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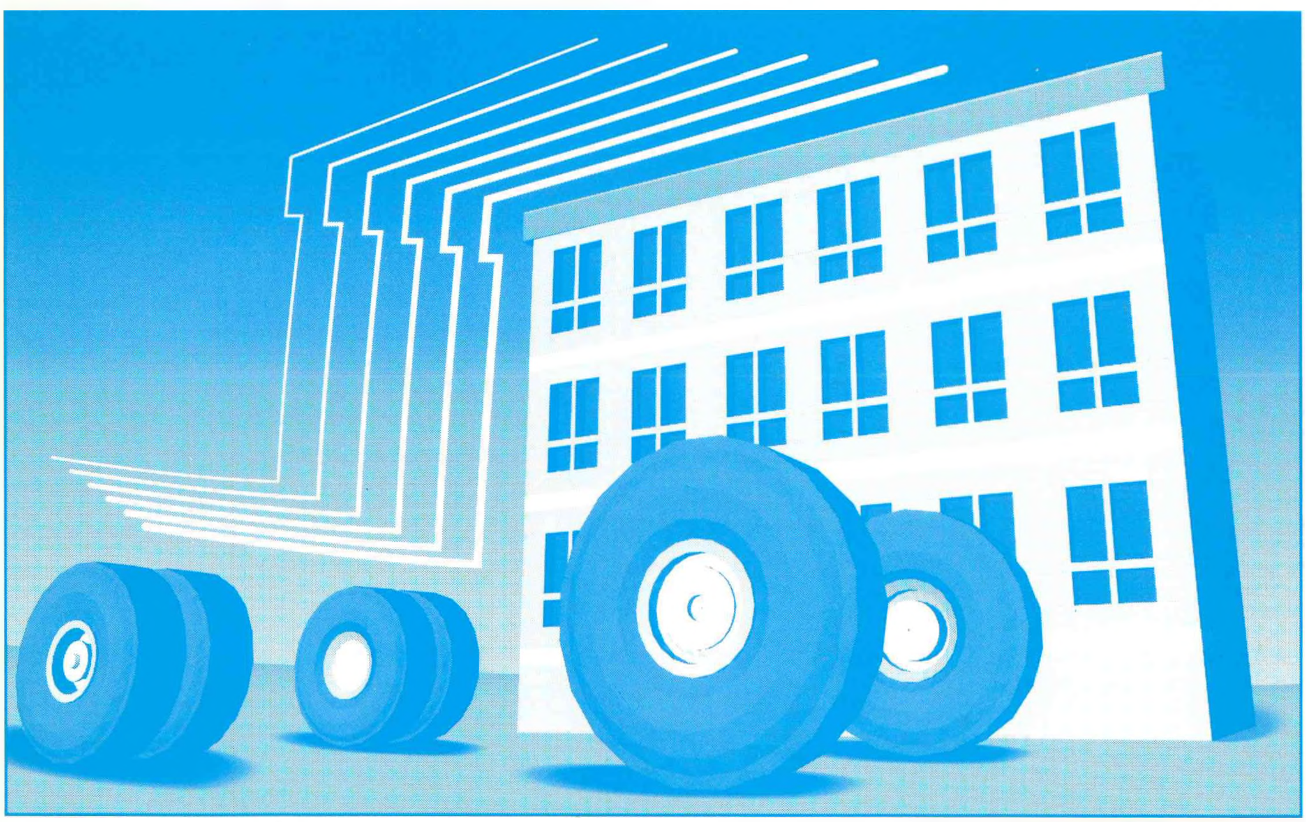

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CANADIAN ACOUSTICS publishes refereed articles and news items on all aspects of sound and vibration. Papers reporting new results, as well as review or tutorial papers and shorter research notes are welcomed, in English or in French. Submissions should be sent to the Editor-in-Chief. Complete instructions to authors concerning the required camera-ready copy are presented on the last page of this issue.

ACOUSTIQUE CANADIENNE publie des articles arbitrés et des information sur tous les domaines du son et des vibrations. On invite les auteurs à proposer des manuscrits rédigés en français ou en anglais concernant des travaux inédits, des états de question ou des notes techniques. Les soumissions doivent être envoyées au Rédacteur en chef. Les instructions pour la présentation des textes sont exposées à la dernière page de cette publication.

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EDITORIAL

Ce numéro de l'*Acoustique Canadienne* contient plusieurs informations. Parmi les publications, on retrouve un article de recherche sur les vibrations des immeubles induites par le trafic, un article de revue sur la prédiction du bruit en milieu industriel et une note technique sur les tests non-destructifs.

La Semaine de l'Acoustique Canadienne 1990 est maintenant chose du passé: quelques photos prises durant cet évènement sont reproduites. Le prochain congrès aura lieu l'anneé prochaine à Edmonton, tel qu'annoncé dans l'appel aux communications ci-joint.

Nous poursuivons notre effort d'informer les lecteurs de l'Acoustique Canadienne en publiant les procès-verbaux de l'Assemblée des Directeurs et l'Assemblée Générale Annuelle tenues à Montréal, ainsi que le rapport financier de l'année dernière. Par ailleurs, nous reproduisons, pour la première fois depuis 15 ans, les règlements de l'ACA. Enfin, troix prix de l'Association - deux de ces prix étant nouveaux cette année - sont présentés.

Lors de l'Assemblée Générale Annuelle, j'avais promis de prendre de l'information sur la possibilité d'obtenir du financement du CRSNG pour défrayer les coûts de composition de la revue, et de vous transmettre les résultats de mes démarches. Malheureusement, et sans que je ne le sache, le CRSNG a, cette année, devancé d'un mois la date limite pour le dépôt d'une telle demande et j'ai dépassé cette date limite; la démarche devra donc attendre à l'an prochain.

Les soumissions d'articles à l'*Acoustique Canadienne* ont augmentées récemment, mais nous sommes encore loin d'une surcharge. Pourquoi pas prendre une résolution de soumettre un article pour la nouvelle année? Sur cette note, les rédacteurs de l'Acoustique Canadienne vous souhaite une heureuse et bonne année productive.

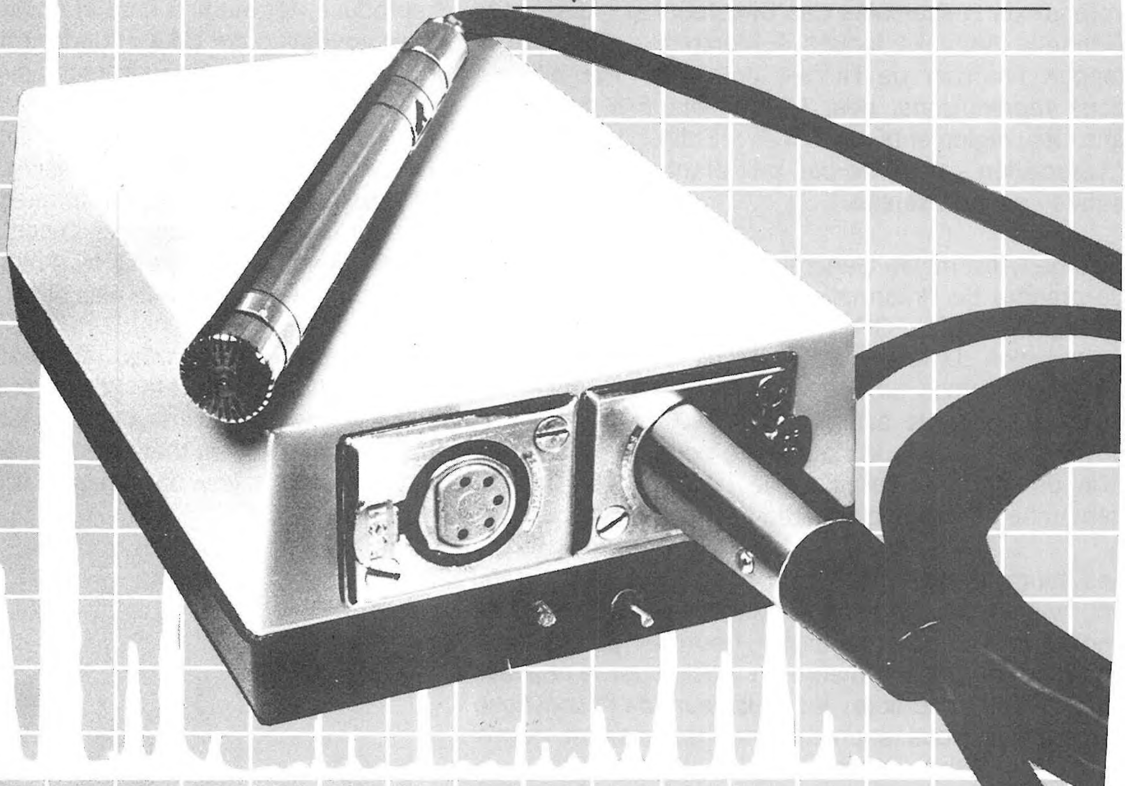
This issue of *Canadian Acoustics* contains a wealth of information. Published are a research article on traffic-induced building vibration, a review article on factory-noise prediction and a technical note on non-destructive testing.

Acoustics Week Canada in 1990 has come and gone; some photos taken during the event are reproduced here. Next year's meeting will be held in Edmonton as the enclosed Call for Papers details.

In our continuing effort to inform readers fully of CAA business, we publish the minutes of the Directors' and Annual General Meetings that took place in Montreal, as well as last year's financial report. We further reproduce, for the first time in about 15 years, the by-laws governing the CAA. In addition, three CAA prizes - two of them new this year - are advertised.

At the AGM I promised to look into applying for an NSERC grant to finance typesetting of the journal, and to report back to you. Unfortunately, and unknown to me, NSERC this year advanced the deadline for applications for such grants by a month and I missed it; an application will have to wait until next year.

Submissions to *Canadian Acoustics* have increased recently, but we're still far from overwhelmed. Why not make it your main New Year's Resolution to submit a paper in 1991? On that note, the editors of Canadian Acoustics wish you all a happy and productive New Year.



Canadian Acoustics / Acoustique Canadienne 19(1) 3-13 (1991) **Research paper / Article de recherche**

REMEDIAL MEASURES FOR TRAFFIC-INDUCED VIBRATIONS AT A RESIDENTIAL SITE. PART 1: FIELD TESTS

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Abstract

Traffic-induced vibrations were investigated at a site after several complaints were lodged by homeowners residing near a roadway. The objective of the study was to investigate the factors influencing the level of these vibrations and their relative quantitative importance for this site. Based on the findings of the study, effective remedial actions were suggested. The present paper reports on the results of the experimental part of the study in which the effects of vehicle type, vehicle speed, vehicle weight, and road surface conditions were investigated. A companion paper reports on the results of the analytical part of the study in which the role of pavement/subbase characteristics, effectiveness of vibration screening by concrete walls, and soil improvement were investigated using finite element simulations.

Résumé

À la suite de plaintes déposées par plusieurs propriétaires de maisons situées le long d'une route, on a mené une étude concernant les vibrations produites à cet endroit par la circulation. Il s'agissait de déterminer les facteurs qui influaient sur le niveau des vibrations et d'évaluer leur importance quantitative relative. En se basant sur les conclusions de l'étude, les auteurs ont proposé des correctifs. Ce document fait état des résultats du volet expérimental de l'étude, qui a porté sur les effets du type de véhicule, de sa vitesse et de son poids, ainsi que sur les caractéristiques de la chaussée. Un document complémentaire présente les résultats du volet analytique de l'étude, dans lequel les auteurs ont étudié, à l'aide de simulations par éléments finis, le rôle de la chaussée-couche de fondation, l'efficacité du blocage des vibrations au moyen de murs de béton, ainsi que l'amélioration du sol.

