12th International Conference on Low Frequency Noise and Vibration and its Control Bristol, UK. 18 – 20 September 2006.

LF 2006, the 12th meeting in the Low Frequency Series, was attended by nearly 50 delegates from 13 countries. The main interest in problems of low frequency noise and vibration comes from Japan and Scandinavia, whilst the host country, the UK, was represented by seven papers. LF2006 followed previous conferences in the series by covering several related areas, including measurement, occurrence and assessment of low frequency noise, effects of low frequency noise on people and structures, cognitive aspects of low frequency noise, effects of vibration on people, control of environmental vibration and its associated noise.

1. PSYCHOLOGICAL EFFECTS

Andy Moorhouse presented the first of three papers describing recent work from the University of Salford on "The effect of fluctuations on the perception of low frequency sound." Laboratory tests on 18 subjects, including some low frequency noise sufferers, included responses to low frequency sounds with varying degrees of fluctuation. Thresholds of acceptability, which were obtained for each sound and each subject, were then normalised to individual low frequency hearing thresholds. It was found that sufferers tend to set thresholds of acceptability closer to their hearing threshold than other subject groups. Also, acceptability thresholds were set, on average, 5dB lower for fluctuating sounds. It is proposed that a sound should be considered fluctuating when the difference between L_{10} and L_{90} exceeds 5dB, and when the rate of change of the 'Fast' response sound pressure level exceeds 10dB.

Toshio Kitamura and colleagues from the University of Yamanashi, a main Japanese centre for work on low frequency noise, discussed "The Psychological Response to Intermittent Rattling Noise of Fittings by Low Frequency Noise". Psychological responses and permissible limits of 20 subjects under intermittent rattling noise of a fitting were measured. Subjects sat in front of the fitting and answered questionnaires on their psychological state during and after exposure to rattling noise from the fitting, when it was exposed to intermittent low frequency noise. The values of 'loud', 'can't bear as living room' and 'can't bear as bedroom' increase according to duty factors of the intermittent rattle time. Permissible limits were measured by $L_{Aeq\ 5s}$ of rattling noise adjusted by subjects themselves. The permissible limit decreases according to duty factor.

Yukio Inukai considered the "Acceptability of narrow band noise and complex noise at low frequencies". The thresholds of acceptability of narrow band noise and complex noise were measured for eighteen non-complainants and eight complainants in a low frequency pressure chamber. In the experiment, three noises with bandwidth of 3.16 Hz at centre frequencies, 16 Hz, 31.5 Hz or 63 Hz and three types of combined noises of two from the three band noise components were used as stimuli with relative levels of the noise components fixed to a particular spectrum.

Acceptability of each stimulus was measured by the method of subject adjustment for three measurement items, i.e., (1) acceptable limits for a bedroom, (2) acceptable limits for a living room, (3) vague annoying level and the results compared with previous data for pure tones. The applicability of the Japanese reference criteria to narrow-band or complex noises was discussed.

Toshio Watanabe presented joint work on "Masking of low frequency sound and mutual relation between masking characteristic and psychological response". Masking of low frequency sound by pure tones and band noise was measured, showing that there were not big subject differences in pure tone masking, but big differences in masking by the band noise. The masking characteristic by band noise was investigated. Forty subjects participated in the experiments. Frequency characteristics of the masking by band noise are divided into three groups by cluster analysis in multivariate analysis. In the first group the masking values are almost positive in all frequencies. In the second they are very small or negative in several frequencies. In the third they are positive at frequencies lower than 20Hz and negative at frequencies greater than 20Hz. To further investigate the subject differences, psychological experiments were carried out.

Stephen Benton of the University of Westminster spoke on "Low Frequency Noise Annoyance (LFNA): Sensitisation and the Conditioned Acquisition of Failed Coping". Sensitisation describes the manner in which an initial level of weak reaction to a stimulus intensifies if the original stimulus is followed by a painful or stressful one. Conditioning processes are said to provide the fundamental neural building blocks for individuals' ability to encode experience of an environment in ways that promote the capacity to cope. It has been reported by LFN sufferers that even at sound pressure levels at, or near to, detection threshold their experience of the noise is one that seems to dominate the acoustic environment. Sufferers describe the noise as one that they cannot 'tune out', ignore or stop from tuning into nor do these attributes diminish with repeated exposure. In fact, an increasingly easy and "unwanted tuning in" seems to follow exposure and is associated with increasing 'unwantedness'.

