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Two Conferences on Noise and Its Control
London, 23-27 January and 9-10 March 1967

W. James Trott

20 April 1967

UNITED STATES OF AMERICA

TWO CONFERENCES ON NOISE AND ITS CONTROL

In April 1960, the Lord President of the Council and Minister of Science appointed a Committee on the Problem of Noise "..... to examine the nature, sources and effects of the problem of noise and to advise what further measures can be taken to mitigate it." This Committee presented its report "Noise" (Cmnd Rpt #2056, Her Majesty's Stationery Office)* in July 1963. In submitting their report the Committee stated:

> "People's reactions to noise vary greatly, and in the past this has prevented the framing of rules for its control except in qualitative terms, with consequent difficulties of administration. We therefore felt an important feature of our task was to try to define, wherever possible, quantitative levels of noise which should become statutory limits, or, where statutory limits were not desirable or could not be laid down at present, to suggest levels which would serve as guides to what is reasonable. We found that to do this we had to ask for a number of investigations and to break much fresh ground in measuring the annoyance caused to representative samples of the population by noises of various kinds.
>
> There has recently been a great increase in the study of noise problems in their social setting, and we do not doubt that in the coming years important advances will be made. We hope that our own work will contribute something to this movement and will help to put the problem of noise into perspective with other problems of modern life."

Clearly a committee's report does not solve the noise problem. Despite attention to the subject in Britain, a recent item in the Daily Telegraph states that protests against excessive noise are starting to reach proportions of a nation-wide revolt. The British custom of leaving doors and windows open in all weather does make them more aware of street and aircraft noise than we are in the United States in our air-conditioned offices. The greater proportion of sports cars, motorcycles and scooters is producing a large number of complaints. The Noise Abatement Society is active. Since 1965 the Ministry of Labour has been able to act against industries where noise may be injurious

*Obtainable from British Information Service, 845 Third Avenue, New York, 10022, Price 13 shillings (approx $1.82).

to the workers.

Two conferences herein reported were held in London for the purpose of analyzing the problem of measuring noise, determining the characteristics of noise which cause annoyance, and finding means for control and reduction of our increasingly noisy environment. Physicists, acousticians, mechanical engineers and biophysicists discussed their respective aspects of the problems related to both structural fatigue and human response due to noise. The law as related to control of aircraft noise, road traffic noise and industrial noise was also discussed.

CONFERENCE ON ACOUSTIC NOISE AND ITS CONTROL, LONDON 23-27 JANUARY 1967.

This Conference was held at the Institution of Electrical Engineers, London 23-27 January 1967. About 230 participants registered from Belgium, Canada, Czechoslovakia, Denmark, France, Germany, Netherlands, Norway, Scotland, Sweden, Switzerland, Turkey, UK and the US. Sessions were held on Subjective Effects, Measurement Analysis, Machines and Noise in Buildings. The organizing committee was under the chairmanship of Dr D.W. Robinson of the National Physical Laboratory. The Conference was sponsored by the Electronics Division of the Institution of Electrical Engineers, The Institution of Electronic and Radio Engineers, The United Kingdom and Eire Section of the Institute of Electrical and Electronics Engineers, The Institute of Physics and the Physical Society, and the British Acoustical Society.

Mr. J.A. Ratcliffe, President of the Institution of Electrical Engineers, opened the meeting with the statement that a man from medieval times would notice two things in the world today, the absence of smell and the presence of noise. An introductory survey was then presented by Robinson who pointed out that with the increasing application of power in our society, machines, autos and aircraft, and the concomitant increase in noise, 15% per decade, we must do something to reduce and control noise.