1 INTRODUCTION

Traffic induced vibrations are characterized by a source-path-receiver scenario. When a vehicle moves on a road, the stress field produced in the ground by the vehicle's weight also moves along and hence stress waves are produced. This happens even in the absence of any imperfections or irregularities in the vehicle or the road. The presence of discrete irregularities in the road surface, e.g. potholes, cracks, unleveled manhole covers etc., as well as periodic and random surface roughness result in additional dynamic forces on the road that generate significant stress waves in the supporting soil. These waves radiate through the soil and eventually reach the foundations of adjacent buildings where certain frequency components can be amplified by the building's structure and lead to unacceptable vibration levels.

Many factors affect the generation of these vibrations and their transmission to adjacent buildings. Chief among them are: degree of road roughness, vehicle weight, vehicle speed, pavement/subgrade characteristics (e.g. pavement/subbase stiffness, soil support value), and transmission path characteristics (e.g. soil type and profile, and site topography).

The possibility of inducing building vibrations due to vehicle acoustic noise also exists, especially if buildings are close to the road (Martin, 1978). Such noise may induce "rattles" inside buildings that may be very annoying. This aspect is not part of the present study.

Building vibrations induced by road traffic can reach levels that cause human annoyance, possible damage to old and historical buildings, and interruption of sensitive instrumentation and processes. Consequently, road administrators are often confronted with complaints and in some cases possible litigation. Thus existing vibration problems need to be resolved and future ones forestalled.

Various counter-measures are suggested to reduce traffic-induced vibrations. The main ones are: periodic maintenance to provide a smooth road surface, traffic flow control, traffic weight control, traffic speed control, improvement of road/subbase structure, screening of vibration by trenches or stiff obstacles, soil improvement, establishing an environmental zone and the use of building vibration isolation systems. Some of these measures may be readily seen as impractical or not cost effective. In addition, the suitability of any one or a combination of these measures is site specific.

The purpose of this study is to investigate the factors influencing the level of traffic vibrations, and their relative quantitative importance, for a site where several complaints were made by homeowners. Special emphasis is on the role of pavement/subbase structure. Based on the findings of the investigation, effective remedial actions are suggested. At this site the road was founded on clay soil.

It must be mentioned that the results of this study should not be understood as generalizations for traffic-induced vibrations. They are applicable only to the site investigated here, although similar results might be obtained at other sites. The paper presents an approach and background work that are needed for arriving at effective remedial measures for a particular site.

The investigation consisted of: (a) Controlled field tests using different kinds of vehicles and sections of the road to establish the relative significance of: vehicle type, speed, weight, and road surface condition; (b) Computer simulations using the finite element method to investigate the role of pavement/subbase characteristics. The effectiveness of vibrations screening by concrete walls as well as the improvement of soil under the road were also investigated. In this paper, field tests are described and their results reported. Computer simulations are presented in a companion paper (Al-Hunaidi and Rainer, 1990a).

2 SITE DESCRIPTION

Field tests consisted of measuring ground vibrations due to a test bus and a test truck on a residential road in the City of Hull, Quebec, where traffic induced vibrations have led to complaints by homeowners. The road runs in the east-west direction with a wide median separating the roadways for each traffic direction. Each roadway is two lanes wide, the right lane is used generally for vehicle parking and bus stops. The road includes a relatively steep hill sloping down towards the east. A much gentler slope continues eastward for the remainder of the road. The road surface of bituminous pavement is cracked and fissured in the transverse direction. Near the left curb many of the catch basins provide major depressions in the riding surface. Posted speed limit is 50 km/h.

Vibration measurements were taken at two locations. One set of vibration tests were performed on the sloping part of the road (Location 1). Another set of tests were performed on the slightly sloping part of the road (Location 2).

3 VIBRATION MEASUREMENTS

3.1 Measurement Stations

At each of the two test locations, ground vibrations were monitored at several measurement stations: at the edge of the road; close to houses adjoining the road; and on the median. The layouts of measurement stations for Location 1 and Location 2 are given in Figures 1 and 2, respectively. Ground vibrations were measured in the vertical and transverse directions (perpendicular to the road). Acceleration transducers were taped to wooden mounting plates (175 x 175 x 19 mm) attached to the ground using threaded thin rods (150 mm long). The plates were mounted on the ground after removal of surface vegetation to a depth ranging from 100 to 200 mm (see Al-Hunaidi and Rainer, (1990b) for details). Stations 1 and 2 at Location 2 were on a paved driveway. For these two stations only, acceleration transducers were taped to steel plates laid directly on the driveway.

3.2 Instrumentation and data acquisition

Measurements were made with servo-accelerometers having a sensitivity of 5 V/g (volts/gravity) in the frequency range 0-400 Hz. Signals from the accelerometers were amplified, low-pass filtered at 125 Hz, digitized at a sampling rate of 500 Hz, and then stored on a hard disk of a micro-computer. The signals were checked on site after the passage of each test vehicle. If overloaded channels were detected, necessary adjustments to channel gains were made and the test was repeated.

3.3 Data Processing

Recorded signals were processed in the frequency domain using both (i) one-third octave band analysis and (ii) narrow-band analysis. One-third octave band analysis was performed on a real-time analyser (Bruel & Kjaer 2134) using a single 8-second integration time. Broad-band amplitude of each record was calculated using the square root of the sum of squares of the one-third octave bands within the frequency range 1.6-25 Hz. Narrow-band analysis (Fourier transform) was performed on a micro-computer. The analysis was performed using a single 8192-

point FFT with a "rectangular" window (i.e. 16.4-second section of the signal). This 16.4-second rectangular window encompassed almost the whole event of vibrations induced by a passing test vehicle (e.g. see time records in Figures 14 and 15). Hence, there was no need for using other types of smoothing windows. Results are presented in the form of magnitude vs. frequency plots (Frequency spectra).

Time histories of recorded signals are presented in the form of envelopes formed by displaying the maximum and minimum accelerations of each 0.08 second time segment of the actual signal.

Narrow-band spectra were used to closely study the frequency content of traffic-induced ground vibrations, whereas 1/3-octave spectra and broad-band amplitudes were used to determine the amplitude variation of ground vibration as a function of vehicle type, vehicle weight, vehicle speed.

4 DESCRIPTION OF FIELD TESTS

Controlled field tests were carried out using a transit bus and a medium size water truck (empty/full). The truck was only used at Location 1, and weighed 8.7 tons empty and 11.08 tons when full with water. Both directions of the road were closed to traffic while experiments were carried out. A summary of field tests analysed in this study is given in Table 1.

4.1 Speed control tests

Test vehicles were driven past the measurement stations at speeds of approximately 30, 50 and 70 km/h. Since Location 2 was close to an intersection it was considered unsafe to drive the test bus at 70 km/h. Vehicle speeds were measured using a hand-held "radar gun".

4.2 Weight control tests

The variation of vibration levels with vehicle weight was investigated by driving the water truck past measurement stations at Location 1 while empty and then full at approximately the same speed. The full truck was about 27% heavier than the empty one.

4.3 Tests of discrete road irregularities

The effect of a discrete irregularity was tested at Location 1 by driving test vehicles over a wood plank 40 mm high and 230 mm wide. In order to simulate a catch basin depression, the wood plank was attached to the road near the left curb so that only the left wheels of the vehicle would pass over it. Location 2 included a catch basin near the left curb of the road (see Figure 2) which provided a typical depression in the road surface . The following tests were performed: (i)bus passes over road depression, (ii) bus avoids road depression. The test bus was driven at speeds of approximately 30 and 50 km/h.

Table 1
Summary of field tests

Test No.	Type	Speed (km/h)	Location
B11	Bus	30	1
B13	Bus	50	1
B18	Bus	70	1
T1	Empty truck	30	1
T3	Empty truck	46	1
T5	Empty truck	66	1
TL1	Loaded truck	20	1
TL2	Loaded truck	47	1
TL6	Loaded truck	70	1
BB2	Bus/catchbasin	30	2
BB3	Bus/catchbasin	50	2
BB6	Bus	30	2
BB8	Bus	48	2
BP2	Bus/wood plank	50	1
H1	Impact Hammer	-	1

5 EXPERIMENTAL RESULTS

5.1 Speed Control Tests

For the tests performed at Location 1, comparisons between one-third octave band spectra of different vehicle speeds are shown in Figures 3, 4 and 5 for the bus, the empty truck and the loaded truck, respectively. In these figures, acceleration spectra for the vibration signals in both the vertical and transverse directions at measurement station No. 3 are shown. These results provide strong evidence that the amplitude of ground vibrations is substantially affected by vehicle speed. The higher the speed the higher the vibrations. This is especially true for frequency components at or near the predominant frequency of vibrations. Measurements made at other stations show the same trend as can be seen in Figure 6 for bus tests at 30 and 70 km/h.

