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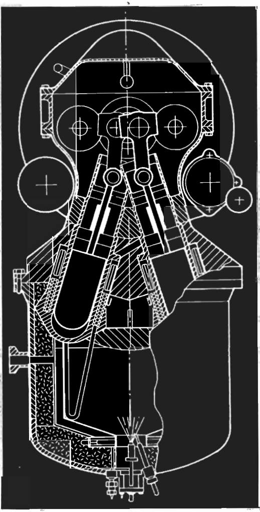

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From The President

It seems like only yesterday that I was writing for the last Acoustics Australia and before long it will be November and the 1994 Acoustical Society Conference.

The Conference is a significant event in any acoustician's life for many reasons. It gives those involved in acoustics the opportunity to hear and to present papers on a wide range of relevant and interesting topics. It also allows people with similar interests from across Australia and possibly from other countries to meet and discuss common problems and solutions; and for the regular attendees it provides an opportunity to meet old friends.

I have always come back from these conferences with new knowledge and often with new ideas. I have also made new contacts that can be invaluable throughout the next year.

I therefore recommend that all members of the Society make the effort to attend.

As an extra bonus this year the Society is holding a workshop on road traffic noise descriptors. This workshop is intended to assist in the development of a National policy on traffic noise in Australia.

I mentioned in my last report in Acoustics Australia that the economic conditions are making it increasingly difficult for noise to have a high profile in the priorities of government. According to the indicators the economic conditions are improving, but governments are still contracting and it is still possible that issues such as noise will be the losers. The proposed workshop is a step towards keeping noise on the political agenda.

Before closing I must pass some exciting news. The Society will be holding the next Noise and Health Conference in Melbourne. This is a very significant international conference which explores the nexus between noise and health and is held at five year intervals. The conference gives researchers from all over the world the opportunity to present the results of their labours and by 1998 I would expect that some very significant advances would have been made in understanding the long term health effects of noise. It therefore gives all those in Australia involved in the health effects of noise an aim; to complete research and have it presented at this most important international forum. It also gives each Division of the Society the opportunity to assess the possibility of supporting research.

I look forward to seeing as many of you as possible in Canberra in November.

John Lambert.

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EFFECTS OF ENGINE SPEED AND POWER ON THE SOUND POWER GENERATED BY A STIRLING ENGINE

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Aeronautical and Maritime Research Laboratory - DSTO,
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Abstract: In modern conventional diesel-electric submarines, batteries are used as the direct source of energy for the electric motor which propels the submarine. The diesel engines, which are used to recharge the batteries, must ingest atmospheric air. A means of increasing the submerged endurance of a conventional diesel-electric submarine is to install an auxiliary propulsion system which is independent of atmospheric air. One such system is based on the Stirling engine, which is being evaluated at AMRL. In this paper the results of an investigation into the effects of varying engine speed and power on the airborne radiated sound power from the Stirling engine are presented. These are compared with the sound power levels from a conventional diesel engine of the same power rating.

1. INTRODUCTION

The Stirling engine is one of a number of air-independent propulsion systems under consideration for possible incorporation in the new Collins class submarine at the first part-life refit. Conventional diesel-electric submarines, such as the Collins class, must periodically either surface or raise a snort mast in order to ingest atmospheric air to run the main diesel engines. The frequency and duration of snorting or surfacing determines the indiscretion rate, or the proportion of time that the submarine is partly exposed. The inclusion of an auxiliary air-independent propulsion system will increase the submerged endurance of the submarine and decrease its indiscretion rate.

Machinery noise is an important consideration in the design of submarines. In the Stirling engine, combustion is continuous and occurs in an insulated pressure vessel, and therefore can be much quieter than in an internal combustion engine. It has smooth, near sinusoidal cylinder pressure variations of the sealed working gas, so there is an absence of the cyclic combustion noise associated with the Diesel and Otto cycles. The engine is still a reciprocating piston engine, and therefore has the mechanical noise associated with the crankshaft, connecting rods, bearings and sliding pistons.

The study of the Stirling engine at AMRL includes the measurement of structure-borne noise and vibration and air-borne noise as a function of engine speed and power level. This report describes an investigation of the effects of varying engine speed and power output level on the radiated sound power from the Stirling engine. The noise levels are compared with values for a diesel engine of the same power. Because of the sensitive nature of the engine's performance figures, these are presented in a modified form in this paper, relative to the engine's nominal rated speed and power.

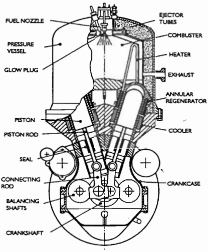

Figure 1. Section through Stirling engine.

2. OPERATION OF THE STIRLING ENGINE

The AMRL Stirling engine, Figure 1, is a closed cycle,continuous-external-combustion engine, that has been specifically designed for air-independent propulsion operation in submarines. It has four cylinders arranged in a V-configuration surrounded by annular coolers and regenerators. The Stirling engine operates by cyclic compression and expansion of helium, at different temperatures. Helium is passed through tubes in the combustion chamber, where heat is supplied by the combustion of a refined diesel-type fuel in gaseous oxygen (from liquid oxygen storage) at high pressure. There are no cylinder inlet or exhaust valves, with the double acting pistons moving the helium between the cylinder space below one piston, through the annular coolers, annular regenerators and heater tubes to the space above another piston.

The cylinder pressure variations are very nearly sinusoidal, and the crankshaft is almost perfectly balanced by two balance shafts, resulting in a low level of vibration. As the pistons are double acting, with gas pressure acting on both sides, the gas pressure forces transmitted to the crankshaft bearings are to some extent reduced. This, together with the short stroke, of approximately half the bore diameter, helps to minimise the inertia loads on the bearings. Since bearing loads are one of the main sources of mechanical noise from pistons engines, the noise level, when compared with other piston engines, is very low.

In the submarine the engine is used to drive a generator which charges the batteries. The engine is commonly operated at one speed and the power output is varied by changing the helium pressure in the engine. The average helium pressure inside the cylinders controls the amount of power that the engine produces for a fixed combustion temperature, which in turn, is controlled by the fuel and oxygen flow. Increasing the helium pressure increases the power output of the engine. Engine combustion and operation is managed by a microprocessor. Engine speed is usually maintained at V_N, a level which for this engine optimises the balance between the low vibration signature and fuel and oxidant economy.

The engine has a nominal rated power of P_R for sustained operation. Maximum power output P_{MAX}, is 115% of P_R. The power levels of the engine are usually set at seven basic positions ranging from $0.4P_R$ to P_{MAX}. However, the engine can be operated at any output to within a few kW between these lower and upper limits if required.

3. SOUND POWER MEASUREMENTS

In this particular investigation of the Stirling engine it was important that the measurements of the noise level of the engine were as independent of the environment as possible, since the real working environment of the engine will be inside a submarine rather than an engine test cell at AMRL. For this reason the sound power levels were chosen to characterise the engine as a noise source.

The sound intensity measurement system consisted of an Ono Sokki CF-350 dual channel FFT analyser, a Bruel and Kjaer type 3520 sound intensity probe, a phased matched pair of Bruel and Kjaer type 4183 microphones with a 12mm spacer and StarAcoustics sound intensity software. This software package has the ability to perform phase corrections on the measured data to compensate for the system phase mismatch.

The system was calibrated for both sound pressure and sound intensity sensitivities using a Bruel and Kjaer type 3541 sound intensity calibrator, before and after the measurements were made. The instrument system frequency response had previously been verified over a frequency range greater than that being measured in the present experimental study using a reference sound source, [1].

The tests were carried out in an engine test cell, 6.7 x 4.0 x 3.3 m in dimensions. Approximately 60% of the wall and ceiling area of the cell was covered with sound absorbing material to reduce the reverberation effects. The measurement surface was a 2 x 2 x 2 m. cube enclosing the Stirling engine. Data were collected by taking measurements at regular points on each face of the cube, except the concrete floor. The latter was omitted, as it was considered that it reflected the sound energy back into the volume enclosed by the control surface.

The sound power of the engine was measured for engine power outputs of $0.4P_R$, $0.7P_R$ and P_R; at speeds of 0.9 V_N, V_N and $1.1V_N$. The results are expressed in dB re a nominal reference. These are summarised in Table 1 and plotted in Figure 2.

Sound power level (dB)			
	engine output		
	$0.4P_R$	$0.7P_R$	P_R
engine speed			
$0.9V_N$	45.1	47.0	49.5
V_N	46.0	48.6	50.8
$1.1V_N$	46.5	48.5	50.7

Table 1 Sound power level of Stirling engine as a function of engine speed and power.

As a comparison the sound power from a small marine diesel engine, of similar running speed, was estimated for the same engine power levels considered above, using data from Nelson [2]. The respective sound power levels were 67, 69.5 and 71 dB, re the same nominal reference.

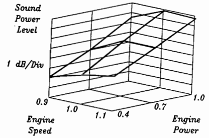

Figure 2. Sound power levels of stirling engine.

4. DISCUSSION OF THE RESULTS

4.1 Sound Power Levels

From Figure 2 it can be seen that the sound power level increased with engine power. For each engine speed setting there was an average 2 dB increase for rise of 0.3 P_R in engine output power. At each engine speed the change in sound power appeared to be directly proportional to engine power.

There was, on average about a 1.5 dB increase in total sound power level as the engine speed changed from $0.9V_N$ to V_N, but virtually no increase in sound power level as the speed changed from V_N to $1.1V_N$.

From the results it can be seen that the change in sound power is a more significant function of engine power than engine speed. Moreover the results indicate that there is a linear relationship between noise level and engine power, with the sound power level increasing by 1 dB for each increase of $0.15\ P_R$ in engine power output. If this linear behaviour is extrapolated over the entire power range then the noise level of the engine can be expected to increase by approximately 5 dB over the full engine power range.

When compared with the sound power levels from a diesel engine with the same engine power output, the Stirling engine running at normal operating speed has noise levels **20 dB below** those of the diesel. The Stirling engine also exhibits a different relationship between engine power and sound power level from that of the diesel. The Stirling engine appears to show a linear increase in sound power level, while the diesel has a logarithmic increase in sound power level for increasing engine power output, [2][3].

Although third octave band levels are not detailed in the results given here, examination of these showed that the spectral characteristics of the sound power for the engines were similar.

4.2 Discussion of Errors

The main sources of error in the measurement were random error, system phase mismatch error and the error caused by the non-uniformity of the sound field over the element area. To reduce the random error 256 spectrum averages were taken for each measurement point.

To minimize the effect of system phase mismatch, a system dynamic capability (L_d), with K=10dB was used. L_d is given by the expression, $L_d = \delta_{pI} - K$, and is the value that δ_{pI} must be less than in order to have the phase error bounded by a particular value, [4]. For K=10dB, the phase error will be bounded by 0.5 dB. The field pressure-intensity index (δ_{pI}), or F2 field indicator, defined as the average ratio between the true free field intensity and the measured intensity, was determined for each set of measurements and was compared with the dynamic capability. A comparison between L_d and F2 for each set of measurements and over all frequency bands showed that $L_d > F2$. A typical set of results is shown in Table 2. They show that the phase mismatch error in the measurements was bounded by + 0.5 dB.

To assess the error caused by non-uniformity of the sound field over the area of each element of the control surface, the F4 field indicator with C = 8 was calculated. The F4 indicator is a measure of the uniformity of the distribution of the sound over the measurement surface. This value determines the number of points needed to measure over the whole surface to a specified measurement grade. The value C = 8 is the factor for results at the level of a survey grade, [5]. Examination of the results showed that most of the sound energy was concentrated in the middle and upper frequency bands of the measurement frequency range. For each of the nine measurement sets it was found that the F4 indicator showed the size of the measurement grid was sufficiently fine in all but the lowest two or three third octave bands. When compared with the middle and upper frequency bands, the sound power levels in the three lowest third octave bands was approximately 12 dB lower, and so it could be considered that the error caused by the inadequacy of the number of measurement points at low frequency was small and would not significantly affect the overall analysis.

Frequency	L_d	F2
125	7.99	7.00
160	9.88	6.23
200	12.21	7.02
250	14.12	6.67
315	13.37	8.13
400	16.26	5.17
500	25.81	5.02
630	17.74	4.73
800	22.77	3.50
1000	16.65	4.05
1250	17.53	4.00
1600	14.87	4.04
2000	13.76	4.27

Table 2 Comparison between L_d and F2 for a typical measurement result.

5. CONCLUSIONS

The broad band sound power level of the AMRL Stirling engine was investigated over a range of engine speeds and engine output powers. Analyses of the measurements indicated that the sound power level increases linearly with engine output power, but is relatively insensitive to engine speed. The sound power levels for the Stirling engine are approximately 20 dB lower that for a diesel engine with corresponding engine power output.

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EFFECT OF SLITS ON THE PERFORMANCE OF ROADSIDE TIMBER BARRIERS

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Abstract: A well constructed timber barrier, with overlapping joints can provide good noise reduction. The results of measurements to assess the degradation of the acoustic performance, resulting from deterioration of the barrier, are presented. The slits in the fence led to a reduction in the screening of around 4 dB(A) for locations close to the barrier. The implications of these changes in terms of the reduction in the transmission loss of the barrier itself are discussed.

1. INTRODUCTION

Barriers can be effective in reducing the noise levels from noise-producing land uses such as roads, industry and other sources, for nearby noise-sensitive land uses such as housing and schools. For normal partition walls which are sealed to the surroundings, it is the noise reduction properties of the partition itself which determine the attenuation. For barriers there is generally no surrounding construction, except at the ground level, and the noise reduction properties of the barrier material itself are not normally the primary factors in the attenuation achieved. Sound can propagate from the source to the receiver by a diffracted path over the top or around the ends of the barrier. Achievable reductions can be as high as 20 dB, depending on the diffraction angle, although values of the order of 5 to 10 dB are more common for free standing barriers.

When the noise reduction properties of the barrier itself are poor, the direct path through the barrier may become significant in limiting the noise reduction. A general guideline for the noise reduction properties of the barrier material itself is that the sound transmission loss via the direct path through the barrier should be at least 10 dB better than the noise reduction due to the diffraction [1]. Most materials used for barriers in outdoor applications such as earth mounds, masonry walls, metal walls etc, are normally well sealed and do not have intentional gaps. Timber barriers generally meet the requirements for adequate superficial mass and no gaps when first installed. However, for some types of timber barriers comprising overlapping boards, subsequent weathering and buckling of the boards can lead to significant gaps within the panels. The presence of these gaps may reduce the sound transmission loss of the fence and hence reduce the overall noise reduction achieved.

This paper considers the effects of gaps or openings in a barrier and presents the results of measurements on a roadside timber barrier with and without the presence of gaps.

2. THEORETICAL BASIS

2.1 Attenuation of a Barrier

The considerations for the construction of a barrier to provide adequate noise reduction are covered in many standard reference books. The important factor is the path length difference; this is the difference between the diffracted path from the source to the receiver (over the top of the barrier) and the direct path (as if the barrier was not present). This is shown schematically on Figure 1. The potential barrier attenuation, based on the assumption that the level of the sound transmitted directly through the barrier is much less than the level of that diffracted, is usually presented in terms of this path length difference (for example in [1]). The greater the path length difference, the greater the potential attenuation to a practical maximum of about 20 dB.

