta.

Question 5.46

What are the economic benefits of night flights? How should the economic benefits be assessed against social and environmental costs?

There have been many claims for the economic benefits of night flights including: development of UK tourism, increased local employment, industrial and logistical investments, increased distribution of products into the UK market, promotion of London as a 24-hour business area and a central economic player, express parcel delivery, efficient UK production processes, etc. It is not yet clear how to weigh these economic benefits which are more widespread across the UK against the more local social costs – do the needs of the 'many' outweigh the needs of the 'few'? A study is required.

Question 5.47

How can the night flying regime be improved to deliver better outcomes for residents living close to airports and other stakeholders, including businesses that use night flights?

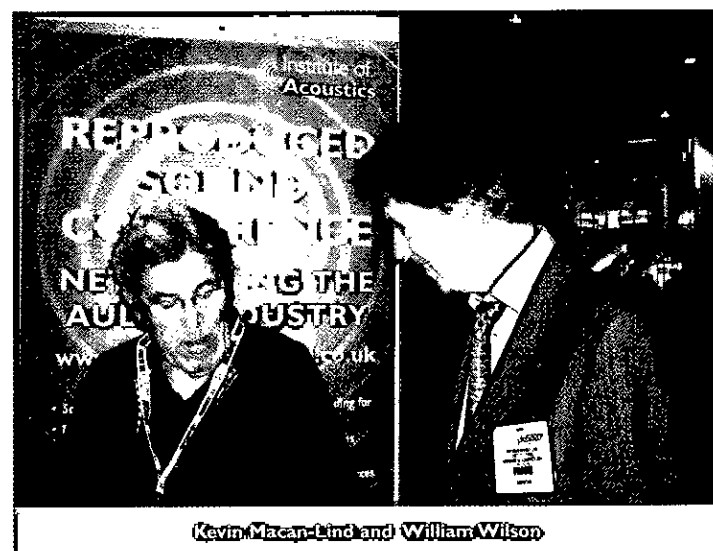
One of the main issues at Heathrow is the many early morning arrivals, and perhaps consideration should be given to how the impact of these can be reduced (restricting further, dispersing the arrivals throughout the night?). Many researchers have argued that the main problem of night noise is a delay in the onset of sleep, and premature awakening in the early morning and therefore consideration should be given to minimising activities in these periods.

Question 5.48

Should extended periods of respite from night noise be considered, even if this resulted in increased frequency of flights before or after those respite periods?

Many researchers have argued that the main problem of night noise is a delay in the onset of sleep, and premature awakening in the early morning and therefore being awoken (once asleep) during the night is relatively not such a big issue. If this holds, then the suggestion above would serve to increase the adverse response not reduce it. Also the impacts on those who do not sleep during the 'normal' sleeping hours, such as shift workers, very young children and the elderly need to be considered.

In addition, airport development needs to consider the potential wider noise impacts due to increased activity of other forms of transportation servicing the airport such as from roads and rail traffic.

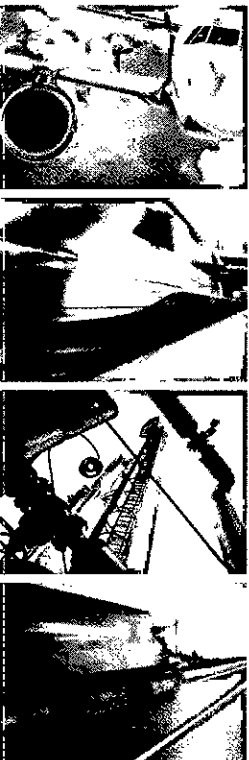


Kevin Macan-Lind and William Wilson



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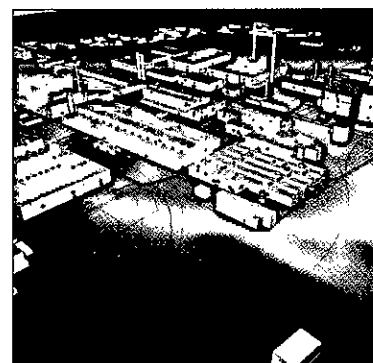
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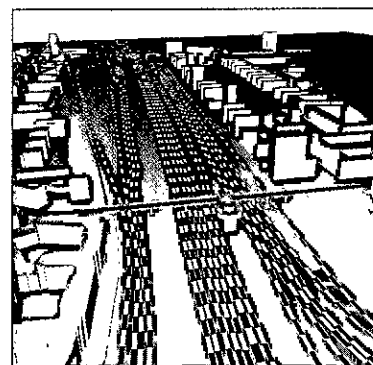
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Visit report

Richard Tyler. Visit to the Hamilton Mausoleum

During the Acoustics 2011 Conference a visit was organised by the Measurement and instrumentation group to the Hamilton Mausoleum, which is famed for having one of the longest 'echoes' of any building in the UK.

Standing over 37m (120 feet) high, the mausoleum was built by the tenth Duke of Hamilton as a resting place for him and his family. Most were interred in the crypt, but the central area has a large plinth on which originally was placed a sarcophagus containing the Duke himself. The building was started in 1842, but was not completed until 1858. Unfortunately, the tenth Duke passed away in 1853, and for the last five years workmen had to complete the mausoleum with his sarcophagus in situ on its plinth. Following coalmining activities in the area underneath the mausoleum the ground became unstable, so the family remains including those of the Duke were moved to a nearby cemetery, and the building itself now stands 6m lower than when it was originally constructed. However, the quality of its construction was such that it has survived this downward move intact.

As befits the Measurement and instrumentation group, equipment was set up inside the mausoleum — with the original plinth now making an excellent resting place for electronic instrumentation — to measure exactly how long the true reverberation time really is. The standard demonstration of the 'echo' is to slam the entrance door shut, then stand back and listen how long the decay lasts: the local guide had an interesting variation on this which involved whirling a hollow tube around, whereon the speed of movement excited different harmonically-related tones that echoed chords around the building. More objectively, using pink noise and bursting balloons, the RT60 was measured at about 23 seconds at 50Hz, with over 10 seconds at 1kHz, so these were indeed very significant figures.

Following the visit, Prof Bob Craik gave a short workshop on the art of measuring reverberation time, and concentrated on the difficulties of measuring very short values, where equipment limitations present challenges not encountered when measuring the mausoleum's reverberation time. Both the visit and the workshop were very interesting and greatly enjoyed by all present.



Objective measurements of reverberation time



Trevor Cox demonstrates an intrinsically safe impulsive noise source



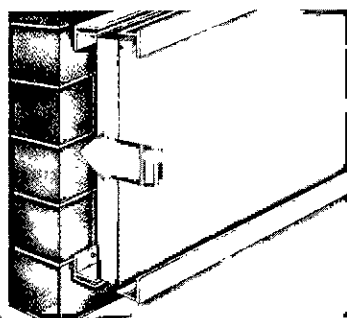
Conference delegates arrive at the Hamilton Mausoleum



It certainly takes a long time to come down again...

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Meeting report

Richard Cowell. Inter-disciplinary collaboration on the natural ventilation of school classrooms

A joint CIBSE/UCL one-day seminar was held on 4 October 2011.

In schools design we have become very familiar with the conflicts between natural ventilation and good acoustics. Over the last decade, we have also stretched our skills to deal with many naturally ventilated school buildings, with BB93 to hand. At this UCL/CIBSE meeting, one could be forgiven for believing that our achievements have 'attenuated' the original worries of building services engineers when tackling natural ventilation for classrooms. On a couple of occasions during the day, the acoustical issues were portrayed as not so very difficult, although our voices were raised to remind our CIBSE colleagues of some of the challenges. In reality, it is the competition from a wide range of other challenges to building services engineers that is more likely to have brought this about. It is useful sometimes to drop the acoustics focus and learn of the non-acoustic challenges that our colleagues in CIBSE perceive in design for natural ventilation, many of which will be familiar.

Some headlines from the seminar

Dr Mike Entwistle (Buro Happold) painted the current scene, noted the tightening of budgets for school buildings (£1100 to £1500 per m²) and the £40m maintenance backlog, and warned against designs becoming too complicated. There are good lessons from history. As an example of simplicity, he suggested that a little extra performance can be achieved with simple recirculating ceiling fans in some cases. Stronger engagement of end-users was needed.

Prof Derek Clements-Croome (Reading University) ran through the real value to education of the quality of natural ventilation, and referred to physiological evidence to support better learning with better controlled air changes, and particularly CO₂ reduction.

Prof Martin Liddament reviewed the development of relevant and partially overlapping standards, some of them being in mutual conflict, but said they were full of good design advice. He made the case for natural ventilation as a common-sense choice over mechanical ventilation.

Roderick Bunn (BSRIA) provided a damning critique of the performance of those delivering natural ventilation in classrooms, and called for a look at the real world and the appalling track record. Briefs for design were not engaging end-users. Procurement contracts are entirely inappropriate with disconnected and second-guessed designers, and systems are unduly complicated. Often the job is not finished, with users having no idea how to use unlabelled controls, and remaining ignorant of when windows should be opened! He asked how

such an appalling situation had been allowed to develop.

John Palmer (AECOM) reviewed a range of natural ventilation strategies for classrooms in practice, the relative benefits of different window configurations and air flow patterns, and put these in context.

Dr Ben Jones (UCL, recently Monodraught, who were co-sponsors) provided measured data on performance of windcatchers, demonstrating the impact on air changes and CO₂ for different seasons, with varying wind direction and speed, and demonstrating substantial improvements in natural ventilation. Some acoustical performance data (attenuation through the windcatchers) were also presented.

Dr Malcolm Cook (Loughborough University) described the calibration and use of modelling techniques for natural ventilation and suggested a satisfactory development of confidence that designs will meet regulations, using models as one of the design tools. The relative merits of CFD and dynamic thermal simulation were discussed. Corrections to allow for the effects of thermal mass were also to be included.

Nick Huddleston (SE Controls, co-sponsors) described a range of detailed issues arising in the mechanisms for opening and closing windows, in particular the weight of the large windows often preferred by architects, which demonstrated a frequent mismatch between architectural intent and the dimensions of available drive units.

Carl Sutterby (Windowmaster, co-sponsor) focused on the difficulties that arose when controls for natural ventilation were not considered properly at the outset. He was clear about the importance of clear labelling of controls, and the thorough briefing of end-users.

As a summary of the day, I felt the shared disappointment that exists in the outcomes at many of the new schools, and the huge scope for improvement. A great deal of the scope for improvement is not dependent on technical knowledge (much of which is well-trodden ground) but rather on patterns of procurement, better inter-disciplinary working (one of the reasons we were there!), proper guidance of users, and keeping it simple!

It was good to have spotted four members of the IOA in the meeting - perhaps there were more. I should add that an article by my colleague on the CIBSE schools design group, Mike Wood (research associate for energy and the environment, University of Exeter) was included in the CIBSE publication handed to attendees. The article was 'Considering the future of acoustics in education' in the CIBSE schools design group publication Engineering sustainable schools which will be loaded on to www.cibse-sdg.org.

IOA Consultation Response

Draft National Planning Policy Framework

Overview

The IOA is the leading professional body in the United Kingdom concerned with acoustics, noise and vibration and is active in research, educational, environmental and industrial organisations. The Institute is a nominated body of the Engineering Council, a member of the International Institute of Noise Control Engineering and the International Commission on Acoustics and a founding member of the European Acoustics Association. Members of the IOA are active in the development of UK, European and International Standards.

The IOA also gives support to the development of legislation and policy in the various disciplines in the field of acoustics and its response to the consultation document is based on this role. The IOA, however, represents a wide range of members and disciplines in acoustics and

the comments presented here are the consensus view of the committee of our Environmental Noise Group, which is formed by members who specialise in environmental noise issues as acoustic consultants, local authority officers and academics.

The IOA response replies to only Question 1 of the list of consultation questions. Our response to Question 1 is given below, followed by our other comments.

1. Presumption in favour of sustainable development (Question 1)

Para 14. IOA members understand the effects noise can have on people, and we consider that noise can affect whether or not a proposal is sustainable for the future health and wellbeing of an

affected population. As such, we consider the framework should more clearly define 'sustainable development' if it is to promote a policy that moves away from a balanced assessment of all planning matters to a presumption in favour of 'sustainable development'. It would help if there was guidance on how positive and negative effects of noise associated with a development proposal can be weighed against other impacts and the overall benefits of the scheme.

2. The need for technical guidance

We understand the policy is to remove PPG24 Planning and Noise, 1994. Although some aspects of this PPG are out of date, and it has areas that can be improved upon, IOA members and many others use PPG24 extensively as both policy and technical guidance. We feel there is a need for technical guidance on noise assessment and if the removal of PPG24 left a gap in such guidance this could lead to bad practice, and incorrect and inconsistent planning decisions for noisy or noise sensitive development.

3. Glossary

The meaning given to 'pollution' should include noise.

4. Paragraph 173

The first two bullet points reflect the first two aims of the Noise Policy Statement for England (NPSE). The third bullet point reads:

- identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.

We welcome the reference to protecting such areas, but feel that the overall requirement for development to be sustainable renders the qualifying need for them to be 'prized for...' redundant and that it should be omitted for the benefit of present and future generations who may use them.

The third aim of the NPSE is as follows:

- where possible, contribute to the improvement of health and quality of life.

The Noise Policy Statement for England (NPSE) requires improvements to be made where possible to help offset the inevitable negative impacts elsewhere in order to help make development overall more sustainable. This aim should be added to the National Planning Policy Framework to help make it consistent with the NPSE.

From the Editor

Ian F Bennett CEng MIOA

As some of you may already know, this will be the last issue of Acoustics Bulletin edited by yours truly. A seemingly ever-increasing pressure of work has meant that in recent months it has been more and more difficult to find the time to edit the many contributions I am offered, and meet the tight production deadlines that seem to come around all too often, every eight or nine weeks.

I have very much enjoyed the job of Editor and it is with more than a little regret that I am giving it up. The 'silver lining' is that when my personal copy of the Bulletin flops onto my doormat in January 2012, the content will actually be a surprise – for the first time in 11 years! I offer my heartfelt thanks to all contributors over the years, and I can say with some confidence that I have managed to make many more friends than enemies.

The Editor's chair will be taken over by Charles Ellis at the St Albans office, to whom all correspondence should be addressed in future (charles.ellis@ioa.org.uk). He will be assisted by a small technical committee, so the Bulletin will benefit from the attention of a professional journalist and that of expert acousticians. I wish them every success....

ANC

THE ASSOCIATION OF
NOISE CONSULTANTS

The ANC has represented Acoustics Consultancies since 1973. We now have over one hundred member companies, including several international members, representing over seven hundred individual consultants.

Members of the ANC can also apply to become registered testers in the ANC's verification scheme, recognised by CLG as being equivalent to UKAS accreditation for sound insulation testing.

We are regularly consulted on draft legislation, standards, guidelines and codes of practice; and represented on BSI & ISO committees.

We have Bi-monthly meetings that provide a forum for discussion and debate, both within the meetings and in a more informal social context.

Potential clients can search our website which lists all members, sorted by services offered and location.

Membership of the Association is open to all acoustics consultancy practices able to demonstrate the necessary professional and technical competence is available, that a satisfactory standard of continuity of service and staff is maintained and that there is no significant interest in acoustical products.

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Citation

Andrew Jellyman. Award for distinguished services to the Institute of Acoustics

Andrew joined the Environmental Health department of Birmingham City Council in 1977 after studying electronics. He has now completed 34 years' service for the Council.

During his time at Birmingham he has developed specialised systems for the investigation of noise complaints as well as providing general technical advice within the department and beyond on matters of acoustics. In 1997 he was part of the team that went on to produce what were then probably the largest and most comprehensive noise maps ever produced. He has continued to develop this work that has helped inform various European working groups and contributed to the development of the European Environmental Noise Directive.

Andrew joined the IOA as an Associate Member in 1993 after he successfully completed the IOA Diploma in 1993. He has been a Corporate Member since 2006.

He was invited to join the IOA continuing professional development committee in 2002 by its then chair, Sue Bird. This committee was later absorbed into the Membership committee, of which he remains an active member to this day. Most recently he has become a member of the committee's working party charged with the task of re-launching the Institute's CPD scheme.

Andrew has taken an active role in the Midlands branch of the IOA and was present at the inaugural meeting held in Rugby in the mid-1990s.

He has been a member of the branch committee for some time, helping to run the branch and plan its very active programme of meetings.

For all his hard work in contributing to the running and development of Institute activities the Institute is delighted to award Andrew its award for distinguished services.



Andrew Jellyman is presented with his Award at Acoustics 2011, Glasgow

Citation

Tim Clarke. Award for distinguished services to the Institute of Acoustics

Tim qualified as an Environmental Health Officer in 1975 working initially in Walsall then for the London Borough of Lewisham where he was a regular participant on that authority's weekend noisy party patrol. His interest in noise extended whilst working for the London Borough of Camden's pollution team from 1988, and he successfully completed the IOA's Diploma in acoustics and noise control in 1990 gaining merits in the transportation noise module and in his project. He also passed additional modules of vibration (merit) and measurement and instrumentation in 1991. Tim became an associate member of the IOA in 1990.

Having moved to Bristol's pollution control team in 1991 he further developed his noise interest whilst working as an Environmental Health Officer, then as a Senior EHO, and he became a full member of the Institute in 1993. He was appointed Bristol's pollution control manager in 1996.

In 1997 he was awarded a Master of Science degree in acoustics, vibration and noise control from Heriot-Watt University having successfully completed its distance learning programme. Since being in Bristol he has been an active member of the South-west branch of the IOA, presenting topics at branch meetings ranging from mediation to noise from licensed premises and noise mapping, and has also been a guest speaker at Southern and Midlands branch meetings. He was chairman of the South-west branch from 2000 to 2010.

In 1997 he was nominated for and elected as a committee member of the IOA's Environmental Noise group and has continued to take an active role in that group. During that time he also represented the IOA on the Noise Forum, which besides the IOA brought together other organisations interested in noise and its effects including government departments, noise campaigners, Environmental Protection UK, and the Chartered Institute of Environmental Health. Probably by natural progression, and owing to his age, he should now also be joining the Senior Members' group.

In 1998 he was also asked to join the advisory committee for the Certificate of competency in environmental noise measurement, but in more recent years due to work pressures has not been able to take as active a role on that committee as he would have liked.

Tim continues to lecture on the Institute's Diploma course at the University of the West of England, which he has done for 16 years, organising the Law and administration module (as it was) and the Regulation and assessment of noise module (as it is now) for the university during that time.

For all his hard work in contributing to the running and development of IOA activities the Institute is delighted to award Tim Clarke its Award for distinguished services.



Trevor Cox, President, presents Tim Clarke with his Award for distinguished services to the Institute

IOA Certificates of competence

Examination results

Workplace noise risk assessment: The following candidates were successful in the examination held on 4 March 2011

EEF Sheffield	<i>Stronach R C</i>	Moloney & Associates	Shorcontrol Safety Ltd	<i>McCloskey E</i>
<i>Barlow M</i>	Leeds Metropolitan University	<i>Collins E</i>	<i>Brogan P</i>	<i>McCormick D J</i>
<i>Calnon K J</i>	<i>Donovan V H P</i>	<i>Hartigan A</i>	<i>Byrne A</i>	<i>Moroney J</i>
<i>Pearson R</i>	<i>Fenwick C J</i>	<i>Murray S</i>	<i>Dunphy R</i>	<i>Ni Loideain D</i>
<i>Plumb J R</i>	<i>Rattigan I G</i>	<i>Wilson T</i>	<i>English A</i>	<i>Ryan C P</i>
<i>Roberts D G</i>				

Assessment of hand-arm vibration: The following candidates were successful in the examination held on 15 April 2011

Institute of Naval Medicine	<i>Hale L</i>	<i>St Hellen-Charles S</i>
<i>Bayne A J</i>	<i>Laramy J R</i>	<i>Vaughan K Walbeoffe A</i>
<i>Bristow P K</i>	<i>Meacher A G</i>	
<i>Corby M</i>	<i>Robinson R</i>	

Environmental noise assessment: The following candidates were successful in the examination held on 13 May 2011

Bel Educational Noise Courses	<i>Clarke T R</i>	<i>Dunthorne H</i>	Liverpool University	<i>McSweeney E</i>
<i>Buchan D L</i>	<i>Du Toit L</i>	<i>Holtby C</i>	<i>Allen S</i>	<i>Mills S A</i>
<i>Cunningham L A</i>	<i>Gutierrez Rodriguez G J</i>	<i>Hulland J E A</i>	<i>Anand M</i>	<i>Moran B</i>
<i>Currie S A</i>	<i>Jaggard C</i>	<i>Jephcott M J K</i>	<i>Fakah K</i>	<i>O'Brien S</i>
<i>Ewing R A M</i>	<i>Lakhiani S</i>	<i>Long R</i>	<i>Finlayson D</i>	<i>Sheridan S</i>
<i>Halliday P</i>	<i>Nagula K</i>	<i>Robinson K</i>	<i>Griffiths M</i>	University of the West of England
<i>Herbertson N</i>	<i>Oliver G L</i>	<i>Shahbaz N</i>	<i>Lalljee B</i>	<i>Bennett D P</i>
<i>Keenan C</i>	<i>Spink J</i>	<i>Watson C B</i>	<i>Lewis N</i>	<i>Day T</i>
<i>Keenan C</i>	<i>Stimpson M A</i>	<i>Yelland P</i>	<i>Smith M G</i>	<i>German K</i>
<i>Kelly P</i>	<i>Sutton D P</i>	Leeds Metropolitan University	<i>Tong J J A</i>	<i>Jane T M</i>
<i>Lieberman S P</i>	<i>Vincent T I</i>	<i>Crawforth P D</i>	NESCOT	<i>Jenkins N A</i>
<i>MacGregor L A</i>	<i>Wan Kamaruddin W A</i>	<i>Dawson K L</i>	<i>Amiri A</i>	<i>Maberly-Jones L A</i>
<i>Murdoch R T</i>	<i>Zainudin M</i>	<i>Duffy P</i>	<i>Callen N</i>	<i>Randall M E</i>
<i>Pellow B</i>	University of Derby	<i>Smith A</i>	<i>Wickens G</i>	<i>Tawn G D</i>
<i>Tait M</i>	<i>Bodsworth B</i>	<i>Thomas L N</i>	Shorcontrol Safety Ltd	<i>Thomas R L</i>
<i>Tierney G M</i>	<i>Brown C A</i>	<i>Wood M J</i>	<i>King C</i>	<i>Walker R O</i>
Colchester Institute	<i>Burke S</i>			<i>Williams R</i>
<i>Attwood S A</i>	<i>Byrne A R</i>			

Meet the acoustic challenges of the modern open office



Room Acoustics Software



Keith Attenborough

Citation for the award of an Honorary Fellowship

Keith Attenborough has been a member of the Institute since its inception in 1974, when he was a research assistant in the Acoustics group at Liverpool University.

A couple of years later, Keith moved to the job for which he has been known by many Institute members – the television face of engineering acoustics at the Open University! Keith's career at the Open University developed and he was awarded a personal chair in 1992, specialising in theoretical and experimental studies on linear and nonlinear acoustical characteristics of porous surfaces, acoustical methods for surveying soils, sound propagation through suspensions and emulsions, and outdoor sound propagation.

In 1999, Keith moved to the University of Hull as Professor and Head of the Department of Engineering. His research activities have been supported by numerous Research Council grants and contracts from other Governmental and industrial sponsors, resulting in nineteen PhD theses, nearly 100 papers in refereed journals and over 120 international conference presentations.

Keith has given long service as Editor-in-Chief of Applied Acoustics, Associate Editor of Acta Acustica united with Acta Acustica and Associate Editor of the Journal of the Acoustical Society of America.

For several years Keith has been chief examiner for the Institute of Acoustics' Diploma in acoustics and noise control, and since his



retirement from Hull University he has been education manager for the Institute.