LEGISLATION

David DeGagne described "Incorporating Low Frequency Noise Legislation for the Energy Industry in Alberta". Environmental noise from energy industry facilities in Alberta is regulated by the Alberta Energy and Utilities Board (EUB) as cited in the *Noise Control Directive*. The fifth edition of the directive has adopted A-weighted energy equivalent sound levels (L_{Aeq}) as the primary measurement system. A-weighted measurements do not reflect the full annoyance potential of the noise after propagation over a distance. Complaints related to low frequency noise (LFN) are often described, by the affected party, as a deep, heavy sound, like humming, sometimes with an accompanying vibration. The complainant is most able to detect the presence of the LFN signifying a particular sensitivity of the individual to the sound while others in the same family may not be able to detect the sound at all. To make a proper determination for the presence of LFN, the data must be collected during a time when environmental conditions are representative of when the sound is annoying. The paper examines the work undertaken by the EUB to understand the issue, the various metrics tested in attempting to easily identify LFN, and finally the approach that would be incorporated into the new legislation *Noise Control Directive 038* to address the problem.

Katsuhiko Naito, from the Japanese Ministry of the Environment, described "The present situation of Noise/Vibration administration and efforts to deal with low frequency noise problem in Japan". The environmental quality standards for noise - the noise regulation law (1968) – includes road (revised in 2001), airplane (1971), shinkansen-railway (1975). The maintenance of these standards is desirable for the preservation of the living environment and for the protection of human health. Recently, the number of complaints has increased against LFN, which has a very low indoor sound pressure level, and there has been a gap between complaints and noise regulation by local government. The Ministry, in June 2004, declared and published "Handbook to Deal with Low Frequency Noise". The diffusion of this handbook, local government efforts to deal with complaints against LFN and future prospects were described.

RAILWAY VIBRATION AND NOISE

Victor Krylov described the "Attenuation of low frequency ground vibrations by means of resonant scattering of Rayleigh waves on heavy masses". A promising and cost effective method of screening affected properties can be by using heavy masses placed on the ground surface near the road (e.g. concrete or stone blocks, specially designed brick walls, etc). The principle of operation of such masses is based on the fact that their natural frequencies of vibration, which depend on the mass value and on the local ground stiffness, can be chosen within the frequency range of railway or road-generated ground vibrations (normally from 5 to 50 Hz). When the mass is shaken under the impact of incident Rayleigh surface waves, it scatters the incident waves into the depth of the ground and at different directions on the surface, thus resulting in noticeable resonant attenuation of transmitted ground vibrations. The paper gave a brief introduction to the theory of resonant mass scatterers and discussed some problems that still need to be considered to achieve a fuller understanding of their operation as a means of damping of low frequency ground vibrations.

Masanobu Iida dealt with "Infrasound generated by a high-speed train running through a short tunnel". When a high-speed train enters a tunnel, pressure waves are generated inside and outside the tunnel. Toward the outside, impulsive waves are radiated directly from its portal where the train has entered. Inside the tunnel, compression and expansion waves are generated and propagated through the tunnel. When the compression and expansion waves arrive and reflect at the opposite portal (the tunnel exit), part of their energy is radiated as impulsive waves, which are called 'micro-pressure waves'. The reflected waves inside the tunnel go back toward the entrance and radiate impulsive waves again as they arrive at the entrance. This reflection and radiation process is repeated while the magnitude of the waves is gradually attenuated. The impulsive waves radiated from the portals are inaudible infrasound with the exception of the micro-pressure wave from a portal of a long ballastless, slab-tracked tunnel, which can be accompanied by a booming noise. Similar phenomena are also caused when the train leaves the tunnel. Field measurement conducted at a short tunnel of length 93 m in Shinkansen were analysed. The calculated and measured results of the waveform of the infrasound are found to be in reasonable agreement in spite of considerable simplification in geometric modelling.