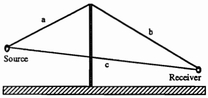

Figure 1. The path length difference is given by a + b - c.

2.2 Attenuation of the Barrier Material

The noise reduction properties of the material for barriers are normally available in terms of Transmission Loss (TL). The laboratory method for determination of the TL involves the installation of the material in a special framework between two large reverberant rooms [2]. The primary pathway for the sound to travel from one room to the other is directly via the material under test. For single homogeneous panels, the mass law gives a good indication of the TL, ie the heavier the panel the better the noise reduction. For double leaf constructions, a higher TL can be obtained than that indicated by the mass law alone, as long as care is taken with the design of the construction such as minimising the number of direct connections between the two faces.

The TL of a partition which comprises a number of component parts is limited by components with the lowest TL even if these components occupy only a small proportion of the surface area. When gaps or slits are present, the TL of these are almost zero and so they have a large effect on the overall noise reduction achieved. For example, the traffic noise reduction for a wall containing a window with a direct opening having an open area of only 4%, ie similar to a slit, has been shown to decrease by almost 10 dB [3].

2.3 Implications of Slits or Openings in Barriers

Recommendations for the design of barriers normally emphasise that even small openings will significantly reduce the noise reduction provided by the barrier but this is usually not quantified. By way of example, let us assume that the material of a well constructed timber barrier provided a TL of 20 dB(A). Let us also assume, for a particular source-barrier-receiver configuration, that this solid barrier achieves a reduction of 10 dB(A) at the receiver behind the barrier. If this barrier now has slits in it (caused by warping for example) such that the area of opening is only as much as 4% of the total barrier area, the level of sound arriving at the receiver by the direct transmission path through the barrier would be some 10 dB (A) greater than before and when combined with the level of sound arriving by the (originally dominant) diffracted path over the barrier, the reduction achieved by the barrier at the receiver would now be significantly less than the 10 dB(A) achieved by the solid barrier.

For a typical timber fence with height 1.8 m and comprised of 25 mm wide butt-jointed palings, an open area of 4% would be represented by 1 mm wide slits between the palings. Similar open areas could be caused by splitting of the timber around the nail joints. Assuming the splits extend one third of the way down the board, an open area of 4% would be represented by an average split width of 3 mm. These dimensions for slits and splits are not unrealistic for a timber barrier which has been exposed to the weather for some time.

However, for a barrier comprised of overlapped rather than butt-jointed timber palings, distortions in the palings can lead to slits which are not direct openings but are angled, as shown schematically in Figure 2. The effect of such angled openings on the acoustic performance is not immediately clear. The principle of angled openings is utilised in baffles around noise sources which require air flow although the surfaces of such baffles are usually covered with sound absorbing material. Angled openings can occur when metal casement window frames are opened a small amount. In this case the nature of the sound field can be quite complex and include resonator effects [4].

Given the complex and variable nature of slits and splits in an overlapped timber paling fence it is not easy to predict the effect on the acoustic performance as a barrier for road traffic noise. Therefore a full scale experiment was set up to investigate this effect.

Figure 2. Schematic indication of the effect of distortions occur in the palings of an overlapped timber barrier. a) well sealed timber paling fence; b) paling fence with slits

3. EXPERIMENTAL FINDINGS

3.1 Description of Barrier

Measurements were made in the vicinity of an overlapped timber barrier, located approx 2.8 m from the edge of the carriageway of a busy highway. The barrier had been well constructed with panels of overlapped boards, 175 mm wide with thickness tapered from 25 mm to 6 mm, secured to timber cross members supported on galvanised steel posts set in concrete footings. After some years, the primary cause of the deterioration was post-construction buckling of individual timber boards about their long axis; the resultant curvature of the boards forcing gaps in the overlapped joints. Approximately ninety percent of the boards exhibited at least slight buckling and up to ten percent were severely affected. The gaps ranged from 5 to 15 mm in width. As the boards were overlapped, the openings were similar to that shown in Figure 2b so that the full effect of the gaps could be seen parallel to the fence, while from about 35^o to the normal, through to normal to the barrier, the gaps were not noticeable.

Other types of deterioration were board splitting at nail holes and loss of seal between the barrier and the ground. These effects were relatively minor and the investigation of the degradation in acoustic performance concentrated on the portions of the barrier where the buckling was the main feature.

3.2 Test Method

There are no standard test procedures for investigating the deterioration in TL for an acoustic barrier in situ. The procedure that was developed involved two parts. Firstly, measurements were made with the existing barrier, several hundred metres in length. This set of data is referred to as the pre-seal data. Then a flexible mastic material was applied to all the gaps in a 40 m long portion of the barrier. Effectively this resulted in that small portion of the longer barrier having a TL equivalent to that for the barrier prior to the deterioration. This second set of measurements is referred to as post-seal data. As all the measurements were made at the same locations and under similar weather conditions, any effects from the surroundings were the same for both tests.

The measurements had to be carried out without disruption to the traffic flow so the existing traffic noise was used as the source. The traffic volume for this road was approximately 75,000 vehicles per day with about 7% heavy vehicles and the speed limit was 80 km/hr. The locations for the measurement microphones are shown in Figure 3. The choice of a position at the top of the barrier for the reference microphone was based on minimising wind and near field effects of the traffic stream and reflection effects from the barrier and on avoiding creation of a traffic hazard. The rear microphone, at 1 m behind the barrier, was located to maximise the attenuation provided by the diffracted path in order to detect differences in the transmitted path between the pre-seal and post-seal conditions. The second rear microphone position, at 5 m behind the barrier, was selected to check the performance at greater distances. It should be noted that pre-seal measurements can be assumed to have been conducted on an infinite barrier (ie 180^{o} angle of view from the receiver position to the barrier) and the barrier was of uniform transmission loss characteristics over its length. Post-seal measurements were also conducted on an infinite barrier, but by contrast this barrier did not have uniform transmission loss characteristics. In fact, the post-seal barrier consisted of a finite (40 m) sealed barrier set in an infinite barrier of lower transmission loss. However, at the 1 m rear microphone position, the effect of this discontinuity would have been negligible as the angle of view from the receiver to the finite length of sealed barrier approached that of an infinite barrier (174^{o}). At the 5 m rear microphone position, the effect of the discontinuity may have been larger (152^{o} angle of view to the finite length of sealed barrier) though certainly much less than 1 dB. Rear microphone positions were restricted to these positions close to the barrier specifically to minimise confounding effects caused by limitations in the length of barrier that was able to be sealed for the experiment.

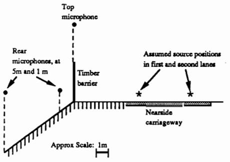

Figure 3. Sketch of the test site showing the position of the microphones, the barrier and the roadway.

Ten minute samples of the signal at the top microphone and at the 1 m microphone position were recorded simultaneously on separate channels of a tape recorder. This was repeated using the 5 m microphone position. Laboratory analysis of the recorded tape provided the values for the percentile descriptors; L_1, L_5, L_{10}, and L_{90} (which are the levels exceeded for 1, 5,10 and 90% of the time period respectively). The L_{eq}, the equivalent continuous sound level, and the maximum noise levels, in terms of dB(A), for individual vehicles which could be clearly isolated from the traffic stream, were also obtained. The individual vehicles were identified during the field measurements in terms of lane position and location of exhaust, ie low level exhaust typical for cars or high level exhaust typical for trucks.

The traffic noise levels could be expected to vary somewhat during the series of measurements. For example, measurements of the L_{10} at the top microphone varied from 80.8 to 82 dB(A). For this reason, the data reported in this investigation is in terms of the differences between simultaneous sound levels at the top and the rear microphones, rather than absolute levels. Thus any variation in source level does not affect the results reported here.

Two replications of each of the measurement conditions (ie 1 m and 5 m microphone location and pre- and post-seal of the fence) were made during each of two separate measurement periods. The repeatability of the measurements was high as shown by the values in Table 1 for the differences in L_{10}, dB(A), between the top and rear microphones obtained over the four replications.

Table 1. Differences in L_{10}, dB(A), between the top and rear microphones for four replications.

	Replications			
	1	2	3	4
Pre seal difference between top and 1 m rear microphone	11.0	11.5	11.5	11.7
Pre seal difference between top and 5 m rear microphone	11.8	12.0	12.7	12.0
Post seal difference between top and 1 m rear microphone	15.3	16.3	15.0	14.5
Post seal difference between top and 5 m rear microphone	12.7	15.7	14.3	14.8

3.3 Changes in Noise Reduction

A comparison of the reduction in the noise level, in terms of L_{10}, between the top and the rear microphones for the pre-seal and the post-seal conditions of the barrier is shown in Figure 4. These data are the mean of the four replications. As one would expect, the effectiveness of a barrier in reducing sound increases with increasing frequency. Also, as expected, the differences between the top and rear microphones are greater at 5 m than at 1 m behind the barrier.

The effect of sealing of barrier on the L_{10} at the two rear microphone positions is shown on Figure 5. The findings for the other descriptors, with the exception of L_{90} at the 5 m position, were similar to those values shown for L_{10} in Fig 5. At the 5 m position the differences between the L_{90} for the pre- and post-seal conditions were less, possibly because the L_{90} levels were not generated solely by the vehicle sources in the vicinity of the microphone but by the long line of traffic sources and other general noises in the area.

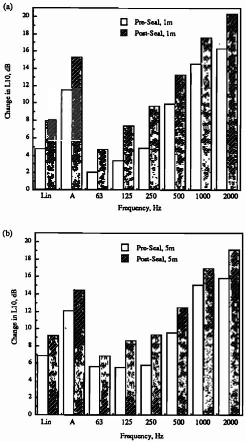

Figure 4. The differences between the sound levels at the top microphone and the rear microphone, in terms of L_{10}: (a) for the 1 m position; and (b) for the 5 m position.

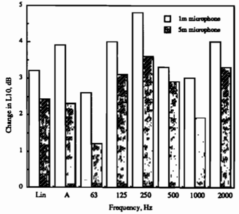

Figure 5. The differences between L_{10} post-seal for each of the two rear microphone positions.

The differences between the pre- and post-seal conditions for the maximum noise levels for isolated individual vehicle passbys in the nearest lane were also determined. For the high level exhausts there were 32 vehicles in the pre-seal and 34 vehicles in the post-seal tests and the difference in the average maximum noise levels between the pre- and post-seal conditions for the rear microphone at 1 m was 5.9 dB(A) (with the standard deviation for the average values of 1.6 and 1.4 dB respectively). For the low level exhausts, there were 101 vehicles in the pre-seal and 84 vehicles in the post-seal tests and the difference was 5.3 dB(A) (with the standard deviation for the average values of 1.6 and 1.2 dB respectively). These reductions in maximum vehicle noise levels are somewhat higher than the reductions obtained for the longer term descriptors such as L_{10}.

4. DISCUSSION

The results of the measurements showed that the effectiveness of a timber barrier can be significantly reduced by the presence of gaps between the palings. For continuous traffic, the reduction was found to be of the order of 4 dB(A). For individual vehicles, the reduction was found to be between 5 and 6 dB(A) depending on the height of the vehicle exhaust.

What does this 4 dB(A) difference tell us about the effective TL of the barrier with gaps? To answer this question, it is necessary to examine the relative contributions made by the two main paths of sound transmission from the source to the receiver. One path is directly through the barrier and determined by its TL, hence referred to as L_{TL}. The second path is the diffracted path via the top of the barrier and determined by the path length difference shown in Figure 1, and hence referred to as L_{diff}. A 4 dB(A) increase in the level as a result of gaps in the barrier requires that either L_{TL} or L_{diff}, or both, have increased.

For a well constructed barrier of practical height, and for most receiver positions behind the barrier of practical interest, receiver levels are determined by the L_{diff}, with the L_{TL} making little or no contribution to the receiver sound level. This is generally worded in barrier design guidelines [eg 1] as the reduction in L_{TL} through the barrier should be at least 10 dB better than the reduction in L_{diff} due to diffraction. More specifically for the source-barrier-receiver geometry in this experiment, the results of Kurze and Anderson [5] can be used to show that the L_{TL} at the 1 m receiver position would have been a minimum of 5 dB below the L_{diff} in the post-seal measurements.

Further, since the source conditions, the dimensions of the barrier and the positions of the microphones were the same in both the pre- and post-seal measurements, L_{diff} would have been constant in both sets of measurements. Hence the increase in receiver levels in the pre-seal measurement must be attributed to an increase in L_{TL} alone.

Simple energy calculations can be used to show that, for the combined level of two sounds A and B to increase by 4 dB, where B was initially at least 5 dB(A) below A and where A remains constant, B must increase by at least 9 dB(A). In other words, the present results demonstrate that the TL of the barrier must have deteriorated by at least

9 dB(A) because of the presence of the gaps.

For greater distances behind the barrier, at the same elevation as the measuring microphones, the contribution of L_{diff} to the receiver level would increase relative to the contribution by LTL because of the smaller path length difference along the diffracted path. This increased differential between L_{diff} and LTL reduces the impact of deterioration in the transmission loss of the barrier. However, as can be ascertained from barrier correction estimates [eg 6], this increased differential is small - about 2 dB between the 1 m and 5 m microphone positions, and only an additional 1 dB out to about 100 m behind the barrier. Using these estimates it is possible to show, again by simple energy calculations, that the increase in receiver levels over the range of 5 m to 100 m behind the barrier would be of the order of 3 dB to 2.5 dB, compared to an observed increase of 4 dB at the 1 m microphone position.

It is interesting to note that the difference in L_{10} between the pre- and post-seal conditions is similar across the frequency range. This indicates that there is no significant resonance effect in the change in TL because of the gaps and is not unexpected as the width and length of the gaps varied from paling to paling so any resonance effect would be spread over a wide range of frequencies.

5. CONCLUSIONS

The results of measurements designed to investigate the effects of gaps or openings between the components of a roadside timber barrier showed a degradation in performance of the order of 4 dB(A) for a position close to the barrier. At a distance of 5 m behind the barrier, the degradation was found to be of the order of 3 dB(A). It is estimated that the degradation would be of the order of 2.5 dB(A) out to 100 m from the barrier. Depending on the noise reduction intended to be obtained by any particular barrier installation, this may represent an unacceptable increase in traffic noise for the receivers. This highlights the importance of ensuring that a barrier, designed to reduce noise, comprises elements which are well sealed. Even though the openings may not be obvious when viewed normal to the barrier because of overlapping, the presence of slits can reduce the overall transmission loss achieved. For the barrier investigated, the slits were estimated to have reduced the TL of the barrier itself by 9 dB(A). This also has applications to ventilation louvre systems or any other partitioning comprising a number of openable, moveable parts.