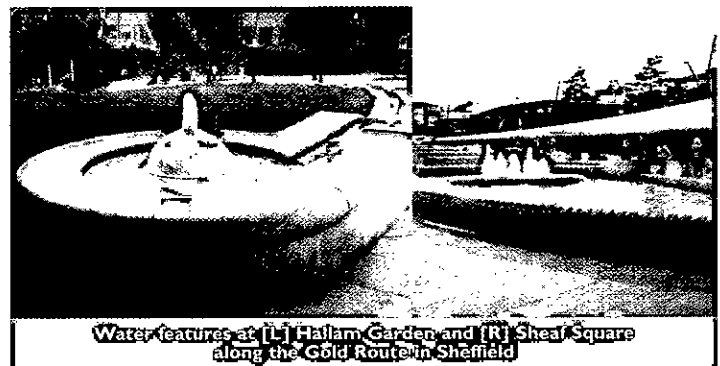
For his sustained contributions to research and to his outstanding contribution to education in acoustics, the Institute of Acoustics is proud to award an Honorary Fellowship to Keith Attenborough.

Meeting report: Midlands branch

Kevin Howell

For the July 2011 branch meeting we travelled further north than is our custom to the University of Sheffield, to hear Professor Jian Kang's presentation on Recent developments in soundscape and case studies on the waterscape and soundscape of Sheffield Gold Route. This was a keynote lecture of the fifth International Symposium on Temporal Design. Professor Kang began by noting that soundscape represents a step change in the field of environmental acoustics as it combines physical, social and psychological approaches. He then presented a review of recent progress in soundscape research and practice and discussed the future challenges. The challenges now are in terms of understanding and exchanging information, collection and documentation of data, harmonising and standardising, creating and designing. He presented some case studies of the waterscape and soundscape of the Sheffield Gold Route. The Gold Route was formed as part of the city centre regeneration and forms a pedestrian route to take people arriving at Sheffield railway station into the city's shopping and business areas via attractive squares and spaces. The case studies included data on the sound spectra, dynamic process and psychoacoustic factors of the features along the Route. A field questionnaire survey had also been carried out. Following the meeting

we were taken on a gentle guided walk along the 'reverse' Gold Route, taking in the sounds of the city and lingering at appropriate points to appreciate the contribution made by the various water features. The walk concluded at the very impressive feature in Sheaf Square adjacent to the railway station. We thank Prof Kang and his colleagues for a most interesting and pleasant evening.



Medals and awards

2011 RWB Stephens Medal

Professor Bridget Shield has been working in the field of acoustics for four decades during which time she has made outstanding contributions to acoustics research and education.

Bridget is a very well-known and highly respected figure globally for her research, especially her more recent work on the effects of noise on children. Working with others, she has provided robust evidence to show how noise affects school children and their ability to learn,

producing six high-quality journal papers as well as delivering invited lecturers at international conferences and symposiums. What is also remarkable is that she has gone on to ensure that this important work does not languish in academic journals, but feeds into the Building Regulations concerning school design. This has partly been done through working as an editor on BB93 but also through presenting her findings to key stakeholders. By actively building on her academic

research to influence regulations through BB93, she has helped improve the design quality of many schools and the learning environment of many pupils.

Because her research into school acoustics has attracted considerable attention in recent times, it is easy to overlook the high-quality work she has carried out in other areas of acoustics. She was asked to appear before the House of Lords Select Committee on the Docklands Light Railway — another example of her research influencing practice. Indeed, health and noise has been a significant strand of Bridget's work. She chaired the organising committee for 19th International Congress on Biological Effects of Noise (ICBEN) earlier this year; was joint author of the Health Protection Agency report on Environmental noise and health published in 2010, and carried out an evaluation of the socio/economic costs of hearing impairment for Hear-It in 2005. Other areas of significant activity include computer modelling of room acoustics (the subject of her PhD), concert hall acoustics, and the

prediction of speech intelligibility.

Alongside this research work, Prof Shield has also been a wonderful and inspiring educator, with many people benefiting from her skills as a teacher and a supervisor to complete MSc and PhD degrees at London South Bank University. Prof Shield has also carried out many public engagement projects to raise awareness of acoustics outside the profession. These include acting as curator for a major exhibition at the South Bank Centre in London on concert hall acoustics, carrying out significant work about women in engineering, and appearing on television and radio.

Bridget Shield is currently President-elect of the Institute of Acoustics. Her presidency will be the culmination of many decades of dedicated work for the IOA including serving on many different committees: Council, Executive, London branch, Education and Publications.

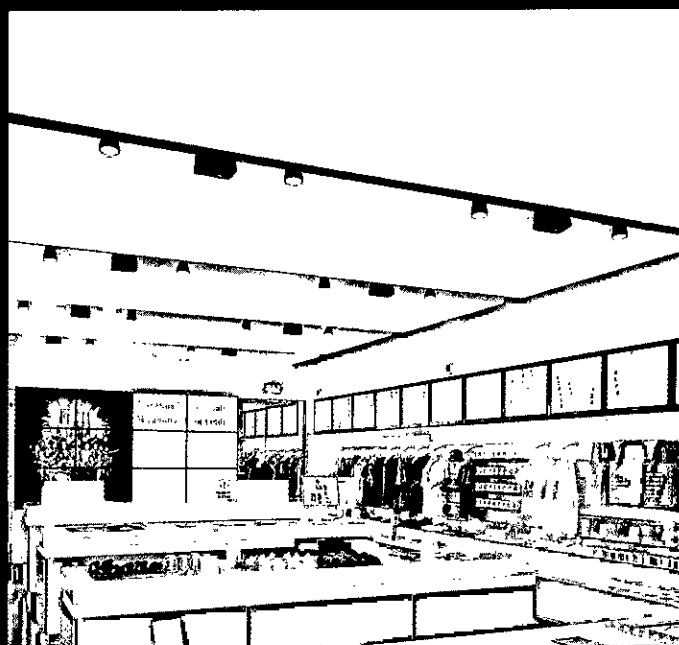
For her outstanding work in both research and education, the Institute is delighted to award the RW B Stephens Medal to Prof Bridget Shield.



Bridget receives the RW B Stephens Medal from Trevor Cox at Acoustics 2011, Glasgow



Bridget delivers her speech



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Investigation of the 'Den Brook' Amplitude Modulation methodology for wind turbine noise

Dr Jeremy Bass

Introduction

An area of significant interest to those in the acoustics community is wind turbine noise and, more specifically, amplitude modulation (AM), which is modulation of the broadband aerodynamic noise emitted by a wind turbine at the blade passing frequency, typically at around 1 Hz. This modulation is also commonly referred to as 'blade swish'.

As it has been suggested that high levels of AM may lead to complaints from wind farm neighbours, it is relevant to consider methods for quantifying amplitude modulation objectively, so that sites with low levels of AM can be distinguished from those with high levels. Quite what is meant by 'high' and 'low' in this context is uncertain and a comprehensive study is currently under way to correct this deficit in our knowledge^{2,3}.

This article focuses on a method which aims to distinguish between 'high' and 'low' levels of AM and which first appeared in the Planning Conditions for the proposed Den Brook wind farm⁴. This methodology is referred to here as the 'AM test method' and is explored using real, measured data to assess its performance.

Background

It has been suggested that the document defining the methodology for controlling the noise impact of UK wind farms, 'The Assessment and Rating of Noise from Wind Farms', generally known as ETSU-R-97¹, is out of date, partly because it has nothing to say about AM.

This is not strictly speaking the case, as demonstrated by the following three quotes from ETSU-R-97.

'The noise levels recommended in this report take into account the character of noise described as blade swish. Given that all turbines exhibit blade swish to a certain extent we feel this is a common-sense approach given the current level of knowledge.'

'This modulation of blade noise may result in a variation of the overall A-weighted noise level by as much as 3dB(A) (peak to trough) when measured close to a wind turbine.'

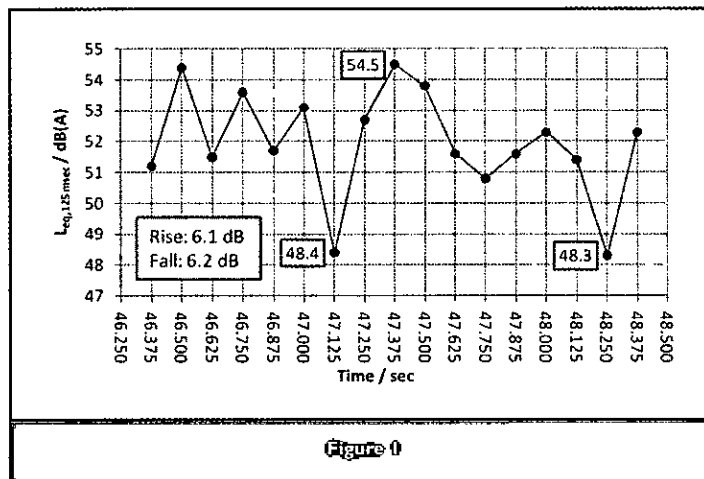
'...it has been found that positions close to reflective surfaces may result in an increase in the modulation depth perceived at a receiver position remote from a site. If there are more than two hard, reflective surfaces, then the increase in modulation depth may be as much as 6dB(A) (peak to trough).'¹

So clearly this noise character, or AM, is acknowledged by, and implicit in, the noise limits which ETSU-R-97 defines. An indicative value, in free-field conditions, of 3dB peak-to-peak is suggested, with higher levels in reverberant conditions, ie where there are reflections.

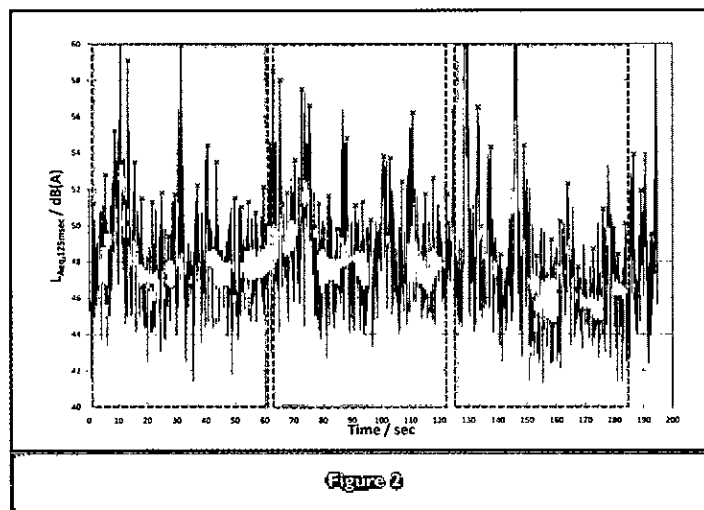
These comments were based on experience at the time (1996) and there is nothing in the text to suggest that it was ever intended that this 3dB value should form the basis of a hard limit - however, it is precisely this limit which is at the core of the AM test method, as we shall see.

The AM test method

The stated aim of the AM test method is to determine whether the noise received at the property of someone living next to a wind farm contains 'greater than expected' amplitude modulation (AM) which, as far as the methodology is concerned, is AM greater than 3dB peak-to-trough in terms of the A-weighted level⁴.



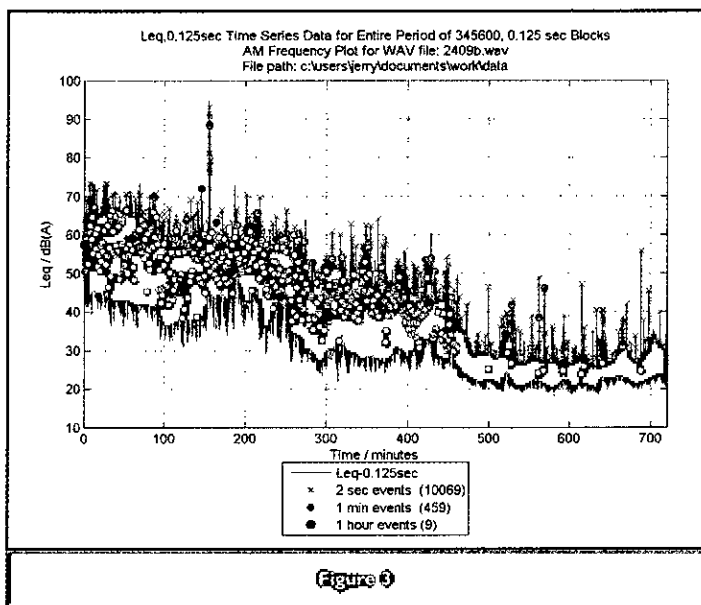
Example of 2 sec Period Meeting Criterion a): 2608a-4



Time series re-scanned in one-minute periods

In outline, the method proceeds as follows:

1. Obtain noise immission data from the wind farm, at the receptor location of interest, as a time series of $L_{Aeq,125msec}$ values.
2. The time series is then scanned to identify two-second periods when there is an increase in the $L_{Aeq,125msec}$ level of more than 3dB(A), and a subsequent fall in level of more than 3dB, as shown in Figure 1.
3. The time series is then re-scanned to identify one-minute periods where there are five or more occurrences of two-second periods containing the appropriate rise and fall in level as defined in step 2. See Figure 2, in which the red crosses denote two-second periods fulfilling the requirements of step 2, and the pale blue boxes identify three such one-minute periods fulfilling the requirements of step 3.
4. A further qualifier is added to this last condition, such that it only applies if the $L_{Aeq,1min}$ level is greater than 28dB.
5. The time series is re-scanned a final time to identify hourly periods where there are six or more occurrences of one-minute periods meeting tests 1 to 4: see Figure 3.



6. The location at which noise measurements should be made is specified as being 1.2m above ground and between 3.5 and 35 metres from the property in question.

Commentary

Based on a straightforward reading of the method, there are a number of difficulties.

- The implication is that the method defined by steps 1 - 6, is the process by which the stated aim of ensuring that 'greater than expected' AM does not occur, can be achieved. It is precisely

this question which this article addresses.

- The method contains a number of arbitrary numbers (ie constants) of which the psycho-acoustical relevance is unclear, although some justification exists. For example:
 - The indicative level of 3dB(A) for AM, taken from ETSU-R-97, here appears as an absolute, hard limit. Can this be justified psycho-acoustically?
 - Why choose five occurrences of 2 seconds within a minute, when clearly any number between 1 and 30 is possible?
 - Why choose six occurrences of 1 minute within an hour, when clearly any number between 1 and 60 is possible?
 - Why is a lower limit of 28dB(A) imposed in step 4?
- Given the complexity of the methods presented in ETSU-R-97 for placing limits on noise immission levels and levels of tonality, the AM test method appears suspiciously simple (although this is not in itself necessarily a problem).
- There are no references to the testing of this method, by the original author or by third parties, nor is the underlying basis of the method explained. Given the significance of the outcome of such tests for wind farm development, and the level of scrutiny such results would receive, this clearly needs to be done.
- The choice of the $L_{Aeq,125msec}$ metric to measure noise immission for AM testing purposes is surprising, given that the L_{eq} is known to be sensitive to the occurrence of short term, high energy events during its measurement. For example, it is interesting to note that in Figure 2 the red crosses almost exclusively occur during such short-term events. It is for this reason and others that ETSU-R-97 itself identifies the L_{90} statistic as a more robust measure for practical noise assessment.
- The 'standard' methodology for assessing noise immission and

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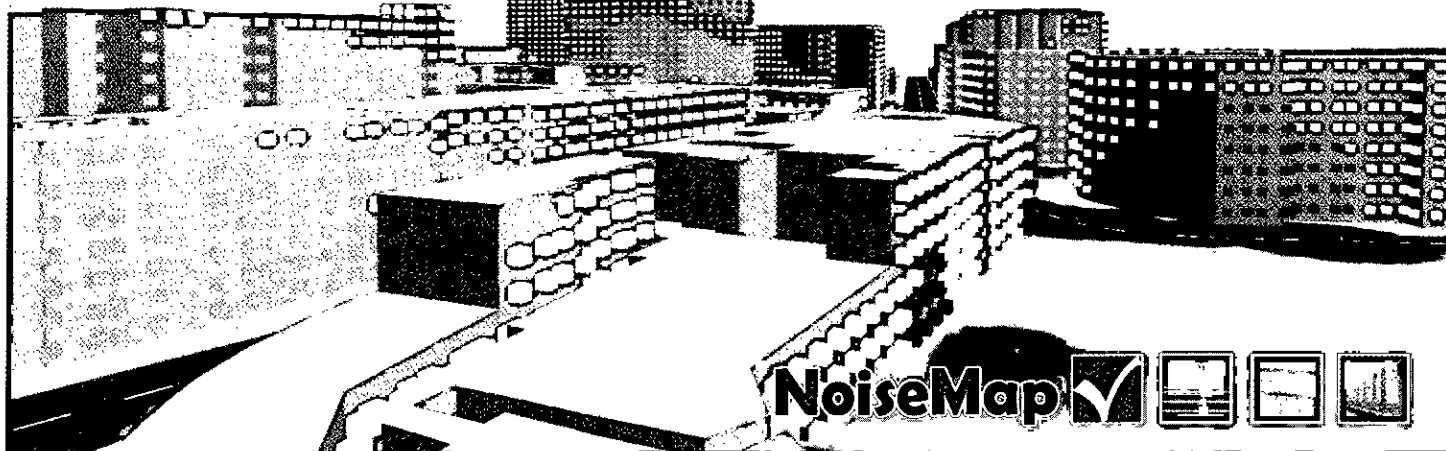
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tonality from a UK wind farm is based on fixed time intervals which can readily be assessed using sound level meters, or computer-based automated methods. This enables large amounts of noise data to be analysed quickly, and maintains synchronism with external source of data, for example wind speed. The AM test method, however, departs from this approach and uses sliding time windows which may or may not align with external sources of data. Whilst this is not necessarily a problem in itself, it may make such external correlation difficult.

- It is not clear from the test whether the five or more two-second periods defined in step 3 are overlapping or non-overlapping. The same question arises for the six or more one-minute periods. This potentially makes a profound difference to the outcome of testing (note that, for the purposes of the testing presented here, non-overlapping periods were assumed throughout).
- Given the sliding nature of the assessment, and the number of scans of the $L_{Aeq,125msec}$ data required, the implementation of the method may prove difficult (as indeed the author found).
- The intention of step 6 is presumably to ensure that measurements are made in free-field conditions, rather than in a reverberant space which may result in higher levels of AM as a result of sound reflections.

Performance with measured data

Irrespective of the comments above, it is instructive to see how the AM test method performs when applied to real, measured data. To do this, the method has been applied to a large body of acoustical data obtained from two rural sites where no wind turbines exist

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Figure 4

Noise measurement setup at Turncole



Figure 5

Noise measurement setup at Rotsea



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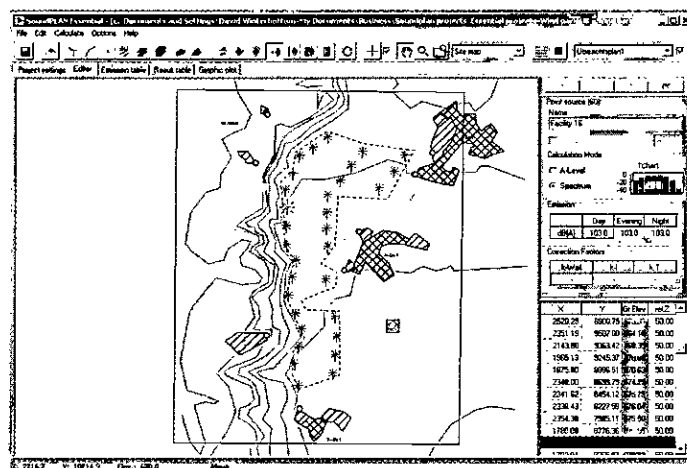
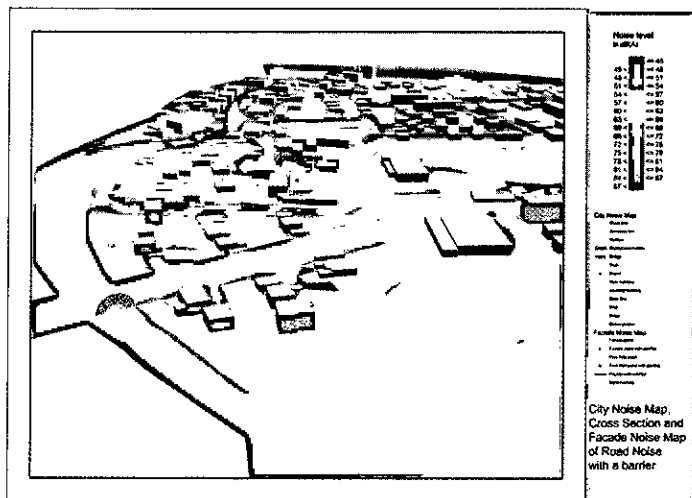
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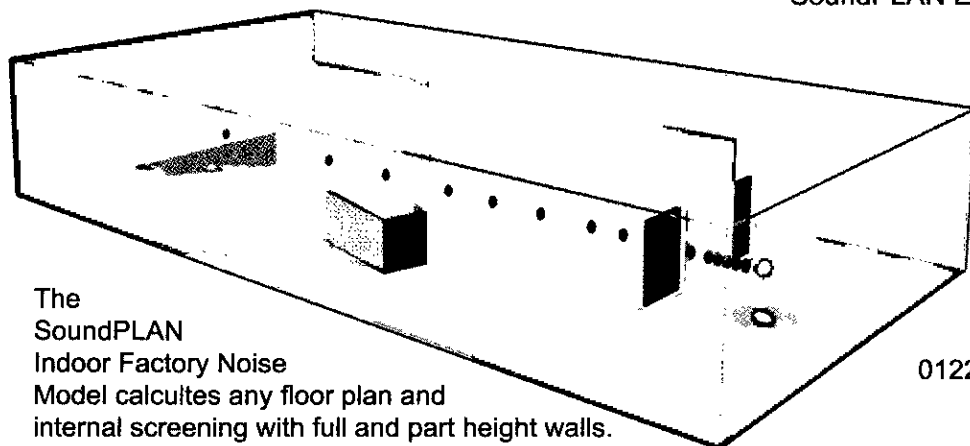
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and where there is therefore no possibility of wind turbine induced AM being present. This absence of AM has been verified by selective listening to audio data from both sites prior to analysis.

Acoustic data have been collected as follows:

Site name	Turncole	Rotsea
Location	near Burnham-on-Crouch, Essex	near Driffield, East Yorkshire
National Grid Reference	TQ 991 983	TA 064 516
Data collection	19-27 August 2011	20-27 September 2011
Sound level meter	Rion NA-28	Rion NL-52
Hours of data (hh:mm:ss)	184:12:17	166:45:57

Table 1

Photographs showing the locations of the sound level meters at Turncole (Figure 4) and Rotsea (Figure 5) are shown below. In each case, the sound level meters were set up between 3.5 and 35 m from the property, as required by the method.

Audio was been recorded in continuous 10 minute blocks, providing a complete record from start to finish of the monitoring. Overall, in excess of 184 hours of data were analysed from the Turncole site, and 166 hours from the Rotsea site, a total of 350 hours.

The AM test method itself was implemented in both Microsoft Excel and Matlab. For the purposes of this assessment, the Matlab implementation is preferred because of its ability to process large volumes of data rapidly.

Key results

The key result from the analysis of the data for Turncole is shown in Figure 6.

Of the 184 hours of audio data recorded, 92% (172 hours) apparently contain 'greater than expected' AM. The general term for a test which returns a positive result, where the 'true' result is known to be negative, is a 'false positive'. So it can be stated that the AM test method appears to have a 92% rate of false positives when assessed using Turncole data.