Prof. S.S. Stevens (Harvard University) introduced his paper, Masking and Sensory Dynamics, by stating that he had been wrong for 30 years. He went on to describe experiments in which a sensation was matched for a tone and a tone plus noise, so that the sensation of tone remained steady. His data were plotted as log sensation intensity vs log stimulus intensity. A slightly higher sensation level occurred when the tone was adjusted than when the noise was adjusted. The tone in quiet was adjusted to match the tone in noise and then the tone in noise adjusted. For both vision and hearing, the sensation intensity grows as the stimulus intensity is raised to approximately 0.3 power, Weber-Fechner Law. The masking stimulus raises the exponent of the power function. Consequently, the log log plot shows a knee in the curve where the tone and noise are of approximately equal loudness. Inevitably, errors in measurement will round the knee, and his error of 30 years' duration was in trying to present a smooth curve instead of a discontinuous function. He referred to the publications by D.W. Robinson and R.S. Dadson and by B.G. Churcher and A.J. King. He showed that recruitment functions observed in certain kinds of hearing loss (nerve deafness) resemble the effects for masking; the slope (exponent) of the recruitment function, sensation intensity to stimulus intensity, increased with increased hearing loss. A hearing loss that raises the threshold by 60 or 70 dB increases the exponent of the loudness function by a factor of 4.

A paper, Effects of Exposure Time in the Evaluation of Noise Intensity, was presented by Prof. Dr. F.J. Meister (University of Düsseldorf, Germany). Curves were presented showing the poststimulation threshold 0.2 sec after the cessation of exposure to noise for a range of noise levels and duration from 1 to 1000 sec. Aural fatigue is indicated by a flattening out of the curve with increasing exposure time when the noise rises above 100 dB. Noise levels 70 dB(A) and 90 dB(A) were used on one group, and frequency bands of 90 - 9000 Hz and 800 - 8000 Hz were presented to two other groups by using a number of speakers in a reverberation room. For low-level noise of 60 dB(A) and the low-frequency band, the level differential for doubling the time was 4.5 dB. The high-frequency band reduced the differential to 3.5 to 4 dB. A level of 90 dB produced a differential of 3 dB that diminished for exposure in excess of 40 sec.

H. Blaesser (Hewlett-Packard, Boeblingen, Germany) described A Loudness Analyser for Computation of the Subjective Loudness. The loudness analyzer automatically makes a 1/3rd-octave level analysis of the noise and computes the loudness by the method indicated by Zwicker in ISO Recommendation 675. The range is 40 to 127 phons. The input signals from a microphone or tape recorder are applied to the inputs of 20 bandpass filters, covering the range from 45 Hz to 14 kHz, via a preamplifier directly, or via a diffuse field network. The 20 outputs of the scanner, sequentially read at 40 Hz, are fed to a summing amplifier. Besides the recording of the total loudness by means of a strip chart recorder, it is possible to sample the picture on the cathode ray tube with a built-in scanner and record the loudness spectrum by means of a X-Y recorder. By means of this new instrument it is possible to measure and analyze immediately all types of sound such as aircraft noise, traffice noise, engine noise and for control of the loudness level in recording or transmission of speech, and music.

Members of the staff of the Office National d'Etudes et de Recherches Aerospatiales at Chatillon sous Bagneux, France, presented two papers on the design and calibration of transducers for measurement of sound at high levels under difficult conditions of vibration and high temperature. The first paper, Noise Measurements in Difficult Conditions of Vibrations and High Temperatures, by M. Benard and P.A. Lienard referred to the 30 kW of sound emitted by each engine on a Caravelle during takeoff and the 400 MW produced by a Saturn during the launch. They listed the disadvantages of piezoelectric ceramics as susceptibility to acceleration and temperature. They argued for the advantages in using capacitive transducers as designed by ONERA. A diaphragm of 0.1-mm laminated zinc-copper alloy is protected by a sintered porous brass disc. One discussant was concerned about dirt plugging the holes and affecting the calibration.