The degradation was found to be not dependent on frequency, probably because the dimensions of the gaps in the fence varied due to the nature of the warping and deterioration of the component palings. The effect of the degradation on individual vehicle maximum noise levels was somewhat greater than for the continuous traffic noise measures.

Because of the potential for a reduction in the overall performance after time, care should be exercised in the selection and design of a timber barrier. Unless special construction techniques such as additional fixing, strips etc, are applied to minimise warping and buckling, a factor of safety should be incorporated in the design process to allow for the effects of the eventual degradation in the barrier and consequently the noise reduction achieved.

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7. ACKNOWLEDGEMENTS

John Esdaile performed extensive field measurements and laboratory analysis for this project.

Technical Report

"Fred's Phonoscope"

Athol Day

Day Design Pty Ltd, 2 Tate Place, Lugarno NSW 2110

On our way over to the last AGM of the Australian Acoustical Society in Adelaide, Audrey and I did the big tour through the Central Flinders Ranges in South Australia. The reliability of Jaguar motor cars is well established. However, as we approached Hawker a nasty noise was emitted from under the bonnet. The motor mechanic at the Mobil garage at Hawker filled up the tanks with petrol, then listened to the noise.

Equipped with twenty years experience as an acoustical engineer, yours truly listened with great understanding as to the level, type and character of the noise. It was a nasty grinding sound, steady in level, about 80 dBA at one metre with the bonnet up, with a frequency- modulating high frequency component, and obviously coming from the alternator bearing.

The motor mechanic had the temerity to disagree with the professional opinion expressed by yours truly. He thought it was coming from the air conditioning refrigerant compressor. "Hang on a minute" says he, and returns in 60 seconds with an obviously amateurishly built listening device. It looked as if it had come out of the ark (no digital readout, no computer output connection). Very primitive, but I had to admit that it was more sophisticated than the average "screwdriver to the ear" method. The photograph shows the motor mechanic demonstrating how to use a "Phonoscope" to the acoustical consultant.

"Its the compressor bearing" he says. "Listen to that". So I did. And clear as a bell the compressor bearing was clearly identified as the offending noise source. "Where did you get this splendid instrument" asks the acoustical consultant. "My dad made it" says the motor mechanic. "I would like to meet your dad" says the acoustical consultant, and within two shakes of a dead lamb's tail, son returns with dad. Yours truly is introduced to dad, whose name is Fred, and congratulates him. Fred is modestly proud of his invention, which on dismantling turns out to be the earpiece of an old telephone handset with a piece of brass welding rod poked through the centre. The secret of its success is the flexible mounting of the earpiece and the close tolerance in locating the end of the brass rod - just touching the metal diaphragm.

Fred explained that people always want to know immediately what the problem is before they spend a lot of money on repairs. "You've got to be able to identify the problem accurately and quickly" says Fred. "I made this just after the war, and its been mighty handy ever since". The photograph of Fred and his Phonoscope is proof of this hitherto undiscovered genius of acoustical engineering. I immediately offered him a position with Day Design in Sydney, but he politely declined my lucrative offer because of more pressing duties. He was going kangaroo hunting that afternoon.

"I've known clever young fellows to be awarded with a PhD with less original research and development than this Phonoscope", says the acoustical consultant. "I will tell the Australian Acoustical Society of your most remarkable achievement". They will probably want to make you an Honorary Member.

Off with the vee belt, and on our way - without air conditioning. Well people have been known to drive with open windows for ventilation before. A bit noisy though - "wind noise, not refrigerant compressor bearing noise" says the acoustical consultant to his long suffering wife, Audrey, who was rather impressed by Fred's short cut methods and uncomplicated approach to noise control.

Fred and his phonoscope

Phonoscope in use

QUIETING THE BILLY GOAT WITH ACTIVE NOISE CONTROL

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Abstract: Billy Goat Vacuum units are used by commercial gardeners and groundsmen to sweep up and dispose of fallen leaves because they are effective and easy to use. Unfortunately, the loud hum generated by these units at the blade passage frequency is a source of annoyance to nearby office workers as well as a source of potential hearing damage to an unprotected operator. Results presented in this paper demonstrate the effectiveness of a single channel active noise control system in reducing the single frequency hum to an acceptable level, regardless of variations in the equipment operational speed.

1. INTRODUCTION

The University of Adelaide currently uses a number of "Billy Goat" vacuum units to collect fallen leaves. During autumn, these units operate for many hours each day and the intense low frequency "hum" they produce is the cause of numerous complaints from University staff.

The business end of the Billy Goat is an approximation to a centrifugal fan, comprising four vertical flat blades direct coupled to an IC engine, which usually runs between 2500 and 3000 rpm during operation, producing a blade passage tone with a frequency varying from 165 to 200 Hz. Although this tone is the primary cause of complaint, there are numerous other lower level tones emanating from the IC engine casing and exhaust. These tones are essentially harmonics of the engine rotational speed. At a distance of 1m from the Billy Goat exhaust, the noise level measured at the blade passing frequency was 105 dB, and close to the exhaust it was 119 dB.

Although this application seemed a good opportunity to demonstrate the viability of active noise control, the high noise levels required at such low frequencies posed a significant practical problem. To keep the solution practical, it was necessary to use relatively small loudspeakers (10 cm diameter), otherwise they would be a nuisance to the operator. To maximise the noise produced by the loudspeaker, a catenoidal horn was designed such that its mouth extended over a large part of the top of the air inlet (see Figure 1). Originally, it was intended to use a second sound source at the air outlet, in the form of a horn driver attached to another smaller catenoidal horn. This second source proved unnecessary as the inlet sound source was capable of suppressing noise radiated from both the inlet and the outlet.

Another practical problem to be overcome involved the derivation of a suitable reference signal for the controller (see Figure 2). At first an inductor was wrapped around the spark plug lead but the signal obtained was much too noisy.

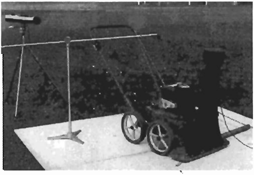

Figure 1. Billy Goat leaf sweeper with catenoidal horn on the inlet

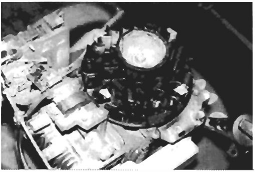

Figure 2. Top of motor with fan cover removed showing reflective strips on the motor fan.

To improve this an optical tachometer was used with the motor cooling fan. Four equally spaced reflective strips were attached to the circumference of the motor cooling fan at the top of the IC engine, thus providing a reference signal of the same frequency as the blade passing frequency. At first the reference signal was low pass filtered so that the controller only affected the tone at the blade passing frequency of the main vacuum fan. Although this would allow the main noise problem to be controlled, it was considered desirable to reduce the levels of some of the engine noise peaks and higher order fan tones as well. Thus, for some tests the reference signal amplifier was overdriven, such that the peaks of the signal were "clipped", to generate odd order higher harmonics.

2. TEST ARRANGEMENT AND PROCEDURE

To conduct the tests, the Billy Goat was taken to the centre of a large oval on a day with a negligible amount of wind. Tests were conducted with the Billy Goat positioned at the centre of a 2.5m square hard chipboard surface, and also with it standing on a grass surface, to find whether the surface over which it was used had an effect on the ability of the active control system to reduce the noise levels.

During the tests, an attempt was made to keep the Billy Goat engine running speed between 2,200 and 2,600 rpm. It was not unusual for the engine speed to vary significantly in this range, but the control system had no trouble in tracking this variation at all times.

An optical tachometer was mounted on the engine fan cover at the top of the engine and adjusted to illuminate the four equally spaced reflective strips on the motor cooling fan periphery. The tachometer output was connected to the reference signal input of the Causal Systems *EZ-TEACH* active noise controller development system. The other input channel was connected to a small lapel-pin type electret microphone, mounted 1m above the plane of the leaf sweeper exhaust. This input channel provided the required error signal for the feedforward control system programmed into the *EZ-TEACH* hardware. The program loaded into hardware was firstly developed using a menu-based interface for the real-time control system, which allowed adjustment of the controller parameters. The particular set of parameters was chosen to provide stability and fast convergence of the control algorithm, which also ensured good tracking of the variation in engine speed. The parameters were then programmed into the hardware, and determined the behaviour of the self-contained controller unit for all further testing. One of

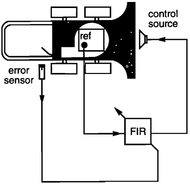

Figure 3. Overview of active control system.

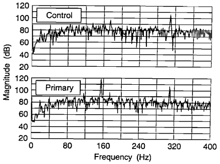

Figure 4. Sound pressure spectra at a point immediately above the Billy Goat exhaust, before and after the application of active noise control, with the Billy Goat over hard surface.

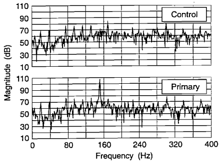

Figure 5. Sound pressure spectra at the error sensor location, 1m above the exhaust before and after the application of active noise control, with the Billy Goat over hard surface.

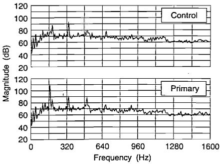

Figure 6. Sound pressure spectra at the error sensor location, 1m above the exhaust before and after the application of active noise control with a clipped reference signal, with the Billy Goat over hard surface.

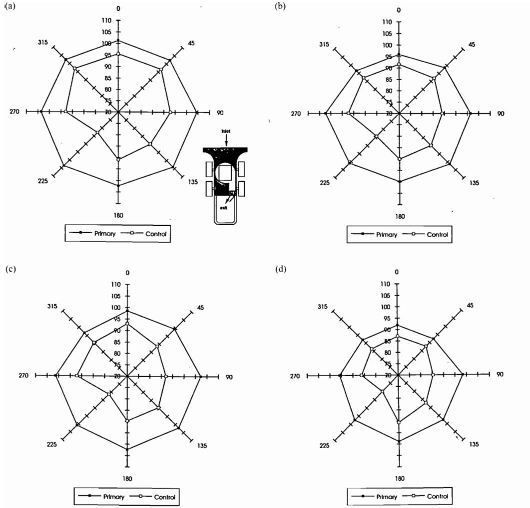

Figure 7. Blade passage frequency noise levels around the leaf sweeper before and after the application of active control.
(a) soft surface, measurement distance of 1.7m, (b) soft surface, measurement distance of 3.6m, (c) hard surface, measurement distance of 1.7m, (d) hard surface, measurement distance of 3.6m

the two controller output channels was connected to the loudspeaker at the end of the catenoidal horn as shown in Figure 1. The loudspeaker was driven by the filtered reference signal as shown in Figure 3. The loudspeaker enclosure was connected via small vents to the front of the loudspeaker to ensure static pressure equalisation between the front and back of the loudspeaker cone. This was necessary because the front of the cone was directly affected by the suction generated at the fan inlet.

The filtered-X LMS algorithm was implemented on the controller using an FIR filter, together with continuous on-line system identification [1]. This algorithm is considered to be the most applicable for a problem of this type, characterised by periodic noise and an incorruptible reference signal. The algorithm was used to adjust the FIR filter weights to produce a control signal which would minimise the error signal.

3. RESULTS AND DISCUSSION

Narrow band spectra showing the sound levels measured at an error microphone adjacent to the Billy Goat exhaust, for the machine mounted on a wooden surface, before and after the application of active control, are shown in Figure 4. Similar results were obtained for the machine mounted on a grass surface, indicating that the impedance of the surface under the Billy Goat has only a small effect on the resulting sound levels. Substantial reductions at the error sensor location of over 30 dB can be observed at the blade passage

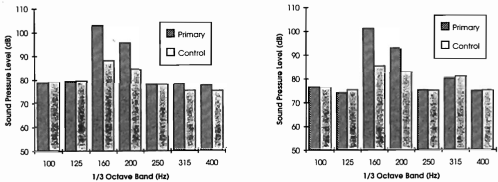

Figure 8. One third octave band sound pressure spectra at an angular location of 225° before and after the application of active control, with the Billy Goat over soft surface. (a) measurement distance 1.7m, (b) measurement distance 3.6m

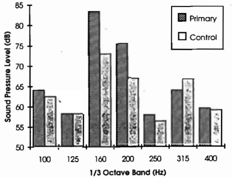

Figure 9. One third octave band sound pressure spectra measurement at a location 20 m behind the Billy Goat before and after the application of active control, with the Billy Goat over soft surface.

frequency with little effect on the levels at other frequencies. Similar results are observed when the error sensor is moved to a location 1m above the exhaust exit, as shown in Figure 5. The lack of effect of the controller on frequencies other than the fundamental blade passage frequency is as expected because the optical tachometer signal used as the reference input effectively contains only this frequency at any significant level.

In an attempt to control higher order harmonics, the reference signal was over-amplified so that it became "clipped" or "squared off", thus producing odd-order harmonics of the fundamental blade passage frequency. The resulting attenuation of the higher order harmonics was not very startling. In addition to the 30 dB attenuation of the fundamental tone at the error sensor location, only the third harmonic was significantly affected (about 8 dB attenuation) as can be seen by inspection of Figure 6. Thus it is clear that it is possible to also control higher order harmonics provided that appropriate signal conditioning electronics are used on the reference signal to provide significant levels of the higher order harmonics in this signal. It is intended to devote future effort to this aspect of the problem, but for now the test results will be presented for a reference signal which contains only the fundamental blade passage frequency at a significant level.

In Figure 7, sound level measurements before and after control at the blade passage frequency are shown as a function of angular location around the Billy Goat at distances of 1.7m and 3.6m. It can be seen that substantial noise reductions are measured in all directions, indicating that the control (with just a single control source) is global in nature. It can also be seen that the type of ground surface under the Billy Goat has only a small effect on the resulting noise level.

In Figure 8, one third octave spectra at one angular location at distances of 1.7m and 3.6m are shown before and after the application of active control. As expected, substantial reductions (up to 15 dB) only occur in the one third octave bands influenced by the blade passage frequency. Differences in the other one third octave bands can be accounted for by the variability in the Billy Goat rotational speed.

Finally, in Figure 9 are shown one third octave band sound pressure levels measured before and after the application of active control at a location 20 m behind the Billy Goat. Again substantial reductions (11 dB and 8 dB) are shown in the one third octave bands affected by the blade passage frequency.

4. CONCLUSIONS

It has been shown that an inexpensive (and physically small) active noise control system can be used to substantially reduce tonal noise problems generated by a leaf sweeper. However, to be practical, it would be necessary to incorporate a small alternator or compact battery in the system to generate the required power for the electronic hardware and loudspeaker. The horn arrangement could also be made less obtrusive by properly integrating it into the machine housing.

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ACOUSTIC PRIVACY AND URBAN CONSOLIDATION POLICIES IN AUSTRALIA

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Abstract: The ability of government authorities to provide high quality infrastructure in outer fringe suburban areas is limited due to budgetary constraints. Urban consolidation has been suggested as an alternative and is being promoted by various State governments. Acoustic privacy is one of the important issues that must be properly addressed if the public is to view favourably such urban consolidation policies. This paper discusses acoustic aspects that require consideration in order to minimise potential noise problems arising from such policies.