If background noise alone fails the test then background noise plus turbine noise will also fail the test. This tells us that even if a wind farm were extremely quiet, and did not display unusual sound characteristics, it would still fail the test. It is therefore fairly certain that any recording made at any wind farm, no matter how far away from that wind farm, would fail the test.

Breaking the results down into more detail, Figure 7 shows that 41% of all two-second periods would be flagged as meeting the requirements of step 2, and 72% of all one-minute periods would be flagged as meeting the requirements of step 3.

As only 10% of one-minute periods need to meet the requirements of step 3 to fail the method, these results suggest that, far from being a marginal fail, the Turncole background noise data comprehensively fails the method. This would indicate that AM is not only present, but ubiquitous. This cannot be due to the presence of the greater than expected levels of AM, however, because the data tested are simply rural background noise measured at two sites where there are no wind turbines and hence no AM.

Similar results have been obtained for Rotsea. The key result is shown in Figure 8.

Based on the 166 hours of audio data recorded, 148 hours apparently contain 'greater than expected' AM, indicating a false positive rate of 88%, similar to Turncole. Inspection of the data suggests that this difference in false positive rates result from a marginal difference in overall levels at Turncole and Rotsea, with

Application of AM Test Methodology:
Turncole Wind Farm: 19 - 27 August 2011:
Total % of 1 hour periods failing test

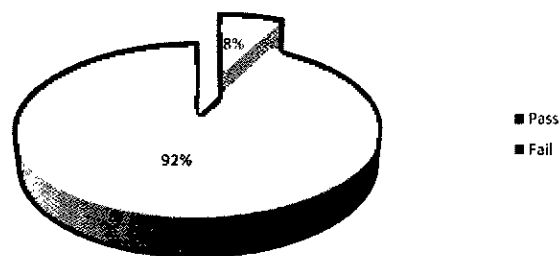
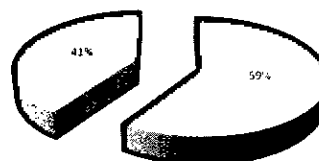


Figure 6

Application of AM Test Methodology:
Turncole Wind Farm: 19 - 27 August 2011:
Total % of 2 sec periods failing test



Application of AM Test Methodology:
Turncole Wind Farm: 19 - 27 August 2011:
Total % of 1 min periods failing test

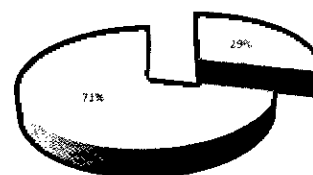


Figure 7

Application of AM Test Methodology:
Rotsea Wind Farm: 20 - 27 September 2011:
Total % of 1 hour periods failing test

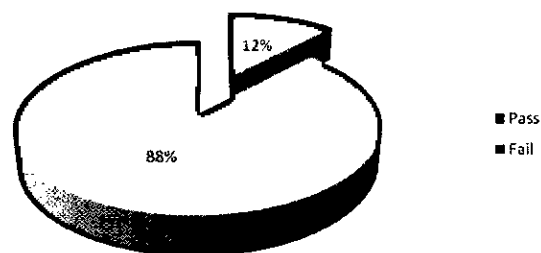


Figure 8

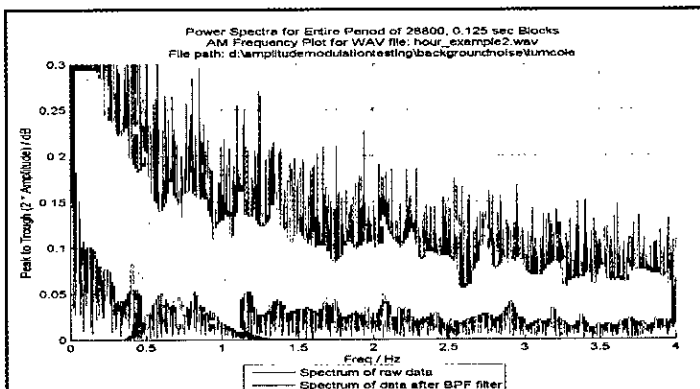
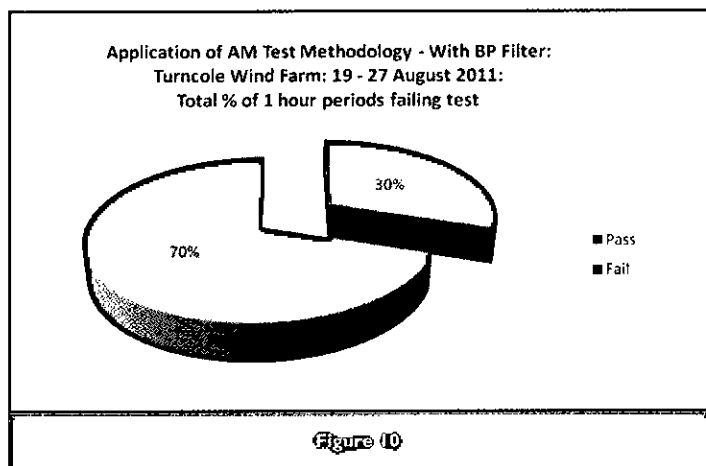


Figure 9



Rotsea being the quieter location. As a result, the 28dB lower limit for $L_{Aeq,1min}$ came into play more often at Rotsea, and disqualified one-minute periods which would otherwise have counted in step 3. The effect can be seen very clearly towards the right-hand side of Figure 3.

Band-pass filtering

Inspection of Figure 3 shows that a typical sample of measured $L_{Aeq,125msec}$ data is highly non-stationary, containing energy at a wide range of frequencies, particularly low frequencies. It may be that it is this low frequency 'rumble' which is causing the AM test method to fail when clearly no AM is present in the data. However, as AM is specific to blade passing frequency (BPF), this suggests that, prior to applying the AM test method, the test data should be band-pass filtered to remove variation at frequencies other than BPF.

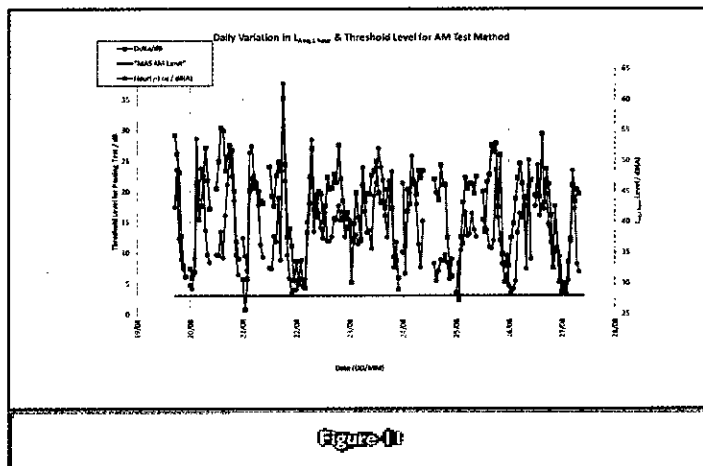


Figure 9 shows a one-sided power spectrum of a one-hour sample of audio data from Turncole before and after band-pass filtering (shown in green and red respectively). A pass band of 0.5 – 1 Hz was chosen as indicative of the likely range of AM frequencies that would be expected for the current generation of available wind turbines. It should also be noted that no evidence of AM is present in the data, which would be indicated by peaks in the green spectrum in the BPF region.

So how does the AM test method perform if this filtering is applied before assessing the Turncole data? The results are shown in Figure 10. Whilst band-pass filtering does improve the performance of the method, in that the 'false positive' rate is reduced from 92% to 70%, this is still an unacceptably high level of false positives, indicating that

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the AM test method is a poor diagnostic for 'greater than expected' AM at BPF.

A number of other refinements could be considered which might improve the performance of the method further, for example:

- Use an L_{50} or L_{90} descriptor instead of L_{eq}
- Change the number of two-second periods required within a one-minute interval
- Change the number of one-minute periods required within one-hour intervals.

However, these improvements are only worth pursuing if the AM test method is actually assessing the level of AM present in a sample of data. The obvious question would be, is this what it is doing?

Apparent level of AM

If it is assumed that the AM test method is extracting information from the test data which relates to AM, and that furthermore that it indicates that for 92% of the time the level of AM is in excess of 3dB(A), it is instructive to question how much AM is actually there in the data.

This can easily be answered by taking each one of the 172 hours of data which failed the method at Turncole, and replacing the 3dB(A) in step 2 with the variable X (also in terms of dB(A)). X can then be varied, for each hour, to find the threshold value at which the method result changes from 'fail' to 'pass'.

The results of this analysis are shown in Figure 11 (red line) and this indicates that the audio data from Turncole wind farm contains levels of AM ranging from 3 to 35 dB(A)! If 3dB(A) were an appropriate limit for AM and if this genuinely reflected the level of AM present in the rural background noise environment at Turncole, we can only speculate about the disturbance this would cause.

However, if the $L_{Aeq,1hour}$ level for each of the 172 hours is also plotted (blue line), it appears to correlate fairly well with the level of AM. This would indicate that the AM test method is actually another measure of L_{eq} , rather than AM, which would in turn suggest that the possible refinements outlined above would be unlikely to make a significant difference.

Conclusions

The above analysis clearly demonstrates that the AM test method is not a good indicator of the presence of 'greater than expected' AM in samples of acoustical data, having a false positive rate of 88 to 92%. Given that the sole purpose of such a test is to discriminate between those samples which do, and those which do not, contain 'greater than expected' AM, this very high rate of false positives demonstrates that the test is not fit for purpose.

This is a key point, because if background noise alone fails the AM test method, how could it be proven that a wind farm subsequently built at the location was causing 'greater than expected' AM? A wind farm operator could turn the turbine off and apply the AM test method, which would most likely show that background noise alone failed the test. This would make it extremely difficult for a local planning authority to claim that the wind farm was any worse than background noise alone.

In summary:

- The AM test method has an unacceptably high rate of 'false positives'.
- False positives can be caused by wind-induced non-stationary noise, not occurring at blade passing frequency.
- However, even if a band-pass filter is applied so that only blade passing frequencies are analysed, there is still an unacceptably high rate of false positives.
- The method is not specific to AM.

- Given the above, it is unlikely that the AM test method complies with the requirements of Circular 11/95.

Finally, it is important to stress that all data, particularly those which appear to contain high levels of AM as indicated by any test method, must be listened to before the test results can be accepted. It has been observed on occasion that some external sources of noise, for example crows and bird scarers, may have a noise signature which 'looks' like AM, but which does not in fact derive from wind turbines. Unless these effects are removed any method may throw up a false positive and overstate the true frequency and severity of AM.

Afterword

The motivation for writing this article was that the AM test method, which has been unequivocally shown not to be a suitable method for assessing wind turbine AM, is now being used at other wind farm sites. Some Planning Authorities are expressing an enthusiasm for its wider adoption.

The question then is if the AM test method is rejected, what can it be replaced with?

Given the results of a 2007 study which investigated the frequency and severity of AM related noise problems in the UK⁶ it is entirely reasonable to suggest that no AM condition is required, especially given that the current state of knowledge makes its drafting difficult. Instead, given their rarity, AM problems could be addressed using a 'Statutory Nuisance' approach.

However, it is anticipated that an alternative methodology based on listening tests and currently being developed under a RenewableUK funded research project, should be available in late 2011^{3,4}.

Jeremy Bass PhD MInstP MIOA is with Renewable Energy Systems Ltd, headquartered at Kings Langley, Herts, UK.

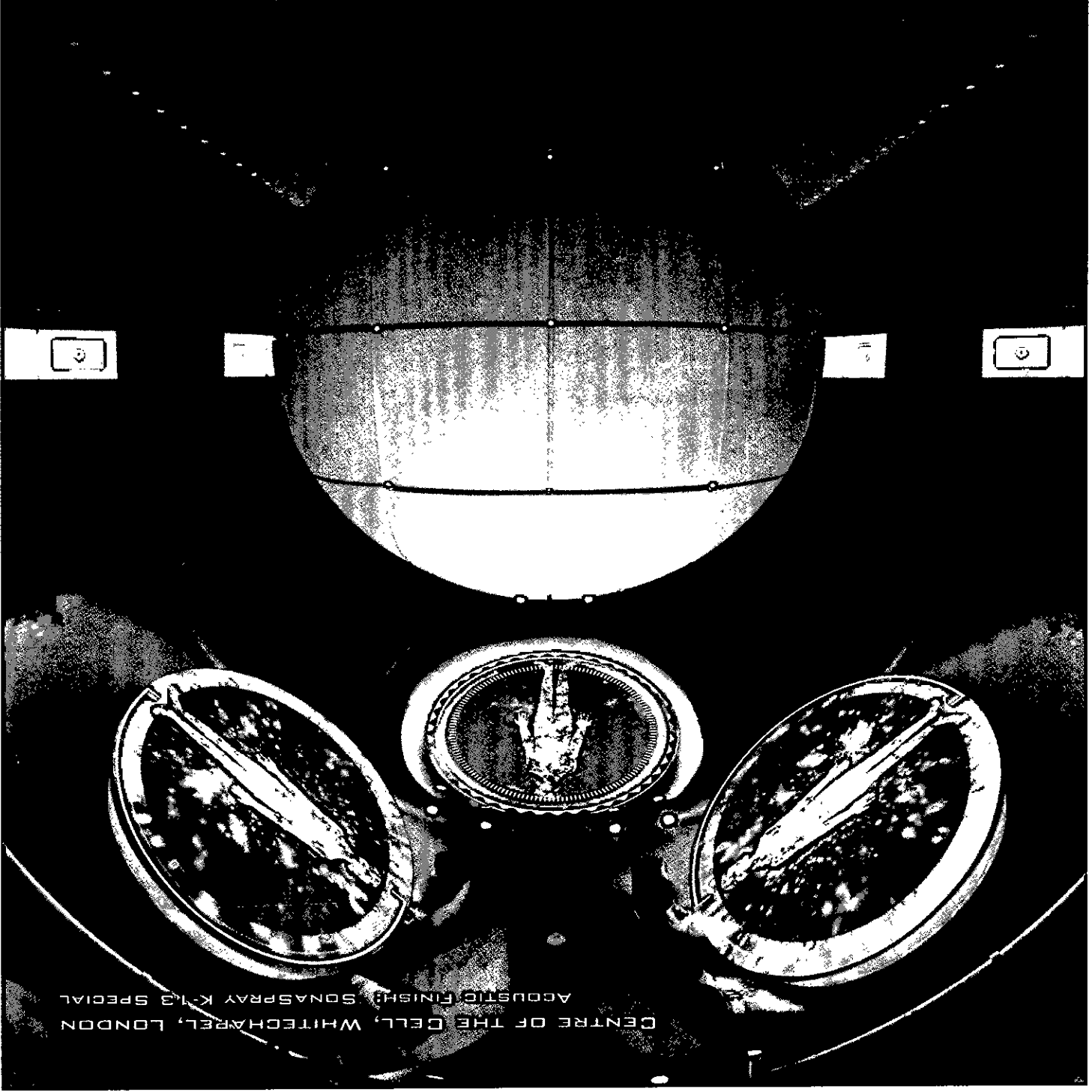
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Wind Farm Noise Dose Response

Dani Fiumicelli, A Literature Review

INTRODUCTION

A literature search reveals most wind farm noise dose response studies have been carried out in Scandinavia, the Netherlands and Germany. Transposing these studies to other countries may not be reliable as methodological and analytical issues, and differences in topography, population density and distribution, as well as variation in societal, language, cultural, environmental and political factors between these countries and elsewhere, militate against the direct transfer of these dose responses. However, these studies make a useful contribution to trying to understand wind farm noise dose response overall.

Review of dose response research

A substantial review of wind farm noise dose response was produced in 2003 by Eja Pedersen¹ on behalf of the Swedish Environmental Protection agency. As a starting point this study looked at work done by Wolsink et al (1993) in the early 1990's, which is summarised below.

1. In all, 13.5% of the study respondents were exposed to turbine noise in the range <25 to 30 dB(A), 70% of the study respondents were exposed to turbine noise in the range 30 to 40 dB(A), and 16.4% were exposed to turbine noise above 40dB(A);
2. The proportion of persons indicating any noise annoyance is low at only 6.5% of the survey sample;
3. The degree of annoyance is only slightly related to noise level;
4. 'The fact that someone was complaining was mainly determined by the personality of the individual';
5. 'The conclusions must not be misunderstood. The fact that sound level is not predicting annoyance does not mean that people are not really annoyed when they are reporting it.'

Importantly, the Wolsink et al (1993) study sounds a note of caution regarding interpretation of its results as 'There are a number of methodological problems involved in the project'.

The Swedish study

Another more recent (2007) field study has been carried out in Sweden² (referred to hereafter as 'the Swedish study'). This study consisted of multiple phases, including cross-sectional social surveys to derive a dose-response relationship. Subjective responses were obtained from 1,288 respondents across the different phases of the study. The first phase was carried out in an area of flat terrain in a mainly quiet rural area, whereas the later phase was carried out in areas with different types of terrain (flat or complex) and different degrees of urbanisation and higher ambient noise levels.

Overall the Swedish study found a greater probability of the perception of wind turbine noise in quieter rural areas compared with noisier suburban locations; and a greater annoyance response rate in quieter compared to noisier locations.

The Swedish study also considered the impact of visual factors by comparing responses from respondents who could see wind turbines with those who could not see wind turbines. The study found that 'being negative towards the visual impact of wind turbines on the landscape scenery, rather than towards wind turbines as such, was strongly associated with annoyance.'

Dose-response relationships were found in the Swedish study both for perception of noise and for noise annoyance in relation to turbine A-weighted sound levels derived in accordance with the Swedish Environmental Protection Agency (2001) Guideline³. Two dose-

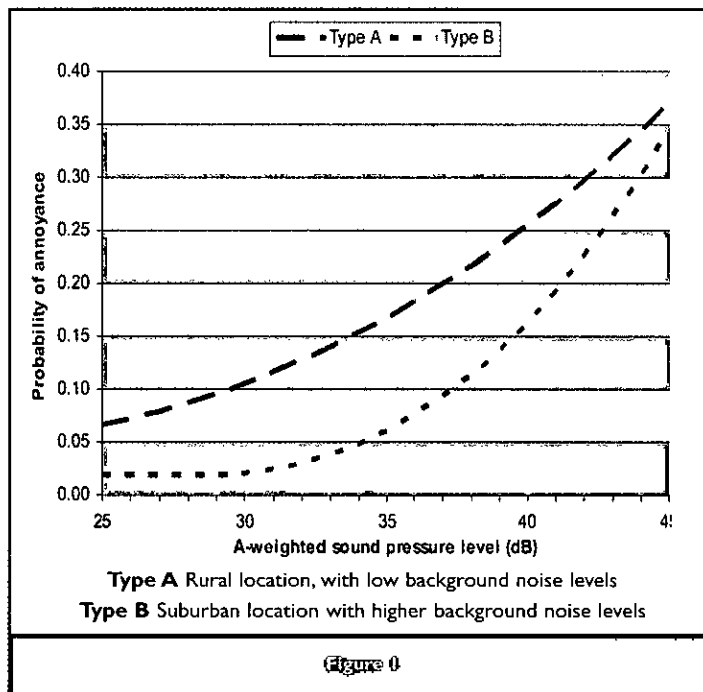


Figure 1
Probability of annoyance with wind turbine noise outdoors: E Pedersen and K Persson Waye (2007) Wind turbine noise, annoyance and self-reported health and well-being in different living environments. *Occup. Environ. Med.* 64, 480-486.

response relationships were presented: one for rural areas (Type A) and the other for suburban areas (Type B) and these are reproduced here in Figure 1.

However, caution is advised when considering the masking effect of other noises, as the distinctive temporal and frequency characteristics of wind turbine noise may mean that it is not completely masked until other noises eg road traffic noise, are at A-weighted levels least 20dB greater than the turbine noise³. However, as the Pedersen and Persson Waye (2007) work referred to above shows, when making decisions on wind turbine noise policy or in regard to specific developments, complete masking so that the turbine noise is not audible is not required in order to manage the impact of turbine noise. As with most other noise sources, there is generally a substantial gap between the proportion of persons who can perceive wind turbine noise at a particular noise level, and the much smaller proportion of persons reporting annoyance, as will be shown shortly in this review. In line with most other noises, this suggests that whilst the overall community response of the relevant proportion of a population reacting adversely to turbine noise at specific levels may ultimately be capable of prediction, the wide variability of human response to noise and the influence of non-acoustical factors typically makes precise prediction of the reaction of individuals to wind turbine noise impracticable.

The graphs in Figure 2 are from the Swedish study and show the proportion of respondents who noticed and/or were annoyed by wind turbine noise in Phases I and III. Care should be taken when comparing the two studies as Phase III was not intended to replicate Phase I: the studies were in different landscapes with different geographical characteristics, and Phase III included questions about evaluation of the environment and feelings invoked by wind turbines and coping strategies

* The paper is unclear as to what noise index applies, but it is assumed that the $L_{Aeq,T}$ is relevant as it is applied to wind turbine noise in all the countries in the study.

† The text in this report suggests that the dose responses use the $L_{Aeq,T}$ noise index. Whilst in the UK ETSU-R-97 advises use of the statistical method (L_{A90}) for the measurement of noise from wind farms, most other countries in Europe use the equivalent continuous noise index ($L_{Aeq,T}$). Most other EU countries have fixed limits, the lowest being Sweden and Ireland (40dB(A) $L_{Aeq,T}$ and the highest being Spain (65dB(A) $L_{Aeq,T}$ - although care should be taken when comparing advice from different countries as noise index, time period and definition of night and day periods can vary substantially).

that were not asked in Phase I. The two phases show clear differences in the degree of response, which suggests that amongst other variables the response rate is influenced by location specific factors.

Both phases of the Swedish study reinforce that mere perception of wind turbine noise is not sufficient to provoke annoyance in most of the respondents, as there is a significant difference in the percentage perceiving the wind farm noise and those who are annoyed, with a smaller differential at lower noise levels compared to higher values.

Both Phases I and III of the Swedish study have in common the general trends that:

- annoyance increases with increasing noise level;
- sleep disturbance was associated with annoyance (although only Phase I showed an association between noise level and sleep disturbance);
- Descriptors of the turbine noise characteristics including 'swishing', 'whistling', pulsating/throbbing' and 'resounding' were highly correlated with noise annoyance in both Phase I and Phase III.

Recent developments

More recently (2009), work⁴ has been published that considers two surveys in Sweden and one in the Netherlands on wind farm noise dose response compared with industrial noise. This concluded that:

- 'At outdoor exposure levels higher than 40dB(A), the expected percentage of annoyed persons indoors due to wind turbine noise is higher than due to industrial noise from stationary sources at the same exposure level;
- Besides noise exposure, various individual and situational characteristics were found to influence the level of annoyance;
- Having economic benefit from the use of wind turbines, or being able to see one or more wind turbines from within the home are two particularly influential situational factors [with positive and negative effects respectively];

- The economic benefit factor is reminiscent of earlier findings that being employed at the noise source (eg airport or industry) attenuates the annoyance reported;
- Also, visibility from the home (eg living room, bedroom) has been reported earlier to affect annoyance from stationary sources;
- In addition, noise sensitivity and age had similar effects on [increasing] annoyance to those found in research on annoyance by other noise sources.'