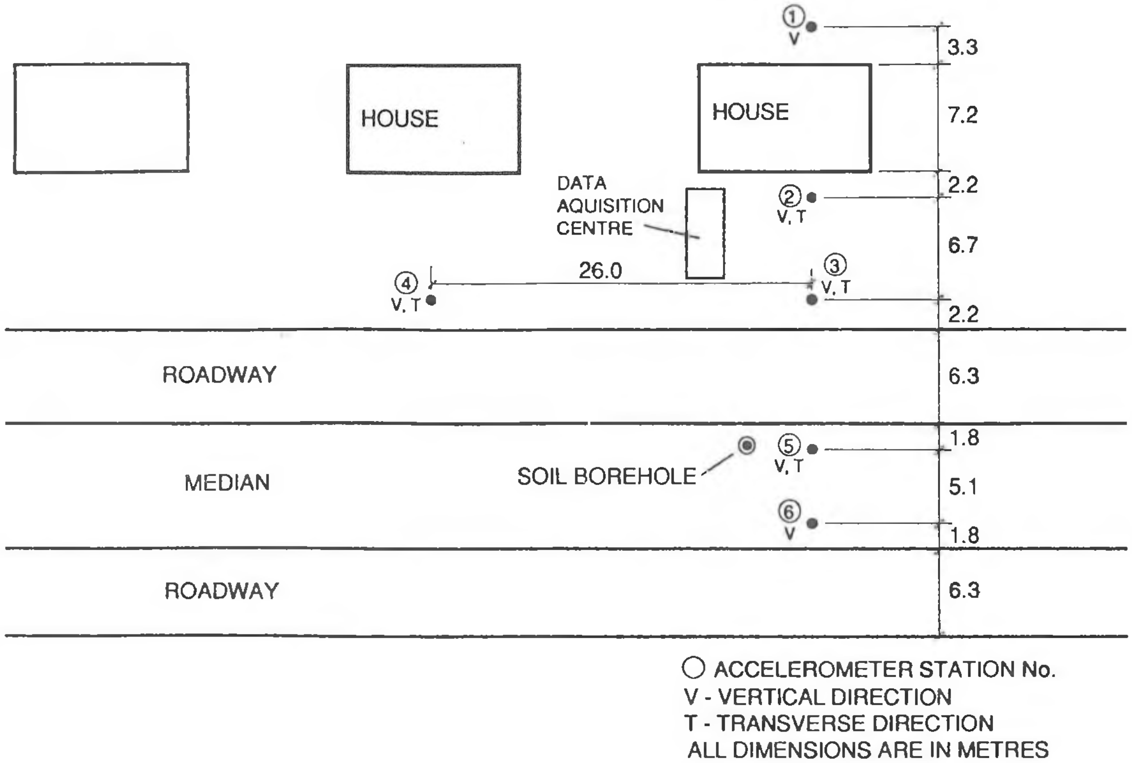

Figure 1 Layout of measurement stations at Location 1

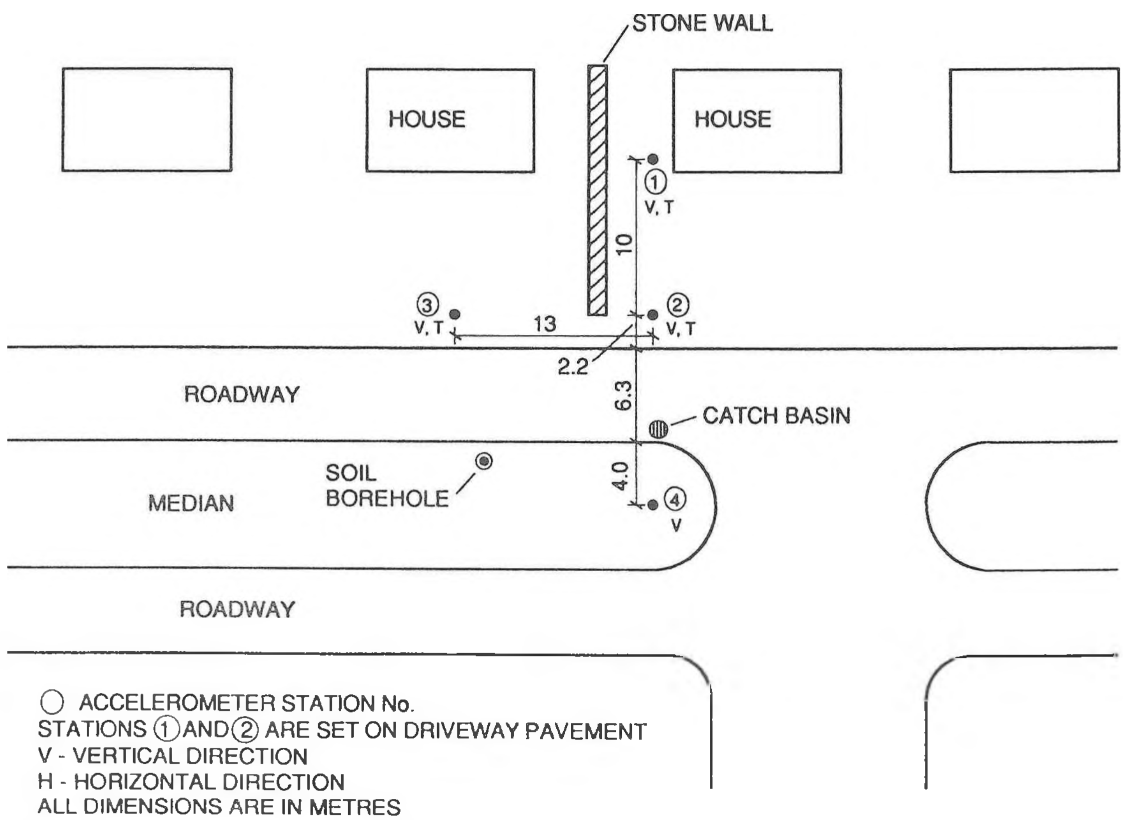

Figure 2 Layout of measurement stations at Location 2

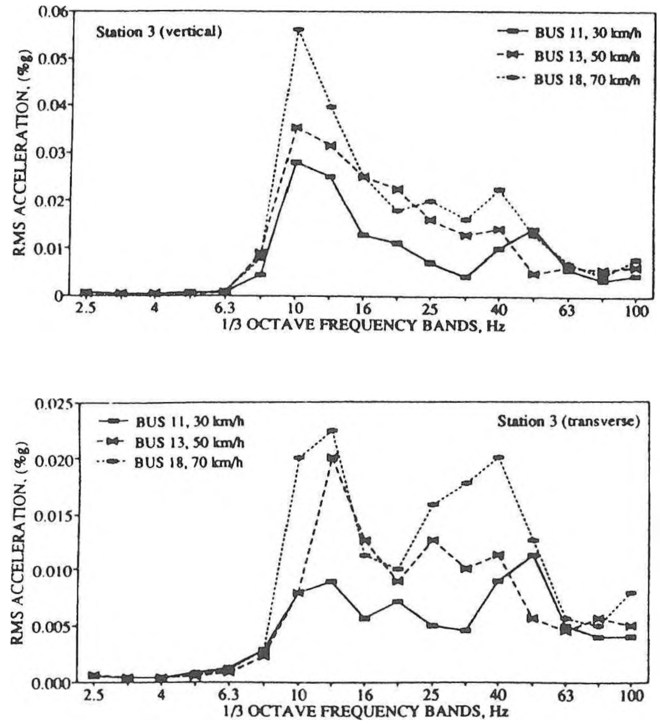

Figure 3 Vibration amplitudes for various speeds of a bus at Location 1

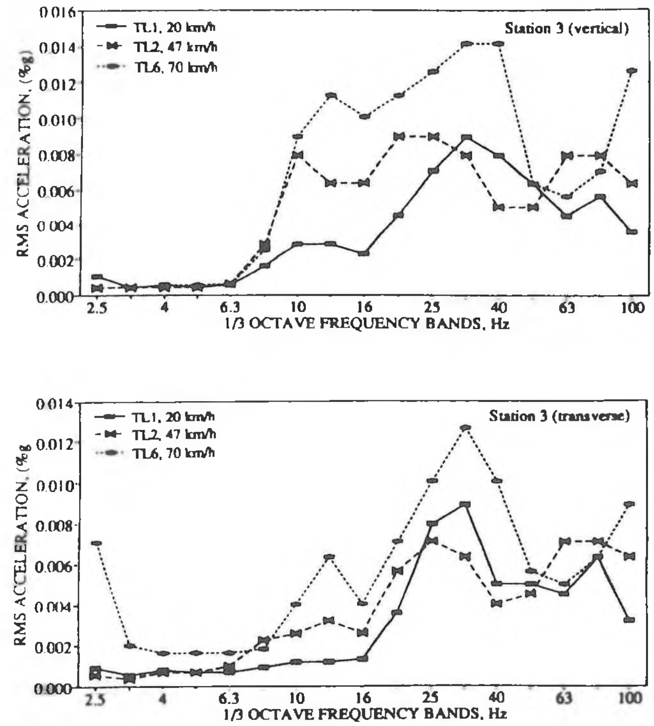

Figure 5 Vibration amplitudes for various speeds of a loaded truck at Location 1

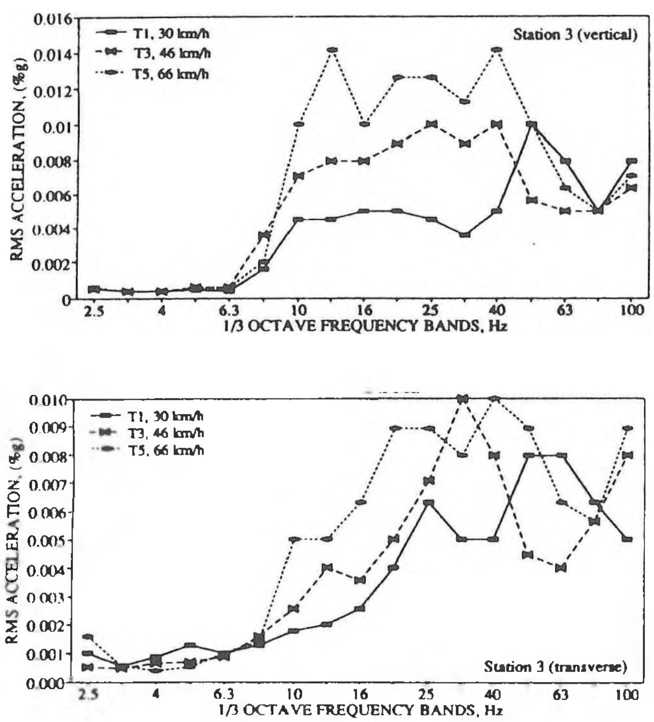

Figure 4 Vibration amplitudes for various speeds of an empty truck at Location 1

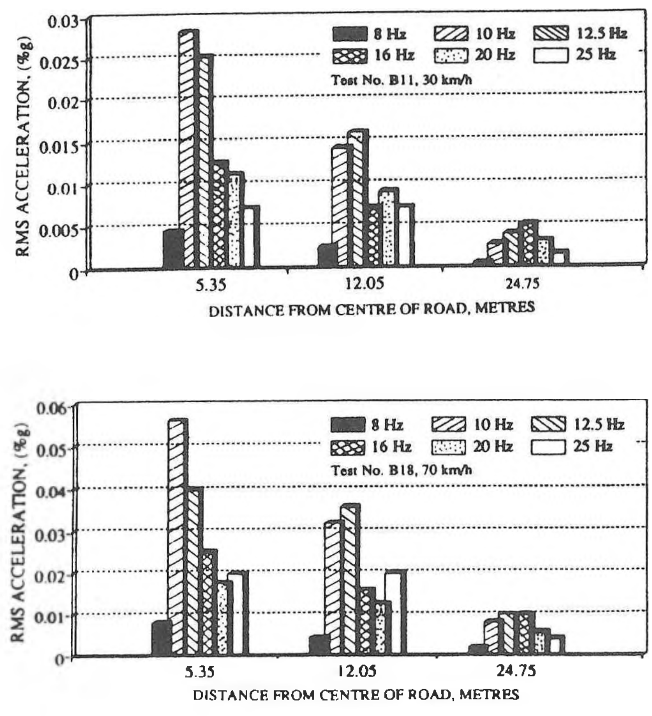

Figure 6 1/3 octave band amplitudes of bus-induced vibrations at different distances at Location 1

Table 2
Broadband acceleration amplitudes ($x10^{-4}$ g rms) at station 3, Location 1

Speed range (km/h)	20-30		46-50		66-70	
Measurement direction	Transverse	Vertical	Transverse	Vertical	Transverse	Vertical
Bus	1.6	4.2	2.9	6.1	3.7	7.8
Loaded truck	0.91	1.0	1.1	1.8	1.6	2.4
Empty truck	0.86	1.1	1.1	1.9	1.3	2.7

From the broad band amplitudes presented in Table 2 it can be observed that increasing vehicle speed from 30 to 50 km/h results in an average increase of vibration amplitudes of 55%; and increasing the vehicle speed from 50 km/h to 70 km/h leads to an average increase of vibration amplitudes of 30%.

Regarding the frequency content of the induced vibrations, there was an obvious difference between buses and trucks. As can be seen from narrow-band Fourier spectra, presented in Figures 7 and 8 for buses and loaded trucks, respectively, the following two observations can be made:

- the frequency content of the bus-induced vibrations is concentrated in a narrow range in the vicinity of 10 to 15 Hz.
- the frequency content of the truck-induced vibration is spread out over a wide range between 10 to 40 Hz.

In general, the predominant frequency of vibrations at Location 1 is about 10 Hz.

5.2 Weight Control Tests

Figure 9 shows the one-third octave band spectra for the cases of empty and loaded water trucks tested at speeds of 50 and 70 km/h. From this figure and the broadband amplitudes presented in Table 2, it emerges that the weight of the truck has little effect on the amplitude of ground vibrations. When significant irregularities are present in the road surface, however, it was observed that heavier vehicles produce higher vibrations.

On the other hand, it is observed that vibration amplitudes induced by buses (at all speeds) in the frequency bands that are of primary interest here, 10 and 12.5 Hz, are larger by at least a factor of 3 compared with the vibration amplitudes induced by trucks. This could be due to the fact that the energy of impacts generated by buses, unlike trucks, is concentrated in these frequency bands, as will be elaborated later. The weight difference is an unlikely cause since the weights of the test bus and the loaded truck were approximately the same. It should be noted that the frequencies of primary interest in this study are those which correspond to the maximum one-third octave band amplitude of vibrations at a house floor. In earlier measurements at the same test sites, these were found to be 10 and 12.5 Hz.