1. INTRODUCTION

Australia has an overall population density which is one of the lowest in the world but it is also one of the most highly urbanised countries. The low urban population densities in Australian cities means that the cities are spread out with a high dependence on detached houses and private motor vehicles. Budgetary constraints at various levels of governments and statutory authorities are limiting their ability to provide high quality infrastructure and services in outer fringe suburban areas and this has prompted the authorities to consider other options such as urban consolidation. In addition, urban consolidation has been suggested as one means of reducing some of the social problems in outer areas, such as isolation and lack of amusement and entertainment facilities. Another potential benefit attributable to urban consolidation is the lowering of environmental impact of cars in terms of fuel usage and emission of greenhouse and other exhaust gases.

2. URBAN CONSOLIDATION

Urban consolidation can be defined as increasing the density of dwellings, or population, or both in an established urban area. In theory, urban consolidation can occur without any changes to the dwelling types e.g. by an increase in average household population. But, in practice, it is likely to occur by converting single dwellings to multiple-unit dwellings, by reducing the average plot size or by converting non-residential land usage to residential use. The cost of infrastructure provision for residential development in outer fringe areas can be as high as $50,000 per lot. It has been argued that a substantial portion of the infrastructure costs can be saved by utilising existing excess capacity or creating additional capacity for residential use in established areas. In Sydney, the well-known urban sprawl or doughnut effect, i.e. the continuous migration of people from inner suburbs to the outer rim of an expanding doughnut, is considered to be putting pressure on roads and energy use while gobbling up largely arable land. One of the causes of this problem is the aging population, whereby the children of families in well-established areas have grown up and left the household. Consequently many houses and flats in these inner areas are occupied by one or two people only. Although the current focus is on revitalisation of inner urban areas, the concept of consolidation is equally applicable to outer fringe areas.

One of the policies adopted by various State governments towards this objective is that an increase in medium density housing should be encouraged. Statistics show that currently about 80% of Australia's dwellings are detached houses and nearly 50% of households consist of one or two people. By geometrical consideration alone, if one were to shrink the metropolitan area by 30% and all existing commuting patterns remained unchanged, the overall distance travelled would shrink by 15% i.e. half the rate of area shrinkage.

The aim of urban consolidation policies is to produce smaller but denser cities and to reduce urban sprawl. Some studies on the population patterns in Australia suggest that medium-density housing policies will at best slow the growth of population in outer suburban areas but will not eliminate the urban sprawl problem. A House of Representatives Standing Committee Report [1] also suggests that urban consolidation is not enough to stop the continuing sprawl and that its saving had been exaggerated.

Although Governments may encourage such policies due to their own savings in terms of reduced infrastructure needs and due to overall economic benefit to the nation, for the people to view urban consolidation positively, many issues of concern have to be properly addressed. The acoustic privacy and visual privacy are two very important issues in this regard and this paper focuses on the acoustic aspects that require attention.

3. NOISE AND URBAN PLANNING

Urban consolidation means that more people will have to live closer together and closer to main roads and railway lines, which means that one natural means of sound attenuation, namely distance, will not be available in many cases. The increase in the sound pressure level ΔL_p caused by a reduction in source-receiver distance from r_o to r in the far field, can be written as:

$$\Delta L_p = 20 \log_{10}(r/r_o) \quad \text{for point sources}$$
$$= 10 \log_{10}(r/r_o) \quad \text{for line sources}$$

The above formula yields the familiar 6 dB and 3 dB increase per halving of the distance for point and line sources respectively.

The reduction in distances would require greater care in allocating land zoning so that noisy facilities or activities are grouped together. For example, noise from railways could be minimised if industrial buildings formed a barrier between the railway lines and residential areas. Lesser separation between residential, commercial and industrial areas could also force planners to consider mixed zoning or at least take noise into account during the planning phase. One of the problems introduced by reducing the average land size is that although the house size is little changed, the distances to the boundaries become very small thus severely compromising acoustic privacy. In fact, suggestions for even zero-lot-line developments have been made which would allow houses side-by-side sharing common boundaries as is allowed in many other countries.

4. NOISE IN DWELLINGS AND NOISE SOURCES

Noise in dwellings is a result of the entry of external noise through the building envelope, noise propagated from different parts of the same building, noise generated by services and activities within the space itself.

4.1 Recommended Ambient Sound Levels

For steady background noise without any tonal components, background levels considered acceptable for dwellings are given in the Australian Standard 2107-1987 [2] and some of these values are listed in Table 1.

Table 1 Recommended Ambient Sound Levels

Residential Buildings: type of occupancy/ activity	Recommended levels, dB(A) Satisfactory	Maximum
Private houses (inner suburbs)		
- bedrooms	30	35
- recreation areas	35	40
- work areas	35	40
Private houses (rural and outer suburbs)		
- bedrooms	25	30
- recreation areas	30	40
- work areas	30	40

It is generally considered acceptable for exterior noise levels in a commercial zone to be 5-10 dB higher than in residential areas and for industrial zones to be even higher. If urban consolidation policies allow for mixed zoning, controls on noise emissions from industrial or commercial premises would have to be stricter in order than they do not impact adversely on an adjacent residential zone. As the most sensitive part of dwellings are bedrooms, the requirement to keep the levels below 35 dB(A) maximum is very difficult to meet in naturally ventilated buildings because such buildings seldom offer envelope sound insulation of more than about 10 dB(A).

4.2 External Noise

4.2.1 Traffic Noise

Of the external noise sources, road traffic noise is a major source of concern in many urban consolidation plans and its potential to cause annoyance and disturbance, including sleep disturbance, is high. Apart from actual measurements, there are several theoretical and empirical methods available for the prediction of traffic noise of which the CORTN method [3] is widely used in Australia.

Guidance for the approximate distance of buildings from traffic flow within which acoustic privacy requires consideration for line-of-sight propagation are given in the Australian Standard 3671-1989 [4] and are shown in Fig.1. Thus for a flow of 20,000 vehicles over the 18-hour period, a distance of up to 1 km has to be examined. For the Sydney metropolitan region, Burgess [5] has suggested the following prediction equation to estimate the L_{10} (dB(A)) level:

$$L_{10} = 10.7\log_{10} Q + 0.3\,p - 18.5\log_{10} d + 56$$

where Q is the total number of vehicles per hour, p is the percentage of heavy vehicles and d is the distance in metres from the centre of flow of nearside carriageway. This equation may be used to make a rough estimate of the traffic noise levels by counting the number and type of vehicles.

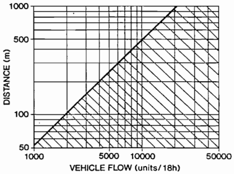

Figure 1. Distances of buildings from traffic flow within which noise should be considered (taken from ref. 4)

Typical exterior noise levels from cars at a distance of 7.5 m can be 78-80 dB(A), while for trucks the levels are about 88-90 dB(A). In view of the fact that the desirable goal for traffic noise descriptors in relation to new residences or new roads is usually a lot lower (for example, 60 dB(A) in New South Wales when measured at 1 m from a residential facade), it is obvious that traffic noise has a serious annoyance potential. In fact, a national noise survey [6] suggested that about 27% of the Australian population considered road traffic noise in their own homes as a source of moderate/high annoyance. Despite urban consolidation policies, the traffic noise problem could spread further into evenings and to more streets than at present. This is because the dependence of the Australian population on motor vehicles is likely to remain high and more people living in a street of given physical size means more visitor's traffic including late night departures, more home-delivered services (eg fast food), and more people arriving home late due to a variety of reasons such as shift work, late-night shopping or even staying away for a few drinks after work to avoid traffic jams.

A positive aspect of urban consolidation is the potential to shield rear buildings by a row of buildings on the front. In such cases, the sound can penetrate through the gaps and over the top of buildings. The attenuation Arow by a row of buildings can be estimated by the equation [7]:

$$A_{row} = -10\log 10\ \{1 - \min(F_l, F_\theta) + 10^{-IL/10}\} \quad \leq 10 \text{ dB(A)}$$

where F_l and F_θ are the fractional linear or angular blockage caused by intervening buildings. The function min denotes the minimum of F_l and F_θ and IL is the insertion loss of the intervening buildings ignoring the gaps between them. Based upon field experience, the attenuation is limited to no more than 10 dB. Each subsequent row of buildings can conservatively provide an additional 1.5 dB subject to an upper limit of 10-15 dB total attenuation. On the other hand, multiple reflections from parallel building facades on both sides of an urban road will increase noise levels by an amount that can be computed using ray-tracing or method-of-images techniques taking scattering into account.

4.2.2 Rail and Aircraft Noise

There are two main noise sources from trains - the locomotive itself and the wheel-rail interaction noise. Typical sound levels at a distance of 30 m for diesel-electric locomotives lie in the range 87-96 dB(A), while electric locomotives are about 6-7 dB(A) quieter. Track and wheel irregularities can raise noise levels of a passing train by more than 10 dB(A) suggesting that the importance of maintenance should not be under-estimated.

In the development of travel routes for new projects, such as very fast trains or rapid light-rail suburban links, consideration has to be given to any urban consolidation proposals as the number of people affected could substantially increase. In addition, if the tracks are going to be elevated to avoid level crossings, the amplification of noise by the elevated structures, which for steel bridges can be as much as 10 dB(A), may also require consideration. By placing tracks underground, airborne noise emissions in urban areas will be reduced but ground vibrations transmitted into the nearby buildings could cause annoyance.

Aircraft noise is different from traffic or rail noise in the sense that the source is in the air and thus will affect all facades of buildings. Pressure on existing land means that many new residents will have to live closer to the airports. The main noise problems from aircraft occur during take-off and landings and the number of people affected is dependent on the suburbs in the vicinity of airports and those which are in the flight path. The suitability of land for new residential areas in Australia is currently assessed by the so-called *ANEF* contours and the criterion used is as follows:

ANEF > 25 not compatible for residential use
= 20-25 conditionally acceptable for residential use.

Building siting and construction for protection against aircraft noise intrusion is discussed in the Australian Standard 2021-1994 [8]. Urban consolidation could result in more people living in the zones that are conditionally acceptable and require acoustic insulation of buildings. Not only that, the use of indices such as ANEF can lead to serious under-estimation of the true noise impact of development proposals as has been pointed out by Hede [9]. As with the aircraft noise, urban consolidation has the potential to generate a strong negative reaction against the operation of helicopters in urban areas especially on weekends because more people will be adversely affected while the demand is likely to increase. One limitation of controlling noise by restricting the time (by curfews) and flight paths is that air safety consideration must have precedence over any noise control regulations set-up by the authorities.

Although external walls by themselves can provide good sound insulation as measured by their STC ratings, this value has to be adjusted for determining reductions in dB(A) due to the noise spectrum. Dunn [10] has suggested the following relations for determining traffic noise attenuation (*TNA*) and aircraft noise attenuation (*ANA*) from the STC ratings

$$TNA = \text{STC} - 6 \quad \text{dB(A)}$$
$$ANA = \text{STC} - 5 \quad \text{dB(A)}$$

In addition the inevitable presence of windows (and doors) reduced the overall STC rating of walls in accordance with the well known formula for sound transmission coefficients of composite partitions. In composite walls with windows, the overall sound insulation may be only marginally better than the window itself. To improve the sound insulation of windows and hence of the composite wall, double glazing is preferable over greater glass thickness as may be seen from the results of measurements made at the CSIRO-DBCE North Ryde Laboratories shown in Fig. 2. If double-glazing is to be used for noise reduction through windows in dwellings, mechanical ventilation may become necessary and such equipment also generates noise. It is worth pointing out here that when examining various noise reduction strategies, all possible paths through which sound can enter a dwelling must be taken into account and components that provide relatively low sound insulation should be improved first.

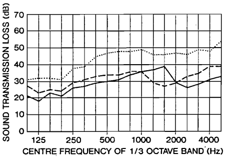

Figure 2. Sound-transmission loss of patterned glazing; solid line represents 6 mm single, dashed line represents 10mm single, and dotted line represents 6 mm and 10 mm with airspace.

4.3 Internal Noise

While the most common noise problem in single-family dwellings is the entry of external noise, in multi-family dwellings the noise from adjoining flats can be a source of nuisance. Urban consolidation policies are likely to increase the percentage of this form of housing and, therefore, the number of people annoyed will increase. This may lead to more noise complaints and demands for upgrading of minimum statutory requirements specified in the Building Code of Australia (BCA) [11]. The BCA stipulates minimum STC ratings that must be allowed for in certain situations in multi-family dwellings. Little field data is available to confirm whether the prescribed STC ratings are being achieved in practice in Australia. It is well known that field ratings can be lower than laboratory based ratings due to flanking, poor workmanship (such as inadequate sealing or hollow masonry joints), and resonant transmission because of the sizes involved. Cracking of non-flexible sealants and deterioration of rubber seals by in-service wear and tear can also reduce insulation performance with time. Dual occupancy and self-contained flats are also examples of urban consolidation and an area that has received relatively little attention is the possible methods for conversion of existing timber floors in order that they can attain STC 45 rating.

Generally, the only areas that get any acoustic consideration by builders and developers are those that are covered by regulations while other aspects are often ignored. Because multi-family dwellings in Australia are often located on or near busy roads or near railways, extra attention is needed to ensure acoustic privacy. To control internal noise, good space planning is important and noise sensitive areas such as bedrooms should be kept away from noise generating areas such as bathrooms, toilets and kitchens particularly in the vertical direction.

5. DEFICIENCIES IN THE BUILDING CODE OF AUSTRALIA (BCA)

There are several deficiencies in the BCA which require consideration if the number of noise complaints due to internal noise transmission in multi-family dwellings are to be minimised. These include:

- The current requirements exclude single-storey terrace houses that are deemed to be Class I buildings. For sound insulation purposes, all dwellings with common walls should be included.
- No consideration is given to the ceiling-to-ceiling transmission in adjacent flats e.g. whether a common wall should be extended above the ceiling to minimise noise transmission.
- A comparison of STC 45 curve and Grade I and Grade II curves of U.K. shows that STC 45 is similar to the Grade II curve, which as the name implies, is a second rate performance. It is certainly inadequate for providing acoustic privacy against amplified music which can have a significant proportion of the sound energy in low frequencies.
- The BCA has no requirements for sound insulation of doors. Doors are likely to have STC ratings well below 45 and two flats separated by a common wall with STC 45 can be flanked by two doors. Requirements for a minimum STC rating for a door between a corridor and a flat entrance could improve acoustic privacy.
- Although for walls an STC 50 is required in certain areas such as bathrooms separated from habitable rooms, the floors in all cases only have to meet STC 45 requirement.
- Kitchens are not treated as habitable rooms for waste and soil pipes, whereas in many modern flats, the kitchen and the living areas form a continuum.
- The BCA does not consider the impact noise transmission through floors. This aspect, however, is included in the by-law 25 of the Strata Titles Act 1973 which requires the proprietor of a lot to ensure that all floor space except kitchens, laundry, lavatory and bath rooms is covered or treated to prevent the transmission of noise likely to disturb the peaceful enjoyment of an other proprietor or occupier. However, no quantitative impact noise transmission ratings are specified.