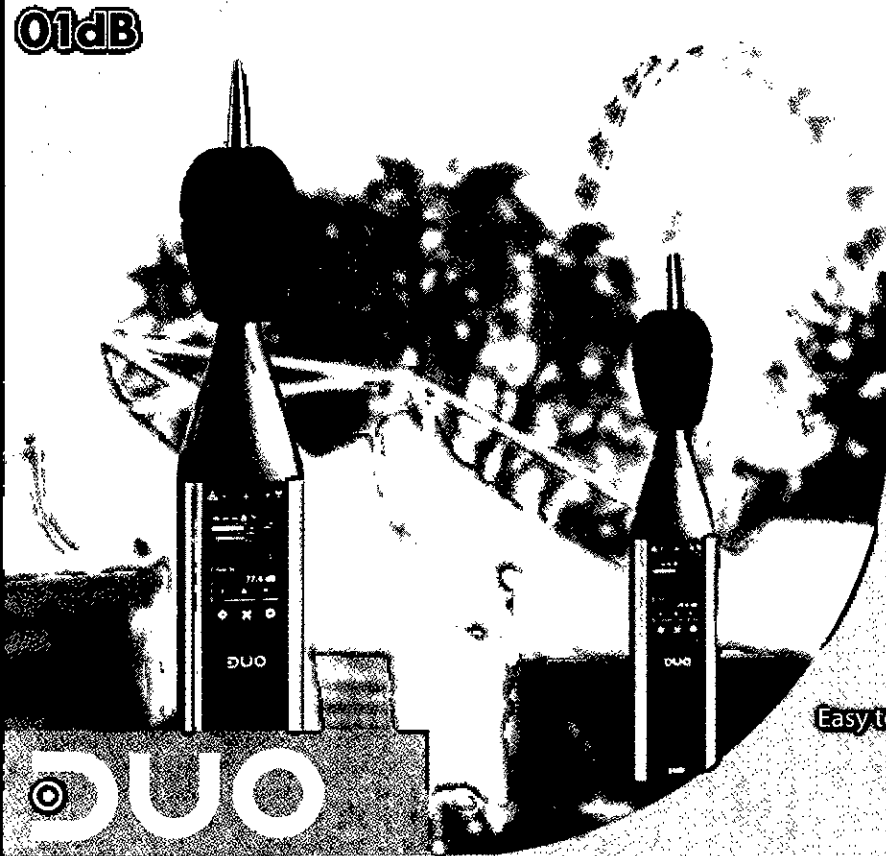
The chart in Figure 3 (taken from the Netherlands study) illustrates that wind turbine noise measured using Lden in dB(A) appears to have a higher annoyance rate than industrial noise.

Also in 2009 further work⁵ concluded that:

- 'A dose-response relationship between calculated A-weighted sound pressure levels and reported perception and annoyance was found;
- Wind turbine noise was more annoying than transportation noise or industrial noise at comparable levels (see Figure 4), possibly due to specific sound properties such as a 'swishing' quality, temporal variability, and lack of night time abatement. High turbine visibility enhances negative response, and having wind turbines visible from the dwelling significantly increased the risk of annoyance;
- Annoyance was strongly correlated with a negative attitude toward the visual impact of wind turbines on the landscape;
- People who benefit economically from wind turbines have a significantly decreased risk of annoyance, despite exposure to similar sound levels.'

The Janssen, Eisses and Pedersen (2009) study compared the Dutch

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study results with results from the Swedish study[‡] and concluded the following:

- The study confirms that wind turbine sound is easily perceived and;
- Compared with sound from other community sources, relatively annoying, and;
- Annoyance with wind turbine noise is related to a negative attitude toward the source and to noise sensitivity, and;
- In that respect it is similar to reactions to noise from other sources, and;
- This may be enhanced by the high visibility of the noise source, the swishing quality of the sound, its unpredictable occurrence, and the continuation of the sound at night.⁷

The importance of acoustic features

G P van den Berg⁶ (2005) has investigated the possibility that uneven

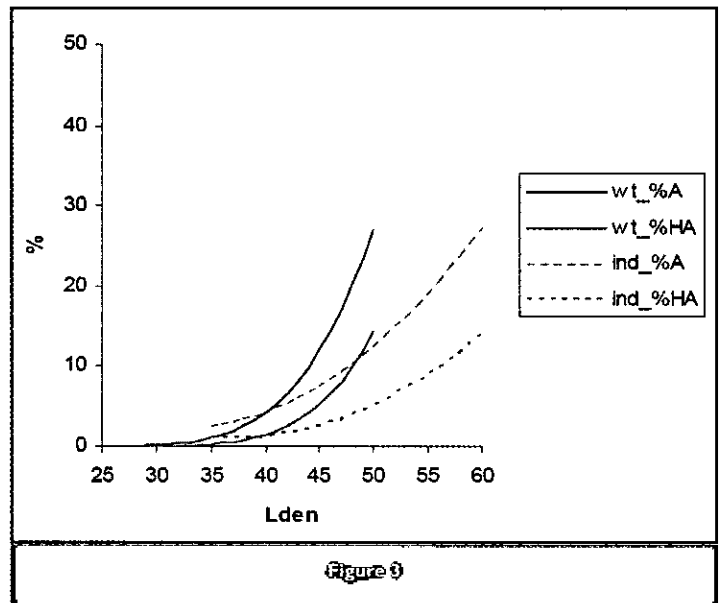


Figure 9 Comparison of the percentage annoyed and highly annoyed persons indoors (%A indoors and %HA indoors) due to wind turbine noise (wt) and industrial noise (ind). Janssen, Eisses and Pedersen, Exposure-response relationships for annoyance by wind turbine noise: a comparison with other stationary sources, EURONOISE 2009, Edinburgh.

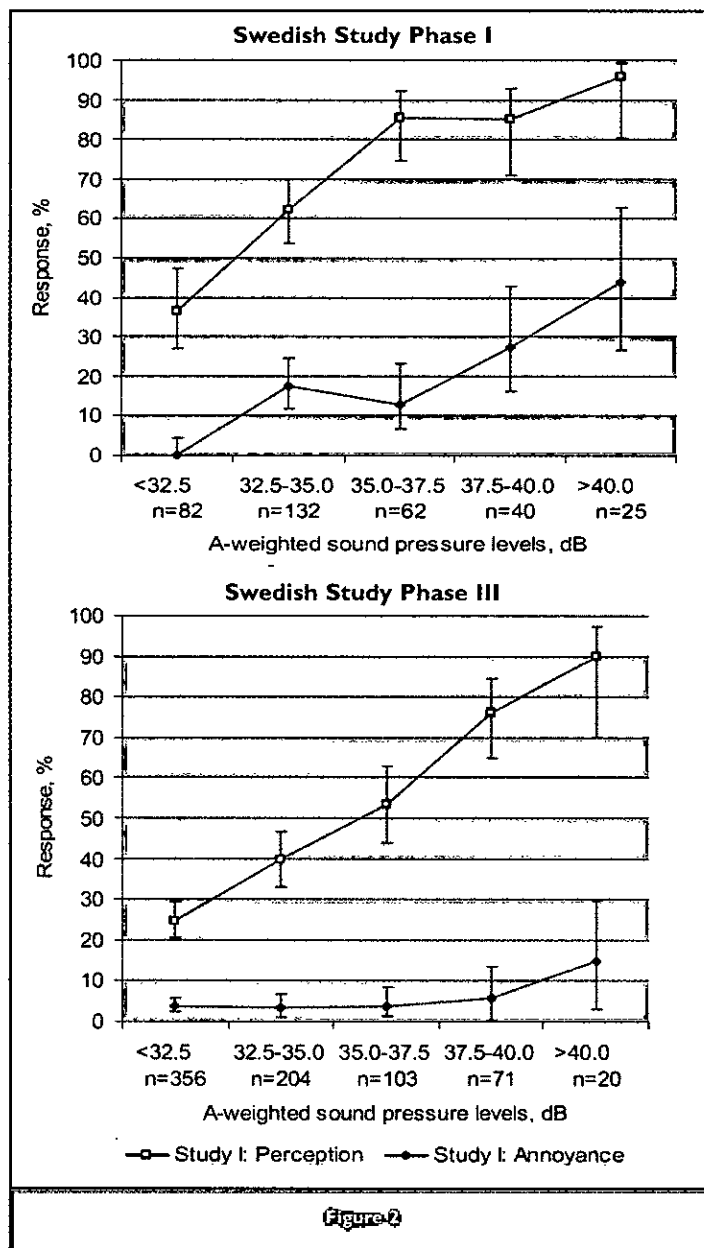
wind speed across the rotor plane may cause fluctuations in noise emission and has suggested that in stable atmospheric conditions the difference in wind speed between the top and bottom of the rotor of a large turbine is relatively high. This may contribute to a cyclical variation in the noise level, which may be characterised as a 'beating' – an effect referred to as amplitude modulation of aerodynamic noise (AM). This type of noise is of interest, as it is likely that a modulated noise will be more annoying than a non-modulated noise at the same sound pressure level. In regard to this point, it has recently (2009) reported that:

'Acoustically this may be due to the diurnal course of the noise and the rapid fluctuation in level related to the rotation, which are not usual features of most transportation and industrial noise sources. It can also be a result of non-acoustic factors such as visual intrusion and the perceived distribution of benefits and adverse effects.'⁷

As wind farm noise typically includes a degree of modulation it will normally be appropriate to include assessment of this factor when assessing dose response. However, aerodynamic modulation of the aerodynamic noise emitted by wind turbines is not well understood and there are presently no peer reviewed and validated models available through which the occurrence of aerodynamic modulation can be reliably predicted. Additionally, there is currently little understanding of the factors that influence how modulation of the turbine noise may affect its impact, or any established thresholds of modulation beyond which the impact is clearly unacceptable.

In 2002 in a laboratory study⁸ 25 subjects were exposed to five wind turbine noises of different character, but all at the same noise level of 40dB L_{Aeq,T} in order to see if differences between the noises with regard to annoyance could be found. The most annoying noises were predominantly described as 'swishing', 'lapping' and 'whistling'. These descriptors could all be regarded as related to the aerodynamic noise and as descriptions of a time varying (modulated) noise with high frequency content.

In another laboratory study⁹ (2007) 20 subjects were asked to rate recordings of wind turbine noise with different acoustic features, principally tonal components and aerodynamic noise from the rotating blades. The rated tonality of the stimuli did not correlate well with the metric developed for the prominence of tones - ΔL_{ta}. However a metric for calculating 'swishing sound' was developed ie fluctuation strength, which is a measure of amplitude and frequency modulation. This was measured in the 350 – 700 Hz band, and correlated well with the ratings on 'swishing sound' in the sound played to the test subjects. The frequency band between 350 and 700 Hz was chosen because it



Response to wind turbine noise: E Pedersen and K Persson Waye (2007) Wind turbine noise, annoyance and self-reported health and well-being in different living environments. *Occup. Environ. Med.* 64, 480–486.

[‡] Again the study is unclear as to the noise index or the measurement time period, but the propagation model used (ISO 9613) suggests L_{Aeq,T}.

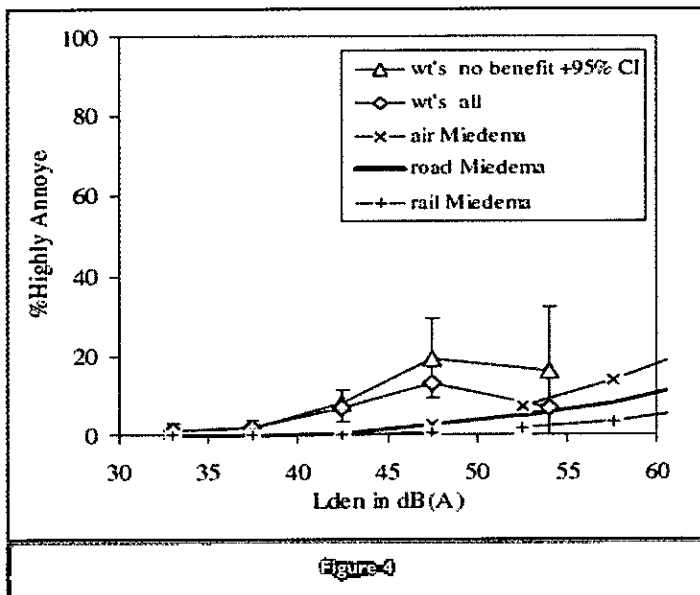


Figure 4
F van den Berg, E Pedersen, R Bakker, J Bouma: Project WINDFARM perception – Visual and acoustic impact of wind turbine farms on residents, University of Groningen, UMCG and Universiteit Göteborg (2008)

seemed to be the optimum range for 'swishing sound' from large modern wind turbines.

Caution should be exercised in transposing results from laboratory studies to the field, as many other studies have identified that laboratory tests often overestimate the impact of noise compared with field studies.

The 2007 Salford University field study¹⁰ attempted to establish the prevalence of amplitude modulation of aerodynamic noise (AM) of wind turbine noise in the UK. Information was gathered from local authorities, and the personal knowledge of council staff was used to determine whether AM was likely to be a factor in complaints about wind turbine noise. Local authorities were asked if the noise contained a number of different features, certain of which could be indicative of AM eg 'like a train that never gets there', 'distant helicopter', 'thumping', 'thudding', 'pulsating', 'rhythmic beat', and 'beating'. The study suggested that aerodynamic modulation may have been a factor in four of the 27 sites associated with complaints included in the survey and a possible factor in complaints at a further eight sites.

However, the Salford University study's categorisation of AM and the subsequent findings differ from other studies which suggest that swishing and other similar descriptors could be associated with AM and that such features are more widely prevalent than the Salford study

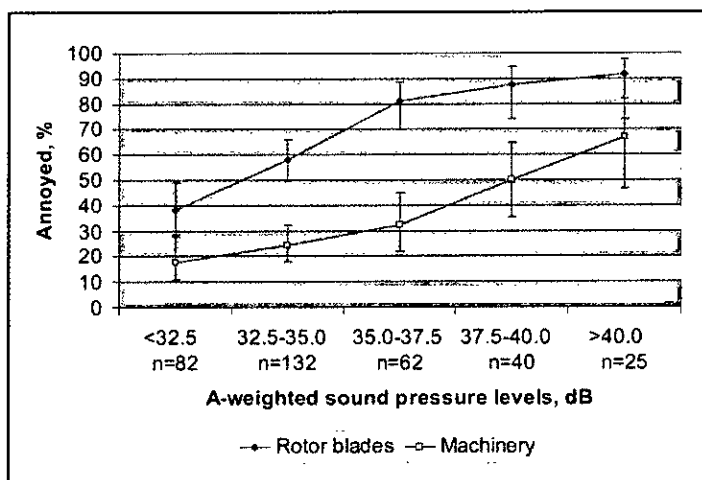


Figure 5

Annoyance of wind turbine noise and mechanical sources. Pedersen (2007) Proportion of respondents annoyed by sound from rotor blades and machinery, respectively, outside their dwelling in Study 1, in relation to sound pressure levels in 2.5dB intervals.

reported. However, this may simply be a question of semantics as the report by Salford University suggested that swishing type features could be associated with blade resonance not amplitude modulation of aerodynamic noise. Additionally, analysis of the complaint information used in the Salford University study suggests that a significant proportion of the cases may have contained acoustic features that could attract attention and may therefore enhance annoyance. For example, if the four cases in the Salford study where AM was a recognised factor are added to the eight where AM was a possible issue, this gives 12 of 27 cases where complaints were made, or approximately 44% where AM may have been a factor. Some commentators have distinguished the four cases where the Salford study recognises AM as a factor, as probably being 'excess AM' of greater modulation over and above the normal 'swish' AM typically expected for a wind turbine.

The Swedish field study referred to earlier found that the sound characteristics of wind turbine noise, generated by the rotation of the blades, were found to be especially annoying. Noise from rotor blades was noticed more than noise from machinery (see Figure 5). Whilst descriptors of sound characteristics relating to sound from the rotor blades were highly correlated with noise annoyance, sound characteristics describing the aerodynamic modulation were appraised as the most annoying eg 'swishing, whistling and pulsating/throbbing'.

A case study carried out in the Netherlands (G P Van den Berg, 2004) showed that aerodynamic modulation can be stronger under certain meteorological conditions and that periodic swishes are louder in a stable atmosphere associated with night-time than in daytime, and residents can use words like 'clapping, beating or thumping' to describe the character of the sound. In the case of the Rhede wind park, the beating could be heard clearly at distances up to 1 km, and at night the beat of the noise could be used to determine the rotational speed of the turbine. When the atmosphere becomes more stable, which is

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usual during the night when there is a partial clear sky and a light to moderate wind (at ground level), there can be an important change in the wind profile affecting the performance of modern, tall wind turbines. The airflow around the blade then changes to less than optimal, resulting in added induced turbulence. It was suggested that this effect is strongest when the blades pass the tower, causing short lasting higher sound levels at the rate of the blade passing frequency. The synchronisation of these pulses from multiple turbines can give rises to additive effects at a distance and the repetitive pulses may be expected to cause added annoyance.

However, the effect of the tower is dismissed by the SIROCCO¹¹ study which shows that the effect of the passage of the blade past the tower is relatively small in comparison to that attributable to the downward sweep of the blade as it approaches the observer, according to the data on which the study was based¹², indicating that the latter can give rise to a modulation of some 12dB in certain third-octave bands.

A study undertaken for the Department of Trade and Industry¹³ looked at low-frequency noise from three wind farms within the United Kingdom, and found that the turbines were not significant sources of low-frequency noise, and that it was the slow cycle of AM that was being mistaken for low frequency noise. The study indicates that the level of modulation from peak to trough was 2 to 5 dB when measured externally and 4 to 6dB when measured internally (in terms of overall A-weighted levels). The depth of the modulation within individual third-octave bands was found to be up to 10dB. The report concludes that

'some wind farms clearly result in modulation at night which is greater than that assumed within the ETSU-R-97 guidelines'

ie excess AM. The report then goes on to suggest that in conditions of high aerodynamic modulation it may therefore be appropriate for a correction for the character of the noise to be applied.

The Salford University AM study (Moorhouse et al 2007) reports in regard to the four sites where AM was identified as a factor in complaints, modulation in noise levels as follows:

'Measurements of the internal noise levels during these periods of wind farm operation indicate that A-weighted noise levels are subject to amplitude modulation levels of between 3 and 5 dB. Analysis of these periods using third-octave band analysis indicates that between 200 and 800 Hz, noise levels in specific frequency bands may change between 8 and 10 dB. External measurements indicate that for external A-weighted changes in level of 3 to 4 dB, third-octave band levels may change by between 7 and 9 dB. Measurements reported for Wind Farm D (Table 1) have indicated that third-octave band levels when complaints were received (before the implementation of wind turbine control features) indicated level changes of 12 to 15 dB. (All the above figures are ranges from peak to trough).'

The DTI report into low frequency noise and wind turbines (Hayes Mackenzie, 2006), states that

'the dominant audible noise associated with wind turbine operation is acoustic energy within the 250 to 800 Hz frequency region which originates from the aerodynamic modulation of the wind turbine noise'.

Whilst the Salford AM study advises that

'The finding that this modulation is concentrated between the frequency bands of 200 and 800 Hz is significant in that this is generally generated by the trailing edge of a wind turbine blade. This has been identified as one of the main sources of aerodynamic noise associated with the operation of wind turbines (Oerlemans and Lopez, 2005).'

Individual and other situational factors

Human response, and hence complaints, can be strongly influenced by individual and situational factors. It is known from other studies of general environmental noise that visual impact and other variables are important, and may be found to be equally relevant or more relevant than noise level in influencing response. For example, work¹⁴ on the influence of non-acoustic factors on the human response to noise has concluded that:

'It is well known that annoyance reactions of residents exposed to

environmental noise are determined partly by acoustical features of the environment, partly by features of the residents. At best, about a third of the variance of annoyance reactions can be 'explained' by the variance of acoustical features, and another third by the variance of personal or social variables.'

'Noise annoyance is considered to be the (long-term) negative evaluation of living conditions with respect to noise. This evaluation is not simply dependent on past disturbances, but on attitudes and expectations too. The personal factors influencing the evaluation are: sensitivity to noise, fear of harm connected with the source, personal evaluation of the source, and coping capacity with respect to noise. The social factors are: general (social) evaluation of the source, trust or misfeasance with source authorities, history of noise exposure, and expectations of residents.'

Additionally, other researchers¹⁵ have concluded that the following individual factors can influence the response to environmental noise:

- 'The awareness of non-noise problems may increase annoyance, and;
- Fear of the noise source can increase annoyance, and;
- The belief that the noise source is important can decrease annoyance, and;
- The belief that the noise could be prevented can increase annoyance.'

The above suggests where wind turbines are regarded as an unwelcome, dangerous or avoidable intrusion that the response of some people to the noise may be more than in circumstances where such factors do not apply. The outlook of study respondents towards the source is known from other community noise studies to influence annoyance, and was found to be associated with noise annoyance in the Swedish study referred to above. In the Phase I and Phase III surveys, 13% and 8% of the respondents respectively had negative or very negative attitudes towards wind turbines. Having such negative opinions towards wind turbines was not associated with the A-weighted noise level but was associated with annoyance due to wind turbine noise. The Swedish study states that

'Of the respondents in Phase I, 40% were negative or very negative about the impact of turbines on the landscape scenery' and '16% of the respondents in Phase III were negative or very negative to this impact.'

There were no differences between residents living in flat areas and those in complex terrains, although in the Phase I study, residents in rural areas were slightly more negative than those in suburban areas. Wind turbines were judged to be environmentally friendly by most of the respondents, followed by positive evaluation of the utility ('necessary' and 'efficient') and a negative evaluation of aesthetic appearance ('ugly' and 'unnatural'). However, the correlation coefficients between the study subject's general point of view towards wind turbines and noise annoyance in these studies were lower than those found in other community noise studies. The general outlook towards wind turbines was of less importance than was visual opinion.

The Swedish study investigated the relationship between noise annoyance and the visibility of the turbines and people's attitudes about the visual appearance of the turbines. Visibility was investigated using a measure of the vertical visual angle, defined as the angle between the horizontal plane and an imaginary line from the dwelling of a respondent to the hub of the nearest wind turbine, expressed in degrees. Visual attitude was measured in terms of the respondents' attitude towards the impact of the wind turbines on the landscape scenery, using bipolar descriptions such as 'beautiful/ugly' and 'natural/unnatural'. Visual attitude had a large influence on noise annoyance among respondents living on flat terrain, but no statistically significant influence among respondents living on complex terrain. The main individual factor that influenced response to wind turbine noise was attitude towards the visual aspects of the turbines.

Pederson (2007) suggests that negatively appraising the impact of the wind turbines on the landscape scenery was highly associated with noise annoyance. The risk of noise annoyance increased when the wind turbines were visible ie residents who could see at least one turbine from their home were more negative about the impact of wind turbines on the landscape.

Adverse feelings aroused by the wind turbine noise were influenced by feelings of lacking control, being subjected to injustice, lacking influence, and not being believed. Appraising an exposure to noise as an unfair social situation has, in experimental studies, been shown to increase the risk of noise annoyance¹⁶. Surprisingly, noise sensitivity was only correlated to response to wind turbine noise to a low degree. The results of the work regarding social justice and other research, highlights the complexity and interdependency of the factors influencing the subjective response to wind turbines and wind farms. This strongly suggests that the manner in which sites for wind turbine and wind farm schemes are chosen, how schemes are permitted and developed, and the community and individual perception of these phases, strongly influence the subjective response and are possibly as important or more important than the physical effects of such schemes including noise.

Type of area and relevance of background noise

An increased risk of perception of wind turbine noise was found in the Swedish study in those areas that were rated as quiet compared with non-quiet areas. Also, the risk of annoyance was increased in quiet areas, indicating that the contrast between the wind turbine noise and the background noise could make the turbine noise more easily detectable and subsequently more annoying, although confounding factors such as expectation of peace and quiet, effects of visual impact, and attitude to wind turbines would have an influence on annoyance response, and may be more marked in quiet rural/natural areas compared with urbanised/non-quiet areas.