Marianna Mirowska described work on "Low frequency noise in dwellings from underground trains". The problems of measurement and assessment of noise in dwellings from underground railways are discussed. Noise measurements were made in twenty multifamily houses whose residents complain about noise and vibration penetrating to their dwellings from underground trains. Analysis of SPL has confirmed that the noise from underground trains was typical low frequency noise containing components from 40 Hz to 125 Hz. Although duration of noise from passing trains is short, about 12 seconds, the passing frequency is at least once every three minutes during the day and A-weighted sound levels inside dwellings are low (average LAmax = 25-35 dB) so that permissible levels are not exceeded, but the dwellers evaluate the noise and vibration as annoying.

CONTROL OF LF NOISE AND VIBRATION

Jack Evans described his company's work on a "Pneumatically Isolated Inertia Base with Active Damping for a Transmission Electron Microscope (TEM)". Low frequency sound and vibration affects the performance and use of electron microscopes by disturbing the stability and resolution of the specimen's video image. A transmission electron microscope addition was proposed to an existing research suite that had three scanning electron microscopes (SEM). The TEM, which is very heavy, rather tall and has a high centre of gravity, is very sensitive to floor vibrations. This case study considered sources of disturbing vibration with spectrum measurements. The designs of the microscope room and an actively-damped, pneumatic vibration isolation system are discussed. Post-installation vibration measurement results to validate performance are presented in spectral analysis charts versus criteria.

Ken Marriott discussed "Low frequency noise problems on oil & gas drilling rigs". Sound level criteria used for oil and gas platforms are based on dB(A), but there are shortfalls in applying the dB(A) criterion to oil and gas platform topsides, specifically the accommodation. A new method of setting criteria, more suited to this application, is proposed. Many of the machines which make up the working areas on rigs have their maximum emissions at low frequencies, which transmit through to the accommodation areas. It is impracticable to reduce levels in these areas to those considered suitable for domestic accommodation, but it is possible to improve on the A-weighting assessment by using a set of realistic, frequency dependent weighting curves, which acknowledge the difficult low frequency problem. Such a set of curves is proposed giving about 40dB difference across frequency between general work areas and recreational areas.

Steve Wise contributed a paper on "Active noise control as a solution to low frequency noise problems". The control of low frequency noise presents special problems, which do not occur at higher frequencies. These problems related mainly to the long wavelength at low frequencies, which leads to little absorption by conventional means, unless large quantities of material or large volumes of space are used. However, there are many examples of low frequency noise problems which can be solved by active attenuation.

Filip Verbandt gave his assessment of "The need of 3D acoustic modelling for successful low frequency applications", summarising eight years of 3D finite element acoustic modelling of low frequency noise applications. Most of the models were made for sonic cleaning in industrial applications, such as: power plants and refineries. Models were made to clean heat exchangers in boilers, economisers, air preheaters, precipitators, catalyst systems and filter bag houses. Combustion enhancement with sound is also an application which was modelled recently. Important parameters like sound frequency, power, pressure or intensity, temperature, sound source positions etc. were explained. The 3D acoustic modelling was started because the number of unsuccessful applications was too great. The sound generators, the models, the sonic cleaning results and the sonic combustion (NOX, CO combustion time, temperature), emission results were discussed.

Xin an Zhang described his development of "The Formula of Sound Absorption Spectrum for Fibrous Material". A current sound absorption theory is still the Rayleigh model, but his model is not in agreement with practice, even though it had been studied for over 100 years. Based on this theory, Zwikker and Kosten established the theory of acoustical effective density and the effective bulk modulus to explain the sound absorption characteristics of fibrous materials. However, because of the complexity of these expressions, it is difficult to obtain physical insight into the acoustic behaviour of the porous materials and to determine the dominant mechanism for sound absorption for a given material at a given frequency. Through testing the sound absorption coefficient of thick and thin fibre layers at different frequencies with cavity depth 5cm, 10cm, 20cm, 30cm and 40cm, the law of sound absorption at different frequencies was found and a formula developed which gives accurate frequency dependent sound absorption coefficient of fibrous materials. The paper showed the requirements to increase sound absorption at low frequencies.