The second paper was on Calibration Methods at High Levels, by M. Benard, P.A. Lienard and J. Lambourion. One method uses a rifle bullet to produce an N shock wave of 60 mbars and 100-μ sec duration. The microphone is mounted on the bench with its face tangent to the Mach cone. Theoretically, with the help of computers, the real part of the Fourier transform will supply a calibration of response versus frequency. In practice only qualitative information is obtained from 2 to 20 kHz. They described two shock tubes in which the pressure pulse used in calibration is the constant pressure between two reflections of the shock wave along the wall of the tube. One cylindrical steel shock tube is 4.1 in diameter by 82.5 ft long. A pressure pulse of $10^4 N/m^2$ and 50 to 70 msec long is obtained. Calibration from 10-1,000 Hz is possible. A second shock tube is 2 in diameter by 33 ft long, wound in a spiral to save space. The frequency analysis is obtained by wrapping the trace on a drum and reading the trace with a light spot scanner and a counter. Some traces shown were analyzable and some were not. One somewhat rough response curve extending to 8 kHz was also displayed. They are installing a pistonphone-driven progressive wave tube 20-m-long in which they hope to obtain calibrations from 0 - 200 Hz at levels up to 150 dB and possibly to 170 dB. There will be absorbing wedges at the far end. For testing the microphone at high temperatures, they use two military searchlight mirrors facing each other to focus an arc light on the microphone. A diaphragm controls the amount of light and the temperature. Sound is fed to the microphone through a water-cooled tube from a speaker.

Dr. Karl D. Kryter (Stanford Research Institute) reported a Field Experiment on Human Response to Aircraft Noise that was performed at Edwards Air Force Base. The tests were run with a C-135 turbofan and a KC-135 during takeoff and landing. Kryter was introduced as the man who wrote a paper on noise and perception, a monumental contribution, when most of us weren't thinking about it. The presented paper created a lively discussion, during which D.W. Robinson spoke of a test with 40 subjects who were asked to describe aircraft noise as noisy, annoying and intrusive. To a group in church, 80 dB(A) was noisy; 90 dB(A) was noisy to a group in an assembly hall; indoors, 65 dB(A) was intrusive; outdoors, 90 dB(A) was intrusive; indoors, 80 dB(A) was annoying; outdoors, 100 dB(A) was annoying. Another discussant tried to analyze the problems of describing noise. He listed the basic attributes of sound for noise control; psychological in terms of noisiness, unwantedness, unacceptability, annoyance and disturbance; physical in the frequency domain in terms of spectral level, bandwidth, complexity in terms of temporal, duration of occurrence and number of occurrences/hr, day, etc; and in practical terms, sounds that have no meaning and sounds that have some meaning in comparison or masking tests.

Experiences with the Automatic Aircraft Noise Monitoring Equipment at Frankfurt-on-Main Airport, by W. Friesz and E. Koppe (Munich), G.B. Hafkemeyer (Frankfurt) and K. Matschat, E.-A. Muller and D. Schmidt (Göttingen) was presented by D. Schmidt. The system (equipment plus organization) has been operating for about two years, supplying physical data and documentation to develop cooperation in reduction of the disturbance due to aircraft noise. Success was attributed to the fact that the Minister of Economics and Transport appointed a former pilot to head the monitoring organization. Six monitoring stations and a monitoring vehicle are used. The stations are located at the side of the flight path at the edge of the populated area to be protected. A level R, not to be exceeded, is prescribed for each station. There are five graded levels from R - 15 dB to R + 15 dB, with the standard ranging ± 2.5 dB. Level 1 is -15 to -10 dB, level 2 with a green light is -10 to -2.5 dB, level 3, the R with an orange light, level 4 from 2.5 to 10 dB is red, and level 5 is blue with a horn. The system includes data transmission, reduction and recording, documentation which includes the monitor, the airline, flight number and any complaints from the public. The mean duration of exceedance of acceptable noise shows a marked improvement from 1965 to 1966.