The higher risks of perception and annoyance in quiet areas were reflected in the differences found between rural and suburban areas in the Swedish study. The results showed higher risks of both perception and annoyance in rural landscapes compared with suburban areas. The rural areas were presumably subject to background sounds of lower levels than those found in a suburban area. Pederson argues that the character of the sound is also different and that background sound of a rural area mainly contains natural sounds leading to large contrasts between the wind turbine noise and the background sound. A persistent swishing noise could in the context of such a soundscape be experienced as intrusive, and may also be incongruent with sounds normally expected in such a surrounding.

However, there are limitations associated with the calculation method used to establish dose in the Swedish study, and that study was not sufficiently powerful by itself to conclude safely that response is significantly influenced by the contrast or the difference between the background noise and the specific wind turbine noise.

The influence of background noise was investigated in the laboratory study referenced earlier (SV Legarth, 2007). In a carefully constructed living room setting within a laboratory 20 subjects were asked to rate recordings of wind turbine noises with and without background noise. The results of the listening tests are shown in Figure 7, reproduced from the paper, which are presented alongside the results from other wind turbine field studies¹⁷. The laboratory study clearly found that by adding natural background noise, the wind turbine sound at low levels becomes less annoying as presumably it is better masked.

Legarth is careful to note that the difference in response between the laboratory and the field studies is substantial, with the laboratory study showing a greater response rate than found in the field studies, as is common for other noise sources. He goes on to suggest that the difference between the laboratory and field study results is primarily due to the different context in which the subjects listened to the noise in the laboratory study compared with the field survey eg it was not

possible to make them feel at home, only to ask them to imagine themselves at home. Additional reasons given are that the questions and the scales used to record the subject's responses were different between the field and laboratory studies.

Work undertaken by G P van den Berg (2005) and by others¹⁸ suggests that in situations with high wind shear, when the noise emitted from the turbine may be higher than expected from the wind speeds at 10 metres, the background noise at ground level may still be relatively low. Consequently, the degree of masking provided by the background noise in such circumstances may be reduced in comparison with low or zero wind shear conditions with lower turbine emissions.

Health effects

Eja Pederson carried out a review of health effects from wind turbine noise in 2003. She found that there was no scientific evidence that noise at levels emitted by wind turbines could cause health problems other than annoyance. However, she suggested that sleep disturbance should be further investigated. Because noise from wind turbines can have special characteristics (amplitude or aerodynamic modulation and 'swishing' sounds), as for any noise that has temporal and spectral characteristics different from the prevailing soundscape it may be detected when close to or even below existing background noise levels: this may increase the probability of annoyance and sleep disturbance¹⁹ (although the Swedish study suggests a significant gap between wind turbine noise being audible and significant annoyance effects). Pedersen comments that the combination of different environmental impacts (intrusive sounds, visual disturbance and the inability to avoid the source in the living environment) could lead to a low-level stress-reaction which should be further studied.

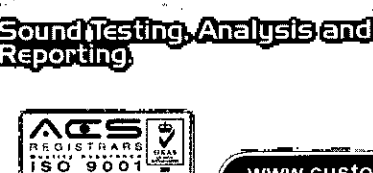
These findings were seemingly confirmed in the Swedish study. In Phase I of the study, the A-weighted sound pressure level was correlated with sleep disturbance; however this result was not replicated in the Phase III survey. In the first survey 16% of the respondents exposed to noise levels above 35dB(A) stated in an open question that they were disturbed in their sleep by wind turbine noise. Only a few respondents reported impaired health and social well-being and no association between wind turbine noise and health was found. It is not known how many of the subjects may have had underlying sleep problems, or how many cases of sleep disturbance were due in part or wholly to other sources but were attributed by the respondent to turbine noise.

The absence of strong evidence on the existence of health effects from wind turbine noise should not be taken as proof that such effects do not occur. However, it would appear that the self-reported health effects associated with wind turbine noise are significantly weaker compared with other types of noise, for example the findings reported for domestic noise²⁰.

Pedersen has updated her earlier work with a recently published paper²¹ (2009) and reports that:

- 'Based on data from two Swedish studies and one Dutch study in which self-reported health and well-being were related to calculated wind farm A-weighted sound pressure levels outside the dwelling of each respondent, the main adverse effect was annoyance due to the sound, and the prevalence of noise annoyance increased with increasing sound pressure levels;
- Disturbance of sleep was related to wind turbine noise; the proportion of residents reporting sleep disturbance in one of the Swedish studies due to noise increased significantly at sound

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levels close to those recommended as the highest acceptable levels in Sweden (maximum recommended external level for houses, educational establishments, nursing homes/hospitals is 40dB LAeq,t - Swedish EPA report 78.5 - as amended) while the Dutch study showed this at a higher level of 45dB);

- No other clear associations between sound levels and self-reported health symptoms have been found;
- However, a statistically significant association between annoyance and symptoms of stress was found;
- The study design does not allow causal conclusions, but the association indicates a possible hindrance of psycho-physiological restitution. Such a hindrance could in the long term lead to adverse health effects not detected here.⁹

None of the above effects are unique to wind turbine noise[§], although it is unclear whether the dose-response for wind turbine noise is the same as for other noise sources, as several of the studies referenced above suggest that wind turbine noise is more disturbing than transportation and industrial noise sources.

Differences between large and small wind turbines in respect of noise annoyance

Turbines on modern wind farms are substantially taller than those erected ten to 20 years ago. It has been hypothesised that this could lead to greater noise annoyance, not simply because the turbines emit more noise, but because larger turbines could produce disproportionately more low-frequency noise and the overall noise emission could have different temporal and frequency characteristics from those of smaller turbines.

Recent work²² has started to examine these questions and has so far reported that the spectral characteristics of large and smaller turbines are generally very similar, apart from a slight increase in the low-frequency content for large turbines. Listening tests simulating an indoor scenario and an outdoor scenario with and without masking garden noise concluded the following:

- Relative sensation levels were calculated from equal annoyance contours to determine whether low frequency tones are relatively more annoying than high frequency tones.
- The frequency dependence was not shown to be significant. The main influence on these levels is the tone level above masking level.
- Tones at higher levels are more annoying than tones at lower levels above masking.
- Both findings are common for the indoor and outdoor scenarios.
- The listening tests showed the spectral characteristics of the small turbine to be more annoying outdoors than those of the large turbine recording. This has been attributed to the different spectral characteristics of the two turbines.
- The indoor scenario did not find the turbines to be differently annoying.

However the report does caution that

'the finding that the small turbine is more annoying cannot be generalised to large and small wind turbines or to a wider range of wind and terrain conditions than were used in the test. The listener responses were, however, consistent and therefore demonstrate the potential of the comparison method.'

Discussion

Evidence of the effects of wind turbine noise is strongest for annoyance and sleep disturbance.

Studies carried out in Sweden, Germany and Holland have shown that a minority of persons report annoyance at relatively low levels of exposure to wind turbine noise, although other factors can strongly

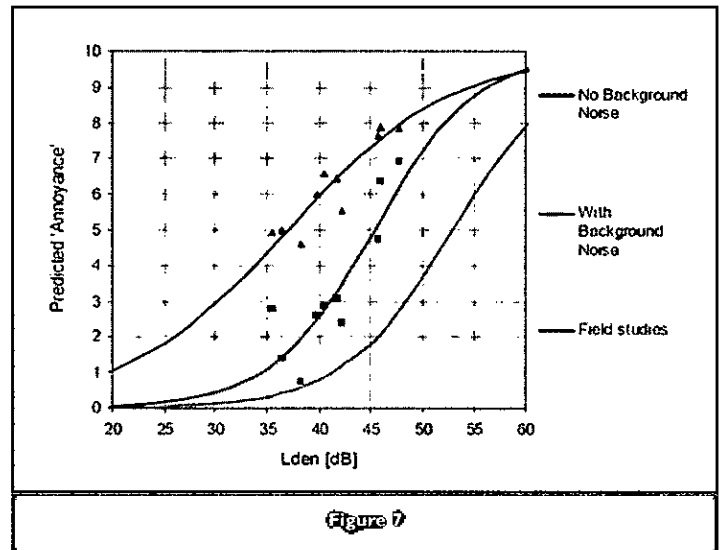


Figure 7
Annoyance of wind turbine sounds. Prediction model on annoyance for 90-second wind turbines sounds with and without natural background noise. SV Legarth, Auralisation and assessment of annoyance from wind turbines: 2nd international meeting on wind turbine noise, Lyon, France 2007.

influence the responses, such as the visual impact of the wind farms and real and perceived injustices regarding the development of such schemes. Additionally, several studies suggest that wind farm noise can be more disturbing than transportation and general industrial noise sources.

The dose responses established so far typically follow the pattern already established for many types of noise source. The data on response versus level are widely spread and therefore the correlation between level and response is not particularly strong. There does not appear to be a step change in response at any specific threshold noise level, or over a narrow range of noise levels.

Virtually all studies so far on the impact of wind farm noise have been cross-sectional studies of the effects of the noise under steady state conditions ie studies of the reaction of a sample of individuals exposed to different wind turbine noise levels, not the reaction of individuals to changing turbine noise levels or the introduction of turbine noise into an existing soundscape without such noise. A cross-sectional approach only considers the impact of the absolute level of the noise and either does not take into account the characteristics of the noise or takes much less account of them, nor does it consider the possibility that the change itself may aggravate the noise impact, which is a well established effect (for example for transportation noise²³). It has been suggested²⁴ that when analysing possible statistical trends in noise annoyance reactions, even for steady-state noise, and especially for changing soundscape situations, the effects of the change should also be taken into account.

The type and level of background noise against which the wind turbine noise is heard may be important because it can help mask turbine noise and affect the connotation of the wind farm noise and therefore influence its intrusion and the subjective response. Although wind turbine noise can be perceived at levels below the existing ambient noise level, the onset of significant levels of community annoyance appears to at substantially higher levels: this means that there appears to be a reasonable degree of community tolerance of wind turbine noise, although this varies significantly at an individual level.

In common with other noise sources, the presence of acoustic features in wind turbine noise such as tonality and AM and the influence of non-acoustic factors are important in dictating the degree of impact.

However, whilst there are various methods which can potentially be used to assess the tonality of noise emissions, there is little guidance regarding the objective rating of effects attributable to other acoustic features such as AM. If methods of objectively rating the effects of these features can be developed, then it is likely

[§] For example, noise annoyance for the same level of transportation noise is greatest for aircraft, less so for road traffic and least for railway noise - H M E Miedema and H Vos: Exposure response functions for transportation noise. Journal of the Acoustical Society of America 104, 3432-3445 (1998);

that suitable corrections to take their impact into account can be developed.

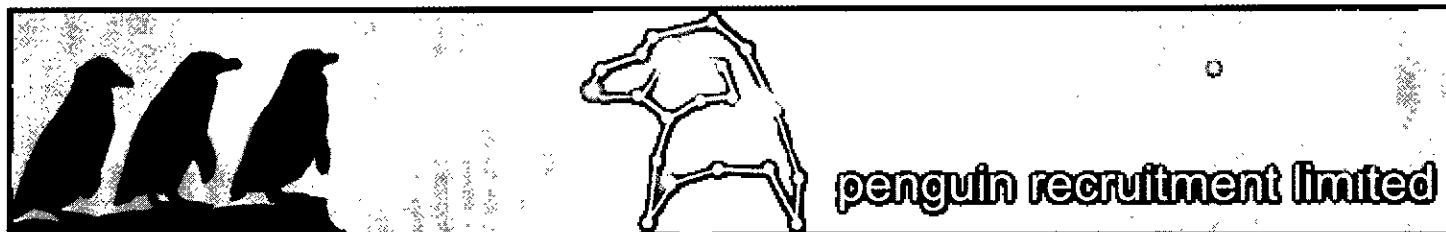
Accounting for the effect of non-acoustic factors is likely to be impracticable as the prevalence and degree of effect on individual response varies substantially, is location and scheme specific, and is volatile over time. Instead, as is common for many other noise sources, these factors are taken into account to some degree by the 'averaging' inherent in the development of community dose responses and using them to derive control limits.

This review has highlighted work which shows general trends in the response to wind turbine noise, but also indicates that there is sufficient uncertainty about human response to wind turbine noise to prevent a robust dose response being formulated at this stage. This is not unique for wind farm noise as similar degrees of uncertainty exist for other noise sources eg industrial noise in general²⁵. It may be that owing to the significant influence of individual non-acoustic factors, such a dose response may never be established. As a result, any guideline or noise limit criterion for wind turbines can only be informed by indicative trends in regard to response, weighed against the benefit of the turbines. This means that unless an unduly prohibitive stance is taken, whereby the guideline or limit criterion is that turbine noise must never be heard at any time, it is probable that some persons will inevitably exhibit negative responses to turbine noise wherever and whenever it is audible, no matter what the noise level.

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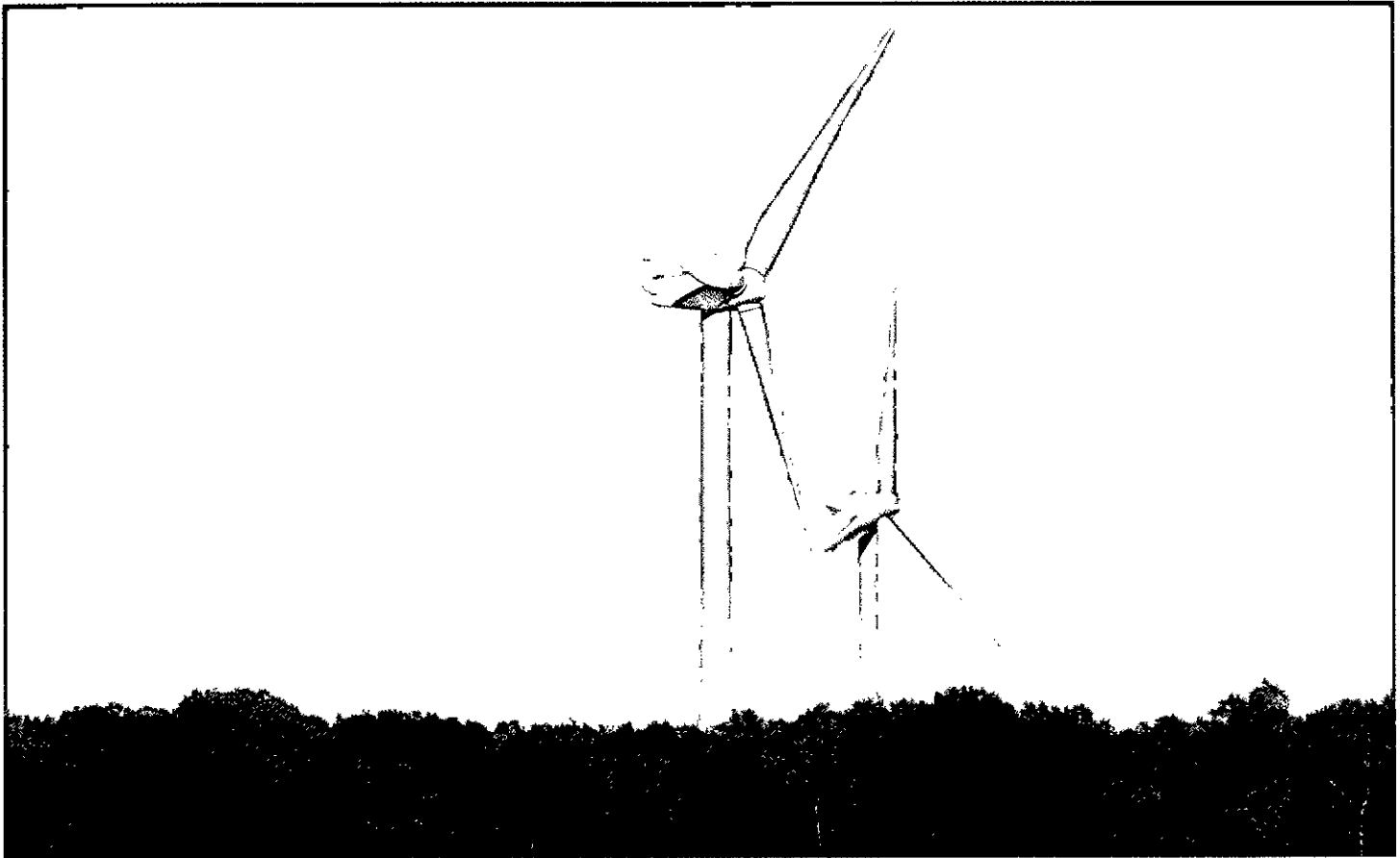
Wind Farm Noise Dose Response - continued from page 33

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A persistent whining noise could be inconsistent with sounds normally expected in such surroundings



The spectral characteristics of large are generally very similar to those of smaller models apart from a slight increase in the low frequency content for large turbines



University of Bedfordshire - RPG Absorbor and Class 1 Oak veneered Slotted planks. Photos by Adam Coupe Photography ©RPG Europe

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The sound of silence

Eoin King and Henry Rice. Preparing for the roar of electric vehicles

The World Health Organisation (WHO) recently estimated that at least 1 million healthy life-years are lost every year from traffic-related noise in Western Europe, and the social costs of noise from road and rail across the EU were recently estimated at €40 billion a year, about 0.4% of total EU GDP. The relationship between environmental noise and public health is perhaps the most significant reason why environmental noise has emerged as a major issue in environmental legislation and policy in recent years, and considerable resources worldwide have been expended in an effort to reduce road traffic noise levels. Maximum permissible noise levels for vehicles have been set in European Directives, strategic noise maps have been developed and are widely available, and every European Member State has developed noise action plans aiming to reduce exposure to environmental noise levels. However, environmental noise is still considered by many to be a problem that is actually getting worse. A radical rethink is required and an opportunity may be at our fingertips in the form of electric vehicles.

Electric vehicles

Many authorities are seriously considering the adoption of electric vehicles, particularly for city use. For example, the Irish Government has aspirations that 10% of the vehicles on Irish roads will be running on electricity by 2020 with its main electricity supply company ESB already developing the infrastructure necessary to support the use of these vehicles. It is planned that there will be 3500 on-street electric vehicle public charge points in Ireland by the end of this year. Interestingly, a not dissimilar facility was in operation in New York in around 1900, where a system of coin-operated 'charging hydrants' was established.

In addition to offering a solution to the emissions problems associated with the internal combustion engine, electric vehicles are also often reported as 'silent' vehicles so the development of an electric fleet offers a unique opportunity to significantly improve the quality of life for those living in areas of acoustical discomfort. The long-serving electric milk floats across the UK proved to be very suitable for delivering in the early hours of the morning. Recent research suggests that the A-weighted noise levels from electric vehicles may be 20dB lower than those of standard vehicles at rest, but the difference may be only 5dB at speeds of about 50 kmh⁻¹ because tyre/road noise then predominates.

Safety concerns with electric vehicles

There are now concerns about the relative quietness of electric vehicles, and plans are being formulated to ensure that threshold levels of artificial noise would be added in order to increase awareness in pedestrians of the presence of such a vehicle. The Department of Transport in the USA has identified that reduced noise from hybrid and electric vehicles can lead to significant increases in accident rates. Indeed, a bill 'Pedestrian Safety Enhancement Act of 2010' was actually signed into law on 4 January 2011. This bill directs the Secretary of Transportation to study and report to Congress on the minimum sound that is to be emitted from a motor vehicle to alert pedestrians to the presence of the vehicle, with specific attention paid to blind pedestrians. A similar committee has been established in Japan.

Is this a retrograde step?

At time of writing there is very little published information on the level of consideration to be given to these measures. The following issues are of concern:

- Who will govern what type of noise is appropriate? Could market forces dictate the type of sound to be emitted (at the expense of non-car owners)?
- Will there be an upper limit to the artificial noise? Acoustical indicators in use today rely on methods originally developed nearly 80 years ago, so it is unlikely that due attention will be paid to the type, nature or characteristics of any warning signal.

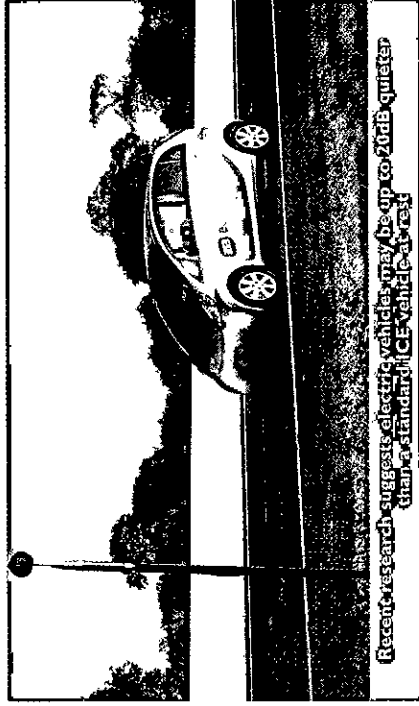
- Will there be a consideration of the 'annoyance' caused by these artificial sounds, and will they be continuous or driver-controlled?
- In a worst-case scenario could we end up eventually being exposed to a plethora of sirens, beeps, jingles, personal music or futuristic sounds, remembering that such artificial sounds will not be 'naturally' generated by the vehicle machinery?
- Finally, an excessive increase in warning sounds on the streets might even have a disorienting effect, thus defeating the original purpose.

Surely alternative safety initiatives must also be considered? Considering the costs associated with noise exposure the development of alternative, silent safety technologies should receive priority over artificial noise sources. Even today there are 'silent' road users that do not require the introduction of artificial sounds. Bicycles may be fitted with warning bells, electric cars and trams currently have (driver operated) horns or bells, and even reversing large vehicles are fitted with beepers or other audible warnings to alert passers-by to the presence of a (presumably unexpected) manoeuvring vehicle. More progressive thinking and a willingness to embrace new technologies should be encouraged. Intelligent sensors could be developed to emit more appropriate warning sounds at more suitable times. A certain amount of re-education will also be required. The UK's safe cross code of 'Stop! Look! Listen!' may need to be revised - but it should still include 'Stop' and 'Look'. The public needs to be made aware of the possible presence of an electric vehicle and drivers of these vehicles must be aware that they are driving a something which is effectively 'silent'. In short, an appropriate integration of these new technologies will require an education process.

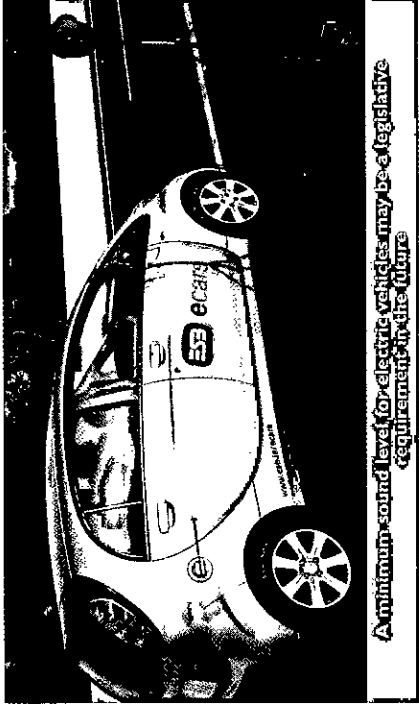
It might be remembered that one safety-motivated response to the replacement of horse-drawn vehicles was the the UK's Locomotive Act of 1865. This introduced vehicle speed limits of about 6kmh⁻¹ in the countryside and 3kmh⁻¹ in urban areas, with the added stipulation that vehicles be preceded at a distance of 55 metres (60 yards) by a pedestrian carrying a red flag. Could this red-flag-man be effectively replaced with a 21st Century sound track? Eventually this unworkable law was successfully challenged 31 years later when motor vehicles were emancipated and society moved on from the horse. It might not be easy to remove in the future a legislated intrusive annoyance originally introduced to ape an outdated transportation technology.

Dr Eoin King is a post-doctoral research fellow in Trinity College Dublin, Ireland, funded by the Irish National Roads Authority. He is the current Irish course coordinator for the Institute of Acoustics tutored distance-learning Diploma in Acoustics and Noise Control. He is also a director of Infrasonic Ltd, an Irish noise and vibration consultancy. In 2010 he was nominated by the Irish Department of the Environment to represent Ireland on the CNOSSOS-EU Technical Committee of experts. His research interests include environmental acoustics, environmental policy and strategic noise mapping techniques.