5.3 Tests with Discrete Road Irregularities

Catchbasins

The results of these tests with buses at station No. 2 at Location 2 are shown in Figure 10 in the form of one-third octave band spectra of the vertical acceleration. Buses No. BB2 and BB3 passed over a a depressed catchbasin at speeds of 30 and 50 km/h. Buses No. BB6 and BB8 avoided the catchbasin, but were driven at the same speed as BB2 and BB3, respectively. As expected, the surface irregularity provided by the catchbasin led to significant increase in vibration levels. The broadband amplitude for buses running at 30 km/h increased by 42%, and for buses running at 50 km/h they increased by 33%. The predominant frequency of vibration observed at this site (Location 2) was found to be between 17 to 23 Hz as can be seen from the Fourier spectrum in Figure 11.

Wood planks

Tests performed with a bus passing over a wood plank (40 mm high) attached near the left edge of the road at Location 2 indicate that vibration levels could increase by a factor as much as 10 times due to the presence of such an irregularity. This can be seen from the one-third octave band spectra presented in Figure 12 for the acceleration at Station 3 due to a bus running at 50 km/h. From the Fourier spectrum in Figure 13a, it can also be observed that the bus impact with the wood plank resulted in new frequency peaks at approximately 20, 25 and 40 Hz. Interestingly, these frequency peaks correspond to some of the peaks of

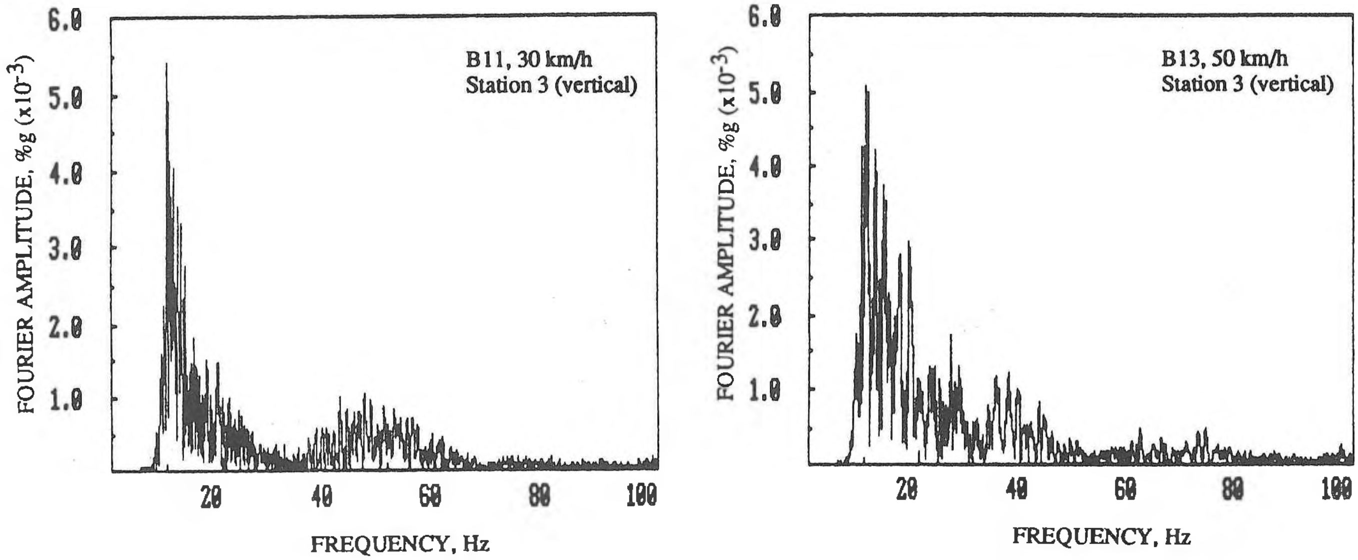

Figure 7 Acceleration Fourier spectra of bus-induced vibrations at station 3, Location 1

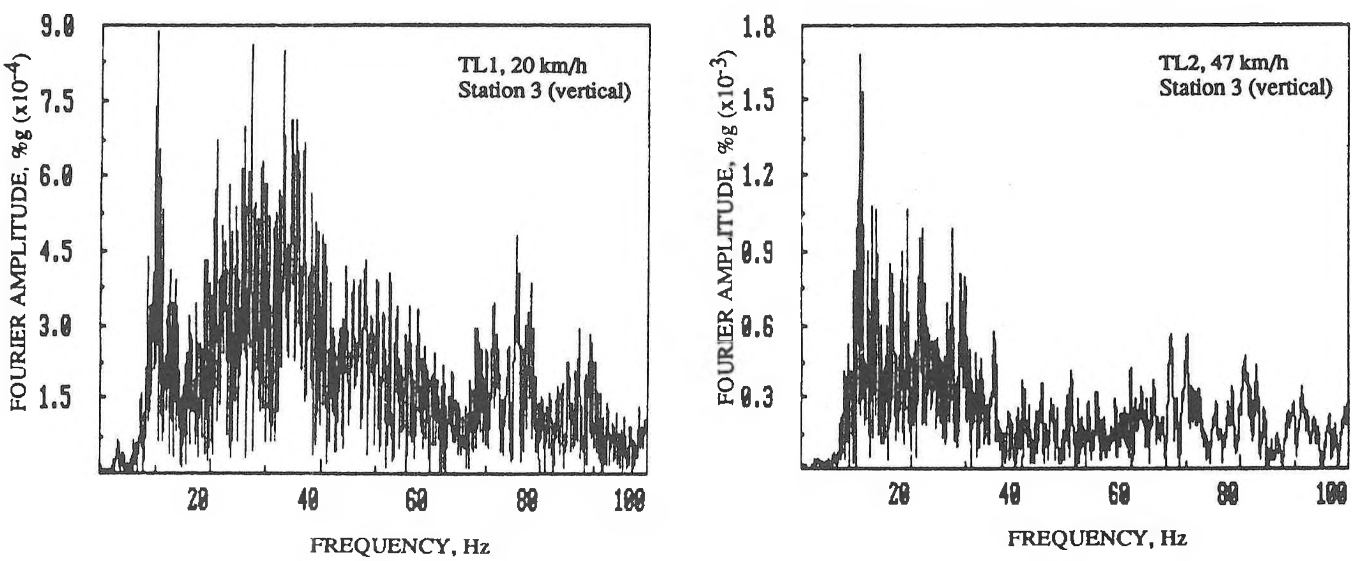

Figure 8 Acceleration Fourier spectra of vibrations induced by loaded truck at station 3, Location 1

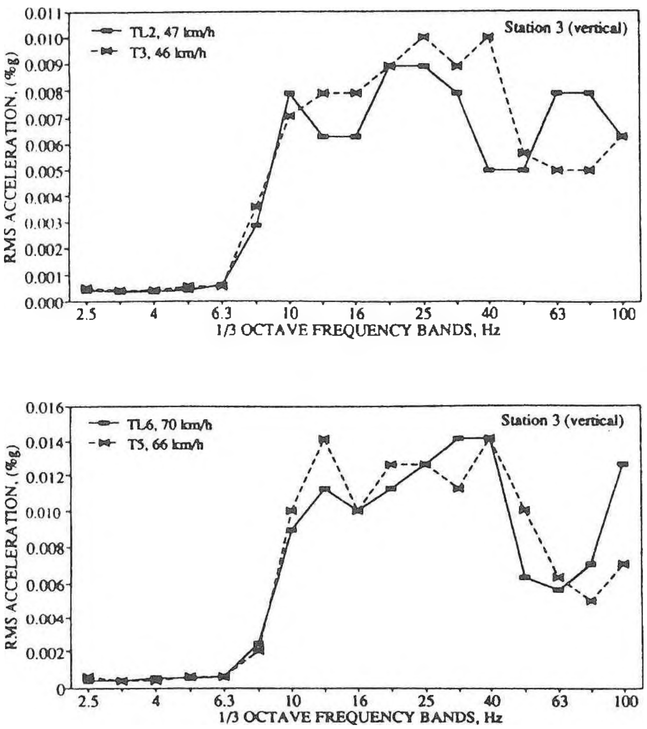

Figure 9 Weight control tests using empty and loaded truck

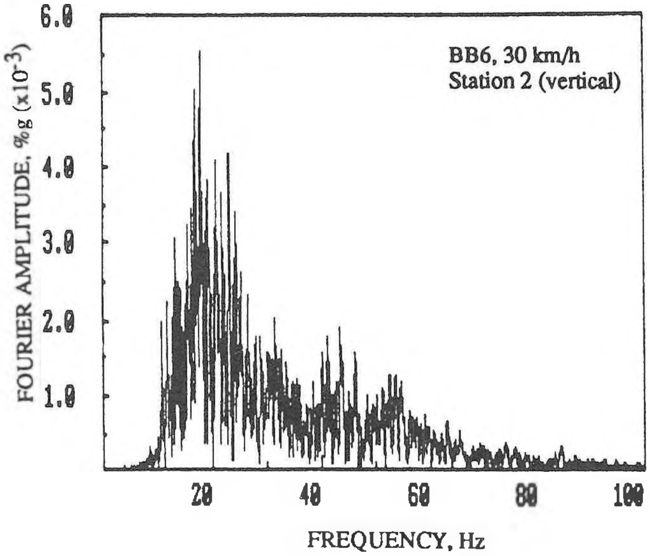

Figure 11 Fourier spectra of bus-induced vibrations at station 2, Location 2

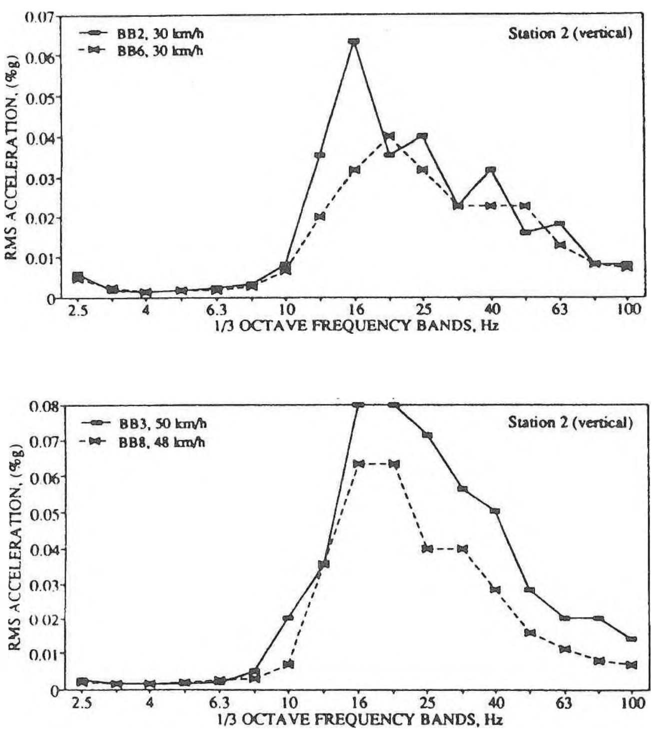

Figure 10 Effect of driving over depressed catchbasin at Location 2, buses No. BB2 & BB3 passed over catch basin

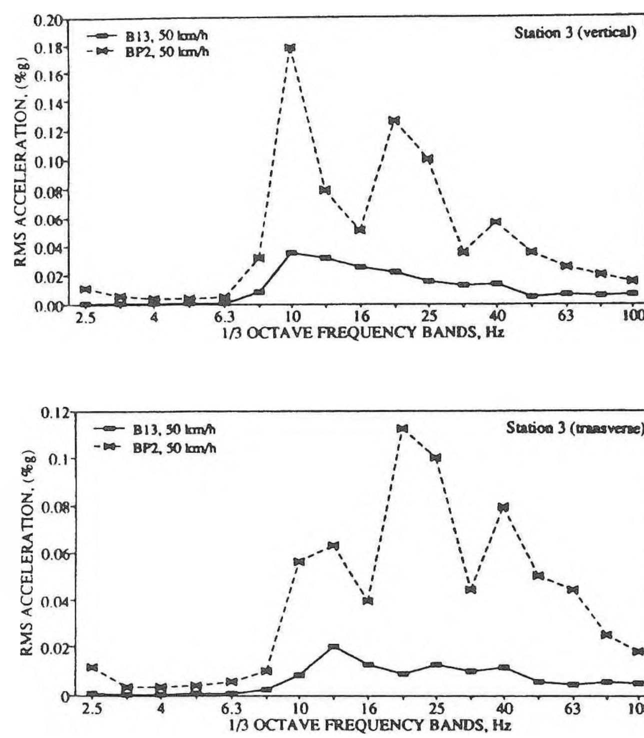

Figure 12 Effect of buses passing over wood plank at Location 1, bus No. BP2 passed over wood plank

the frequency response function for the site, shown in Figure 13b, obtained from an impact test using an instrumented hammer. This means that the predominant frequencies of traffic-induced vibrations correspond with the natural frequencies of the site (note: natural frequencies of a site are the frequencies of the various modes of one-dimensional vibration of the soil stratum; they are the frequencies of peaks of the site's response function).