The Determination of the Static and Dynamic Elastic Properties of Resilient Materials, by Dr. A.J. King, T. Smith and F. Fowweather (Physics Department, University of Manchester

Institute of Science and Technology) was read by F. Fowweather. The paper stressed the importance of measuring dynamic properties under load. A 24-in-long I-beam is pivoted at one end and loaded at the other. The sample is placed on a 4-in-diameter steel block, capped by a ½-in-thick plate and coupled to the beam for drive and load through a knife edge. The knife edge is 5 in from the pivot. The oscillatory force is obtained by an ac-driving coil attracting a mild steel plate attached to the beam 13 in from the pivot. Dynamic stiffness is given by $S_d = \pi^2 Mf_o^2/6$, where M is the combined effective mass of the beam and load and f_o is the resonance determined by the maximum amplitude of vibration: f_o is generally in the range 5 to 30 Hz. Measurements were presented for expanded polystyrene of 1-in thickness and density of 1 lb/ft^3 and for a proprietary material, a mixture of granulated cellular material in a rubber base. The polystyrene material under load of 1.71 psi showed strain 0.15% per decade, dynamic stiffness was constant after the first 40 hours under load for 1.71 psi and 3.45 psi. The second material showed similar creep, but the dynamic stiffness varies in an unusual way as a function of load. The dynamic stiffness increased appreciably from 20 to 40 psi, remained constant for a load from 40 to 80 psi, then rose appreciably again as the granular material crushed down. The authors stressed the need for manufacturers to establish a test procedure and to quote the results and limitations in material applications.

Dr. R. Martin (Physikalisch-Technische Bundesanstalt, Braunschweig, Germany) presented a paper, Comparative Sound Level Measurements on Motor Vehicles. Noise was measured by moving a microphone around a vehicle at a distance of 7 m, with the vehicle operating at various engine speeds under various loads on a vehicle dynamometer. Variations were shown in the response of the six sound level meters, and the noise level was measured simultaneously by six observers measuring the same vehicle. Variations between the meters peaked around 2 to 3 dB in the number of measurements versus magnitude of the error. Measurement of seven motor vehicles for noise octave level showed a peak between 100 and 200 Hz, which is preferred by customers, one psychological aspect of trying to reduce vehicular noise. The owner likes the feeling of power that the low-frequency roar supplies. Curves of cumulative distribution of sound levels measured during traffic controls for motor vehicles of the same type with untrained drivers showed a decided reduction of about 2 dB between cars built in 1958 and 1960 and those built between 1961 and 1963.

Mr. W. Denby (Mechanical Engineering Division of the Ministry of Transport) talked on Effective Control of Road Vehicle Noise. The British Standard 3425 (1966), Method for

Measurement of Noise Emitted by Motor Vehicles, specifies a microphone $7\frac{1}{2}$ m to the side, a speed of approach 30 mph in 2nd or 3rd gear, accelerating at full throttle along the 20-m length where the measurements are made. Comparison was made with limiting the approach speed to 10 mph for safety in roadside checks. The need for roadside checks was stressed, not only due to increased noise with wear but due to the installation of parts that don't suppress noise as much as original equipment. Reasonable correlation was shown for all classes of vehicles, commercial, private cars and motor cycles for the 10 mph test, not so for the ISO stationary test.

The Sound Transmission Loss of Plates with Beams, by G. Venzke and P. Dammig (Physikalisch-Technische Bundesanstalt, Braunschweig, Germany) was read by G. Venzke. Plates were screwed on an angle-iron frame 75 mm x 100 mm x 7 mm and cemented into an opening between two rooms of 45 and 55 m^3. The measurements were carried out along the lines of ISO Recommendation R 140. The test sound was white noise of third-octave bandwidth from a loudspeaker. The plates were steel--3 to 10 mm, aluminum--4 mm, and wood--25 and 52 mm thick. Beams were welded to the metal, cemented and screwed to the wood. The aluminum plate was stiffened with beams and crosswise buckling stiffners. The addition of the buckling stiffners reduced the transmission loss by 3 to 5 dB in the frequency range from 300 to 2,000 Hz. Instead of following the mass law, the steel plates showed nearly constant transmission loss from 300 to 2,000 Hz. They calculated the mean square velocity of the plate from acceleration measurements and determined a radiation coefficient s. This coefficient would be 1 for piston radiation.

$$s = \frac{\overline{p^2_{eff}}\, A}{(2\rho_o c_o)^2\, \overline{v}^2_{eff}\, F}$$

A is the equivalent absorption area of the quiet room,
F is the plate area,
$\overline{p}^2_{eff}$ is the mean square pressure in the quiet room.