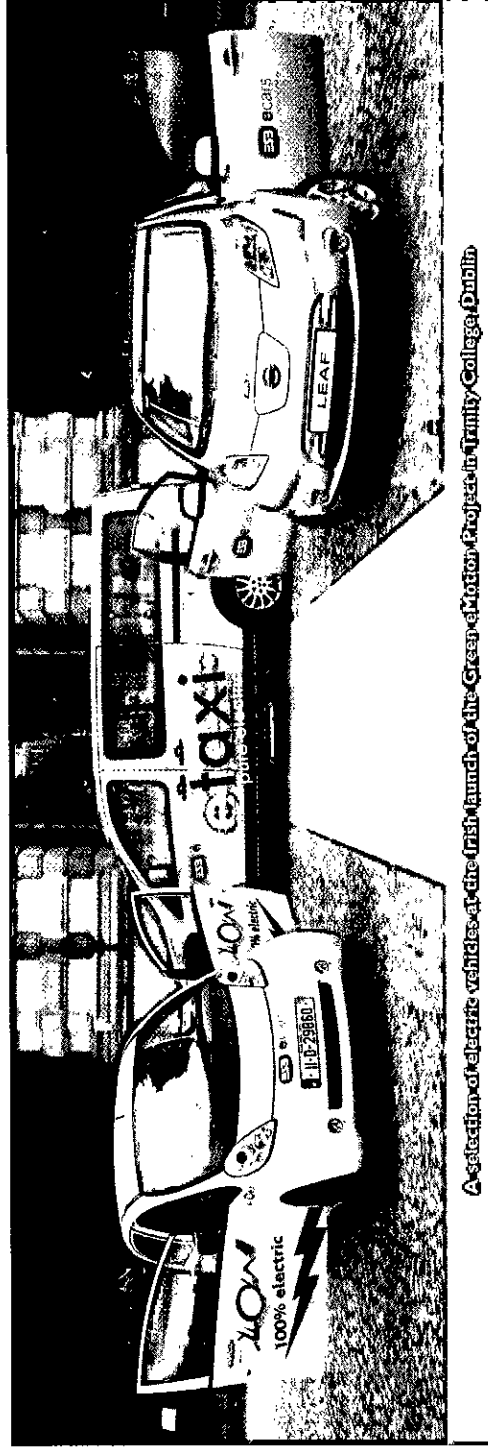
Prof Henry Rice is a mechanical engineer. He works in the area of numerical and experimental vibration and acoustics. He is a regular reviewer with the Journal of Sound and Vibration and other leading journals and has acted as a referee for EU and national funding programmes in the vibroacoustics topic area. He has over 25 years' experience in acoustics and some of his research interests include the analysis of vibroacoustic systems, numerical modelling of vibrations and acoustics at mid-frequencies, acoustic perception, and auralisation.



Recent research suggests electric vehicles may be up to 20dB quieter than a standard ICE vehicle at rest



A minimum sound level for electric vehicles may be a legislative requirement in the future



A selection of electric vehicles at the Irish launch of the Green eMotion Project in Trinity College, Dublin

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Concert Studio for the BBC Philharmonic Orchestra at MediaCityUK, Salford

Mark Howarth

Introduction

This article describes the acoustic design of a new concert studio for the BBC Philharmonic Orchestra at MediaCityUK, in Salford, Greater Manchester. The studio was completed and commissioned on October 2010 with the BBC Philharmonic moving in permanently in May 2011. The concert studio is within a studio block which also contains seven TV studios and a multi-purpose audio studio. The studio block was developed by the Peel Group and is operated by Peel Media Ltd with the concert studio, five TV studios and the multi-purpose audio studio leased to the BBC. The principal design and construction team members were: Fairhurst Design Group (architect); AECOM (MEP engineer); Jacobs (structural engineer); Bovis Lend Lease (contractor) and Gleeds (cost consultants and project management). Sandy Brown Associates were appointed as a sub-consultant to AECOM. The BBC appointed Akustikon/Gade & Mortensen to review the design and assist with commissioning on behalf of the orchestra.

Previous Studio

Studio 7 at New Broadcasting House, Oxford Road, Manchester was the home of the BBC Philharmonic Orchestra for 30 years. The studio was used for recording, rehearsals and live broadcast concerts with an audience of up to 250 people. The studio had a flat floor with loose movable risers for staging. Bleacher seating accommodated audiences for concerts but was normally retracted during recording sessions and rehearsals. The gross internal dimensions were length: 26.6m, width: 22.2m, height: 14.025m, with a volume of 8282m³ and floor area of 590m². A 0.3m zone within this was used for sound absorbent treatments, diffusing fins, and for ventilation routes, which resulted in an effective net floor area of approximately 560 m². The studio was well regarded for recording and considered by sound engineers to have a 'balanced acoustic with minimal colouration'. Musicians, however, had a less favourable opinion of the studio with regard to the ease of hearing each other. Measured reverberation times in the studio are shown in Table 1. Measurements were made with the room unoccupied but with music stands, musicians' chairs and percussion instruments present.

An average early support, STEM, of -15.1 dB was measured on the stage area when set up for a typical orchestra rehearsal. A photograph showing the studio appears in Figure 1.

Brief For New Concert Studio

The new Concert Studio was specified to have variable acoustic treatments to enable the following reverberation time conditions to be achieved:

- 1) Live condition, T_{30} (average 250Hz-4kHz) to be greater than 1.8s in an occupied state with audience;
- 2) Dead condition, T_{30} (average 250Hz-4kHz) to be less than 1.6s in an unoccupied state with audience seating retracted.

The studio was to provide suitable conditions for an orchestra and be able to provide stage conditions to provide ease of ensemble and ease of hearing for musicians. The background noise level was to meet BBC criterion GTO. This provides maximum third-octave band sound pressure levels, which are approximately equivalent to an A-weighted sound pressure level of 22dB, along with requirements for controlling tonal, temporal and spatial variations.

continued on page 40

	$T_{30, mid}$ seconds	$T_{30, (125-250Hz)}$ seconds
seating retracted	2.0	1.7
seating exposed	1.9	1.6

Table 1

Measured reverberation times in Studio 7, Oxford Road, Manchester (August 2007)

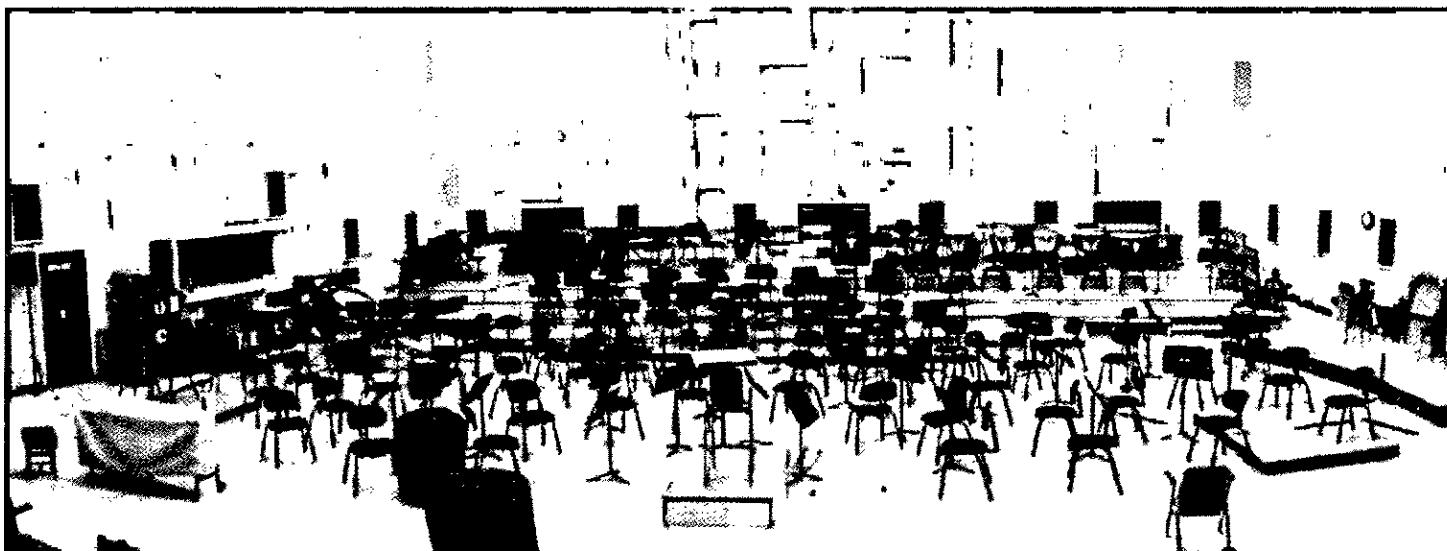


Figure 1

Previous concert studio at New Broadcasting House, Oxford Road, Manchester

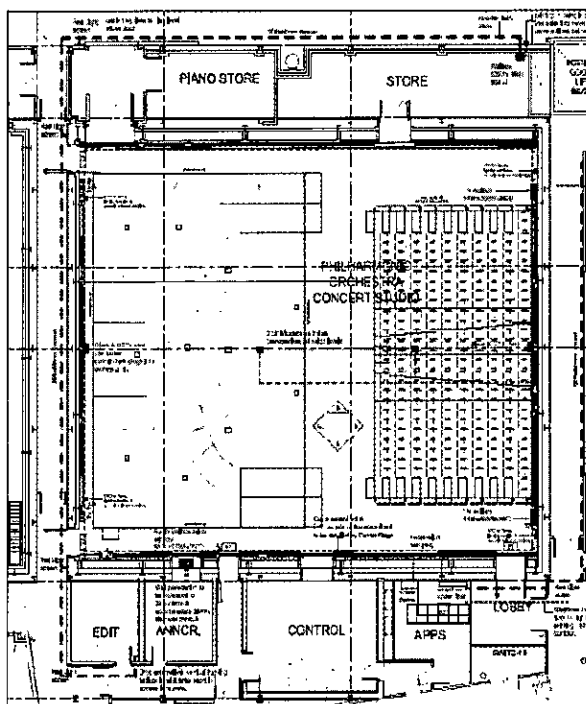


Figure 2

Plan of new concert studio

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Concert Studio for the BBC Philharmonic Orchestra - continued from page 38

New Concert Studio Construction

Dimensions and layout

The new concert studio has internal dimensions of length: 26.8m, width: 22m, height: 16.5m with a volume of 9728m³ and floor area of 590m². The floor area is therefore similar to the previous studio but with a larger volume. The layout is arranged so that the studio is buffered from other studios and service areas by corridors and other rooms. A stage takes approximately half of the floor area with the remaining floor area available for bleacher seating, or for larger orchestra layouts when required. The general arrangement is shown in Figure 2.

Shell construction

The structural floor is concrete on piles with a floated concrete floor above on jack-up isolation mounts. A stage pit is provided to house mechanical risers for an adjustable stage, as indicated in Figure 3.

The walls are a cavity construction of floated dense blockwork inner leaf with an independent plasterboard outer leaf with mineral fibre cavity insulation. The studio has a lid of concrete on profiled metal decking to complete a floated inner box. A concrete roof is located above this. Air supply ducts drop along the two side walls and these are boxed with two layers of cement board and two layers of plywood to reduce low-frequency resonance. All door access is lobbied and angled double glazing with a wide airspace is used to the control and announcer rooms, and for high-level internal viewing windows.

Ventilation and lighting

The studio is air-conditioned using a displacement system with a roof-mounted dedicated air handling unit. The air supply is fed through sound insulating ductwork at roof level via the roof void and ductwork to low-level grilles along the side walls. High level extracts return air through attenuated ductwork through the studio lid and roof void. High frequency fluorescent lighting is used for general lighting and this is supplemented by smaller adjustable task lighting fixed within the orchestra canopy.

Room Acoustics

Finishes and acoustic treatments

The floor finish is solid timber directly fixed to the floated concrete floor for the non-stage areas. The end walls are of painted blockwork. The side walls are of painted cement board. The ceiling is an exposed soffit of profiled metal decking supporting a concrete lid. Three types of sound absorptive treatment are employed:

- Panels of medium-high sound absorber of 50mm melamine foam
- Low-frequency absorbers of BBC 'D2' modular boxes
- Movable 'duvets' of 100mm thick fabric-wrapped mineral fibre panels on sliding rails.

Bands of slatted timber positioned 0.3m from the walls are used to provide surface scattering. The slats are open where they are over untreated wall and foam panels, and backed by plywood where they conceal movable duvets. Behind the open slats, the foam panels are arranged in patches on the painted walls to provide diffusion through impedance differences. A photograph of treatment on the wall behind the stage treatments is shown in Figure 4.

Stage design

Design of the stage was carried out in close collaboration with representatives of the BBC Philharmonic Orchestra. The design intent was to provide a defined stage area with tiered risers to minimise distances provide clear lines of sight between orchestra members. To achieve this, the starting point of the design was a tiered semicircular riser arrangement, similar to that used at halls such as the Berlin Philharmonie, the Muza Kawasaki Symphony Hall, Tokyo and the Walt Disney Concert Hall, Los Angeles. The BBC Philharmonic Orchestra regularly tours internationally so the players are familiar with different

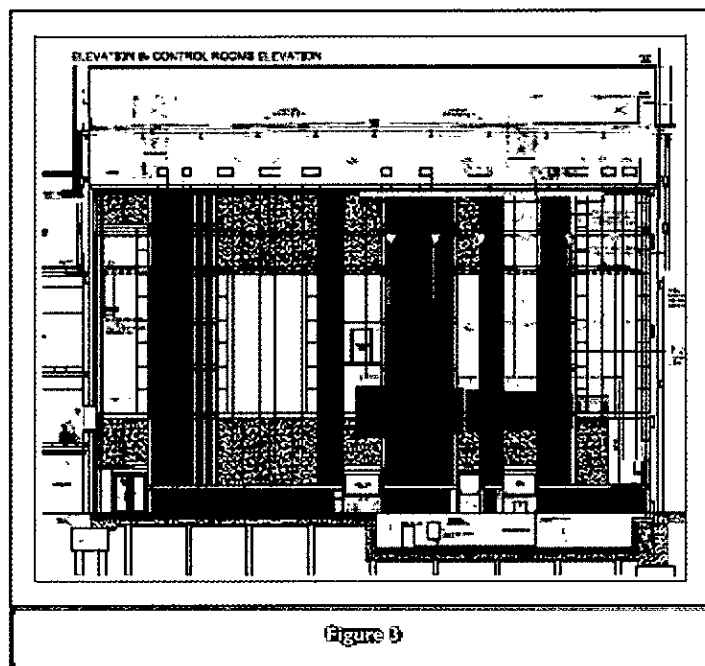


Figure 3
Long section of studio showing pit for stage

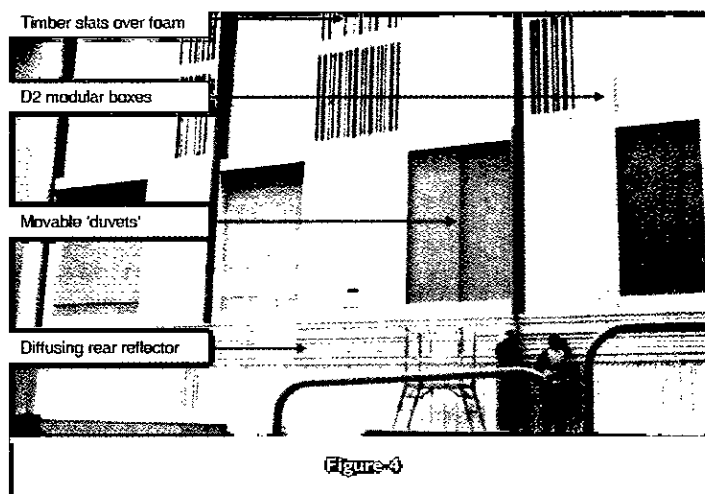
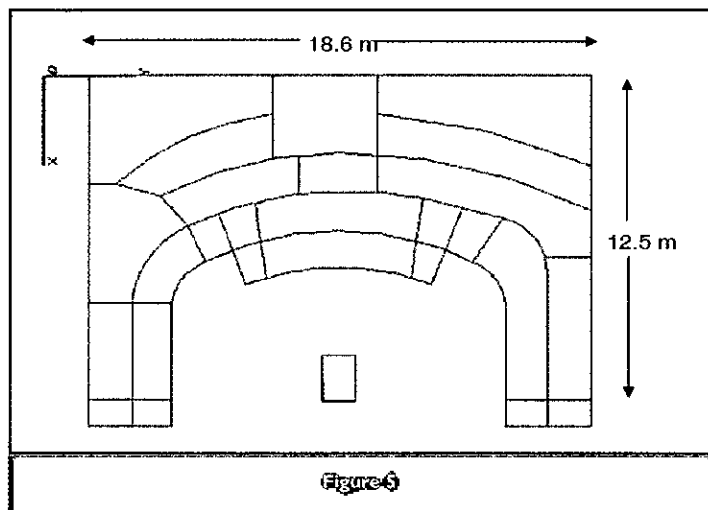


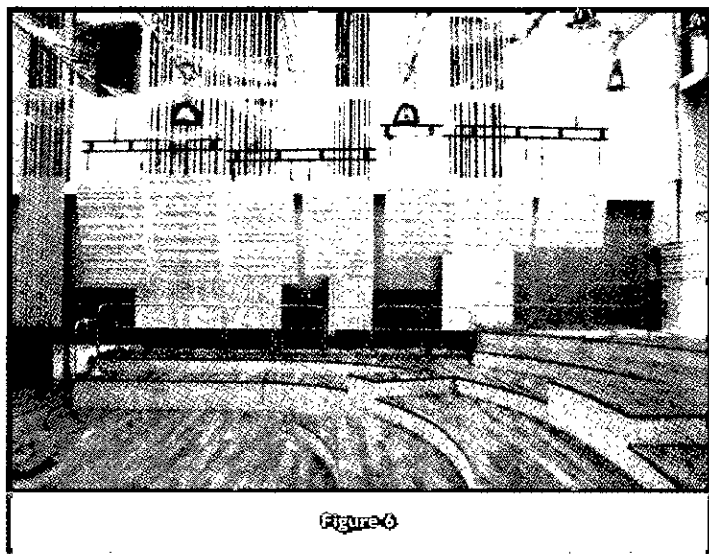
Figure 4
Photograph showing wall treatments

stage types and arrangements. During the development, an initial riser layout following the semicircular form was marked out on the flat floor of the existing concert studio and the orchestra members arranged themselves for rehearsals for a week. The feedback from this exercise was informative. It illustrated that the simple semicircular arrangement limited the space available for musicians. While musicians were prepared to accept space constraints when performing on tour, when they may only need a few hours on a stage, they did not feel it was suitable for everyday rehearsals. In many of the halls with semicircular risers visited by the orchestra, risers provided insufficient space for cellists and double bassists to use spikes on the stage. This meant extension pieces were required to hold instrument spikes off the stage risers, so players lost the low frequency resonance assistance often provided by risers. The BBC Philharmonic also plays a wide repertoire of music which often requires use of large or unusual instruments, which they like to be able to locate towards the side or rear of the orchestra. The riser layout was therefore developed to provide sufficient space and flexibility for the different uses.

All main risers are mechanically operated from a central control. Loose 1m wide extension pieces are also provided for addition when the music requires extra musicians. Each riser is adjustable with a step height of up to 0.3m. To assist with resonance, 38mm solid timber on



Sketch plan of stage riser layout



Side view of stage with side and overhead reflectors (before 'tuning')

300mm battens is used for areas designated for cellos and double basses. The remaining stage floor is a 38mm laminated construction of timber on a plywood backing.

Orchestra reflectors and diffusers

To the rear of the stage a timber reflector with applied battens of different dimensions is used to provide surface scattering. The upper half of the reflector is to be angled and adjusted during tuning with the orchestra. To the sides of the stage, timber reflectors with applied battens are suspended and angled downwards and forwards. These provide early diffuse reflections and reduce early decay time on the

stage. Forty-five acrylic reflectors with dimensions of 1.8×0.8 m and a thickness of 10mm are arranged over the orchestra with increased numbers over the string section to provide more support where needed. These are suspended at the corners to curve under their own weight. The overhead and side reflectors are suspended on mechanically operated hoists which are set using the same central control as for the stage risers. A photograph of the stage with risers at full-height showing the side and overhead reflectors (before tuning) is shown in Figure 6.

Tuning And Commissioning

Subjective tuning

As part of the commissioning process, acoustic tests were carried out with the orchestra during three days in September and October 2010. The first day's testing was carried out with a small orchestra playing Mozart and Schumann/Holloway pieces. The overhead reflectors were adjusted in height and feedback from the orchestra indicated a preference for lower reflector heights than anticipated. The curvature of the reflectors was greater than expected and it is thought that this reduced harshness even with very low reflector positions. A second day of testing was carried out with a full orchestra playing Rachmaninov's 2nd Symphony. Musicians completed a subjective questionnaire, provided by Akustikon/Gade & Mortensen, to rate different configurations of reflectors, stage positions and absorption. The results of this testing were used to optimise the reflector positions and variable absorption settings. These were set for the final day of testing to ensure that the orchestra was happy with them. Initial feedback from the BBC Philharmonic has been positive, particularly in respect to the ease with which musicians can hear each other.

Objective measurements

Reverberation times

A summary of the measured reverberation times with in various configurations for comparison with the requirements of the brief is presented in Table 2.

STEM values

During the commissioning tests, average Early Support, STEM, values of -11.6 and -12.2 dB were measured on the stage area with absorbent panels respectively fully exposed and fully retracted. However, further tuning was undertaken following the measurements which resulted in increased height of the overhead reflectors, and repeat measurements were conducted in May 2011.

Acknowledgments

The author is grateful to Trevor Cousins and Evanthis Simitsi of Fairhurst Design Group Graham Millard, Belinda Hatton and Ben Hooker of AECOM, Richard Wigley, Fiona McIntosh and Richard Cole of the BBC, Anders Gade and Jan-Inge Gustafsson of Akustikon/Gade & Mortensen, and Neil Spring for discussions regarding the development of Studio 7 at New Broadcasting House.

Mark Howarth is with Sandy Brown Associates.

This article is closely based on his presentation at Auditorium Acoustics, Dublin, 2011.

config.	variable absorption	bleacher seating	requirement	average RT, s (250Hz-4kHz)
A	dead (all panels exposed)	occupied	maximum RT 1.6s	1.44
B	live (all panels hidden)	occupied	minimum RT 1.8s	1.81
C	dead (all panels exposed)	seating exposed	maximum RT 1.6s	1.47
D	live (all panels hidden)	seating exposed	minimum RT 1.8s	1.86
E	dead (all panels exposed)	seating retracted	maximum RT 1.6s	1.60
F	live (all panels hidden)	seating retracted	minimum RT 1.8s	1.86

Table 2

Summary of RT results in studio with orchestra

Industry news

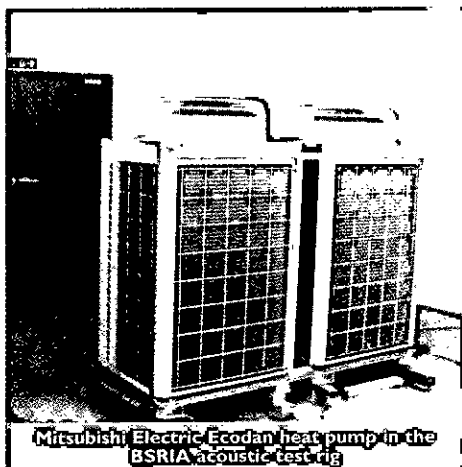
New acoustic test rig

This year the Building Services Research and Information Association, BSRIA, has added to the capabilities of its test laboratory in Bracknell having completed a new acoustical rig for testing of airborne noise from space heating and cooling products.