6. NOISE FROM SERVICES

Noise from air-conditioning units is a potential source of annoyance in flats as well as houses. Washing machines in flats can cause annoyance by causing the floor to vibrate and the vibrations can be transmitted throughout the structure. Higher density living could also increase the noise pollution from intruder alarms as the incidence of false alarms will increase if a greater number of alarms exist. These alarms are usually loud and are allowed to emit sound for up to ten minutes. Even construction and demolition/renovation activities are noisy processes and thus potentially annoying to nearby residents.

Plumbing noise is another source of noise that causes annoyance, especially in flats. Noise associated with cistern flushing and refilling can also exceed 70 dB(A), as may be seen by inspecting Fig. 3, which is based on measurements made at the CSIRO-DBCE North Ryde Laboratories on a popular model toilet suite. Another problem, known as water hammer, occurs whenever a moving column of water is brought to an abrupt halt by rapid closing of a valve, thus causing the kinetic energy to be released and dissipated in the form of a pressure wave. The resulting noise can be transmitted by the piping system to various parts of the building and thus annoy occupants. The noise level produced by the action of on-off solenoid valves can be in the range of 60-70 dB(A) and, therefore, such valves and the piping system should be installed away from bedrooms in dwellings.

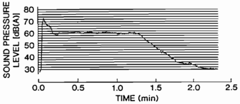

Figure 3. Noise levels measured at 1 m in a reverberation room by flushing and refilling a toilet cistern.

7. VIBRATION AND DWELLINGS

The BCA has no limits to which people can be exposed to vibrations in the home. Acceptable limits of vibration cannot be easily specified as they depend upon specific circumstances. The acceptability criterion for human exposure to vibrations in buildings is generally given in terms of base response curves intended for most demanding situations and a suitable site multiplying factor [12]. Because the recommended multiplying factors are different for residential areas, hospitals, offices and workshops, the use of mixed zoning may lead to complications in prescribing vibration limits to minimise complaints. Complaints of excessive ground-borne vibrations due to movement of trains, road traffic and construction site equipment are common forms of complaints and these could increase if the distances are reduced by urban consolidation and an increase in demolition and construction activity takes place. Physical damage to buildings and structures from most common causes of vibrations is rare, particularly if it does not appear to be intolerable to the occupants. The possible damage depends on the vibration amplitude and the frequency and can be estimated using the data shown in Fig. 4 [13]. Vibrations can, however, induce re-radiation of sound from vibrating surfaces which can also be a source of annoyance. With modern structures, the structural damping is often small and resonances can occur when the excitation frequency is close to a resonance frequency with an amplification that can easily be 10-15 for concrete structures. In flats, vibration from mechnical vibration-generating equipment is known to cause annoyance if the proper selection and installation procedure is not followed. Such vibration problems could increase if a higher proportion of the population were to live in flats due to urban consolidation policies.

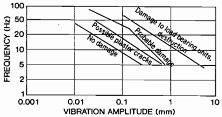

Figure 4. Potential damage to buildings by vibration.

8. CONCLUSION

Although urban consolidation policies are being viewed favourably by policy markers, such policies have the potential to substantially increase noise annoyance for the population at large unless proper care is exercised in the planning, design and construction stages by taking acoustic impact into consideration. Techniques to minimise noise problems are available but they have to be implemented properly to maintain acoustic privacy. The provisions of the Building Code of Australia require strengthening to control the transmission of internal noise to different parts of buildings. Co-ordinated efforts by various regulatory and planning authorities, including efficient policing by bodies such as the environment protection authorities, will be needed to ensure that any adverse noise impact due to urban consolidation policies is minimised.

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Product Review - Noisebuster NB-DX

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The NoiseBuster NB-DX headset manufactured by Noise Cancellation Technologies was recently introduced into Australia by Dick Smith electronics stores. The headset uses active noise cancellation technology to reduce noises such as those from lawn mowers, vacuum cleaners, cars and aircraft. The concept of active noise control was documented as early as 1936 by Lueg in a U.S. patent. In the NoiseBuster headset, noise measured by microphones in the earcup is used by an electronic controller to generate an out-of-phase 'antinoise' which is essentially a mirror image of the noise to be cancelled. This antinoise signal is then fed to the driver in the earcup where the undesired noise is reduced. Active noise reduction communication headsets, such as those manufactured by Bose or Racal, were first available for military pilots and later for civilian pilots during the 1980s. However, being marketed for $249 by Dick Smith Electronics, the NoiseBuster headset is one of the first of its kind made available at an affordable price in Australia.

The performance of the NoiseBuster headset has been determined in 1/3 octave frequency bands with centre frequencies from 63 Hz to 1.25 kHz. A Knowles miniature microphone EA1842 was placed in the outer ear cavity covered by the headset to measure the 'in-ear' sound pressure level. One-third octave sound pressure spectra were obtained with an OnoSokki FFT CF350 spectrum analyser. A Bruel & Kjaer 4205 sound power source was used to provide a background noise to be cancelled. Measurements were made in an anechoic chamber and also in an office with a reverberation time of 0.7s at 500Hz. The repeatability of the tests is to within 1 dB. The passive noise reduction due to the headset without activating the electronic controller is less than 1 dB. The noise reduction (in dB), expressed as the difference between the measured sound pressure level without and with electronic controller activated, is shown in Fig.1. Results indicate a maximum reduction of 12 dB at 100Hz 1/3 octave centre frequency. For comparison, the noise reduction expressed in % and supplied by the manufacturer is reproduced in Fig.2 which indicates a maximum reduction of 95% (corresponding to 13 dB) at 140 Hz. Overall, there is general agreement between the measured performance (Fig.1) with that supplied by the manufacturer (Fig.2). In order to illustrate the effect of using NoiseBuster in a Cessna 172-R6 single

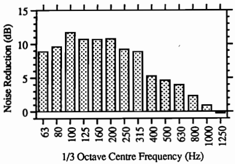

Figure 1. Performance of NoiseBuster in 1/3 octave frequency bands.

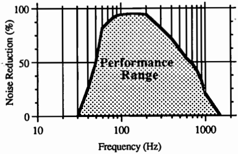

Figure 2. Performance of NoiseBuster as supplied by manufacturer.

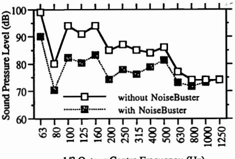

Figure 3. Sound pressure level in a Cessna aircraft measured without and predicted with the use of Noise-Buster.

engine 4-seater aircraft, the sound pressure level in the cabin has been measured in 1/3 octave frequency bands using a Bruel & Kjaer 2231 sound level meter. The expected 'in-ear' sound pressure level in the Cessna cabin with the use of NoiseBuster has been calculated using the measured performance data in Fig.1 and compared with the measured cabin noise in Fig.3.

The NoiseBuster headset weighs about 126 gm and the electronic controller, including a 9 volt battery, weighs about 134 gm. The controller is intended to be clipped to the user's belt. The headset is not a safety product and should be used for comfort only. The NoiseBuster is supplied with an audio cable with volume control and adaptor plug so that it can also be used in conjunction with home or portable stereo equipment to enhance listening to music and broadcast in a noisy environment. There is an 'on/off' switch that allows audio playthrough without noise reduction for preserving battery life.

We have asked fourteen people to try the NoiseBuster to obtain their subjective evaluation. The general consensus is that it works well against steady noise from vacuum cleaners, polishers and lawn mowers and in particular, low frequency road noise in a car and low frequency engine noise in an aircraft. Its ability to adapt to a time varying noise is almost instantaneous. Most people who have tried it on find the headset quite comfortable to wear. However, for some, the earcups tend to slip if there are a lot of head movements. The electronic controller for the product we have for evaluation has a 'sticky' on/off switch, which was annoying. Most people commented that it would be good to use NoiseBuster in aircraft or cars to listen to music. The NoiseBuster certainly works according to the manufacturer claims and it is good to see the implementation of the latest technology in a consumer product. Perhaps you may like to try it yourself!

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Technical Report

An Overview Of The Ship Noise Research Work At AMRL

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The ship noise and vibration control group is part of the Ship Structures and Materials Division of the Defence Science and Technology Organisation's Aeronautical and Maritime Research Laboratory. The group occupies a purpose built laboratory at the AMRL site in Maribyrnong.

The objective for the group's work is the reduction and control of acoustic signatures of RAN vessels in order to enhance the Navy's operational capability. The work is divided into two broad areas. The first area is in providing practical and appropriate means of reducing the acoustic signatures of RAN ships and submarines, concentrating in particular on minimizing those sources which provide an identifier for the vessel or interfere with the deployment of acoustic sensors. The second area is in establishing a technology base in support of naval vessel noise signature measurement, attenuation and control.

The research work includes studies into quietening machinery noise, isolation systems, noise transmission in structures and piping systems, materials and designs for machinery mounts and rafts, active feedback control of noise and vibration transmission, low frequency sources and development of selfnoise monitoring systems. An outline of some of the work taking place is presented below.

Specific noise problems on the current fleet of RAN vessels are investigated and solutions proposed, to reduce the acoustic signature contribution from that item. This work usually involves a mixture of onboard measurement and trials, theoretical analysis, numerical modeling and laboratory experiments. Examples are the Ship Service Diesel Generator and the FFG-7 rudder. The SSDG investigation involved the onboard measurement of airborne noise levels and spatial averaged velocity levels on the foundation, calculation of the radiated noise due to airborne and structureborne paths and the investigation of possible reduction measures. The rudder investigation involved determination of the frequencies and mode shapes of the rudder, measurement of the underwater vibrations of the rudder and proposal of measures to reduce the noise emissions.

Vibration isolators are used to reduce the transfer of vibrational energy from plant and machinery into ship and submarine hull structures. A test facility to measure the frequency dependant dynamic properties of isolators has been constructed. This facility allows the measurement of isolator four pole parameters and their variation with preload, frequency and temperature. Work is underway in conjunction with the elastomer science people on the development of improved isolator designs, and studies into the effect of environmental factors on isolator performance over the course of their service life.

The work on passive systems will permit prediction of vibration levels in the ship structure given a machine source, an isolator, and the mounting position dynamic characteristics. Once the vibrational energy is transmitted into the machinery mounting it is important to understand how it propagates through the entire hull structure. Hence new concepts and techniques to measure vibrational power flow in structures are being developed. Finite element techniques are being used to predict structural intensity and power flow. A second area of work is focusing on statistical energy analysis, in particular the spread of energy in ribbed stiffened plate structures. The present work is dealing with the pass/stop bands for energy transmission in periodic structures and the energy coupling between periodically ribbed plates and other structural elements.

Piping systems and ducts connected to machinery are important elements for the transfer of vibrational energy and fluidborne noise. Both passive and active means of controlling these noise paths are being studied. In the area of active control, work is taking place on control system design and development. An active control system for an airduct is used to test new control algothrims and their implementation. In conjunction with this, an active control actuator for use in water filled pipes has been made and its performance is presently being investigated. The actuator is made from layers of PVDF and forms a concentric annulus inside the pipe.

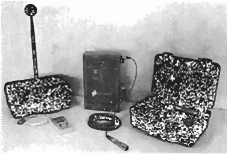
To date, the low frequency region of noise signatures has received only limited attention. There is little published work concerning the origins and characterisation of low frequency sources. Work is currently being undertaken on these sources and the low frequency structural modes associated with the hull.

In the area of modal analysis, work has encompassed the development of the random decrement method to detect modal frequencies, particularly in relation to the low frequency modes of the hull structure; and the use of modal coupling methods to predict the overall transmission path properties from a knowledge of the individual path components.

Facilities available in the laboratory and used in the program of work include:

- 6m x 6m x 4m water tank with an interchangeable side wall. Sides with the same construction details as selected ship hulls are able to be mounted on the tank for testing.
- Vibration isolator test rig, to measure the frequency dependant properties of isolation mounts. Preload can be varied up to 6 tonne and the frequency range is from 20 Hz to 3 kHz.
- 25 kN shaker and slip table, complete with solid state amplifier and control system
- Anechoic chamber with working volume of 3.6m x3.6m x3.6m.

The building features one main laboratory and two smaller laboratories. The floor area in the main laboratory is cast in isolated sections to minimise possible transmission between different experimental areas. It also features a series of cast-in steel strips on to which machinery items can be welded down. In all, a total of 10 professional and 2 technical staff are engaged in the research program.



News...

NSW Technical Visit

In late October 1993, 23 of the Society's members were given the rare privilege of a guided tour of BHP Steel's Mini Mill complex at Rooty Hill. Leading the tour were **Mr Paul Atkinson**, the manager of the Mini Mill, and **Mr Enzo Sgammotta** of BHP Newcastle. The Mini Mill is essentially a scrap steel recycling plant producing approximately 250,000 tonnes of steel annually.

The first thing members noticed when nearing the Mill facility was how unobtrusive it was with the absence of any noticeable noise despite the fact that normal operations were being carried out inside. The EPA's goal for the development is an L10 of 40 dB(A) at the nearest residences which are between 100 and 150 metres away.

Members were able to see first hand the high degree of noise control design and treatment incorporated into the Stage 1 building structures and ventilation systems. The acoustic design was carried out by BHP in collaboration with Sydney consultants Robert Fitzell Acoustics and the German acoustic panel supplier. Inside the building the recycling process begins with large semi-trailer trucks dumping metal in the enclosed scrap handling area. The metal is then transported in a giant ladle to the Melt Shop with its Frankensteinian primary and secondary arc furnaces, ultimately ending in the Continuous Casting area.

Perhaps the noisiest area of the Stage 1 development is the Melt Shop in which the noise from the primary Electric Arc Furnace has been measured to be 120 dB (A) at 1 m. The 200 mm thick roof panel is designed to provide a sound transmission loss of 56 dB at 500 Hz. The acoustic concrete panel walls containing layers of acoustic absorbent material are up to 350 mm thick. Stage 2 of the Mini Mill development which is under construction will be a rolling mill for the manufacture of various rolled steel sections.

One of the principal innovations in this unusual development is its open management system. This system places importance on each employee, who signs an agreement that there will be no restrictions on the work they undertake, which has helped to create a committed and motivated workforce. The majority of the 105 employees have been hired from the local area. This approach meant training people without any previous experience in the steel industry.

All those in attendance found the tour to be of great interest. Both Mr Sgammotta and Mr Atkinson were very helpful and hospitable guides, willing to answer all questions put to them.

Andrew Zelnik

WA Technical Meeting

Members of the WA Division and a few friends gained a sneak preview of the proposed new environmental noise regulations at a technical meeting in May. **Dick Langford**, Senior Environmental Officer with the Department of Environmental Protection explained the approach the regulations would take and how various types of noise would be assessed.