The velocity of a 10-mm-thick steel plate was plotted as a function of position between beams for frequencies of 100, 400, 1600 and 6400 Hz. Diaphragm type motion was indicated for 100 Hz, diminishing to piston motion at 6400 Hz. The test rooms were described in more detail in another paper by the same two authors, Improvement of Sound Insulation between Two Adjacent Rooms by Progressive Reduction of Direct and Flanking Transmission. The two rooms are one above the other separated by a 12-cm-thick structural concrete floor of area 16 m^2. With false ceilings and floating floors in both rooms and mineral-wool quilt covered with gypsum wallboard on the walls, the sound reduction between the rooms ranged from 40 dB at 125 Hz to 85 dB at 2 to 4 kHz. With the floating floors in both rooms there was a 25-dB reduction of impact noise in the band at 1 kHz.

One discussant during the meeting stated that the deep noise of a furnace roar had made a workman sick. The construction of the new cinema at Marble Arch (London) was described as a 5,000-ton auditorium supported on rubber to reduce the rumble from the underground trains. The treatment was not entirely successful. The problem is fairly common in London; the trains can be heard during quiet passages in the Royal Festival Hall.

The last day was devoted to laboratory tours, one of which was a visit to the Institute of Sound and Vibration Research, the University of Southampton. Prof. E.J. Richards, its Director, stressed the importance of training research students, currently about 100, although many become disillusioned when they are employed by industry and spend only about one week per year in the field of acoustics. The work of the Institute covers audiology, structures and vibration such as vibration due to reactor noise, industrial acoustics such as fan noise, and basic work in air dynamics and sonic boom. The work has expanded into several nearby houses, but additions to their main laboratory are under way and will include anechoic and reverberation rooms. They are installing assisted resonance treatment to the University theater, Nuffield Theatre. The equipment being used is the original test equipment that was installed in Royal Festival Hall. One project is to study the vibration induced in helicopter blades due to blade overlap and proximity to the fuselage. They have an air siren that produces 130 dB of noise from the passage of a nylon belt over an air blast. The belt was slotted by positioning the slots in proportion to random numbers. Slotting was done through several revolutions of the belt, thus producing slots of varying width. The noise reduction through redesign of diesel engines was also demonstrated. There are 5 MD's (Medical Doctor) in the audiology laboratory. Some of this work is being done for the military.

Papers Presented at the Conference on Acoustic Noise and Its Control

M. Benard, P.A. Lienard and J. Lambourion - Calibration methods at high levels.

M. Benard and P.A. Lienard - Noise measurements in difficult conditions of vibrations and temperature

H. Blaesser - A loudness analyser for computation of the subjective loudness

P.A. Bourassa and Y. Jullien - Effect of damping on simple elastic systems subjected to harmonic and random vibrations

P. Dämmig and G. Venzke - Improvement of sound insulation between two adjacent rooms by progressive reduction of direct and flanking transmission

W. Denby - Effective control of road vehicle noise

J. Dunsbee and F. Billingsley - Ambient noise levels in residential areas

A.J. Ellison and C.J. Moore - Measurement of acoustic noise radiated by small electric machines

J. Erskine, W.F. Dennison and C. McNally - Noise control in the chemical industry

M. Foti - On the measured transmission of impact sound

W. Friess, G.B. Hafkemeyer, E. Koppe, K. Matschat, E.A. Müller and D. Schmidt - Experiences with the automatic aircraft noise monitoring system at Frankfurt/Main Airport

Mlle. H. Gavini - On the loudness of intermittent acoustic stimuli

C.L.S. Gilford - Background noise in broadcasting studios

W. Hawel - A model of a network for weighting the annoyance of noise with respect to its parameters on sound-level-meters

W. Hawel - Personality, situation, activity and sound as parameters of the subjective evaluation of the annoyance of noise

H.H. Hubbard and D.J. Maglieri - The nature, measurement and control of sonic booms

R.S. Jackson, L. Jump and J.D. Lawrence - The reduction of transformer noise by attached panels