The 210m³ reverberation chamber has been independently qualified in accordance with BS EN ISO 3741. It has been designed so that there is full control of temperature and humidity within the chamber, thus enabling simultaneous measurements of thermal performance and noise levels. This control allows a replication of a range of typical real-

life operational situations in accordance with measurement standards. BSRIA is able to supply manufacturers with accurate, reliable, and relevant data on their products. Acoustical testing is a mandatory requirement of EN 14511, and of some incentive and quality schemes that call upon EN 12102:2008 for sound power measurement. This applies to heat pumps, air conditioners, fan coils, liquid chilling packages, dehumidifiers, and other space heating and cooling products. BSRIA is also able to offer acoustical testing for boilers, radiators and bespoke requirements.

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St Pancras Chambers

An ideal location, especially if you are a rail enthusiast with a fascination for quirky architecture, can be found at one of London's latest apartment conversions. Originally part of St Pancras railway station and the adjoining Midland Grand Hotel (now the five-star Renaissance Hotel), St Pancras Chambers is a complex of 67 individually designed apartments carved out of the interior of George Gilbert Scott's gothic Grade I masterpiece fronting London's Euston Road.

The apartments occupy the top five floors of this magnificent building, which began its life in 1873. However, to create high calibre living spaces within a building boasting a maze of gigantic vaults and timber roof frames represented a real challenge to developers, the Manhattan Loft Corporation, particularly when it came to providing 'mod cons' in parts of a building which had been abandoned for 75 years.

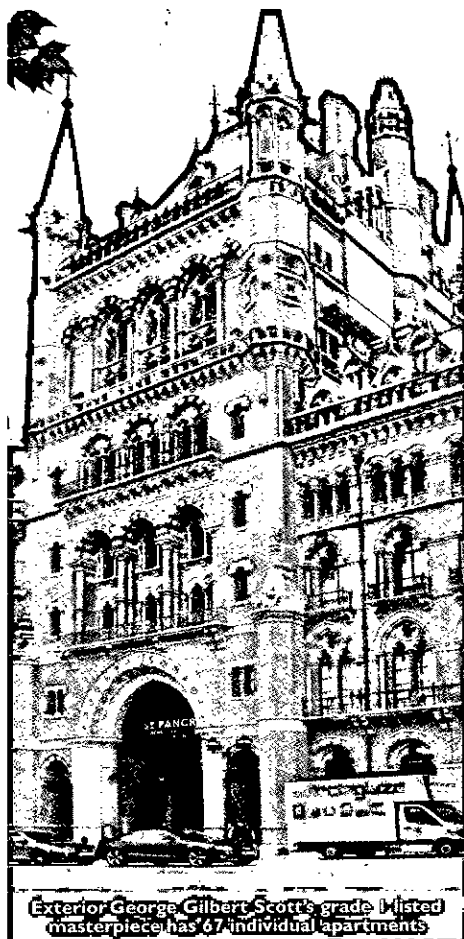
Perhaps one of the most spectacular apartments, as featured here, belongs to Peter Tompkins. Spreading over two floors, it incorporates the main access to the service tower of St Pancras Station's 80m high landmark clock, which cleverly helps to create a living room with a ceiling 10 metres high, mezzanines and balconies — all with unparallel views across the station. Peter says that most of the apartments were sold off-plan so it was not until last winter that the owners began to realise just how cold they could be. With the original single-glazed lancet windows retained in line with English Heritage requirements, even after installing seven radiators in one of his rooms, he was unable to heat the apartment adequately. Speaking on behalf of several owners, Peter went on to say that they contacted Selectaglaze because they knew that secondary glazing was permitted by heritage bodies. They were also aware that to

insulate the windows in St Pancras Chambers would present a challenge because of the sheer size and multitude of shapes. Selectaglaze produced individually tailored secondary units that exceeded all expectations, not only from a thermal point of view but because the noise from Euston Road can no longer be heard. In addition to Peter's 'Tower Room', where the windows have been treated with Selectaglaze's Series 45 slimline side-hung casements, the 4.6 metre high master bedroom with bathroom mezzanine features four monumental windows treated with their Series 30 slimline lift-out units which offer a practical way of treating windows that are rarely used, but which need access for cleaning or maintenance. Other windows within the apartment were treated with Series 10 horizontal sliding units.

This is a highly theatrical space and the owner feels privileged to live there, particularly now that cold days are a thing of the past. The unique apartment with its spectacular views is so stunningly presented that it is now available to hire for drinks receptions, private dining, small musical events and art exhibitions.

Royal warrant holder Selectaglaze is the UK's leading secondary glazing specialist. The company recently launched a new Guidance Note on the ability of secondary glazing to improve a building's energy performance. This is proving to be of great interest to owners and managers of all types of buildings looking to reduce energy usage and so manage costs and environmental impacts. A new comprehensive Product Guide demonstrating the range and diversity of styles is also available together with technical information, detailed drawings and photography.

The launch of these two publications comes in a year which sees the company celebrate its 45th anniversary and move into new



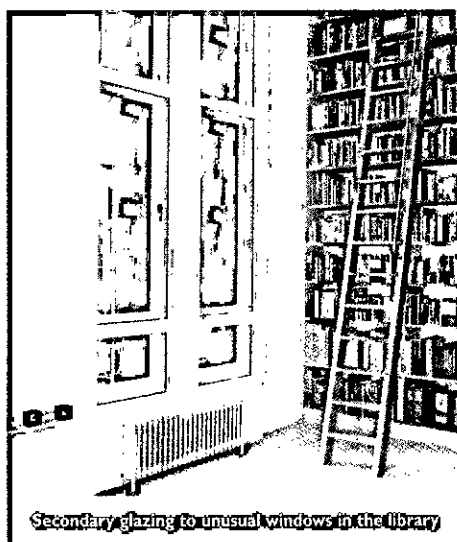
Exterior George Gilbert Scott's grade I listed masterpiece has 67 individual apartments

purpose designed factory and office premises in St Albans.

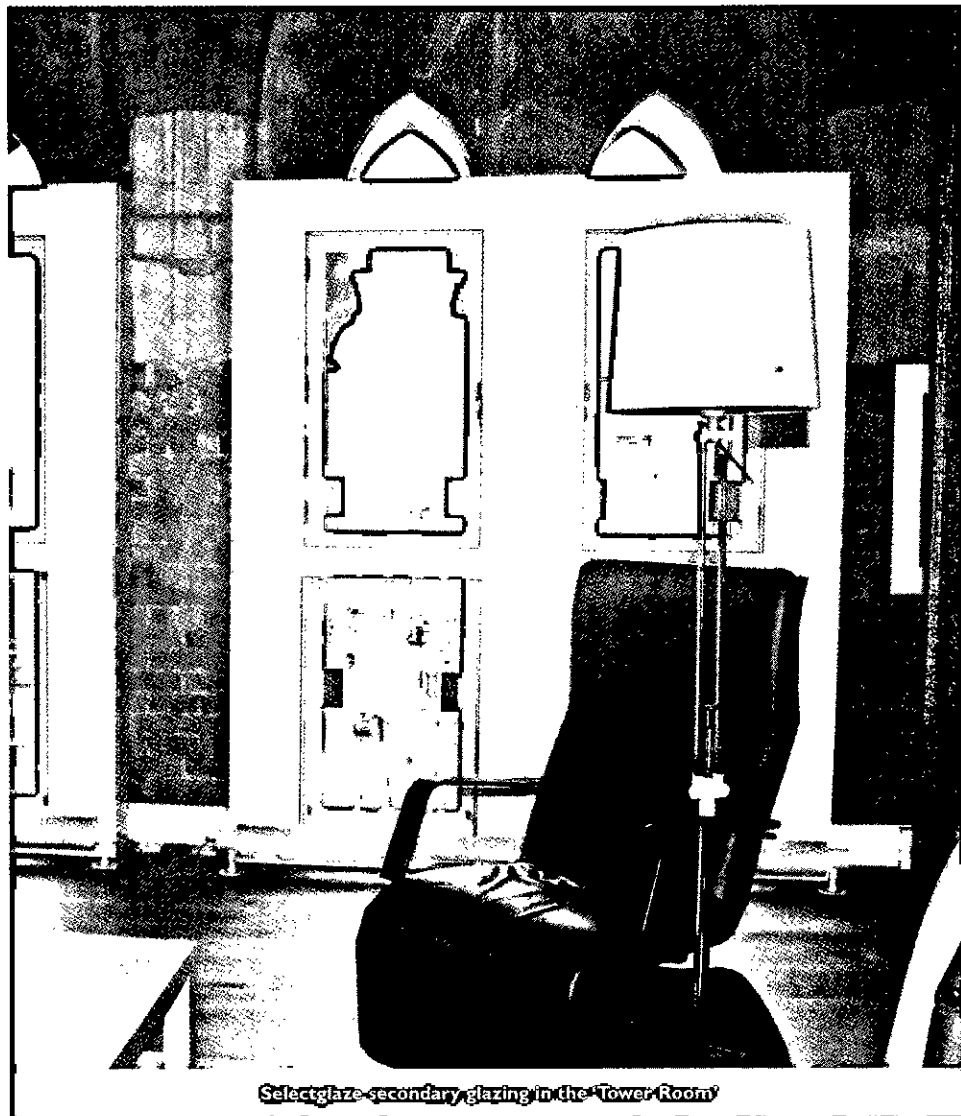
For further information, please contact Selectaglaze on 01727 837271; enquiries@selectaglaze.co.uk or visit: www.selectaglaze.co.uk



Spectacular views from the dining room



Secondary glazing to unusual windows in the library



Selectglaze secondary glazing in the 'Tower Room'

CMS Acoustics and Danskin

Merge for a sound future

The merger of two market leading acoustic solution providers, CMS Acoustic Solutions and Danskin, has created a one-stop operation for specifiers, architects and contractors to form the UK's largest dedicated acoustical product supplier, CMS Danskin Acoustics.

The merger represents the union of two complementary businesses for the benefit of their customers. Offering nationwide coverage with three strategically located offices, operations will combine manufacturing facilities with specialised technical support. In turn this will allow customers the peace of mind that the entire spectrum of acoustical challenges can be fulfilled.

Specialists at working to provide solutions that meet the requirements of Part E, Section 5, BB93 and other noise regulations, CMS Danskin Acoustics will offer a combined

CMSDANSKIN

ACOUSTICS

product portfolio that will be unrivalled in breadth and depth for acoustic insulation, sound absorption and reverberation for all types of applications.

CMS is headquartered in Warrington with a second office in St Ives, Cambridgeshire. It has played a leading role in high profile acoustic projects such as The Grand Theatre, Leeds; News International, Broxbourne; The Nanoscience Laboratory; Cambridge University and The Young Vic Theatre, London.

Danskin has been a manufacturer and supplier of innovative high performance acoustic floor treatment products for over 40 years.

Now part of SIG Plc it is able to supply not only the widest range of acoustic products but also provide the practical experience to help achieve any noise control requirements. Danskin pays particular regard to environmental considerations and was the first Scottish acoustic products manufacturer to gain full PEFC and FSC timber chain of custody. Danskin resilient layers are selected to ensure the minimum environmental impact and products are manufactured to ISO 9001 standards.

For further details on the merged organisation's full product portfolio, email info@cmsdanskin.co.uk

Armstrong Ceilings

Helps bring the Bishopsgate up to date

Canopies from Armstrong Ceilings used on the ceilings, and more unusually, the walls, of the Grade 2 listed Bishopsgate Institute in London have helped reduce noise to a more acceptable level for staff and visitors. Around 150 of Armstrong's mineral Optima and Ultima canopies, in a variety of shapes and sizes including circles, squares, rectangles and concave and convex formats, were specified by Sheppard Architects for the reception area, Great Hall stairwells, corridors and side rooms.

For the Great Hall, Armstrong worked with the architects, acoustical consultants Adrian James Acoustics and Armstrong-approved Omega installer PCC Interiors to adapt the Optima canopies to pioneering vertical hangings on the walls.

The £4.5 million refurbishment of the building was completed in two phases by main contractors Neillcott Construction to allow it to remain operational throughout, as it is the venue for courses for adults with a focus on arts, culture and new ideas; cultural events including concerts, talks and debates; a historic library, and corporate hire.

Christopher Palmer of Sheppard Architects LLP said that aesthetically there was a good choice of shapes and sizes from Armstrong that were not readily available from their competitors. The view was taken that the 'modernish' aesthetic would, by contrast, be complementary to the heritage building. Because of its historic nature the design stuck mainly to the more formal flat squares and

rectangle shapes, only introducing concave and convex canopies to highlight specific points within the building. The different sized shapes allowed patterns to be designed for suspension below the historic ceilings so that perimeters with historic decorative corning and other architectural features would still remain visible in their full extent. There were also architectural reasons to need to integrate lighting into the canopies so that the historic ceiling above did not become too cluttered with canopies and lights suspended separately, circular apertures were cut in the flat panels to allow fitting recessed luminaries.

The acoustical issues were another matter. The acousticians for the project confirmed that the products met their criteria for sound control, and in conjunction with other acoustic assemblies the building is now much quieter within the general circulation areas. These were previously prone to high levels of noise from the existing hard-surfaced floors, walls and ceilings. Within the Great Hall, wall-mounted canopies have successfully contributed to modified reverberation times for both speech and music, and high reverberant noise levels in corridors have been successfully reduced by adding large areas of absorption. The requirements for acoustical adjustment were initially assessed by computer modelling, and following completion of construction, the reverberation times were confirmed to be within criteria by on-site acoustics measurements.

In their completed state the wall-hung groups

of canopies look very effective and because they are quite lightweight, it was not particularly challenging to install them in this manner. The products were erected swiftly and were quite easy to integrate into the Grade 2 listed building without damage or consequential loss to any part of the historic building fabric.

PCC Interiors had a team of four on site for a full year and although it was not a particularly large project for them, it was pioneering in its use of the Optima canopies on the walls which required the design of a special 100mm bracket.

There were access challenges as the walls had architectural covings and timber mouldings which had to be worked around, or the canopies had to be designed around them, so although Armstrong and their products were well-known by the installation team, the boundaries were definitely being pushed.

Vanguardia Acoustics

Publication of pop concert research

In November 2009 Vanguardia was awarded a Defra research contract to review environmental noise at concerts. The research papers have now been published and are available to view online.

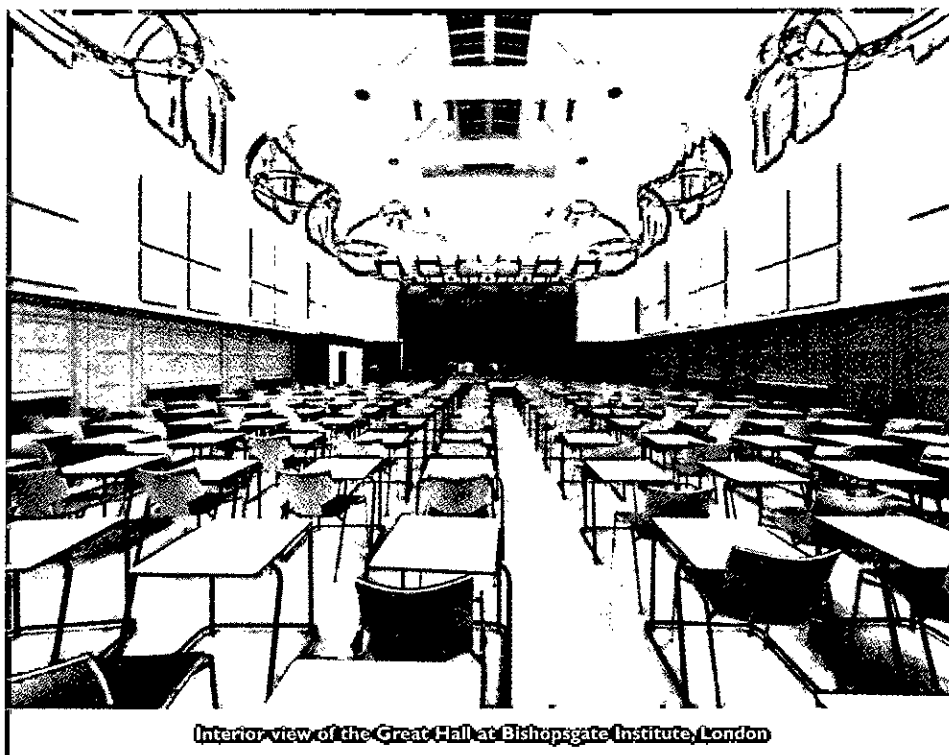
The research was necessary given the growing demand for concerts in the UK coupled with the change in licensing regime, so there was a need to establish a robust relationship between noise and community disturbance from varied types of music events. During the 2010 season of concerts, Vanguardia carried out noise surveys at numerous events throughout the UK, and in addition to this, further social surveys were completed to discuss community disturbance.

Surveys were conducted at the concerts listed below:

- Pink, Coventry and Glasgow
- Proms, Swansea
- Evolution, Newcastle-upon Tyne
- Green Day, Wembley Stadium and Manchester
- Mowtown, Kenwood House
- KISS, Wembley Arena
- Pride, Brighton
- Help for Heroes, Twickenham

The advice taken from this will contribute to the revision of the Noise Council's Code of Practice on environmental noise control at concerts.

The links to the reports are on the project pages. Go to <http://randd.defra.gov.uk> and enter 'NANR292' in the search box.



Interior view of the Great Hall at Bishopsgate Institute, London

D-I-Y SRS!

Acoustic insulation for BBC 'Children In Need' project

Sound Reduction Systems Ltd (SRS) has recently been approached by the team at BBC's D-I-Y SOS to help out on a very special project in Liverpool. Nick Knowles and his team have been involved in the restoration of the Norris Green Youth Centre in Liverpool as part of a special programme for Children In Need.

The project has managed a complete refurbishment of the Youth Centre, which is a vital part of the community, helping the local kids of this deprived area to stay away from crime by offering them opportunities that they otherwise would never have had. The project is the largest ever undertaken by the D-I-Y SOS team, and something of this size would usually take over six months and cost around £1m.

Thanks to the fantastic support of local trades and companies donating time, products and services, the project was fully completed in only nine days. Ian Osprey of D-I-Y SOS commented that he had watched footage from the reveal and the reaction from the staff and its users was immense, not to mention the number of trades with more than just a tear in their eyes! When D-I-Y SOS approached Bolton-based acoustical insulation experts SRS Ltd with a desperate requirement for acoustic insulation to treat the floor of a music studio within the building, the company was delighted to be able to donate some of its products to the cause. SRS contacted

its Liverpool-based stockists, Floorscan Acoustics, who delivered 80sqm of the market leading acoustic flooring system Acoustilay to site the very next morning. SRS director Alex Docherty, commented that when the company received the call from D-I-Y SOS to help out with the acoustic insulation on this project, they were only too happy to contribute to such a worthy cause. The fact that one of their stockists happened to be in Liverpool allowed them to get the material to site very quickly indeed. SRS would like to wish everyone at Norris Green Youth Centre the very best of luck for the future.

Acoustilay is an extremely versatile acoustic flooring system, suitable for domestic and commercial projects alike. Simply loose-laid under most floor finishes, it is the quickest and most economical method of upgrading the acoustic insulation of a floor: it can also be used to meet Part E of the Building Regulations.

It is hoped that the special edition of D-I-Y SOS – 'The Big Build' will be screened on BBC TV in November. SRS Ltd is a specialist in the field of sound insulation and absorption for both domestic and commercial buildings.

Please feel free to get in touch with the market leading technical team for free, friendly advice on 01204 380074, visit the web site www.soundreduction.co.uk or email info@soundreduction.co.uk



BBC's Nick Knowles thanks SRS for its donation



Acoustic flooring system Acoustilay installed at the charity project

News from Brüel & Kjær

Model acoustics

New room acoustics modelling software

Brüel & Kjær has launched a flexible, faster and more comprehensive version of room acoustic prediction software, ODEON 11.

This latest version enables users to perform their calculations twice as fast as before, with the addition of a new ray-radiation pattern based on the Fibonacci spiral. This spiral provides the same calculation precision, but with half the number of rays.

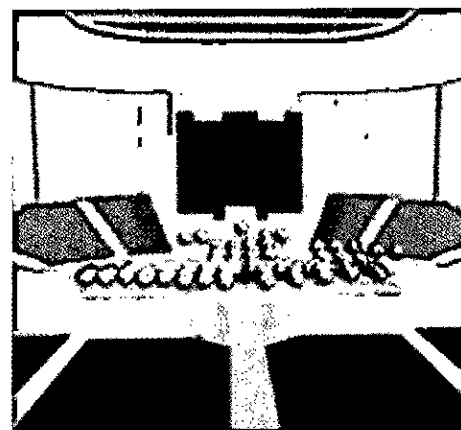
ODEON 11 also has multi-core support, allowing multiple grid calculation points to be processed simultaneously. The more cores, the faster calculations can be performed. With a quad-core processor, for example, grid processing will speed up by a factor of five, so

- combined with the new ray-tracing technique - job calculations will be ten times faster than they were previously.

Users can specify the parameters to be calculated and displayed for a particular project. Preferences can also be saved in user-defined templates. ODEON 11 combines this with a new, general way of defining room acoustical parameters, enabling expansion of the default set of parameters. This means if the exact parameter needed is not available, it can simply be defined by the user.

For more information, visit <http://www.bksv.com/Products/RoomAcousticsSoftware/ODEON>

continued on page 46



A screen capture from ODEON



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News from Brüel & Kjær - continued from page 45

Prevention is better than cure

A wireless, lightweight, personal noise-dose meter

As noise-induced hearing loss is one of the most persistent and costly occupational health problems, Brüel & Kjær has launched a portable noise-dose meter that assesses work environments before the damage is done.

Millions of workers are at risk from repeated exposure to high noise levels. Once the damage is done, social and psychological handicaps can lead to potentially massive expenses from the loss of skilled labour, early retirement and worker compensation.

The noise dose meter type 4448 is shoulder-mounted and cable-free. It has been designed to accompany employees throughout their working day, measuring and registering all relevant data about their noise exposure. Type 4448 can be used to assess the risk of hearing damage to workers in noisy environments such as machinery workshops, forestry sites and music venues.



The type 4448 shoulder-mounted noise dose meter

Special versions are available for use in hazardous areas, such as mining and petrochemical facilities, where only certified equipment can be legally used. The type 4448 is part of Brüel & Kjær's wide range of solutions for assessing noise and vibration exposure in the workplace.

For more information, visit:
www.bksv.com/Type4448

Sound and the city

A range of urban noise management tools

Urban noise management is a major concern for politicians, urban planners and municipal officials. There are many tasks involved in managing noise including solving noise complaints, noise mapping and policing noise limits, as well as noise abatement and zoning. Reports must be written, actions taken and the public must be kept informed.

Reduction of the noise levels by traffic regulation, low-noise road surfaces or noise barriers is very expensive, so it is important to know exactly which areas have the largest problems before investing in noise reduction. To help those involved in managing urban noise, Brüel & Kjær has created a wide range of tools for planning, assessment and noise control.

Noise planning prevents noise issues arising and optimises the use of resources by managing the future noise environment. This can be achieved through noise mapping software which performs a series of calculations and is essential for planning urban development of residential areas, such as with industrial sites, highways and airports.

Assessing noise is essential to ensure that noise limits are respected. Noise limits in urban environments are defined by the specific source type, such as traffic,



Urban noise management is a major concern

construction sites, industrial plants, entertainment and leisure activities - and for neighbours. Brüel & Kjær has created a variety of noise tools for environmental engineers including sound level meters with innovative wireless communication options, built-in high capacity sound cards and self-calibrating instruments.