Essentially, the regulations will specify maximum acceptable L10 and Lmax levels which will be common to all types of noise sensitive areas. For example, between the hours of 10pm and 7am, the noise emitted from any premises shall be such that the noise level received from that emission at any noise sensitive premises is less than an L10 of 40 dB(A) or an Lmax of 50 dB(A), measured over any 15 minute period. Where the ambient noise level during this period is above 35 dB(A), the L10 is not to exceed the ambient noise level by more than 5 dB(A) and where the ambient noise level is above 45 dB(A) the Lmax is not to exceed it by more than 5 dB(A). Similar types of criteria would apply during evenings, weekends and holidays. Additional criteria are given for noise received at commercial, mining and industrial premises, and for noise from blasting and sporting and entertainment events. Intrusive or dominant noise characteristics, namely tonality, impulsiveness, frequency and amplitude modulation are given objective descriptions and must be removed or the overall level reduced to specified levels.

Dick's presentation raised some interesting questions from the floor, on issues such as how ambient noise is defined, how wilderness areas are to be protected, and how prevention of "creeping noise" is to be achieved.

Currently the regulations are in the legal drafting process which may take some months and produce further changes. It is hoped that they may be finalised later this year or early next year. The new regulations would be proclaimed under the Environmental Protection Act 1986.

After Dick's talk, new member **Murray Limb**, Traffic Noise Adviser from Main Roads WA presented a brief overview of traffic noise assessment and demonstrated the "TNOISE" software for traffic noise prediction. Murray is well qualified to speak on this, having been involved in the development of the software. TNOISE is based on the well known CORTN procedure for traffic noise prediction and operates within a user-friendly Windows environment. It enables a scenario to be set up and run quickly, and provides an easy "what if" capability for optimising noise reduction treatments such as barriers.

John Macpherson

AAAC – NSW EPA Meeting

Following on the positive direction of the AAS Conference in December 1993 on "Proposed Revisions to the NSW EPA Environmental Noise Control Manual", the Association of Australian Acoustical Consultants had a small but important conference with senior staff from the NSW Environment Protection Authority on 25 January 1994.

The EPA was represented by **Dr Marlene Phillips, Mr Geoff Mellor, Dr Urszula Mizia, Mr Chris Beasley, Mr Colin Grant and Mr Roger Treagus.** The AAAC was represented by **Mr Dick Benbow** (Chairman), **Dr Renzo Tonin, Mr Graeme Atkins, Mr Peter Knowland, Mr Bob Fitzell, Mr David Eden, Mr Richard Heggie, Mr Neil Gross** and **Mr Athol Day.**

The conference lasted seven hours and covered such topics as:

• The use of a 15 minute sampling period for extended monitoring of background noise level and the "Renzo Tonin Accumulation Method" for establishing a typical repeatable background noise level from long term statistical data. The application to "structured" and "non-structured" level variations was discussed.

• The use of Leq in lieu of L10 for measuring and describing level-varying noise.

• A more liberal noise criterion for level varying noise (when it is in-character with the ambient noise) in the order of 15 dB(A) above the background L90 noise level rather than 5 dB(A) as currently in general use.

• The use of L90, Lmax, statistical descriptors, spectrum analysis and "character" descriptions in addition to Leq.

• The advantageous use of an analogue meter and Lmax for assessing the level of intrusion of outdoor concert noise.

• Serious disadvantages were seen in the use of "audibility" for assessing noise.

• Suitable Leq and Lmax criteria for assessment of railway noise were suggested. Criteria for assessment of railway-generated ground-vibration were suggested.

• The criterion of L1 = L90 + 15 dB(A) for sleep arousal was discussed.

• Noise assessment within 30 metres of rural residential locations and possible criteria were discussed.

• The accuracy and effects of barriers and temperature inversions on the RTA Environmental Noise Model was discussed.

• Standardised heights for continuous weather monitoring were suggested.

• dB(C) Peak was recommended in lieu of dB(Lin) Peak for monitoring shooting noise. This is suggested to overcome the problems caused by a slight breeze.

The Conference was conducted with enthusiasm and willing participation from both the acoustical consultants and members of the EPA. As prime users of the EPA Noise Control Manual, the AAAC members were vitally concerned that any future review of the Manual include a number of important revisions. As the government body with prime responsibility to the people of NSW for administration of the Noise Control Act, the EPA members showed great interest in all suggestions made. A number of resolutions were made at the conference, and the EPA agreed to seriously consider all suggestions for inclusion in future revisions to the Blue Book.

Expressions of thanks were made all around and the conference concluded with a feeling of goodwill and accomplishment.

Athol Day

Queensland Environmental Protection Bill

Following several years of development and a program of public consultation, the Environmental Protection Bill upgrading Queensland's environment laws has been prepared for submission to Parliament this year. The objectives are to protect the environment, provide for administrative responsibility and allow integration of the environmental legislation with the development approvals system. When passed, the Environmental Protection Act will replace the current Clean Air, Clean Waters, Noise Abatement, Litter and State Environment Acts. An information package can be obtained by phoning (07) 225 1409 and leaving your name and address.

AAS Annual Conference

The 1994 Conference will be held in Canberra, 9 to 11 November. It will be held at the Eagle Hawk Resort Motel, which is 12 Km from central Canberra.

Over 30 contributed papers will be presented in parallel technical sessions from Thursday morning through to Friday midday. A range of topics will be covered including the following: architectural acoustics, acoustic properties of materials, musical acoustics, environmental noise, transportation noise and occupational noise control. A workshop session will be held to discuss road traffic noise descriptors and criteria. A technical exhibition will be open for the duration of the Conference for manufacturers and suppliers to show their latest products.

The President's Prize will be awarded for the best paper presented by an AAS member. The Excellence in Acoustics Awards will be made for the first time on entries from around Australia. The Social Program will include a welcome buffet, dinner and lunches.

For further details see Diary section of this issue.

International Conference on Underwater Acoustics at UNSW

The role of underwater acoustics in the economic exploitation of marine resources and in defence is of vital interest to Australia's needs. Recent advances in acoustic imaging and remote sensing technology have added new capabilities to both the assessment of marine biological resources and the mapping and classification of the sea bed. After the previous two successful conferences on underwater acoustics held at UNSW in 1984 and 1988, the Australian Acoustical Society is sponsoring another major meeting at the UNSW in December 1994. Internationally renowned speakers in attendance will include Jules S. Jaffe from SCRIPPS and Shu-yin Zhang from Academia Sinica. For further details, see the Diary section of this issue.

Publications for Society

The Australian Acoustical Society has recently received a complete set of Bruel & Kjaer Technical Reviews plus some other related publications. This kind donation from **Cliff Winters** will be held with other publications of the Society at the library at the Australian Defence Force Academy in Canberra. This resource will be invaluable for any acoustical historian and access is available throughout Australia via normal inter-library loan arrangements.

STANDARDS AUSTRALIA UPDATE

It has been some time since an article has been published in this magazine which provides information on the current status of acoustical matters at Standards Australia. Therefore I was requested by the Editor of Acoustics Australia to write a brief article giving a summary of those projects, related to acoustics, which are presently being undertaken by Standards Australia.

Of major importance is the current revision of **AS 1269-1989:** Acoustics - Hearing Conservation. This Standard is undergoing an extensive revision, mainly owing to the need to complement the recently published National Occupational Health and Safety Commission Code of Practice on Occupational Noise and recent legislative changes in certain Australian States. Also, because this Standard is to be published as a Joint Australian/New Zealand Standard the concerns and legislation of New Zealand need to be taken into account. It is anticipated that a Draft for Public Comment will be available early 1995.

The three parts of **AS 1055-1989:** Description and measurement of environmental noise are also undergoing revision at present. This set of Standards are also proposed as Joint Australian/New Zealand Standards and therefore the equivalent New Zealand Standards NZS 6801-1991: Measurement of sound and NZS 6802 - 1991: Assessment of environmental noise are being considered as part of the revision. One of the more important matters that is to be looked at during the revision is impulsive noise from explosions and small and large calibre weapons.

Other Australian Standards that are presently under revision are:

AS 1270 – 1988: Acoustics – Hearing protectors. **AS 1276 – 1979:** Methods for determination of sound transmission class and noise isolation class of building partitions. **AS 2253 – 1979:** Methods for the field measurement of the reduction of airborne sound transmission in buildings.

Standards Australia is also proposing the adoption of several International Standards as Australian Standards or Joint Australian/New Zealand Standards. The following is a list of those that will be available for review as Public Comment Drafts in the near future.

ISO 7566 – 1987: Acoustics - Standard reference zero for the calibration of pure-tone bone conduction audiometers is to be adopted as AS/NZS 1591.1 - 199X: Acoustics - Instrumentation for audiometry - Part 1: Reference zero for the calibration of pure-tone bone conduction audiometers. **IEC 373 – 1990:** Mechanical coupler for measurements on bone vibrators is to be adopted as AS/NZS 1591.4 - 199X: Acoustics - Instrumentation for audiometry - Part 4: A Mechanical coupler for calibration of bone vibrators.

ISO 532 – 1975: Acoustics – Method for calculating loudness level is to be adopted as AS 3657.2 – 199X: Acoustics - Expression of the subjective magnitude of sound or noise - Part 2: Method for calculating loudness level.

ISO 3891 – 1978: Acoustics - Procedure for describing aircraft noise heard on the ground is to be adopted as AS 3657.3 – 199X: Acoustics - Expression of the subjective magnitude of sound or noise - Part 3: Procedure for describing aircraft noise heard on the ground.

It is hoped that this type of summary can become a regular occurrence to keep you informed of the publication of Standards and the release of Drafts for Public Comment as well as general happenings.

If you have any queries on the above or other matters you can contact Standards Australia at: Standards Australia, 1 The Crescent, Homebush, NSW 2140 or telephone number of Standards Australia's Information Centre, who are more than happy to assist, is (02) 746 4748.

Grant Cooper
Projects Manager, Standards Australia.

Forum on Machine Condition Monitoring

Australia's first conference/workshop on Machine Condition Monitoring will be held at Ballarat in November 1994, organised by Monash University's Centre for Machine Condition Monitoring. The objectives of the forum are to provide an opportunity for practitioners and re-searchers in predictive maintenance/ machine condition monitoring to share their experiences, to extend the knowledge of the benefits and technologies of machine condition monitoring amongst people involved in maintenance, and to present a range of instrumentation and services available in the field. The program will include structured technical sessions, mini courses, panel discussions, and an equipment expo. For details, see the Diary section of this issue.

Singapore Conference - Call for Papers

As mentioned in the April issue, the Annual Conference of the Society of Acoustics (Singapore) will be held on January 11-12 1995. Contributed papers for the lecture sessions of the technical program are welcome in all areas of acoustics. The deadline for receipt of abstracts is 30 September 1994. For further details, see the Diary section of this issue.

Sabine Centenary Symposium

It is just one hundred years since Wallace Clement Sabine was asked by the President of Harvard University to attempt to "do something" about the terrible acoustics of the newly built Fogg Lecture Theatre. Sabine was perhaps not an obvious choice for the job, since he was a relatively young Assistant Professor who had not previously done any work related to sound. But he was available, since he was not heavily involved in any other research, and "something" needed to be done about the Fogg Theatre. It took Sabine nearly two years to find a remedy, and in the course of that time he established the whole theory and practice of reverberation measurement and control. In a space of twenty years, indeed, and virtually single handed, he laid the scientific foundations of architectural acoustics.

In June 1994 this event was celebrated in a Sabine Centenary Symposium in Cambridge Massachusetts, held in conjunction with the 127 th meeting of the Acoustical Society of America. The Symposium was not actually held at Harvard, but on the campus of nearby MIT, and was well attended, though dwarfed by the two thousand who attended the main ASA meeting. The Sabine Symposium ran from Sunday afternoon through Tuesday and its sessions covered the whole range of contemporary architectural acoustics as well as including talks of historical interest.

A highlight of the Symposium was an evening at the Boston Pops in Symphony Hall, which is considered as perhaps Sabine's crowning design achievement, although it was not met with great approval when it opened in 1900. Today it is widely regarded as the best hall of its size (about 2600) in the world, and the polished performance of the Boston Pops Orchestra (which is the summer version of the Boston Symphony) showed this off to perfection. Boston Pops concerts, like the Prom Concerts in the Albert Hall in London, have been wildly popular since the time of Arthur Fiedler, and it is still a tradition to end with "Stars and Stripes Forever", just as the Proms end with "Land of Hope and Glory".

As well as a nicely bound volume containing the papers presented at the Symposium --- 390 pages and 89 papers all told --- participants were presented with a bound volume of Sabine's classic papers on Architectural Acoustics. This volume (Peninsular Publishing, Los Altos California) displays the extraordinary breadth of his achievement, with papers on topics as diverse as reverberation, musical scales, building materials, whispering galleries, theatre acoustics and sound insulation. He developed the method of wavefront imaging in scale models of buildings to assist in the acoustic design of theatres, and was the acoustical consultant for many notable buildings. Sabine died at the rather early age of 51, and a nicely phrased memorial in the minutes of the Harvard Corporation, while extolling his achievements, paints a picture of a stern man "whose severity of judgment sometimes bordered upon intolerance."

The main ASA meeting, as usual, covered the whole gamut of acoustics from engineering vibration analysis through auditory and speech physiology to psychoacoustics. Included was a ceremony at which the gold and silver medals of the Society were presented. This will remain memorable to me particularly for the words of one young medal recipient, who ended his acceptance speech: "Finally, I would like to thank my wife for giving up her own promising career to support me in mine." (Applause) "However, she is not that kind of woman." (Stunned silence) "So, instead, I would like to thank her for making a great success of her career and keeping me in a fashion to which I am fast becoming accustomed." (Wild applause!)

Neville Fletcher

FASTS

The Federation of Australian Scientific and Technological Societies (FASTS) has recently released a draft policy document for consideration by the member societies. It is based on the 1993 Policy Forum and represents a move towards a more proactive role in the development of science and technology policy in Australia. The document deals with four main areas; education, industry, government in-stitutions and university research/training. Copies of the document can be obtained from Marion Burgess tel (06) 268 8241.

David Widdup, who has been the executive director of FASTS since its inception eight years ago has recently resigned. FASTS intends to replace Dr Widdup as soon as practical so that it can continue to lobby vigorously on behalf of Australian scientists and technologists.

Internoise 93 Proceedings

The proceedings of the Internoise 93 Conference, held in Leuven, are available. The three volumes contain 404 technical papers. Thirteen special sessions on topics of current interest in noise control engineering were organised by experts in the field and the papers from these sessions ar included in the Proceedings. The topics covered in these special sessions include active noise control, aircraft noise, numerical modelling, outdoor sound propagation, vehicle noise and ship noise control. The cost of US$ 150 includes surface mail; an additional $ 45 is required for overseas air mail. Orders to Noise Control Foundation, PO Box 2469 Arlington Branch, Poughkeepsie, NY 12603 USA.

Scientific Exchange Programs

The Australian Academy of Science has developed an exchange program with similar bodies in Korea, Taiwan, Japan and China. The primary purpose of the program is to support collaboration between researchers. Scientists and technologists who are Australian citizens or permanent residents are invited to apply to participate in the 1995 program. Applicants should propose a collaborative research project, or a specific activity, which has been developed in consultation with scientists or technologists in host institutions. The expected outcome of research should be of value to Australian science or technology. Programs may include either short-term or longer-term visits. For information: International Exchanges, Australian Academy of Science, GPO Box 783, Canberra ACT 2601. Tel (06) 247 3966, Judith Hlubucek (9:30am to 1:30pm).