LOW FREQUENCY NOISE IN ENCLOSURES

Tsung-Hsien Tu described work on "Low Frequency Noise in Hemi-anechoic Chamber". The cut-off frequency is one of the general specifications for an anechoic chamber, and is usually located in the range 80-120 Hz. Ordinarily, for relating to human hearing reception, the noise emissions of consumer products will concern the frequency range from 20 Hz to 20 kHz. This frequency range is beyond the cut-off frequency associated with the free-field condition. The presentation described an experimental investigation of the low frequency sound pressure level deviation from the estimated inverse square law and also the difference in the sound power level evaluation of a reference sound source.

Steffen Pedersen dealt with "Indoor measurements of sound at low frequencies". For assessment of annoyance from low-frequency noise it is relevant to measure a level close to the highest level of the room, rather than a room average. As a means for this, current Swedish and Danish measurement methods include corner measurements. These positions are however still with some specified height and distance to the walls, and they may not effectively serve the purpose. Alternative measurement positions were investigated based on theoretical considerations and observations from numerical simulations. The performance of the methods in practice was studied by measurements in three rooms, while various low-frequency sounds were produced in adjacent rooms. The sound pressure level was measured in 1) the entire room by scanning, 2) corner positions specified by Swedish and Danish measurement methods, and 3) all three-dimensional corners. Good results can be expected with the Swedish method, as the Swedish corner position is obtained by scanning and yields levels close to the target; however thee are serious concerns regarding the use of C-weighting in the scanning. With the Danish method, good results can only be expected, if complainants can accurately indicate measurement positions, since the corner position in this method generally fails to represent high levels in the room. As an alternative method, it is proposed to use the power average of measurement in some or all three-dimensional corners. This method is simple and seems to offer reliable and repeatable results in all rooms and at all frequencies.

HEARING AT LOW FREQUENCIES

Torsten Marquardt spoke on "Features of cochlear impedance at low frequencies in humans and guinea pigs". A non-invasive method is given to estimate Basilar Membrane (BM) displacement to a low frequency (LF) sound. BM displacement by loud LF tones periodically alters the level of distortion-product otoacoustic emissions (DPOAEs) as a function of the phase of the modulating LF-tone. For a range of frequencies (15-480 Hz) the level of a modulating LF-tone was adjusted to maintain a constant DPOAE-modulation depth, indicating a constant amplitude of BM displacement. The resulting LF-tone levels match the shape of iso-loudness contours (ISO226:2003) except for a parasitic resonance centred at about 50 Hz. At 55 Hz, an increase in level of approximately 3 dB above the iso-loudness contour, and at 45 Hz, a decrease in level of approximately 3 dB below the iso-loudness contour is required to maintain constant periodic LF BM displacement. The parasitic resonance separates two distinct regions of the cochlear impedance function: a slope of 12 dB/oct at frequencies below 45 Hz suggests a mass-controlled impedance resulting from perilymph flow through the helicotrema; a slope of 6 dB/oct above 55 Hz suggests the existence of a travelling wave with resistive impedance. Modulated DPOAEs provide a non-invasive method to study objectively the BM displacement at low frequencies, which might be of importance in investigations into the cause of LF hyperacusis of some human individuals.

Kenji Kurakata described work on "Low-frequency hearing thresholds of young and older adults". The hearing threshold for low-frequency tones in the range 10-160 Hz was measured in a pressure field to investigate the effects of aging on hearing ability. Participants were 34 young adults of 19-25 years old and 34 older adults of 61-83 years old. Measurement results showed that, on average, the older listeners had a higher threshold than the young listeners. However, the difference of median thresholds between these two groups was 5-10 dB at every measurement frequency, which was a much smaller difference than that observed for high-frequency tones around 2,000 Hz and above. Comparison of the low-frequency thresholds and audiograms of the listeners indicated almost no correlation between these two. These experimental results suggest that older people retain good hearing sensitivity in the low-frequency region compared to their degraded sensitivity at higher frequencies and that they might suffer from low-frequency noise problems, just as younger people do.