Noise control practices can be employed for noise mitigation, including the development and enforcement of noise limits and urban design. Typically, the only practical way to managing compliance with noise regulations has been for organisations to purchase noise measurement equipment, software and training and use existing resources to operate the equipment on an ongoing basis. To simplify this, Brüel & Kjær has launched Noise Sentinel - an internet-based subscription service, which compiles the data and reports on behalf of the user. Noise Sentinel enables users to demonstrate that they are taking community noise seriously, reporting trends, handling noise disturbances and publishing information to the Web.

For more information visit:
www.bksv.co.uk/UrbanNoise

Recticel absorbers

Flutter echo solved by impact resistant class 'A' absorber gym panel

The acoustic treatment of a room depends not just on the requirement to control reverberation times but also on ensuring that the treatment is robust enough to suit the conditions of the application.

This is not so much of a challenge for offices, classrooms and other areas where minimal interaction with the room's surfaces is expected. However sports halls are a special case because the walls, ceilings and floors are often large, flat, hard, parallel and highly acoustically reflective surfaces. When coupled with minimal levels of equipment these all contribute to the high reverberation times

usually encountered.

Whilst treatments in the ceiling area and above ball impact height will help to reduce reverberation times, they will not reduce significantly the flutter echo which can interfere with the requirements for reverberation control.

Recticel has recently launched a new acoustic panel for demanding applications such as gymnasiums and sports halls. Recticel's Dutch acoustic division, Akoestikon, solved the noise problem at the Lyceum, Baarn, Netherlands using this innovative product.

Unlike more traditional acoustic panels,

because of its high ball impact resistance the panel can be placed at low level with no fear of damage from sports activities.

The newly built school complex consists of four gymnasiums of 350m² each: two of them can be combined into one larger gymnasium.

The measured reverberation time before treatment was between 2.3 and 2.7 seconds in each of the rooms, but about 100 panels mounted in each gymnasium reduced the time to a more acceptable 1.4 seconds.

In order to fulfil NOC/NSF (Dutch sports federation) regulations a reverberation time of 1.2 is recommended: this is slightly lower

than the BB93 recommendation of 1.5 seconds, and Sport England's 2 seconds.

The ISOL+ Impact S gym panel is a Class 'A' absorber which passes the DIN 18032 Part 3 standard. The panels are manufactured from robust acoustic foam inserted into a specially manufactured fire resistant cover which is easily cleanable and which if necessary can be removed and washed to remove heavy soiling. The impact standard was developed to assess ball impact resistance of wall and ceiling panels in sports facilities. Wall elements are classified as 'ball impact resistant' if they can withstand the impacts from a hand ball (54 times at 23.5ms-1 impact speed) and a hockey ball (12 times at 18ms-1).

Impact resistance is also relevant to ceiling systems, so the European Norm for suspended ceilings, EN 13964, has adopted the principle of testing impact resistance from DIN 18032-3. For suspended ceilings, three classes of impact resistance are defined - 1A, 2A and 3A - depending on the speed of impact of a handball.

The standard says that the speed of impact for suspended ceiling systems is reduced in relation to wall elements owing to the nature of the installation and the inevitable force of gravity, so other systems could possibly be more prone to impact damage if the lower forces used in the test are taken into account.

Some products are only classified as 2A (35mm)/ 3A (20mm) for mechanical impact according to EN 13964. The Impact S product

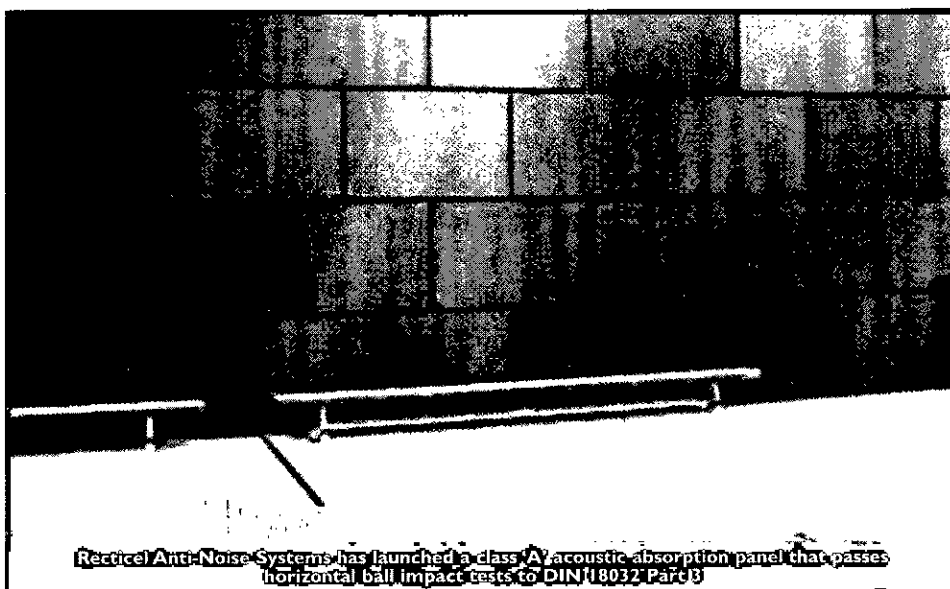
achieves ball impact resistance to the original standard for indoor sports panels for both wall and ceilings.

Recticel is a manufacturer and supplier of technical foams to a wide range of industries. The Recticel Group is one of the world's largest manufacturers and converters of polyurethane foam, supplying the sports, acoustic, industrial, retail automotive and filtration markets. The group has established itself as an innovative market leader with a heavy focus on research and development at

its own IDC (a €10m International Development Centre).

Recticel works in partnership with customers to develop new products for specific market areas, whilst also satisfying customers' needs through a wide and diverse range of existing products.

For further information please contact Chas Edgington at Recticel on 01536 402345 or email edgington.chas@recticel.com



Recticel Anti-Noise Systems has launched a class 'A' acoustic absorption panel that passes horizontal ball impact tests to DIN 18032 Part 3

GRAS Sound & Vibration

Introduces ANSI S12.42-compliant acoustic test fixture

GRAS Sound & Vibration of Denmark has announced the introduction of the 45CB Acoustic Test Fixture according to ANSI S12.42.

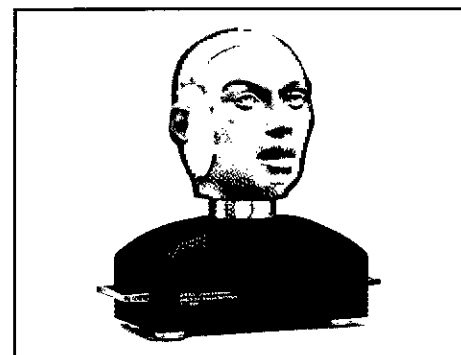
Offering high-reliability performance over a wide dynamic range, the 45CB is expressly designed to meet a growing industry need for commercially available acoustic test fixtures (ATF) that can help meet or exceed the ANSI/ASA S12.42 standard *Methods for the measurement of insertion loss of hearing protection devices in continuous or impulsive noise using microphone-in-real ear or acoustic test fixture procedures*.

The 45CB provides sufficient acoustic damping for objective measurements of both high-level continuous impulsive noise and the attenuation-related insertion loss encountered with active and passive hearing protection devices such as earplugs, earmuffs and safety helmets. The sturdy, high-temperature and humidity resistant construction of the 45CB is ideally suited for outdoor measurement environments, as well as simulated real-life conditions of test sites, vehicle interiors, aircraft and other areas. In addition, ear simulators with built-in quarter-inch pressure microphones ensure a

measurement system that can rapidly and correctly account for impulse peaks produced by heavy industrial and agricultural equipment, vehicle airbags and guns. They can therefore be used with any type of test signal or real-life noise source, including environments where the use of human test subjects is simply not possible, owing to high noise levels or expressed requirements for objective statistical data.

The 45CB fulfils requirements for real-life objective hearing protection measurements over a wide dynamic range, including self-insertion loss measurements of greater than 70dB over a wide frequency range. A peak dynamic level of 174dB allows for realistic testing levels. Levels of up to 190dB can be measured and calculated accurately based on closed ear measurements, combined with measurement of the transfer function of the open ear (TFOE). Ear canal extension dimensions, rubber coating and appropriate shore hardness make it possible to further measure the insertion loss of insertion plugs and other elastomeric materials at actual human body temperatures.

Controlled heating of the ear simulator ensures that any temperature-related



ANSI S12.42-compliant acoustic test fixture

performance issues of hearing protectors and ear plugs are accurately measured, and the widened soft tissue around the pinna accurately simulates sealing in the real-world.

The GRAS 45CB acoustic test fixture includes the head assembly, heating control panel and connectors for both couplers and heating elements; two ear simulators, based on IEC 60318-4, including a GRAS type 40BP quarter-inch pressure microphone and newly designed ear canal extension.

GRAS products are available in the UK from AcSoft Ltd of Aylesbury, a sponsor member of the Institute of Acoustics

For more information, visit www.ansihead.com

Acoustic ventilation products for excellent indoor air

Window vents, louvre panels and continuous louvre systems

Renson

The ability to control the level and frequency content of noise needs to be taken into account when designing a sound absorbing façade. The different sources of sounds, including those from children plying outside to fast-moving and urban traffic, must be taken into account. The level of external noise may vary as well as the frequency content, highlighting the difficulties for low-frequency noise reductions when designing a façade.

Since 1909 Renson has developed and manufactured innovative solutions and concepts which improve the living conditions of people and cut energy costs. As a specialist in natural and acoustic ventilation the Belgian company provides window vents, louvre panels and continuous louvre systems that ventilate buildings and meet acoustical requirements. An extensive research and development department has the benefit of the latest technology in order to accomplish the necessary analyses and tests, and works together with international organisations to provide innovative solutions. Renson Fabrications based in Maidstone, Kent provides these acoustical products to the UK construction market.

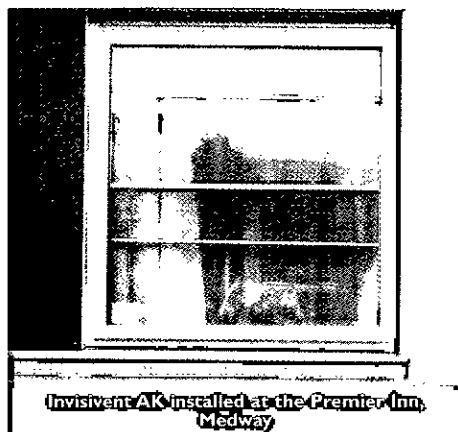
Invisivent AK

The Invisivent is a self-regulating thermally broken flap ventilator. Thanks to the installation above the window frame, the vent is almost invisible from the outside when designed with a stepped head. From the inside only the internal tip lever can be seen. This vent allows ventilation of the building without any disturbing influence from external noise (including that from a busy road) by means of the acoustical version Invisivent AK. This offers a maximum airflow of 12.9l/s per linear metre at 2Pa, and a claimed sound reduction in the open position of up to 49dB.

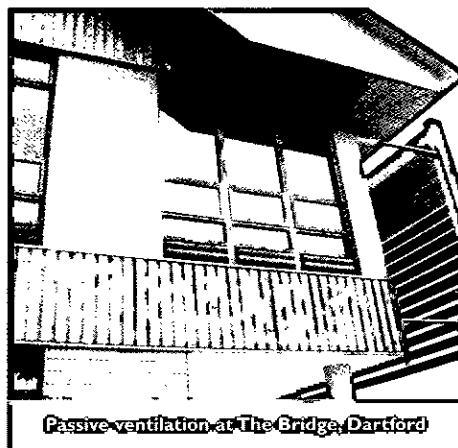
The Invisivent AK was used in the Premier Inn in Medway Valley Leisure Park in Rochester. The product was selected to provide each room with the necessary acoustical rating as specified in the Building Regulations Part E, and are visually unobtrusive.

Sonovent

Renson Sonovent is a thermally broken acoustic vent which can be installed on glass of thickness 20, 24, 28 or 32 mm or at transom (other glass thickness are available on request). Sixteen options are offered as four types each with four different free areas: small, medium, large and extra-large with an air slot of 10, 15, 20 or 25 mm respectively. The vent offers a maximum airflow of 26.7l/s per linear metre at 2Pa. Equipped with non-combustible mineral wool as noise-absorbent material, it provides an excellent sound attenuation figure whilst in open position, claimed to be up to 56dB.



Invisivent AK installed at the Premier Inn, Medway



Passive ventilation at The Bridge, Dartford

The BREEAM 'excellent' SusCon (Sustainable Construction) Academy was built at The Bridge near the Dartford tunnel. This building uses passive ventilation and natural cooling techniques to minimise the energy needs. The self-regulating Sonovent vent was used to maximise air flow but without compromising the acoustical comfort.

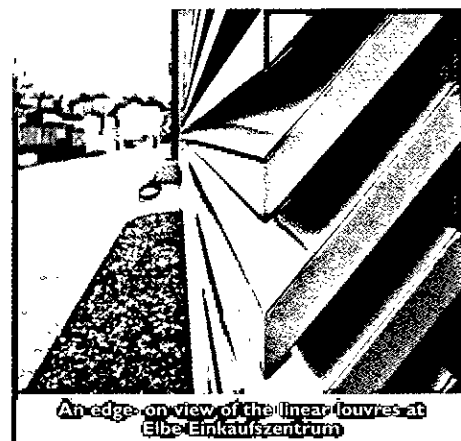
Acoustic louvre panels and the Linius acoustic continuous louvre system

The louvres and the Linius® continuous louvre system are aesthetically designed aluminium products allowing the passage of air in and out of buildings whilst protecting from wind, rain and vermin. They are also ideal for concealing unsightly equipment or façades. When specified with acoustic properties the systems also reduce noise ingress.

The acoustic blades consist of extruded aluminium sections with an inorganic mineral wool core (not flammable) and a perforated back. They combine a high physical free area with an excellent sound reduction. A complete set of louvre panels and acoustic Linius systems is offered, with sound insulation R_w (C; Ctr) ranging from 6 to 17 dB. Most of the blade types have been



Linius continuous louvre system at Elbe Einkaufszentrum, Hamburg



An edge-on view of the linear louvres at Elbe Einkaufszentrum

System	blade pitch mm	% visual free area	% physical free area	R_w (C; Ctr)dB
Louvre 445/86				
Linius L.060AC	60	74	34	6 (-1; -2)
Louvre 447/150				
Linius L.170ACS	170	59	37	9 (0; -1)
Louvre 446/150				
Linius L.150ACS	150	54	34.3	11 (-1; -2)
Louvre 447/225				
Linius L.170ACL	170	59	37	13 (-1; -3)
Louvre 446/225				
Linius L.150ACL	150	54	34.3	15 (-1; -4)
Louvre 446/300				
Linius L.150ACSV	150	54	34.3	17 (-1; -4)

tested and officially approved by the internationally renowned IFT Laboratory in Rosenheim (Germany).

In order to allow acoustical engineers and specifiers to select the best product for each specific application, the table gives an overview of the various technical specifications:

Linius L.150ACL blades were used for the Elbe Einkaufszentrum (mall) in Hamburg (Germany), where a guaranteed airflow had to be combined with an excellent sound reduction, as the car park of this mall is right in the middle of the busy town centre.

For more information contact: Renson Fabrication Maidstone on 01622 754123 or email stuart.murden@rensonuk.net or lucy.barratt@rensonuk.net

Obituary

Peter Watkinson

It is with deep regret that we have to inform you of the death of Peter Watkinson on 15 July 2011, aged 56, after a prolonged illness.

Peter had been a member for several years and was a regular contributor to the Institute of Acoustics. He was a respected principal acoustician and leader in the submarine acoustics community in the UK. He gained Chartered Engineer registration through IOA in 2004.

Peter began his career in acoustics at the University of Surrey where he was awarded a PhD for his research into "The Wall properties of Brass Instruments" in 1981. He had a life-time love of brass music in which he excelled in playing the cornet and was a regular member of several brass bands in the SE and SW. Peter then moved from Surrey to the ISVR where under the tutelage of Frank Fahy became an expert in Acoustic Intensity Measurement and produced several papers evaluating and characterising the technique. In particular his research on intensity microphones revealed that the usable frequency range of the 1/2 inch spaced, face-to-face, two-microphone intensity probe was considerably larger than had been previously considered and widely disseminated. In 1983 on the strength of his research at ISVR he was recruited into what was then the Plessey Marine Research Unit in Templecombe, Somerset, the leading sonar company in the UK, as a technical specialist. Peter thrived in this environment and was soon leading a small group of researchers in the field of noise transmission through submarine pressure-hulls. He provided direction and participated in underwater acoustic intensity measurements on scaled pressure-hull structural models submerged in a flooded quarry in Somerset.

Peter co-authored the results of this work which was presented at the 2nd International Symposium on Shipboard Acoustic, Den Hague 1986. He subsequently lead several scientific acoustic based trials on-board Swiftsure and Trafalgar class submarines through the late 1980s and early 1990s collecting baseline measurements of the platform self-noise environment in preparation for the development of an innovative flank array sonar. He provided, as a side-line, leadership in the development of an Auxiliary Mass Damping tile to control the radiated noise from wind turbine towers and presented papers at two Wind Energy conferences. The company changed ownership from Plessey to GEC Marconi and Peter became heavily involved in GEC's winning bid to design and build the UK's next generation of attack submarine, Batch Two Trafalgar, later to become the Astute class. He wrote the Submarine Signature Management Plan and was instrumental in the systematic development of mathematical models for prediction and control of submarine noise. After the acquisition of GEC Marconi by BAE Systems he was appointed Signature and Shock manager of the Astute class submarine at the commencement of its development programme. He continued in this role up to the launch of Astute by which time he had become the manager of the dynamic and shock groups in BAE Systems at Barrow-in Furness, comprising 30 specialist Engineers, and was the industry representative in the MoD signature core team for the Trident replacement submarine.

Peter was also passionate about improvements he had made on his grade I listed house in Bruton, Somerset, which he couldn't give up



Peter Watkinson

and instead decided to commute each week to Barrow via the company's aeroplane from Bristol.

The following is a comment from John Hudson, MD Submarine Solutions, BAE Systems:

'Peter had a long and distinguished career in submarine acoustics. His dedication and professionalism has ensured that UK submarines remain at the forefront of sonar / signature performance. Peter was an enthusiast for his subject with a keen eye for detail, he will be sadly missed by his many colleagues in the submarine world'.

His family should be justly proud of his achievements and will be missed by his friends and colleagues. He leaves a wife Carol and children Henry and Rachael.

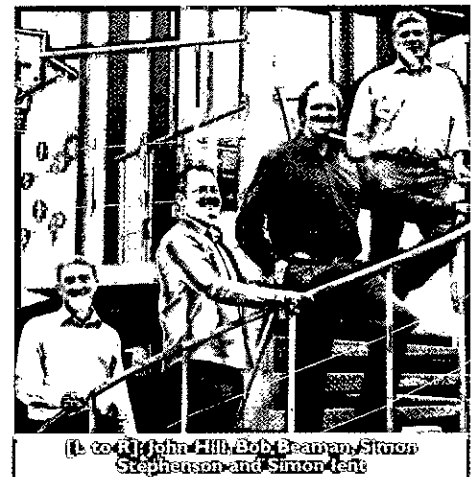
Making a noise at Xodus Group

A wealth of experience now on board

Simon lent, acoustics team manager, has recently joined specialist engineering consultancy Xodus Group and will be based in their new Southampton office. Simon, formerly of Bureau Veritas is joined by former colleagues Simon Stephenson, Bernard Postlethwaite and John Hill in Southampton, and by Bob Beaman in Aberdeen, bringing a vast wealth of experience in industrial noise and vibration consultancy to the group. The team will focus on supporting Xodus' oil and gas and low carbon industries through their existing environmental, health and technical safety and risk business lines. Together with the newly formed dynamics team headed by Rob Swindell which looks at the impact of vibration on 'structures', the acoustics and

dynamics engineers at Xodus now number over 20.

Simon says that they are joining the group at an exciting time as Xodus looks to increase its environmental engineering capability in the renewable energy and low carbon markets as well as maintaining focus on core business streams such as oil and gas. This together with the increasing pressures from the development of coastal infrastructure and seas will put greater emphasis on the need to look at the overall impact on the marine environment. Underwater noise impact will therefore play an increasingly important role in the integrated engineering approach adopted by Xodus.



(L to R) John Hill, Bob Beaman, Simon Stephenson and Simon lent

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Committee meetings 2012

DAY	DATE	TIME	MEETING
Thursday	12 January	11.30	Meetings
Thursday	19 January	10.30	Diploma tutors and examiners
Thursday	19 January	13.30	Education
Thursday	26 January	10.30	Membership
Thursday	9 February	11.00	Publications
Thursday	16 February	11.00	Medals and awards
Thursday	16 February	13.30	Executive
Thursday	1 March	10.30	Engineering Division
Tuesday	6 March	10.30	Diploma examiners
Thursday	8 March	11.00	Council
Monday	2 April	11.00	Research co-ordination
Tuesday	3 April	10.30	CCWPNA examiners
Tuesday	3 April	13.30	CCWPNA committee
Thursday	19 April	11.30	Meetings
Thursday	3 May	10.30	Membership
Thursday	17 May	11.00	Publications
Tuesday	22 May	10.30	CMOHAV examiners
Tuesday	22 May	13.30	CMOHAV committee
Thursday	29 May	10.30	Engineering Division
Tuesday	29 May	10.30	ASBA examiners
Tuesday	29 May	13.30	ASBA committee
Wednesday	20 June	10.30	CCENM examiners
Wednesday	20 June	13.30	CCENM committee
Thursday	21 June	10.30	Distance learning tutors WG
Thursday	21 June	13.30	Education
Thursday	28 June	11.00	Executive
Thursday	12 July	11.00	Council
Thursday	19 July	11.30	Meetings
Tuesday	7 August	10.30	Diploma moderators
Thursday	6 September	10.30	Membership
Thursday	13 September	11.00	Executive
Thursday	20 September	11.00	Publications
Thursday	27 September	11.00	Council
Monday	1 October	11.00	Research co-ordination
Thursday	4 October	10.30	Diploma tutors and examiners
Thursday	4 October	13.30	Education
Thursday	11 October	10.30	Engineering Division
Thursday	1 November	10.30	Membership
Tuesday	6 November	10.30	ASBA examiners
Tuesday	6 November	13.30	ASBA committee
Thursday	8 November	11.30	Meetings
Thursday	15 November	11.00	Executive
Wednesday	21 November	10.30	CCENM examiners
Wednesday	21 November	13.30	CCENM committee
Thursday	22 November	11.00	Publications
Tuesday	4 December	10.30	CCWPNA examiners
Tuesday	4 December	13.30	CCWPNA committee
Thursday	6 December	11.00	Council

Refreshments will be served after or before all meetings. In order to facilitate the catering arrangements it would be appreciated if those members unable to attend meetings would send apologies at least 24 hours before the meeting.

Meetings programme 2011/2012

17-18 November 2011

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Heriot-Watt University, Edinburgh

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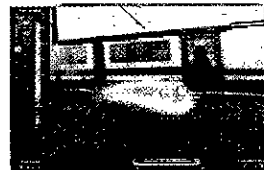
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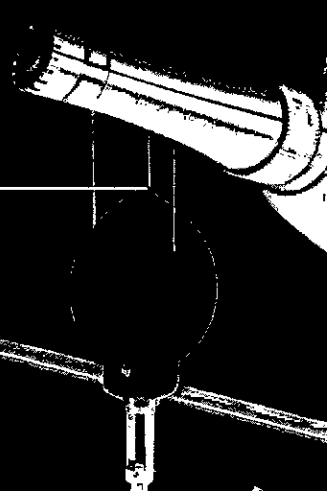
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