EXCELLENCE IN ACOUSTICS AWARDS 1994

Entries are open to all individuals and organisations who consider their work deserving of recognition.

Awards will be made at the AAS Conference, November.

Closing date for submissions: 1 September 1994

Entry forms available from:

Excellence in Acoustics - AAS
Professional Centre
Private Bag 1
Darlinghurst NSW 2010
Tel (02) 331 6920
Fax (02) 331 7296

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Tony Hewitt has joined the Sydney office of Mitchell McCotter as a Senior Associate. He is a mechanical engineer with extensive experience in both the public and private sectors. He recently retired from the NSW EPA, where he was the Regional Manager for the Inner Sydney area, and prior to that, the Principal Engineer, Noise.

John Macpherson has moved form the Department of Occupational Health Safety and Welfare of WA to a position as an Environmental Officer specialising in noise with the WA Department of Environmental Protection. He can be contacted on tel (09) 222 7119 or fax (09) 222 7157.

Stuart McLachlan, Treasurer of the NSW Division of the Society, has recently left the NSW EPA to run his own consulting practice named "Environmental Results". Stuart's expertise lies not only in acoustics, but in environmental strategies, transportation, environmental training, environmental approvals and assessment and project management. His office is in Mosman and his contact phone numbers are (02) 960 3032 and 015 246 481. We wish Stuart the best of luck in his new endeavour.

Phil Banks has recently joined the staff of Wilkinson Murray after leaving Day Design where he worked for 10 months following his arrival back in Australia from England. During his four year stint in England, Phil worked at Lucas Power Train on diesel engine research. Phil's wife, Sarah Banks, is working in the Acoustics Section of environmental consultants, Mitchell McCotter.

ACU-VIB, a company formed to provide independent services to customers in the fields of acoustics and vibration, has recently moved to 56A Thompson St, Drummoyne, NSW 2047 with tel (018) 470 179 and fax (02) 819 6398. Their new mail address is PO Box W16, Wareemba, NSW 2046.

Acoustics Research Laboratories, a company providing noise and vibration monitoring instrumentation, have moved to 265-271 Pennant Hills Rd, Thornleigh, NSW 2120 with tel (02) 484 0800 and fax (02) 484 0884.

Acoustics Research Laboratories, have appointed Curtis Brown (trading as BELCUR) as their Queensland agent for noise and vibration loggers. Curtis can be contacted on tel (07) 207 7592 or 015 119 368 or fax (07) 207 6466.

NEW MEMBERS

The following are new members of the Society, or members whose grading has changed.

New South Wales

Member

Ms S E Banks, Mr N Gross, Mr A J Hundley, Mr M B Pettigrew, Mr J H Wasserman

Student

Mr S Suine

Subscriber

Mr M Mouzakis, Ms S Shankar, Mr M K Warpenius

South Australia

Member

Mr M J Stead

Letter...

Five years ago I purchased two Sony capacitor electret microphones, type 23F Mk 11. Following my own advice [1], I calibrated them, to check if they were within specification, (4.0 +/- 1.3)mV per pascal.

I have calibrated these microphones on another five occasions, to check the electret stability. The average sensitivities of the microphones are 4.39+/-0.14mV and 4.02+/-0.14mV per pascal respectively. Much more important, the calibrations are randomly scattered about the means and there is no observable loss in sensitivity.

The above suggests that modern capacitor electret microphones are very reliable instruments. Further, the fact that an AA cell in the body of the microphone powers the system compares with complex phantom power supplies needed for their more illustrious brethren. This means the capacitor electret microphone has great operational advantages.

At a minor level, my claim that accurate free field microphone calibrations can be carried out in backyards is further substantiated.

R.S. Caddy
NSW

[1]. R. Caddy, Self-calibration of your microphone and sound level Meter, *Acoustics Australia*, **12**, (1) 20-21 (1984)

Books...

Profitable Condition Monitoring

B K N Rao (ed)

Kluwer Academic Publishers Group 1993, 328 pp. ISBN 0-7923-2098-0. Australian Distributer: DA Information Services, PO Box 163, Mitcham Vic 3132. Tel (008) 33 8863 Fax (03) 873 5679. Price A$ 221.25.

This book is really a collection of 27 articles presented at the 4th International Conference on Profitable Condition Monitoring held in Stratford-upon-Avon, UK, on December 8-10, 1992. The papers are divided into the following categories:

Profitable condition monitoring; Condition monitoring through performance evaluation; Industrial case studies on condition monitoring; Human factors approach to condition monitoring; Condition monitoring using neural networks; Vibration condition monitoring; Condition monitoring of fluids in machinery.

Of the 27 articles, a total of 22 were contributed by authors from the UK, two from India, one each from from the USA, Norway and Slovenija. It is indeed suprising that so few countries participated in the conference, considering that it was an international meeting.

The papers varied in length and quality with an average of 12 pages each. It may be noted that the shortest paper was four pages and the longest paper took up 30 pages - quite a variation!

I found three papers of particular interest, one on the application of what looked liked the correlation dimension in chaos theory to the analysis of shaft displacements in a Kaplan turbine, another on the application of neural networks to health monitoring of gas turbine vibrations and the final one on the application of neural networks in the diagnosing faults in a machine tool coolant system. I am sure there are other papers that may be of interest to other readers but such is the nature of condition monitoring conferences where a variety of disciples are represented.

It is difficult reviewing a book which is a collection of conference papers. As is common these days, the quality of the both the technical content and presentation of the papers presented at the conference vary considerably. It would have helped if the editor did try and unify the typeface and presentation. My overall impression of the papers presented were that the majority were basic in content with a handful claiming new or innovative applications of the various disciplines of condition monitoring.

We are starting to see a proliferation of so called "books" and it is a disturbing trend. A technical book should be a systematic composition on a specific topic. This book certainly does not fit that definition. Buying this book "sight-unseen" would therefore be disappointing - certainly its title does not convey the impression that it is really a collection of conference papers. However, having criticised the notion of publishing conference proceedings as a book, I can see the advantage to be gained from such a marketing approach. It is clear that the publishers of the book will be in a position to ensure a large and global circulation for the set of bound proceedings, thus providing some justification.

Joseph Mathew

Joseph Mathew is an Associate Professor in the Department of Mechanical Engineering, Monash University and specialises in vibration analysis, machine condition monitoring and manufacturing. He is also the Executive Director of the University's Centre for Machine Condition Monitoring.

Occupational Hearing Loss, 2nd Edition

Robert Thayer Satloff & Joseph Sataloff

Marcel Dekker, 1993, hard covers, ISBN 0 8247 8814 1. Australian Distributer: DA Information Services, PO Box 163, Mitcham Vic 3132. Tel (008) 33 8863 Fax (03) 873 5679. Price A$ 267.50

This book is the most comprehensive treatise I have read on the subject of Occupational Hearing Loss and should set the standard for any further works in this area. It is extremely comprehensive of its coverage of the topic and indeed goes far more deeply into the subject of hearing loss generally than most texts. I would suggest that the title is misleading in that it would on first glance limit the readers' interest to occupationally induced hearing loss when it in fact covers virtually every aspect of the condition of hearing disorder.

The first half of the book, over 400 pages, is devoted to the description of sound, the nature of hearing loss, its causes, its measurement and the diagnosis of various hearing disorders and their classification. This section could be recommended as a text for any student of the subject be they of medical, audiological, rehabilitation or scientific background.

The third quarter of the book deals specifically with noise, its measurement, its effects and its control. It has specific chapters on noise as it affects workers in industry, the field of music and those who working in high pressure areas (specifically underwater workers). Chapter 25 details the establishment of a Hearing Conservation Program.

The final section addresses the legal implications of Occupational Hearing Loss and also looks at a range of specific legislation. This section, though of interest in a general sense, is specific to the North American and British scene and has limtied direct implication for Australia. The student of international law or of the development of local legislation may well find it of interest.

In short, this text has most of the information that working or studying in the field, no matter what orientation, should need. At in excess of $A250 it is not the sort of volume that will find its way to everyone's shelf. It should, however, be considered a 'must have' text for any reference library that is likely to be used by anyone who has anything more than a superficial interest in hearing loss.

Stephe Jitts

Stephe Jitts is an audiologist with over 20 years clinical experience. He is currently in private practice in ACT region.

Vibration of Shells and Plates, 2nd Edition

Werner Soedel

Marcel Dekker, 1993, hard covers, ISBN 0 8247 9035 9. Australian Distributer: DA Information Services, PO Box 163, Mitcham Vic 3132. Tel (008) 33 8863 Fax *(03) 873 5679. Price A$ 185.25*

Werner Soedel, Professor of Mechanical Engineering at Purdue University, North American editor of the Journal of Sound and Vibration and author of numerous papers on the topic is eminently well qualified to write a book such as this. Following the tradition set by the first edition, the book is extremely well written and easy to follow, although much of the subject matter is complex. This second edition contains some new material as well as a revision and extension of much of the material in the first edition. More topics are covered, including shells of non-circular cross section, inextensional approximations for rings, combined structures (such as systems joined by springs), travelling modes in rotating shells, thermal and fluid loading, finite difference and finite element analyses.

This book is intended for graduate students or as a reference for practising engineers interested in analysis of vibrating structures. It is recommended that the reader has some knowledge of the fundamentals of vibration and boundary value mathematics. Although the book contains many equations and excellent mathematical derivations, the author has not lost sight of their physical significance and provides very good explanations of the various theories, and the assumptions and simplifications embodied in each of them.

After a short history of vibration analysis of continuous systems, the book begins with the generalised derivation of shell equations following Love's classical approach but using Hamiltons principle rather than the principle of virtual work. Various simplifications made by Love to make the problem more tractable are then discussed. This is followed by a discussion of various other shell theories and the corresponding simplifications and assumptions associated with them.

In chapter three, the equations of motion for generalised shells of revolution are derived by a reduction of the Love shell equations and are then applied to the specific cases. In the next chapter, Love's equations are reduced to describe non-shell structures such as rings, beams and plates. In Chapter 5, procedures are described for calculating resonance frequencies and modes from the equations of motion for beams, circular rings, rectangular plates and circular cylindrical shells. Included is an interesting discussion of modal orthogonality modal superposition and modal damping.

In Chapters 6 and 7, simplified versions of Love's equations followed by Galerkin and Rayleigh-Ritz approximations are used to obtain approximate solutions to shell and plate configurations for which exact solutions are not possible.

Forced or non-resonant vibrations of shells are discussed in Chapter 8 and solutions are expressed in terms of modes of vibration. Various forms of load distribution and excitation type (harmonic and impact) are considered and the use of the Dirac delta function to represent point forces is clearly explained. This concept is extended to the representation of moment excitation in Chapter 10. In Chapter 9, the dynamic influence function (or Green's function) for the shell, which takes into account coupling between transverse, axial and tangential displacements, is discussed.

Effects of initial stresses are discussed in Chapter 11 by extending Love's equations. In Chapter 12, the effects of shear deformation and rotary inertia on the equations of motion for beams, plates and shells are discussed in a unified way.

The remaining chapters cover in depth the following topics: combinations of structures, hysteresis damping, composite material shells, rotating structures, thermal effects, equations of motion for 3-D solids, liquids and gases, including a discussion of interface boundary conditions, and discretised approaches (finite difference and finite element).

Overall, this is a very well written book, containing clear physical explanations of the derivations of the multitude of equations. In spite of all the equations, the book is a pleasure to read because the derivations are presented in such a way that they are generally easy to follow with no substantial gaps in their development. I would enthusiastically recommend this book as a text for any graduate course in structural vibration and also as an important reference for practising engineers involved with this topic.

Those familiar with A. Leissa's comprehensive volumes, "Vibration of Plates" and "Vibration of Shells" may be tempted to believe that this book may not have much additional to offer. However, this book does represent a more unified and easy to follow derivation of the necessary equations of motion and their solution and for that reason alone is a more suitable text. This book also includes a discussion of many applications from the more recent literature which are missing from Leissa's work. These comments are not intended to detract from Leissa's excellent books which contain some information not in this book. Those seriously interested in this topic should have this book as well as Leissa's books because both are extremely useful and in many ways complimentary.

Colin Hansen

Dr Colin Hansen, a Reader in Mechanical Engineering at the University of Adelaide, is the co-author of the book "Engineering Noise Control", and is an active researcher in active and passive noise and vibration control, and has taught courses in vibration fundamentals, structural vibration, engineering acoustics, industrial noise control and active control of noise and vibration.

New Products...

CEL
Sound Level Meter

The CEL-254 digital impulse sound level meter is designed to meet sound survey requirements. The meter uses a large digital display with 0.1 dB resolution. Just two measurement ranges, both covering a 70 dB span, are needed to achieve a 30 to 135 dB(A) total measurement span. The meter complies with IEC 651 and ANSI S1.4 1983 Type 2 categories, and provides both F and S response. The meter is supplied with microphone protective cover, screwdriver and batteries. Available also as a kit which includes the meter, a Class 2 calibrator, foam windshield and a case.

Further information: AWA Distribution, 112 Talavera Road, North Ryde NSW 2113.

ONO SOKKI
FFT Analyser

The new CF-5200 FFT analyser has a real time rate of 20 kHz, two measurement channels and a 90 dB dynamic range. It features a "Quick Expert" easy operation system, in which all parameters of various measurement types, eg vibration, sound, frequency response etc, are set out on the screen with detailed instructions for the selected function. It is equipped with direct sensor inputs in addition to the standard voltage signal source input, thus extra amplifiers or signal conditioners are not required. Options include real-time 1/1 and 1/3 octave analysis, rpm tracking analysis, sound intensity analysis and Wigner distribution. The analyser operates from AC or DC power sources, and includes a built-in high speed thermal printer.

Further information: Vipac Engineers and Scientists, 275-283 Normanby Road, Port Melbourne, Victoria 3207. Tel (03) 647 9700. Fax (03) 646 4370.

BILSOM
Electronic Earmuff

The new 707 Impact is a high attenuation, heavy duty electronic earmuff designed to amplify human speech while filtering out loud environmental sound and blocking out impulse sound instantly. It enables the user to hear normally during quieter periods, and provides an SLC 80 rating of 27 dB

Earmuff

The new 727 earmuff is a lightweight, comfortable, highly effective earmuff with an SLC 80 rating of 28 dB. Weighing only 195 g, the new 727 is one of the lightest products on the market. As result it can be worn for prolonged periods on the work-site without discomfort. It has large, asymmetric cups with deep, wide cushions which provide generous space for the ears, increasing wearer comfort. Each cup is flexibility mounted to the forks of the padded headband, ensuring a uniform pressure and a close, leak-free fit.