A.J. King, T. Smith and F. Fowweather - The determination of the static and dynamic elastic properties of resilient materials

K.D. Kryter - A field experiment on human response to aircraft noise

R.C. Legg - Noise control as applied in the design of the air conditioning plant for a hospital ward

R. Martin - Comparative sound level measurements on motor vehicles

F.J. Meister - Duration-effects on subjective evaluation of noise intensity

S.S. Stevens - Masking and sensory dynamics

G. Venzke and P. Dämmig - The sound transmission loss of plates with beams

Conference papers were published and are available from the Institution of Electrical Engineers Publications Department, Savoy Place, London, as IEE Conference Publication #26.

THE ORIGIN AND TREATMENT OF NOISE IN INDUSTRIAL ENVIRONMENTS

This Conference, organized by Prof. E.J. Richards, Director of Institute of Sound and Vibration Research, University of Southampton, was co-sponsored by The Royal Society and the British Acoustical Society. It was held at The Royal Society Apartments, Burlington House, London, on 9 and 10 March 1967. In his introductory remarks, Prof. Richards said that the subject was of interest to physicists, acousticians, mechanical engineers and bio-physicists. The subject matter had to do with structure failure due to noise, human response due to noise and the limits that must be imposed on the industrial noise environment in relation to industrial efficiency and human response such as communication effort, mental fatigue and deafness. The program was divided into (1) Deafness in Industry, (2) Social Effects of Noise, (3) Noise Control of Factory Plant and (4) Roadway Noise.

Deafness in Industry

Dr. H.A. Van Leeuwen, Organization for Health Research, TNO, The Hague, spoke on Industrial Deafness Studies in Holland. He said that TNO coordinates this study in the Netherlands. Research involves finding the parameters that are related to hearing loss. In the initial study to find acceptable threshold levels they worked with broad-band, steady-state noise. The hearing loss for several industrial types, textile, electronic manufacturing, concrete pile drivers, propeller grinders, etc, were plotted against the center frequency for octave bands from

250 Hz to 8 kHz. Curves for % of people affected, a median and a shaded area for the 25% to 75% were shown. The workers in the textile mills showed a median loss of 20 dB at 250 Hz, 10 dB from ½-1 kHz, 20 dB at 2 kHz, 50 dB at 4 kHz and 25 dB at 8 kHz. Boilermakers showed a median loss of 55 to 70 dB which increased from 2 to 8 kHz.

Dr. W. Taylor (Queen's College, Dundee, Scotland) also discussed deafness in textile factories. He quoted a warning, published in 1892, that the noise in the textile mills was causing deafness. Some of the looms in use today were installed that same year. Some of the workers tested in his research have operated the same loom for 45 years. The urge to modernize comes slowly in Scotland. In the past year or so the speed of the looms has been increased by a factor of 2, and the increased noise has prodded research. Plastic components reduced the noise only 2 dB; a water jet shuttle reduced the shuttle noise by 10 dB. His curves showed the same hearing loss characteristics as shown for the textile workers in Holland. His sample was 39 weavers, mean age 54, mean exposure 34 years. By means of a questionaire he obtained information on the social effects of the hearing loss in relation to communication by telephone, within the family, at social functions and as to tolerance of noise. Pop music of teen-agers was not tolerated in spite of the hearing loss! He also had data on coal graders, with a mean exposure of 26 years. To emphasize the social effects of the loss, he played voice and music with filters inserted that matched the progressive loss curves.

Mr. C.G. Rice (Audiology Group, Institute of Sound and Vibration Research, Univ. of Southampton) presented a paper which is to be published in the Journal of the Acoustical Society of America some time soon so I'll not scoop the journal. The paper will be Hazardous Exposure to Impulse Noise by R.R.A. Coles, G.R. Garinther, D.C. Hodge and C.G. Rice.

Social Effects of Noise

Dr. J.C. Webster (NEL, San Diego) presented a paper, Speech Interference by Noise. He combined 16 ship-and-land-noise recordings and measured speech interference levels for selected bands, and clipping. The 300 - 2400-Hz band with clipping was best.