EFFECTS OF VIBRATION

Masashi Uchikune reported on "Measurement for evaluating recumbent posture of whole body vibration strain". The purpose of this study was to make clear the physiological and psychological effects of vibration on the human body, leading to a guide for the application of frequency-weighting curves with respect to health effects. Existing standards are not well defined in the border between the two effects on human response. For recumbent persons, tests were carried out to fund the effect of whole-body vibration in the low frequency range. Physiological effects were examined by investigating the effects on the cardiovascular system, the blood flow system, the respiratory movement, the salivation, to confirm the effects on the autonomic nervous system and on postural sways in the normal Romberg position.

Yukio Takahashi reported on "A consideration of an evaluation index for high-level low-frequency noise by taking into account the effect of human body vibration". At high sound pressure levels, noise-induced body vibrations are induced by low-frequency noise. The purpose of this study was to show that considering the effects of noise-induced vibration is effective in evaluating high-level low-frequency noise. Using the A-weighted sound pressure level and the W_k-weighted vibration acceleration level of noise-induced vibration measured on the body surface as independent variables, empirical evaluation indices were estimated on the basis of previous experimental data. The effectiveness of these indices in evaluating high-level low-frequency noise was examined by comparing them with the effectiveness of other evaluation indices. It was found that the indices were able to evaluate the unpleasantness caused by high-level low-frequency noise better than the A-weighted sound pressure level. The results of this study suggest the possibility that high-level low-frequency noise can be more effectively evaluated by taking into account the effect of human body vibration.

Geoff Leventhall described work on "Somatic Responses to Low Frequency Noise". The main response of the body to high levels of low frequency noise is a chest resonance, which occurs in the region 20Hz to 70Hz for the subjects investigated. This is shown to be a structural resonance, which occurs when excitation levels are considerably in excess of the hearing threshold. An associated question is whether there is a hierarchy of alternative body receptors, of which the ear is the most sensitive, whilst other receptors in the body may come into prominence at lower frequencies, where the hearing threshold is high. It is concluded that current evidence is that the ear is the most sensitive receptor at all frequencies.

Malcolm Hayes considered "Low frequency noise from wind turbines and vibroacoustic disease". The development of wind energy within the UK and elsewhere is forecast to continue for the foreseeable future. However, with the application for planning permission associated with wind farm development, the emergence of objector group web sites has continued. Of particular note is the alleged link of vibro-acoustic disease (VAD) to low frequency noise immissions from wind farms. Data is available to compare actual operational noise levels and the suggested levels of noise which are required to induce VAD, which has been defined as a consequence of long-term (years) exposure to large pressure amplitude (≤ 90 dBLin) at low frequencies (≤ 500 Hz). The source noise levels which have been identified as a cause of VAD show levels ranging between 55 – 90 dBLin below 20 Hz and 55 – 123 dBLin at frequencies above 20 Hz. Low frequency noise from wind turbines is considerably lower in levels than these sources and unlikely to be a cause of VAD.

Liz von Muggenthaler gave a paper on "The Felid purr: low frequency therapeutic biomechanical stimulation". However, as Liz was unable to be present, she was replaced by a DVD of her presentation. Although popular conception holds that the felid purr indicates contentment, cats purr when they are severely injured and threatened. This contradiction was addressed by analysing the acoustical purrs of a variety of feline species, whilst an accelerometer measured the strength of domestic cat purrs on various portions of the body. Interestingly, purr frequencies of all cats recorded corresponded exactly or within +/-2 hertz of frequencies used in treatment for bone growth/fractures, pain, edema, muscle growth/strain, tendon strength/strain, joint flexibility, dyspnoea, and wounds. A mechanism that prevented disease would be advantageous, decreasing recovery time from wounds, and keeping muscles and bone strong when sedentary. This data supports the hypothesis that purring provides a mechanism for these animals that decreases recovery time from wounds, and keeps muscles, tendons, ligaments and bone strong when sedentary.