Cool II

This is a simple solution to the problem of earmuff discomfort, caused by perspiration in hot or humid environments. Cool II is a self adhesive pad that fits over the cushion on all types of earmuffs. It absorbs all perspiration providing a skin-contact surface that stays dry, fresh and comfortable all day. It has no effect on the attenuation and acts as a hygienic soft pad between the earmuff and the skin.

PerFit Detecter Earplugs

Especially designed for use in the food industry, the PerFit Detecter reusable earplugs can be detected by metal detectors and removed by magnetic rollers should the ear plug fall into the food stream. The PerFit Detecter is entirely composed of materials enriched with iron powder, including the soft silicone earplug and the connecting PVC cord, so that even if the plug is fragmented in the food manufacturing process, every portion is still detectable. All other plugs rely on a single specific metallic insert. The PerFit Detecter earplug has an SLC rating of 20 dB, and comes in two sizes, regular and large.

Further information: Bilsom Australia Pty Ltd, 19 Tepko Road, Terrey Hills, NSW 2084. Tel (02) 450 1544

MITCH MITCHELL AND ASSOCIATES
Total Quality Management Safety System

Developed in Australia, the TQM Safety System combines well-established safety engineering and management practices with the principles of TQM. The clear objectives of the TQM Safety System are to reduce the pain, suffering and social cost caused by work related injury, stress, occupational disease and environmental degradation. This is achieved by focusing attention on the design, organisation and management of OHS&E processes. A valuable collateral benefit is the reduction in management's exposure to the risk of prosecutions for breaches of health, safety and environmental protection laws.

Further information: Mitch Mitchell and Associates, P O Box 292, Riverstone NSW 2765. Tel (018) 161 239, Fax (02) 627 1627.

CSR GYPROCK BRADFORD
Gyprock Stud Walls - a Staggering Success

Anyone who has tried to get a bit of shut eye next door to a wild party will appreciate the necessity for noise resistant walls. CSR Gyprock has the solution with two innovative, non load bearing plasterboard and metal stud wall assemblies that boast outstanding acoustic properties. The Series 144 Staggered Stud Wall uses alternate laterally offset metal studs. This leaves the plasterboard attached to only one side of the staggered stud clip, isolating the noise, and achieving Sound Transmission Class 58. The Series 200 Chase Wall has an even higher acoustic rating of Sound Transmission Class 59. The Series 200 Chase Wall incorporates two independent metal wall frames, each clad on one side with plasterboard. With a 148 mm wide cavity, it allows easy installation of services. Both walls can be quickly assembled using standard plasterboard tools and techniques.

Further information: CSR Gyprock Bradford, Locked mail bag No 6, Chatswood NSW 2057. Tel (02) 372 5700, Fax (02) 372 5744.

TNOISE FOR WINDOWSTM

TNOISE for WindowsTM is a state-of-the-art software package for quick and simple calculations of noise levels caused by road traffic. Applications include:

- alternative route options
- design of major roads through residential areas
- evaluation of alternative noise reduction treatments
- design of residential developments near major roads

Developed by Main Roads Western Australia, TNOISE is based on the latest version of the British method of calculating road traffic noise which is widely used in Australia. Users have direct access to the Main Roads WA software developers and the comprehensive User Manual contains over 30 worked examples on disk. The UK Department of Transport Manual 'Calculation of Road Traffic Noise' (CRTN) is also included. The costs for the package are: single user A$695 and site licence A$975.

Further information: Judy Gathercole at the Australian Road Research Board on (03) 881 1508

ACOUSTICS RESEARCH LABORATORIES
Sound Level Meter

The ARL SLM-22 is a low cost hand-held fully integrating sound level meter. Complying with type 2 instruments it has all the features necessary for a wide variety of noise measurements. It offers both A and C frequency networks with a range from 30 to 120 dB and can be configured for either Leq or sound exposure level.

Calibrator

The ARL CAL-100B is a low cost calibrator which provides 1 KHz level at either 94 or 104 dB. It is cased in a sturdy aluminium housing and meets class 2 requirements. Adaptor plates are available to suit most commercially available microphone types.

Music Monitor

The BB-01 music monitor has been designed to combat the nuisance caused by loud noise escaping from places of entertainment. When properly installed and set up, the system controls the supply of mains power to the amplifiers. When the threshold level is detected, the power is disconnected for 20 secs. Green, amber and red warning lights assist the sound operator. The trip range is 85 to 115 dB and A, B or C frequency weightings are provided. The unit also includes a "trip counter".

Further information: ARL, 265-271 Pennant Hills Rd, Thornleigh, NSW 2120. Tel (02) 484 0800, Fax (02) 484 0884.

BRUEL AND KJAER
New Sound Analyser

The new modular Precision Sound Level Meter, type 2260 is a hand held high performance field analyser for today's noise measurement needs. With an array of communication ports and application software modules, it guarantees built in growth paths to match future needs. The analyser also provides the flexible platform for these software modules, which are available in different languages, including context sensitive help. It is ergonomically designed with both soft and hard keys, easy to remember icons, large graphical back lit display and ability to give real-time frequency analysis.

Further information: Bruel and Kjaer Australia Pty Ltd, P.O. Box 177, Terrey Hills, NSW 2084. Tel (02) 450 2066, Fax (02) 450 2379.

CAUSAL SYSTEMS
Low Cost Active Noise and Vibration Control Systems

Causal Systems has announced the release of the two-channel EZ-TEACH and the six-channel EZ-ANC systems. Both systems are designed to facilitate the development of low cost (less than $50) product embedded active noise and vibration control systems. Potential applications for low-cost active noise and vibration control systems include attenuation of interior and exterior vehicle noise (engine, road and exhaust noise), air-handling system noise, and machine vibration isolation mounts. In the near future it will be possible to cascade these low cost systems together to produce a system with a large number of input and output channels. Each development system is designed for both feedforward or feedback implementation, with full software support provided for feedforward implementations. Both systems are intended to be used by non-specialist engineers with some knowledge of acoustics, vibration, control, signal processing and electronics to design their own product specific systems. The user friendly software supplied with each system allows easy user adjustment or selection of algorithm types, algorithm parameters, automatic system ID type and associated parameters, filter lengths, number of active channels, sampling rate, and input and output signal levels, while at the same time providing real time displays of error signals and filter weight coefficients. The menu-driven user interface is designed for rapid turnaround during compile-download-run development cycles. It is expected that the EZ-TEACH will retail for between $1000 and $1,400 and the EZ-ANC will retail for between $1,600 and $2,500.

Further information: Colin Hansen, Department of Mechanical Engineering, University of Adelaide, South Australia, 5005 Fax (08)303-4367.

AUSTRALIAN ACOUSTICAL SOCIETY ENQUIRIES

*** Notification of change of address**

*** Payment of annual subscription**

General Secretary
AAS– Professional Centre of Australia
Private Bag 1, Darlinghurst 2010
Tel (02) 331 6920 Fax (02) 331 7296

Enquiries regarding membership and sustaining membership should be directed to the appropriate State Division Secretary as under:

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Professional Centre of Australia
Private Bag 1, DARLINGHURST 2010
Sec: Mr Ray Piesse
Tel (02) 969 6668

AAS - SA Division
C/–Department of Mech Eng
University of Adelaide
GPO Box 498, ADELAIDE 5001
Sec: Mr A C Zander
Tel (08) 228 5698 Fax (08) 224 0464

AAS - Queensland Division
C/– Ron Rumble Pty Ltd
PO Box 29,
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Sec: Mr R H Rumble
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Fax (07) 378 6485

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Fax (09) 351 2711

AAS - Victoria Division
PO Box 417 Market St PO
MELBOURNE 3000
Sec: Mr C Senese
Tel (03) 794 0677
Fax (03) 794 5188

SOCIETY SUBSCRIPTION RATES

From 1 APRIL 1994 membership subscriptions will be as follows:

Fellow and Member	$86
Affiliate and Subscriber	$68
Student	$20

ANNUAL CONFERENCE

Copies of past conference proceedings may be ordered from:

Publications Officer
Australian Acoustical Society
15 Taylors Road, DURAL 2158

ACOUSTICS AUSTRALIA INFORMATION

GENERAL BUSINESS

*** Advertising *Subscriptions**
Mrs Leigh Wallbank
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Acoustics & Vibration Centre
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ACOUSTICS AUSTRALIA ADVERTISER INDEX - VOL 22 No 2

Diary ...

CONFERENCES and SEMINARS

• Indicates an Australian Activity

1994

September 12 - 14, LEUVEN
Tools for Noise and Vibration Analysis
Details: Dept Mech Eng, Celestijnenlaan 300B, B-3001, Heverlee, Belgium

November 2 - 4, BALLARAT
(CM)^2 Forum 1994
Machine Condition Monitoring
Details: Centre for Machine Condition Monitoring, Department of Mechanical Engineering, Monash University. Tel (03) 905 5699, Fax (03) 905 5726

November 3 - 6, WINDEMERE
Reproduced Sound 10
Organised partly by Institute of Acoustics
Details: Ken Dibble, Old Rectory House, 79 Clifton Rd, Rugby, Warks CV21 3QG UK. Tel 0788 541133, Fax 0788 541314

November 9 -11, CANBERRA
• AAS Annual Conference 1994
Noise and Sound: Nuisance and Amenity
Details: Marion Burgess, Acoustics and Vibration, ADFA, Canberra, ACT 2600. Tel (06) 268 8241, Fax (06) 268 8276, email m-burgess@adfa.oz.au.

November 24 - 27, WINDEMERE
Speech & Hearing
1994 Conference, Institute of Acoustics
Details: Prof Aisnworth, Dept Communication & Neuroscience, Keele Uni, Keele, Staffordshire ST5 SBG UK.

November 28 - December 2, AUSTIN
128th Meeting Acoustical Society of America
Details: Acoustical Society of America, 500 Sunnyside Boulevard, Woodbury, NY 11797, USA

December 5 - 7, SYDNEY
•Int Conf on Underwater Acoustics
Acoustic Imaging & Remote Sensing
Details: Dr J I Dunlop, c/o School of Physics, UNSW, Sydney 2052 NSW. Tel (02) 385 4575, Fax (02) 663 3420, Email: jid@newt.phys.unsw.edu.au

1995

January 11-12, SINGAPORE
Society of Acoustics (Singapore)
Annual Conference - Noise
Details: Dr W S Gan, c/- Acoustical Services Pty Ltd., 209-212 Innovation Centre, Nayang Avenue, NTU, Singapore, 2263, Republic of Singapore. Tel 65-791 3242. Fax 65-791 3665

March 21 - 23, LYON
Euro-Noise Control
Software for Noise Control
Details: Euro-Noise 95, CETIM, 52 Avenue Felix Louat, 60300 Senlis, France. Fax (33) 44583400

April 5-7, SOUTHAMPTON
Int Conf Computational Acoustics Environmental Applications
Details: Jane Evans, Conference Secretariat - COMACO 95, Wessex Institute of Technology, Ashurst Lodge, Ashurst, Southampton SO4 2AA, UK. Tel 44 (0)703 293223, Fax 44(0)703 292853, Intl EMail CMI@ib.rl.ac.uk

April 20 - 22, LISBON
Eighth International Conference on Low Frequency Noise and Vibration
Details: Conference Secretariat, 107 High Street, Brentwood, Essex, CM14 4RX, UK. Tel (Int+) 0277 224632, Fax (Int+) 0277 223453

May 15 - 19, FERRARA
CIARM 95
2nd Int Conf Acoustics & Musical Research
Details: Nat. Res. Council Italy, Cemoter Acoustics Department, Via Canal Bianco, 28-44044, Ferrara, Italy, Tel +39 532 731571, Fax +39 532 732250 email CIARM 95 @CNRFE4.FE.CNR.IT

May 31 - June 4, WASHINGTON
129th Meeting Acoustical Society of America
Details: Acoustical Society of America, 500 Sunnyside Boulevard, Woodbury, NY 11797, USA

June 12 - 16, ABERDEEN
Symp Fisheries & Plankton Acoustics
Details: J Simmonds, Marine Lab, PO Box 101, Victoria Rd, Aberdeen AB9 8DB, Scotland. Fax 44 224 295511

June 20 - 22, WARSAW
Noise Control '95
Noise - Civilsation Hazard
Details: Noise Control 95, Central Inst Labour Protection, Czerniakowska 16, 00-701 Warsaw, Poland, Fax 482 623 36 95

June 26-30, TRONDHEIM
15th International Congress on Acoustics
Details: ICA'95, N-7034, Trondheim, Norway.

July 2 - 6, PARIS
Int Symp on Musical Acoustics
Details: ISMA'95 Secretariat, c/o Rene Causse, IRCAM, 1 Place Igor Stravinsky, 75004 Paris FRANCE Tel (331) 44 78 47 60, Fax (331) 42 77 29 47, Email: isma@ircam.fr

July 10-12, NEWPORT BEACH, CALIF
Internoise 95
Details: INCE/USA, PO Box 3206 Arlington Branch, Poughkeepsie, NY 12603 USA. Fax +1 914 473 9325

November 27 - December 1, ST LOUIS
130th Meeting Acoustical Society of America
Details: Acoustical Society of America, 500 Sunnyside Boulevard, Woodbury, NY 11797, USA

August 1 - 19, STOCKHOLM
Int. Cong. Phonetic Sciences
Details: ICPhS 95, Dept Linguistics, Stockholm Uni, 106 91 Stockholm Sweden Fax 46 816 2347

September 3 - 7, BERLIN
Congress on Ultrasound
Details: J Herbertz, WCU95, Gerhard Mercator Univ., 4708 Duisburg, Germany

November, PERTH
•AAS Annual Conference 1995
"Acoustics Applied"
Details: AAS-WA, PO Box 1090, West Perth WA 6872. Tel (09) 367 6200

December 4 - 7, HONG KONG
SDVNC 95
Int. Conf. on Structural Dynamics, Vibration, Noise & Control
Details: Prof De Mao Zhu, Nanjing Uni Aeronautics & Astronautics, Nanjing, Tiangsu210016, China, Tel +86 25 4492492, Fax +86 25 4498069

1996

April 1 - 4, ANTWERP
Forum Acusticum 96
1st Conv. European Acoustics Association
Details: Forum Acusticum, Technological Institute KVIV, Desguinlei 214, B-2018, Antwerpen, Belgium, Tel +32 3 216 0996, Fax +32 3 2160689

August 25 - 31, KYOTO
Int. Cong. Theoretical & Applied Mech
Details: Prof Watanabe, Dept Civil Eng, Kyoto Uni, Sakyo-ku, Kyoto 60601, Japan Fax 81 75 752 5296

♦ ♦ ♦

COURSES

In accordance with the recognition of the importance of continuing education, details of courses held in Australia are included in this section at no charge. Additional details can be given in an advertisement at normal rates.

1994

November 8-9, CANBERRA
BASICS OF ACTIVE CONTROL FOR NOISE AND VIBRATION
Details: Marion Burgess, Acoustics and Vibration, ADFA, Canberra, ACT 2600. Tel (06) 268 8241, Fax (06) 268 8276, email m-burgess@adfa.oz.au.

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