A paper entitled A Study of Problems of Noise in Offices by Mr. E.C. Keighley and Dr. F.J. Langdon (Building Research Station at Watford (Garston) Herts) was presented by Langdon. Offices in London having at least 50 people were surveyed by questionnaire and by recording noise. From this survey he obtained scores of acceptability when noise peaks were 5, 10, 15, etc., dB above the average level. An acceptability in which 1 in 10 were dissatisfied showed a noise level of 70 dB(A) with no peaks, 65 dB(A) with 10 dB peaks (a peak index of 10), a slightly lower noise level for a peak index of 20, and then a greater drop in the acceptable noise level for a peak index greater than 25. He pointed out that a reduction of the noise level without reducing the noise peaks will make the noise less acceptable.

Noise and the Householder was presented by Mr. I.J. Sharland (Institute of Sound and Vibration Research, Univ. of Southampton) who referred to this in terms of finding a guide to the intrusiveness of noise in the household. His equation for the critical bandwidth of noise when a pure tone is masked by a noise of the same level is

$$10 \log \Delta f_c = 24 \left[\log f + 6.76/\log f\right] - 108$$

Noise and the Law

Mr. J.B. Cronin (Univ. of Southampton) presented the most interesting and the only paper on law in this session. He is the Deputy Vice-Chancellor of the Law Faculty. He discussed the common law concept and then outlined the three court actions that are open to people in a noisy environment in the absence of specific statutes. The law of nuisance covers acts not specified by law. (1) Private nuisance generally relates to the use of land and is referred to as civil law. (2) Public nuisance relates to crime and is handled by the attorney general. (3) The court can be asked for an injunction. If action is taken as a public nuisance, there must be proof of danger or injury. If action is taken as a private nuisance, then the person must prove there is more damage to him than to the general public, a group or to anyone else. The third approach is for a group to ask for an abatement order, and a fine of £5 can be imposed. If the noise is not abated, then the fine can be increased up to £2000. Aircraft is excluded from this last action since there is a statute that refers to the level of aircraft noise that is excessive.

Cronin felt that there are plenty of laws on abatement and not much need for the activities of the Noise Abatement Society. He said, however, that the present attitude is when in doubt, legislate. Cronin said that no employee has ever taken action in court against his employer for injury due to noise. There is no reason why he shouldn't with all the evidence available. Parliament is revising the law so that deafness is to be considered an industrial disease. This will help the employee in a court case. Since 1965, the Ministry of Labour can act against an industry if noise causes injury. The court-appointed inspector can stop an industry causing injury or affecting bodily health. Cronin concluded that sociologically, deafness is not recognized. He then defined negligence which deals with a hypothetical person, one who is liable to suffer dermatitus, deafness, etc. Negligence is not related to the average or normal person. Even if the employer furnishes ear protectors and the employee fails to use them, the employer is still negligent. It is the responsibility of the employer to see that they are used. After a lengthy discussion, Surgeon Commander R.R.A. Coles, R.N. showed a film, Medical Aspects of Hearing Conservation. After Cronin's comments on negligence, it was interesting to note the exposure of an ear behind the ear-protector cup worn by an engine-room operator in the engine room during one short scene (not part of the script).

Noise Control of Factory Plant

The morning session of the second day began with a paper, Noise Control on Textile Machinery, by R. Crawford (Institute of Sound and Vibration Research, Univ. of Southampton). He analyzed the noise produced by a nylon draw twist machine before and after modification. The octave-band sound-pressure level for this machine ranged between 80 and 100 dB in the range of center frequencies from 63 to 8000 Hz. Broad peaks occurred at 125 and 1000 Hz. In this machine the spindle and draw rolls operate at 10,500 rpm, giving a bobbin surface speed of Mach 0.17, noise increase in proportion to the 6th power of the rpm being 80 dB(A) at 4000 rpm and 115 dB(A) at 10,000 rpm. In the program to reduce the noise level they found that a rigid spindle mount with isolated bearings reduced the noise level by 23 dB. A programmed speed reduction of the bobbin as it filled, reducing from 11,400 to 8000 rpm, kept the noise constant instead of rising. Cast polyurethane gears reduced the noise above 1 kHz by 5 to 30 dB from that produced by the normal steel and brass gears. The modified machine brought the operating area noise level below the NR 90 curve. On another machine the standard shuttle loom at 205 picks/min produced a noise level of 94.5 dB(A); a water jet shuttle loom at 400 picks/min reduced the noise level to 84.5 dB(A).