ENVIRONMENTAL LOW FREQUENCY NOISE

Mags Adams gave the second paper from Salford on "Social effects of low frequency noise exposure on sufferers: developing a procedure of assessment". In most situations a single sufferer, or perhaps a couple living in the same property, is affected, but occasionally a cluster of complaints arises in a particular area. Human reaction to sound is known to be dependent not just on the sound itself, but on a complex array of other factors including personal associations with the sound. Combining measurements with a questionnaire gave a significant amount of personal data about the individuals themselves. This gave an overview of the background to the LFN complaint that might have a bearing on the responses. The paper discussed the rationale for collecting details about individual's residential and occupational histories, their general health, details of the noise exposed to, suspected sources of the noise, effects of the noise on themselves and their health, and any measures they have taken to cope with or avoid the noise. Many complainants have ongoing problems which they associate with low frequency noise, and which have a fairly serious impact on their lives. These sociological factors have been incorporated into a 'Procedure for the assessment of low frequency noise complaints' to be used by local authorities. The answers to the questions developed help local authorities distinguish cases where they should intervene from those where they can do nothing to help.

David Waddington, also from Salford, spoke on "Field measurements in the development of methods for the assessment of LFN". A procedure for the assessment of LFN by Environmental Health Officers has recently been developed in the UK. The paper presented aspects of the original field measurements performed in the development of this procedure for assessment of low frequency noise complaints. The overall aim of the field measurements was to provide a database of field data for the development of a proposed criterion. Specifically this involved collecting data with which to test proposed criteria, and to provide audio recordings for use in the laboratory tests. Human reaction to sound is known to be dependent not just on the sound itself, but a complex array of other factors like personal associations of the sound. Furthermore, LFN cannot be reliably evaluated on the basis of the investigator's experience, since officers investigating LFN may not themselves be able to perceive the sound. Consequently, the procedure for the assessment of LFN complaints requires detailed acoustical monitoring over a period of three to five days combined with a synchronised log completed by the complainant. In each field study the sound measurements were supported by questionnaires to determine whether sociological or other factors might influence the results.

Piety Sloven spoke on "Proof of the importance of low frequency in noise policy". To develop knowledge of the impact of the assessment of low frequency noise, compared with that of A-weighted noise, about 1000 simulations were computed. Included in this are about 110 sources in nine different situations consisting of three distances (25, 100 and 400 m) and three types of houses. There was variety in types and distances of sources, and working at night or daytime. The noise levels of interest are those inside houses. The results confirm experiences of LFN – the greater noise, the more attempts to reduce it, with the consequence that the noise becomes more low frequency. In about 11% of the cases the LFN has the same importance or is more important than that of the A-weighted noise. This makes it very clear that low frequency noise needs more attention. The results show that the 63Hz octave is of prime importance in measurements and computations. Including the 31 Hz octave improves the quality of the assessment. The 16 Hz octave is not important, and cases in which the 125 Hz octave is decisive are a minority.

Carel Ostendorf shared his experiences on "How to find the source of low frequency noise: three case studies". When people are annoyed by low frequency noise, their first concern is to stop the noise. Therefore it is necessary to find the source of the noise. Unfortunately, the source may not be very obvious. In most cases a lot of potential sources are available both inside and outside the building. Of course, in theory it is possible to find the source by switching on and off all the potential sources but in practice this is not always possible. Three cases of possible low frequency noise are presented in which different methods of finding the source have been used. In all these cases the nuisance is present in a domestic situation and has been present for several years. Some of the residents suffer from mental problems due to the unwanted noise. By use of the measurement result, the searching methods are discussed and evaluated. If the source is unknown, the search for it is one of patience, endurance and financial sacrifices. Because there are a lot of possible sources such as fans, air conditioning devices, cooling systems, pumps, burners or diesel engines, one does not know where to start and a carefully scheduled investigation is required.