Time history envelopes of vertical ground acceleration at Station 3 of Location 1 are shown in Figures 14 and 15 for the test bus and the test truck, respectively. By closely inspecting the spikes in these records one can detect a certain pattern of impacts. Mainly, it can be observed that a small spike is usually followed by a larger spike. The first spike corresponds to the front wheels of a vehicle hitting a crack or a ripple on the road surface, followed by the rear wheels hitting the same irregularity. This can be seen clearly from the record of truck TL1 running at 20 km/h (Figure 15). The first major spike in this record is smaller than the second major spike. The time difference between the two spikes is approximately 0.86 seconds. During this time the truck travels a distance of 4.8 m which is about the distance between the front and rear wheels of the front and rear wheels.

Since the spikes in the time records of Figures 14 and 15 have been identified as resulting from road irregularities, e.g. cracks and ripples, the potential of reducing ground vibration levels by providing a smooth road surface is thus evident. By comparing the amplitudes of the spikes to the general vibration background amplitude, it is conservatively estimated that the peak acceleration can be reduced between 40 to 50%.

6 DISCUSSION & RECOMMENDATIONS

The fact that the frequency content of bus-induced vibrations, unlike truck-induced vibrations, is concentrated in a narrow range is probably an indication that the energy of bus-road interaction forces is also concentrated in a narrow frequency range. This is possibly due to the different characteristics of suspension systems of buses and trucks. The characteristics of a suspension system depend on its stiffness and the unsprung mass of the vehicle. In general, buses tend to have "soft" suspension systems as opposed to "stiff" (uncomfortable) ones in trucks. A stiff suspension system produces "sharper" impacts on the road than those produced by a soft system. Sharp impacts have wide frequency content. Concentrating the impact energy in a narrow frequency range, as happens with buses, leads to higher vibration peaks. Most likely also, the unsprung masses of the two test vehicles are different. This could lead to significant difference in interaction forces between the vehicle and the road. A detailed investigation of this whole phenomenon was beyond the scope of this study.

The predominant frequency of vibrations at Location 2 being higher than that observed at Location 1 is due to the fact that the soil layers at the latter location are deeper than those at the first one, as was found from the soil surveys. It is well known that the deeper the site the lower its fundamental frequency (e.g. see Wolf, 1985).

Finally, based on the findings of field experiments it emerges that:

- enforcing the 50 km/h speed limit, which was observed to be generally exceeded by 20 km/h, results in 23% vibration reduction;
- eliminating discrete irregularities such as catchbasin depressions reduces vibration levels by approximately 30% and
- providing a smoother road surface by eliminating cracks and ripples reduces peak vibration levels by as much as 50%.

It should be noted that the effects of these three measures are not simply cumulative since they are interdependent. It is estimated, however, that the overall effect of these remedies is likely to reduce the vibration levels by more than 50%. Such a reduction would help bring down the vibration levels for the test sites to an acceptable human annoyance level. This is based on earlier measurements at the same site which showed that acceptable levels were exceeded by up to 50%.

7 SUMMARY OF RESULTS

The results of field experiments, for the site under investigation, show that:

- The amplitude of ground vibrations is significantly influenced by vehicle speed. Broadband amplitudes increase by an average of 55% when speed is increased from 30 to 50 km/h and by an average of 30% when speed is increased from 50 to 70 km/h.
- Tests with empty and loaded water trucks show that the weight of the vehicle has little effect on the amplitude of ground vibrations.
- Discrete irregularities in the road surface have a significant effect on the amplitude of ground vibrations. Broadband amplitudes increased by 42% and 33% for a bus passing over a depressed catchbasin at 30 and 50 km/h, respectively, compared to a bus that avoided passing over the depression.

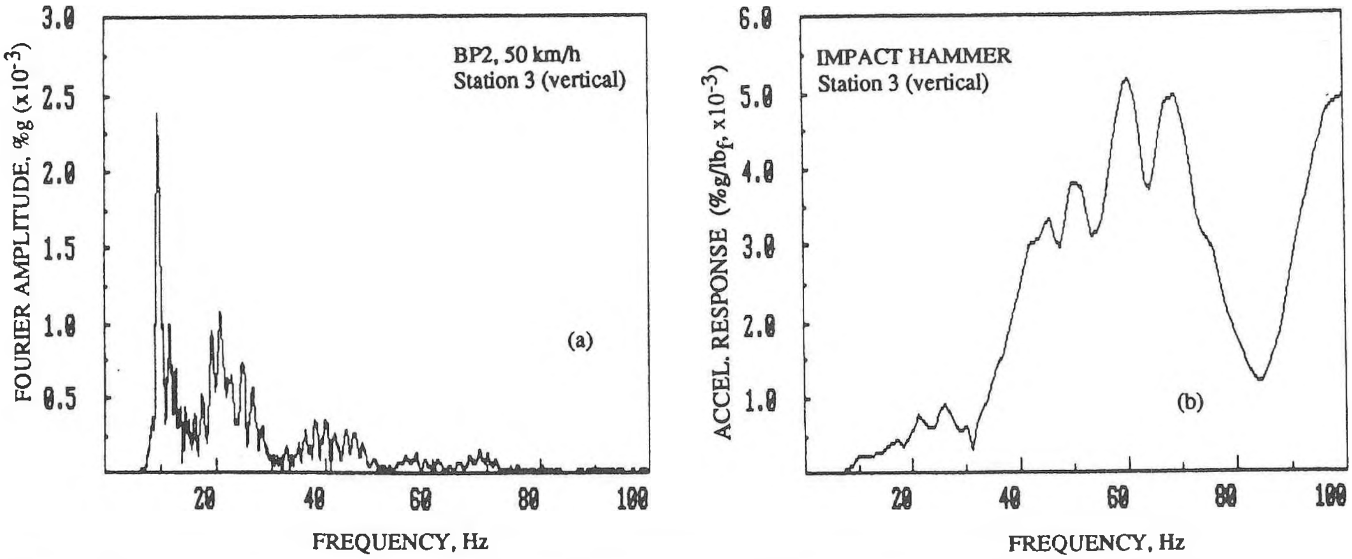

Figure 13 Fourier spectra of a bus passing over a discrete irregularity; and an impact using an instrumented hammer at Location 1

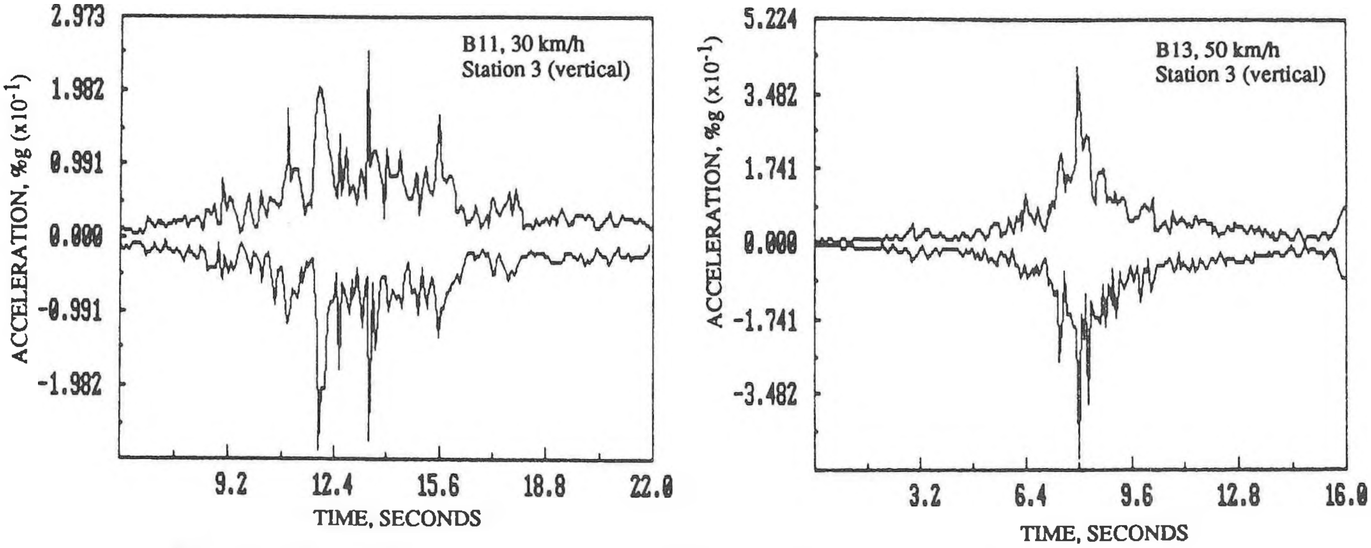

Figure 14 Time-versus-amplitude envelopes of bus-induced vibrations at station 3, Location 1

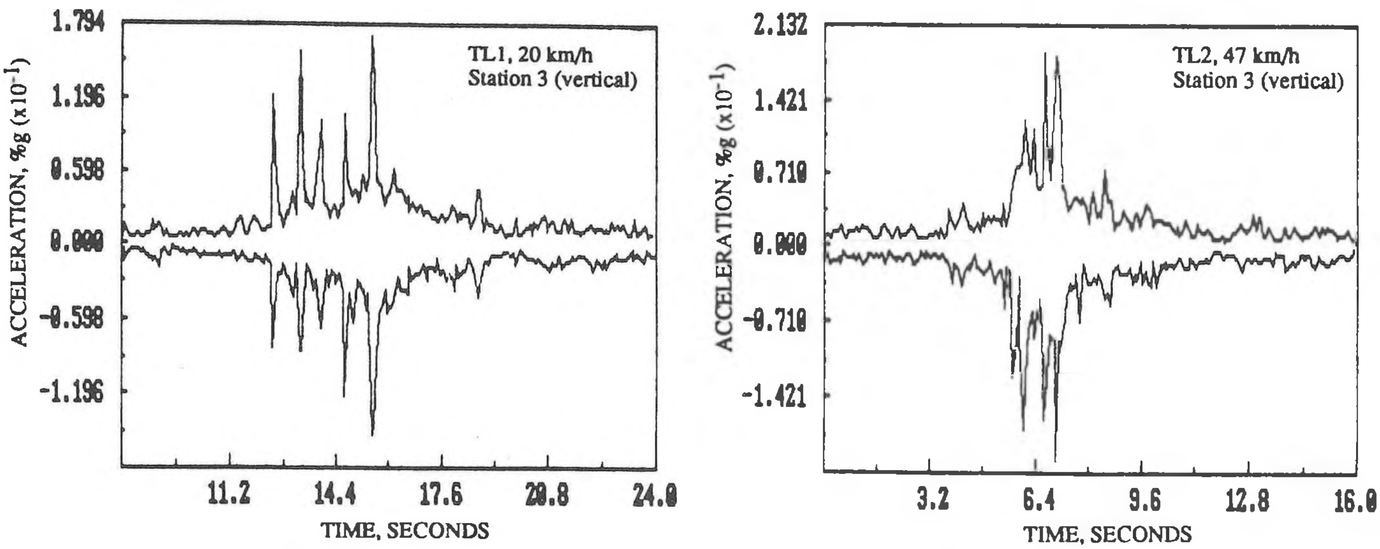

Figure 15 Time-versus-amplitude envelopes of loaded truck-induced vibrations at station 3, Location 1

- Tests with a 40 mm wood plank show an increase of vibration levels by a factor of 10.
- Time history envelopes suggest that peak ground acceleration can be reduced by as much as 50% by eliminating cracks and irregularities and providing a smooth road surface.
- The frequency content of bus-induced vibrations is concentrated in a narrow range whereas that of truck-induced vibrations is spread over a wide range.
- For the frequency bands of interest, 10 and 12.5 Hz, bus-induced vibrations are higher by at least a factor of 3 than truck-induced vibrations.
- Fourier spectra obtained from tests in which the bus passed over an irregularity show several frequency peaks that did not appear before. This can cause individual building components, e.g. slabs and walls that generally have high resonance frequencies, to start resonating.
- The dominant frequency of ground vibrations was found to be between 17 and 23 Hz at the Location 2 and about 10 Hz at Location 1.