Prof. H. Opitz (Univ. of Aachen, Germany) analyzed the Noise of Gears. The sound pressure level increases 3 dB for doubling tooth load, 6 dB for doubling speed, and reduces 3 dB for doubling the face width (length of tooth). A 5-dB reduction in noise was obtained when the surface finish was improved from 10 micrometers to 5. Pitch error should be less than 6 micrometers and tooth alignment error should be less than 50 micrometers/100 mm. Tapered roller bearings produce 3 dB less noise than ball bearings. A cylindrical gear box reduced the noise level of a shift gear box by 10 dB over the conventional square box due to the increased stiffness.

Roadway Noise

Noise Reduction on Road-breaking Drills by Dr. A.J. Pretlove (Univ. of Reading) was the first paper on the last afternoon. The noise ratings were given in dB(A) at a distance of 50 feet. Standard models varied in noise level from 77.8 dB(A) for the electric model to the noisiest, pneumatic at 98 dB(A), in which the exhaust noise represents 87.5% and impact noise 12.5% of that figure. The hydraulic drill with lead shot-damped steel point reduced the noise to the acceptable NR 35 curve. E.J. Richards (Institute of Sound and Vibration Research) has reported a substantial reduction in tool bit noise in the frequency range 3 - 20 kHz when an alloy of manganese and copper, having a specific damping capacity of 41% is used.

Dr. T. Priede (Institute of Sound and Vibration Research) discussed Noise and Engineering Design. Noise level versus rpm for the diesel engine is proportional to the third power, petrol engine to the fifth power, a hydraulic pump to the second power, and a ball bearing to the fifth power of the rpm. In comparing diesel and petrol engines rated at 3 liters/cylinder at 4000 rpm, the sound pressure levels were the same at 102 dB(A). There is little change between a 3 liter/cylinder and a 30 liter/cylinder engine. The Institute has been working for several years on the problem of reducing diesel engine noise. A magnesium cased engine reduced the sound pressure level by 10 dB from the standard engine. Substitution of the cheaper construction of aluminum, rubber, aluminum sandwich sheet produced the same reduction.

Papers Presented

H.A. Van Leeuwen - Industrial deafness studies in Holland

W. Taylor - Deafness in textile factories

C.G. Rice - Deafness due to impulsive noise

W.P. Vermeer (Mrs) - Boundary between safe and unsafe noise

J.C. Webster - Speech interference by noise

E.C. Keighley and F.J. Langdon - A study of problems of noise in offices

I.J. Sharland - Noise and the householder

E. Lübcke - Effect of noise on the individual

J.B. Cronin - The law as it applies to noise

R. Crawford - Noise control on textile machinery

H. Opitz - Noise of gears

B. Berger - Transformer noise

R.S. Jackson and C.R. Maguire - Noise of electrical machines

H. Oberst - Reduction of noise by the use of damping materials

A.J. Pretlove - Noise reduction on road-breaking drills

R. Martin - Traffic noise

T. Priede - Noise and engineering design

E.J. Richards - Industrial acoustics--the future

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13. ABSTRACT

Two London conferences on noise, industrial, road and aircraft, dealt with means for analyzing and measuring noise to determine physical characteristics which relate to subjective degree of annoyance and to structural fatigue. Methods of control covered existing laws, monitoring and reporting and design for noise reduction.

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14. KEY WORDS	LINK A		LINK B		LINK C	
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Noise, industrial, road and aircraft, industrial deafness, noise annoyance, structural fatigue due to noise, noise measurement.						

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