Christian Pedersen described his work "Twenty-two cases of low-frequency noise complaints – a detailed investigation". In Denmark and in other industrialised countries there are cases where people complain about annoying low-frequency or infrasonic noise in their homes. Besides noise annoyance, people often report other adverse effects such as insomnia, headache, lack of concentration etc. In many cases the noise can only be heard by a single person in the household, and if measurements are performed the authorities cannot find any noise exceeding the existing limits. This raises the fundamental question of whether the complainants are annoyed by an external physical sound, or if other explanations must be sought. The main aim of this study is to answer this question by thoroughly investigating 22 such cases. Recordings and analyses were made of the sound in the complainants' homes. Each complainant was then invited to the laboratory where low-frequency thresholds and equal-loudness contours were measured. In a blind test it was checked if they are able to hear the sound recorded in their homes.

The conference concluded with a discussion on the themes of:

1. Can people hear sounds which cannot be measured?
2. Are people affected by sound which they cannot hear?

The next conference in the series

will be held in Japan in September or October 2008. To be kept in touch with developments go to the LF2006 web page www.lowfrequency2006.org – and sign up for further information.

H.G. Leventhall

Note: In addition to those reviewed above, the following papers, which had been accepted but not presented, area also in the Conference Proceedings.

Identification of aerodynamic sound sources: the basic problem for noise control. Alexander Fedorchenko

Effect of Low Frequency Noise on Psychological Responses, Jin Sup Eom, et al

Effect of Low Frequency Noise on ANS and EMG Response, Jin-Hun Sohn, et al

Evaluation of vibrations from the tunnel boring machine in soft soil. Herke Stuit et al

"Hum Noise" From overhead transmission lines. S. Basir-Jafari

Measurement of Low Frequency noise in Offices. Azam Omar et al

EUROPEAN HEARING IMPAIRMENT

"Hearing impairment (HI) is a real health problem in Europe. In Europe, 40 million individuals (over 10% of its population) suffer from HI with 2 million profoundly deaf. In children, deafness impedes language acquisition and generates learning difficulties. In adults, it often leads to severe disruption of social links which very frequently results in depression. All together, in Europe, the financial cost of HI has been estimated at 3,500 Euros per year per patient and includes special education, speech therapy, hearing aids, and physician and specialists fees. In the range of 100 billion Euros, this is more than the combined economic cost of epilepsy, multiple sclerosis, spinal injury, stroke and Parkinson's disease. Furthermore, this figure is likely to grow continuously in time due to noise pollution and ageing. Hearing loss is the third leading chronic disability following arthritis and hypertension. Therefore, Europe supports research to find new solutions to alleviate HI and thereby decreasing the burdens of these defects on European Society." Jacques Remacle, scientific officer, European Commission.

DUBAI CONSTRUCTION

Residents expecting luxury living at Dubai Marina are instead living with round-the-clock noise pollution and so much dust in the air that they cannot open their windows. Al Seef Tower, a 44-storey residential skyscraper in Dubai Marina is surrounded by construction sites, according to its residents who claim it is not the "supposed luxury accommodation we paid for". Tareq Al Haji, 29, a telecom engineer from Jordan, said night-time construction should be controlled and limited as the sound of heavy machinery is constant. "There are five or six construction sites around my flat. They are working 22 hours a day and sometimes we cannot sleep," said Al Haji, who moved in to his 14th floor apartment 16 months ago. "The noise started above seven months ago. There are no noise barriers and it is very noisy. Even on nice days we cannot open the window because of the dust and noise, and when the window is closed we still hear the sound," he said. "It is a hot topic among residents and a common problem for us. I don't want to give my flat up because of the noise but if someone paid the right price I would consider leaving. I lived in Bur Dubai for 6 years and came here because it was supposed to be luxury living," said Al Haji. Another resident on the 11th floor said it is not only the noise pollution from the heavy machinery which drives him "insane" but also the air pollution from the machines. "It seems there is no policing of fumes and the engines spurt out black smoke. It is like living downtown," he said. "Some of the buildings, including ours, had no access road for a long time. I understand if things are not completed when you move in to a near-finished apartment, but after a year and half it's too much," he said.