ACKNOWLEDGEMENTS

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REVIEW AND CRITIQUE OF EXISTING SIMPLIFIED MODELS FOR PREDICTING FACTORY NOISE LEVELS

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ABSTRACT

This article is based on a report to the CSA Industrial Noise sub-committee in response to its request to study the need for and feasibilty of revising the existing CSA standard procedure for predicting noise levels in factories[1]. It reviews and attempts a preliminary evalution of existing models for predicting noise levels in factories. The important factory-acoustic parameters and factory-noise characteristics are discussed. Six models are described, along with the extent to which they have been validated. The models are then evaluated with respect to what extent they take the various parameters into account, and predict the various characteristics. It is concluded that the models have significant merits and short-comings, and that they have not been adequately validated in comparison with reliable experimental results. It is further suggested that there may be scope for a new, more comprehensive simplified model.

SOMMAIRE

Le présent article est fondé sur un rapport présenté au sous-comité sur le bruit industriel de l'ACNOR, qui avait demandé à l'auteur d'examiner le besoin et la faisabilité d'une révision de la méthode normative de l'ACNOR visant à prédire les niveaux de bruit dans les usines[1]. Il passe en revue les modèles existants de prédiction des niveaux de bruit dans les usines et tente de les évaluer de façon préliminaire. Les plus importants paramètres acoustiques et caractéristiques de bruit des usines y sont discutés. Six modèles sont décrits de même que leur dégré de validation. Ces modèles sont ensuite évalués en fonction de l'importance qu'ils accordent aux divers paramètres et de la justesse de la prédiction des différentes caractéristiques. Selon les conclusions du rapport, les modèles présentent des avantages certains mais aussi des faiblesses, et ils n'ont pas été validés adéquatement en comparison de résultats d'essais fiables. Il serait peut-être justifié d'élaborer un nouveau modèle simplifié, plus exhaustif.

1. INTRODUCTION

Recent years have seen a considerable increase in awareness of occupational hearing loss due to elevated noise levels in industrial work environments. This has naturally lead to an increased interest in industrial noise control. An important aspect of the noise-control process concerns the prediction of factory noise levels. Prediction models allow factory noise levels to be estimated, and noise-control measures planned, before construction at considerable potential cost savings. In existing factories they allow retro-fit noise-control measures to be evaluated for cost-effectiveness. The measures may consist of changes to the factory layout, construction and/or equipment, as well as the introduction of acoustic barriers and absorptive treatments.

Many models for predicting factory noise levels have been proposed over the last thirty or so years. Many of these are complex, computer-based models based on method-of-image or ray-tracing approaches. While potentially quite flexible and accurate, their implementation requires knowledge, computer facilities and an expenditure of time that many practitioners do not possess. There is considerable need for more simplified prediction models which, while being less accurate and generally applicable, would allow reasonable estimates to be made with little effort in typical cases. Several simplified models have in fact been developed, but are not well known. One simplified model, not developed for but often applied to factories, is the well-known Sabine diffuse-field model. Let it be said from the beginning that this model is not generally applicable to factories and provides very inaccurate predictions (examples are shown in Figures 1 and 2). It is not considered further here.

It is the aim of this report to review the existing models and to draw preliminary conclusions regarding their usefulness. In order to help in this task, we first discuss the factory-acoustic parameters that influence factory noise and that, in principle, a comprehensive prediction model must take into account. Next, using experimental and prediction results, we discuss some general characteristics of factory sound propagation that a model should be able to predict. The existing simplified models known to the author are then described, along with the extent to which their authors validated them experimentally. Finally, a preliminary attempt is made to evaluate the various models.

It must be stated immediately that this report discusses models which take an energy-based approach, ignoring wave, and therefore modal and diffraction, effects. Since we are dealing with large rooms and octave-band results, this should not represent a serious limitation except perhaps at low frequencies and when predicting levels in the presence of acoustic barriers. Further, all models predict the sound pressure level at some distance from an omni-directional point source, which radiates broad-band noise. We define the Sound Propagation Function (SPF) as the variation with distance, r, from an omni-directional point source of the sound pressure level, $L_p(r)$, minus the source sound power level, L_w: that is, $SPF(r) = L_p(r) - L_w$. The sound propagation function describes the variation of noise levels normalized for the source power. Both parameters are necessary to determine noise levels.

2. PARAMETERS

Factories are buildings of highly variable shape, construction and contents. Many factories are essentially of rectangular plan and section shapes (that is, parallelepipedic). Others are of more complex shape, with non-rectangular plan and section shapes, or with the space sub-divided by barriers such as mezzanine floors, internal enclosures and internal partitions. The composition of the various surfaces may vary from building to building and from surface to surface within a given building, especially if the factory contains acoustic treatment. Thus, the magnitude of the acoustic absorption of the surfaces may be highly variable and its distribution non-uniform. Factories contain furnishings (equipment, stockpiles, benches, roof trusswork, etc.) that scatter and absorb propagating sound, resulting in noise levels which are very different from those in the empty factory. The furnishing density and absorption usually vary throughout the factory. Finally, factories contain many noise sources and noise-sensitive positions, located throughout the building. Receiver positions may be operator positions, for which the average source/receiver distance is small. In the other extreme, a long factory may have noise sources at one end and noise-sensitive receivers at the other; in this case, the average source/receiver distance may be large. The surface absorption and the noise radiated by sources may vary with frequency as, of course, do factory noise levels.

The main factory-acoustic parameters that have a significant influence on factory noise levels, are as follows:

- geometry - the geometry (size and shape) of the building envelope, and the positions of internal barriers;
- surface absorption -the absorption coefficients of the various surfaces;
- furnishings - their density, absorption and distribution;
- source power and position;
- receiver position.

The frequency variation of the parameters and of noise levels is conventionally described by their values in octave bands.

3. CHARACTERISTICS

The main characteristics of factory sound propagation will be illustrated using two examples. The first illustrates the influence of sound absorption and of furnishing density. The second illustrates the influence of factory geometry.

Figure 1 shows the 1000 Hz octave-band sound propagation function measured in an empty, untreated factory with average dimensions 45 m x 42.5 m x 4 m high and a double-panel roof. As is often the case, the sound propagation function at most source/receiver distances is found to be highest at mid-frequencies. It decreases at low and high frequencies due, respectively, to increased surface and air absorption. The effect of furnishings is also illustrated in Figure 1, showing the sound propagation functions in the factory after first 25 and then an additional 25 printing machines were introduced. These metal machines had average dimensions of 3 m x 3 m x 2 m high. Introduction of the furnishings has only a small effect on the sound propagation function at small source/receiver distances but significantly decreases it at larger distances. For reference, Figure 1 also shows the sound propagation function curve predicted by diffuse-field theory for the empty factory, and that for a point source in a free field. Figure 2 shows the sound propagation function predicted by a ray-tracing model for four furnished, parallelepipedic rooms with different dimension ratios, but the same total surface area,

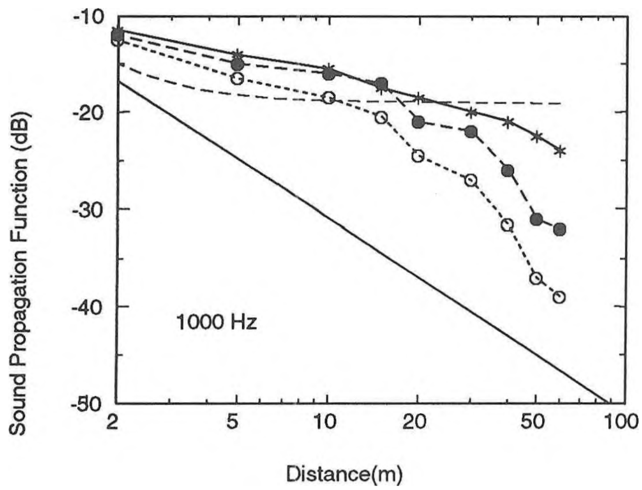

Figure 1. Measured 1000 Hz octave band sound propagation function in a factory when empty ( ), partly furnished ( ) and fully furnished ( ). Also shown for reference are the functions predicted by diffuse-field theory for the empty factory ( ) and for a point source in the free field ( ).

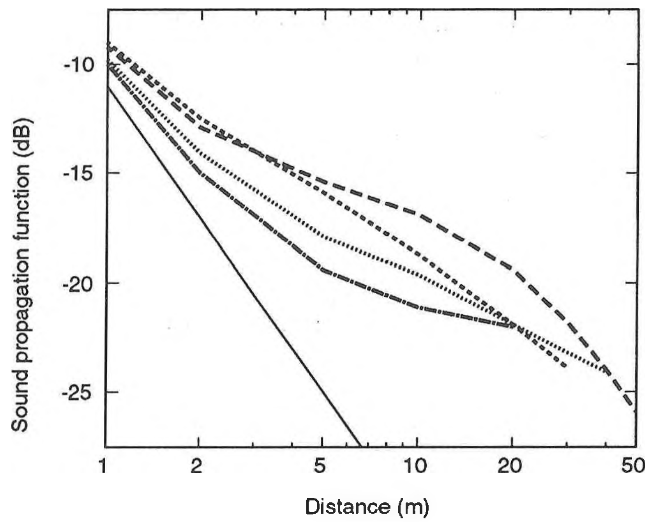

Figure 2. Sound propagation function predicted by ray tracing in four furnished factories with different length:width:height ratios: ( ) 1:1:1, ( ) 5:2.5:1, ( ) 10:10:1, ( ) 10:1:1. The curve for the cubic room is similar to that predicted by diffuse-field theory. Also shown for reference is the function for a point source in the free field ( ).

absorption and furnishing density. In all cases, the source and receiver are at half height and width; the source is at 5 m from one end wall. According to diffuse-field theory, all rooms should have the same sound propagation curve (that shown for the cubic room). Clearly this is not in fact the case; predicted levels vary significantly with dimension ratio. Figure 2 also shows the sound propagation curve for a point source in the free field.

Note also the characteristic shapes of the sound propagation curves. Only in certain cases is the slope of the curve approximately constant. More generally the slope varies with source/receiver distance. In particular, the slope tends to increase with distance at large distances from the source - especially in densely-furnished factories. The slope of the sound propagation curves also increases with room dimension ratio and furnishing density. Note also that levels even as close as 1 m to a source may be several decibels above free-field levels.

4. MODELS

We present six models, in chronological order of publication. In each case the model is briefly described. To what extent each model was validated by its author(s) is then discussed. Finally, each model is evaluated with respect to the extent to which it accounts for the factory-acoustic parameters and sound-field characteristics discussed above. These latter results are summarized in Table 1 for easy comparison of the models.

4.1 Friberg Model

Friberg[2] developed an empirical formula, from measurements in many factories, for predicting the slope, assumed constant, of the A-weighted sound propagation function curve. It applies to long, parallelepipedic factories of any height to width ratio, without internal barriers. The factory furnishings are assumed to be located on the floor and to have some average height. The surface absorption is quantified by the ceiling absorption coefficient at "around 1000 Hz", α'. The slope, in dB/dd, is given by $-(a\alpha' + b)$, in which a and b are constants whose values depend on the furnishing density, as determined by qualitative descriptors, and on the room's height to width ratio, as shown in Table 2.

Friberg presented measured and predicted slopes for six factories with and without absorptive ceiling treatments. In general, the average slopes of the sound propagation function curves, which varied from -2.5 to -8 dB/dd, were predicted within 2 dB/dd. Prediction tended to underestimate the slope.

The Friberg model can be applied to long factories of any height to width aspect ratio. Ceiling but not wall absorption is taken into account. Furnishing density is modelled, but the furnishings are assumed to be isotropically distributed over the floor area; their absorption is not specifically considered. The source power is not included; the user is left to decide how to de-normalize the sound propagation

Table 1. Summary of the extent to which existing simplified models account for the main factory-acoustic parameters and sound propagation characteristics: Y= taken into account fully; ? = taken into account partially or approximately; N = not taken into account or modelled incorrectly.

	PARAMETERS										CHARACTERISTICS	
MODEL	Geometry		Absorption		Furnishings			Source		Receiver	SPF curve	Freq
	Shape	Barriers	Magn.	Dist^n	Density	Abs^n	Dist^n	Power	Pos^n	pos^n	shape	var^n
FRIBERG	?	N	Y	N	Y	N	?	N	N*	N*	N	N
THOMPSON ET AL	?	N	Y	N	N	N	N	Y	N*	N*	N	Y
WILSON	?	N	?	N	?	N	N	N	N*	N*	N	N
EMBLETON/RUSSELL	?	N	?	Y	N	N	N	?	?*	N*	N	Y
ZETTERLING	?	N	Y	?	Y	N	N	N	N*	N*	Y	N
SERGEYEV	?	N	?	?	?	?	?	Y	N*	N*	?	Y

* includes the source/receiver distance as a prediction parameter.

Table 2. Constant required for predictions according to the Friberg[2] model. The room shape and contents are categorized as follows (h = average furnishing height, H = room height, W = room width):

<u>Room Shape</u>

N - rooms with W < 4 H
M - rooms with 4H < W < 6H
B - rooms with W > 6H

<u>Room Contents</u>

L - rooms with zero or low furnishing density, or densely furnished with h < H/8
M - rooms with medium density of high furnishings, or high density of furnishings with H/8 < h < H/4
H - rooms with high density of furnishings with h > H/4

Room category	*a*	*b*
BH	-3.0	-4.0
BM	-2.5	-3.75
BL	-2.0	-3.5
NH	-3.0	-3.0
NM	-2.75	-2.75
NL	-2.5	-2.5

function curve. Only the source/receiver distance, and not the exact source and receiver positions, is accounted for. Presumably the model applies only to fairly flat source sound-power spectra. Sound propagation function curves are assumed be of constant slope. The model predicts the slope of only the A-weighted curve.

4.2 Thompson et al. Model

On the basis of experimental observation, Thompson, Mitchell and Hurst[3] proposed a modification to the expression describing steady-state levels according to diffuse-field theory, to allow its application to irregularly proportioned factories, as follows:

$$L_p = L_w + 10 \log_{10} [1/4\pi r^2 + 4MFP/r(\alpha S+4mV)]$$

in which

r is the source/receiver distance, in m;

MFP = 4V/S, is the room mean free path, in m;

α is the average room absorption coefficient;

S is the room surface area, in m^2;

m is the air absorption exponent, in Np/m;

V is the room volume, in m^3.

Predictions were compared with experiment in octave bands for three empty rooms and good agreement was found.

The Thompson et al. model accounts for room geometry according to its volume and surface area; internal barriers are not considered. Surface absorption is assumed to be uniformly distributed. Furnishings are not taken into account. The source power is included. Source and receiver positions are described only by their relative distance. The slope of the sound propagation function curves at large distances is assumed to be always -3 dB/dd. The model allows full frequency-varying information to be obtained.

4.3 Wilson Model

Wilson[4] proposed a very simple method for predicting the slope of the A-weighted sound propagation function curve in parallelepipedic factories with width and length at least four times the height, and without internal barriers. It is based on his experimental observations of the extent to which the average slope of the sound propagation function curve increases with increased absorption and/or furnishings. The slope is assumed to be constant with the following values:

-3 dB/dd in acoustically hard, empty factories;

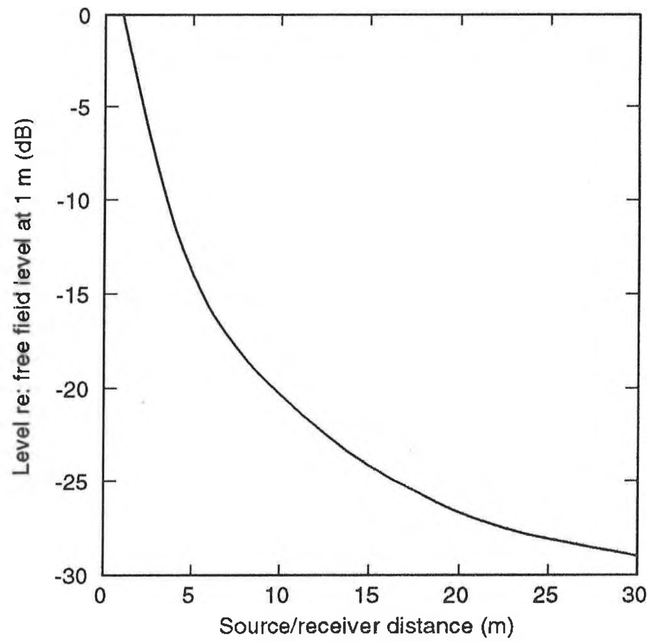

Figure 3. Noise levels relative to free-field levels at 1 m from a source in factories without ceiling and walls, according to the Embleton/Russell model[1].

-4 dB/dd in acoustically hard, furnished factories or in absorbent-lined, empty factories;

-5 dB/dd in absorbent-lined factories with furnishings.

No comparisons between prediction and experiment were presented to validate the model.

The Wilson model applies only to long and wide factories. Surface absorption and furnishings are accounted for according to whether or not they are present in significant quantity. The source power and exact source and receiver locations are not modelled. Sound propagation function curve shape is not correctly modelled (that is, the experimentally-observed characteristics are not reproduced) and no frequency-varying information is provided.

4.4 Embleton/Russell Model

The Embleton/Russell model[1] constitutes the existing Canadian standard. It predicts levels assuming the existence of free-field levels at 1 m from a source. It applies to empty rooms with rectangular plan shape and relatively-constant height, with length and width which are at least four times the height, and which contain no internal barriers. Levels as a function of source/receiver distance are first determined for the room without ceiling and walls using Figure 3.

Table 3. Corrections to noise levels for ceiling and wall reflections according to the Embleton/Russell model[4].

A. Ceiling corrections

Distance / Height	Highly absorbing ceiling (dB)	Partly absorbing ceiling (dB)	Poorly absorbing ceiling (dB)
1.0	0	0	0
1.25	0	0.25	1
1.6	0	1.0	2
2.0	0	1.5	3
2.5	0	2.0	4
3.2	0	2.5	5
4.0	0	3.0	6
5.0	0	3.5	7
6.3	0	4.0	8
8.0	0	4.5	9
10.0	0	5.0	10
12.5	0	5.5	11
16.0	0	6.0	12
20.0	0	6.5	13

B. Wall corrections

Side wall absorption	dB
Poorly absorptive	3
Partly absorptive	2
Highly absorptive	1

These levels are then corrected for ceiling and wall reflections using correction factors, presented in Table 3. The corrections depend on the source/receiver distance, the room height, the distance from the source to side walls, and whether the reflecting surfaces are "poorly", "partly" or "highly" absorptive. No attempts were made to validate the model.

This model accounts for arbitrary geometry in parallelepipedic rooms. Surface absorption is taken into account to some extent. Furnishings are not considered. The source power is included; it is assumed that free-field levels exist at 1 m from any source. Horizontal source and receiver positions are taken into account. The shape of the sound propagation function curve is apparently not correctly modelled in the case of furnished rooms. The variation of levels with frequency is predicted in a highly approximate manner.

4.5 Zetterling Model

Zetterling[5] proposed a model to predict the reduction of dB(A) noise level relative to the level at 1 m from a source in parallelepipedic factories of any shape without internal barriers. First, the "acoustic quality of the room" is quantified by a "total score" using Figures 4 a,b and c which relate this quantity to, respectively: 1) the room volume; 2) the ceiling height and average mid-frequency absorption coefficient; 3) the room width and average mid-frequency wall absorption coefficients. The reduction is then determined from the total score, the source/receiver distance and the estimated furnishing density using the appropriate version of Figure 4d, or extrapolating between them.

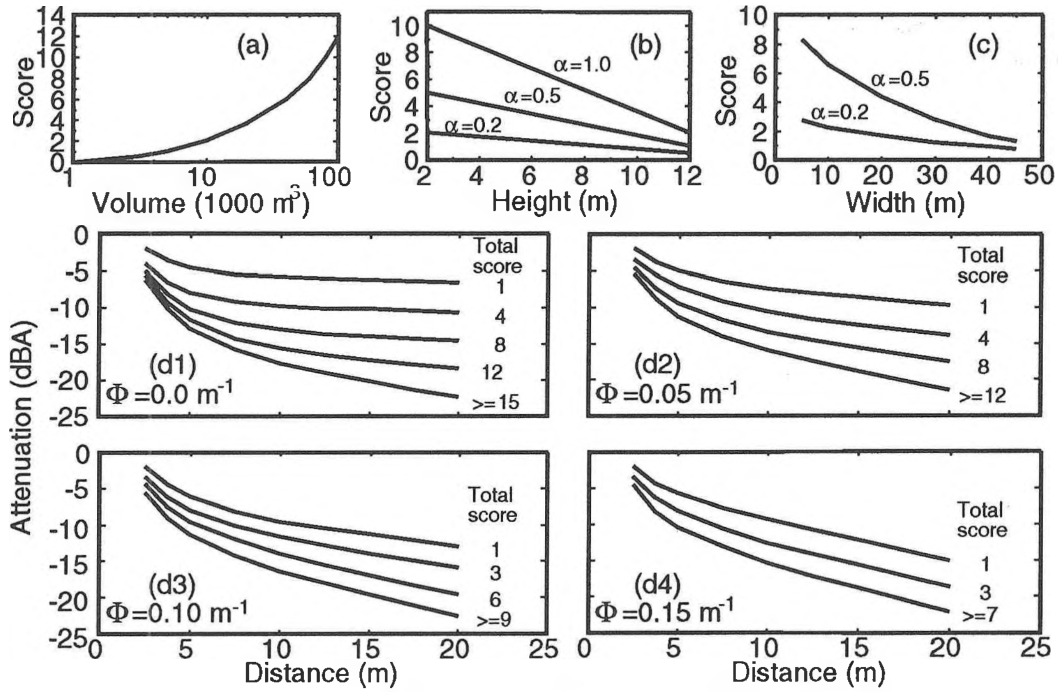

Figure 4. Curves relevant to prediction according to the Zetterling model[5] (Φ = furnishing density).

By way of validation, Zetterling presented comparisons between measured and predicted dB(A) levels at distances of 4-22 m from a source in five empty and furnished factories. Differences were typically 0-5 dB(A).

The Zetterling model is flexible with respect to building geometry. Ceiling and wall absorption are included but all walls are assumed to have the same absorption. The factory furnishings are assumed to be isotropically distributed. Source power is not modelled. Source and receiver locations are described by their relative distance; the prediction curves extend only to 20 m. In principle, the shape of the sound propagation function curve is correctly modelled, but the model provides no frequency-varying information.

4.6 Sergeyev Model

The Sergeyev model[6] predicts noise levels at positions not too close to a source. It applies to untreated, parallelepipedic factories of typical construction containing furnishings with average densities, and without internal barriers. Noise levels are determined using the following formula, found by fitting a regression line to experimental results:

$$L_p = L_w + 10 \log_{10} \{ 1/2\pi r^2 + (1-\alpha)(r+W)\, J(\alpha,\rho) / [\, H\, W\, (r+H)\,] \}$$

with $J(\alpha,\rho) = 0.1 / [\, \alpha + \rho^2 \exp(0.65\, \rho)]$

and $\alpha = 1 - (1-\alpha)\ \exp(-m \bullet MFP)$

in which

ρ = $-r \ln(1-\alpha) / MFP$ is a dimensionless distance;

r is the source/receiver distance, in m;

α is the average absorption coefficient of the room surfaces calculated as if the room were empty, using Table 4. The "empty factory" values are used for the walls and ceiling; the values for the appropriate industry are used for the floor;

W is the room width, in m;

H is the room height, in m;

$MFP = 4V/S$ is the mean free path, in m;

V is the room volume, in m^3;

S is the total room surface area, in m^2;

m is the air absorption exponent, in Np/m.

Absorption coefficients were determined for typical empty factories and for furnished factories in various industries (textile, metal working, printing, as shown in Table 4); thus, they in principle account for differences in furnishing density and absorption for equipment in different

Table 4. Effective octave-band absorption coefficients for typical empty factories and furnished factories in various industries for use in the Sergeyev model[6].

	Octave band (Hz)				
Case	250	500	1000	2000	4000
Empty factories	0.09	0.09	0.09	0.08	0.09
Textile industry	0.25	0.29	0.40	0.40	0.43
Printing industry	0.31	0.27	0.26	0.31	0.31
Metalworking industry	0.32	0.30	0.34	0.34	0.38

industries. Comparisons between prediction and experiment were presented for validation; agreement within 2-3 dB was generally found.

The model deals with regularly-shaped rooms. Surface absorption and furnishings are taken into account on the assumption that the factory is of typical construction and typically furnished. Source power is included, as is the source/receiver distance. The shape of the sound propagation curve is, in principle, accurately modelled. Levels can be predicted as a function of frequency.

5. CRITIQUE

Let us discuss the merits and short-comings of the models one parameter at a time with an aim to comparing and evaluating the models and to envisaging how a better model could be developed.

Geometry

All of the models assume the factory to be of parallelepipedic shape and to be without internal partitions. These are reasonable assumptions for a simplified model to make, given the difficulties associated with taking arbitrary geometry and barrier diffraction effects into account. The Friberg, Wilson and Zetterling models are limited to long factories. The Wilson model applies to long and wide factories, while the other two models allow variable height to width ratios. The Thompson et al. model inaccurately accounts for shape according to the volume and surface area. The Sergeyev model does so via the floor area, thereby assuming typical height. Only the Embleton/ Russell model accounts for arbitrary shape by considering reflections from individual surfaces.

Surface absorption

The Wilson model accounts for the magnitude of the surface absorption simply by its absence or presence; that is, according to whether or not the building is acoustically treated. The Embleton/Russell model uses the qualitative descriptors "poorly, partly and fully" absorbing. The other models more accurately employ the absorption coefficient.

Only the Zetterling and Embleton/Russell models take the distribution of absorption into account. However, the Zetterling model assumes uniform wall absorption. Only the Embleton/Russell model allows the absorption of individual surfaces to be considered.

Furnishings

The Thompson et al. and Embleton/Russell models ignore furnishings completely.

The Wilson and Sergeyev models assume the factory to contain average densities of furnishings, and thus cannot deal with non-typical situations. Friberg uses qualitative descriptors and the average furnishing height to determine their density. Zetterling quantifies furnishings by the more rigorous average furnishing scattering-cross-section volume density. Unfortunately, it is not yet known how to determine this quantity accurately; it can only be estimated by approximate means and from experience.

As far as the furnishing absorption is concerned, only the Sergeyev model takes this into account. The parameter is included implicitly in the effective absorption coefficients used in the model. Only the Friberg model accounts in any way for non-isotropic furnishing distributions, and this only in the vertical plane; the furnishing height is a parameter of the model.

Source and receiver

Surprisingly, since this parameter is necessary to determine noise levels from the sound propagation function, the source power is not a parameter of all models. The Friberg and Wilson models do not include this parameter. The Zetterling model predicts levels relative to that at 1 m from a source, leaving the user to estimate this level from the sound power, for example. The Embleton/Russell model incorrectly assumes free-field levels at 1 m from a source.

Only the Thompson et al. and Sergeyev models include the source sound power level explicitly.

The Embleton/Russell model accounts for the source position in the horizontal plane in that it corrects levels according to the distance of the source to each wall. Neither the vertical position, nor the exact position of the receiver is considered. However, all models calculate noise levels using the source/receiver distance.

Sound propagation function curve shape

The Friberg and Wilson models incorrectly assume that all sound propagation function curves have constant slope. The Thompson et al model incorrectly assumes the slope to be -6 dB/dd near a source and -3 dB/dd far from a source. Since the Embleton/Russell model does not include furnishings, it would not be expected to predict the correct curve shape. Both the Zetterling and Sergeyev models apparently predict the correct curve shapes since they are based on measured curves.

Variation with frequency

The Friberg, Wilson and Zetterling models only predict noise levels in dB(A). The Thompson et al., Embleton/Russell and Sergeyev models allow octave-band predictions to be made.

6. CONCLUSION

Clearly, all of the existing models have merits and shortcomings. All are easy to use. All are limited to rooms of parallelepipedic shape without barriers. None accounts for arbitrary furnishing absorptions and distributions, nor for exact source and receiver positions. However, given the objectives of simplified models, these do not represent serious limitations. More seriously, the Thompson et al. and Embleton/Russell models ignore furnishings. The Friberg and Wilson models do not include the source power. The Friberg, Thompson et al., Wilson and Embleton/Russell models do not correctly model the shape of the sound propagation function curve. The Friberg, Wilson and Zetterling models do not allow octave-band predictions. The Embleton/Russell model stands out in its flexibility with respect to geometry, absorption distribution, source position and frequency variation. The Zetterling model has the advantage of modelling furnishings in a comprehensive way. The Sergeyev model is interesting in that it models absorption, furnishings and frequency variations, but depends heavily on the statistical accuracy of the data on which it is based. In summary, it is not obvious which models would perform best if evaluated in comparison with reliable experiments. There is a definite need for a careful evaluation of the models.

There is also an apparent need for a model that better takes into account the relevant parameters and better predicts the main sound-field characteristics. Either a new approach could be taken, or a model could be developed from the strong points of the various existing models. Including furnishings and octave-band surface-absorption variation into an Embleton/Russell approach is one possibility. Incorporating frequency variability into a Zetterling approach is another. Improving the data base behind a Sergeyev approach would be a third. These options require careful evaluation, but the development of an accurate, comprehensive simplified model appears entirely feasible Finally, the resulting model should be carefully validated before being put into use, particularly as a Canadian standard.

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NON-DESTRUCTIVE TESTING VIA STANDARD LABORATORY TEST EQUIPMENT

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ABSTRACT

Non-destructive testing research involving ultrasonics is being pursued at the United States Naval Academy under the sponsorship of the David Taylor Naval Ship Research and Development Center. Specifically, efforts to improve various aspects of testing, the equipment used and software developed, are addressed in this article. Particular emphasis is placed upon the software and the problems that were overcome in using a digitizing oscilloscope and computer made by different manufacturers.

SOMMAIRE

Des recherches portant sur des essais non-destructifs et utilisant des ultrasons sont menées à l'Académie Navale des Etats-Unis sous l'égide du Centre David Taylor de Recherche et Développement en Construction Navale. Les efforts poursuivis pour améliorer les divers aspects des tests, l'équipment utilisé et le logiciel développé sont traités de manière spécifique dans cet article. Un accent particulier est mis sur le logiciel et les problèmes qui furent résolus en utilisant un oscilloscope digital et un ordinateur fabriqués par deux companies différentes.

Numerous applications require that a pulse be detected in background noise. Radar and Sonar are common examples. Ongoing ultrasonic research uses the basic principles of sonar to detect flaws in materials where non-destructive testing is a necessity. Examples are qualifying the hulls of deep diving submersibles (nuclear submarines and research bells) and testing of nuclear reactor containment vessel walls. Another method of non-destructive testing is the use of X-Rays. This method is expensive due to both the initial capitol investment plus the additional cost of performing laborious measurements. The measurement costs are exacerbated by the removal of most workers from the local area while the X-Ray equipment is in operation. X-Ray testing is best suited to the detection of voids in solids. Detection of small cracks is best done with ultrasonic testing.

Continuous research is being performed at the Naval Academy in the use of ultrasonics to either supplement or replace the use of X-Rays as a measurement tool. This sonar type of hardware may typically consist of an ultrasonic transducer mounted on a pair of rails that are attached to the hull of a ship or some other test specimen. This assembly and the object to be tested are then immersed an ultrasonic conducting medium such as water. The transducer is then moved on the rails in close proximity to the test object's surface either in a steady lateral direction or in short lateral increments. Whether this controlled movement is continuous or in steps depends primarily on whether the returned ultrasonic pulse is discernible within the background noise. Background noise is added to the returned pulse either by the randomly oriented crystalline structure of the test specimen (a form of synchronous noise) or by local ambient noise source (asynchronous noise - amplifier thermal noise, welding, etc.) Asynchronous noise is more readily removed by statistical processing of the data. If the pulse is "buried" within the random noise, it may take many transmitted pulses at one test fixture location to "dig the pulse out-of the mud."

As better performance transducers evolve, the hardware design of the detection electronics, the computing hardware and software and the hardware used to display the collected data must also change accordingly.

In 1987, research efforts that included the mating together of some "off-the-shelf" hardware to perform a detection and display operation were implemented. The basic system consisted of a noise source, pulse generator and mixer supplying a signal to an oscilloscope. This signal was digitized by the scope and the data points were then sent over the IEEE-488 bus to a computer (see Figure 1). From the computer, the data were then sent over the IEEE-488 bus to a printer.

After the scope-computer-printer section was made operational, the noise source and pulse generator were replaced with a transducer. In this configuration, the transducer was mounted above a glass plate submerged in water and a reflection was detected at both plate surfaces. Two general approaches could have been used to detect the pulse in either test configuration.

First, the averaging capability of the Tektronix 2430 oscilloscope can be utilized. In this mode of operation, the scope is programmed to accept up to 256 samples of 1024 data points, average the data points that have been digitized by its flash converter, and send these data to the Hewlett-Packard 9000/300 computer. A sub-program then produces data that is plotted by the Hewlett-Packard 2932A printer.

A second approach is to use the scope to digitize the waveform but not average the values. In this mode of operation, each incoming pulse and its associated noise are immediately digitized and passed on to the computer. At the computer, a cross-correlation routine is used to extract the

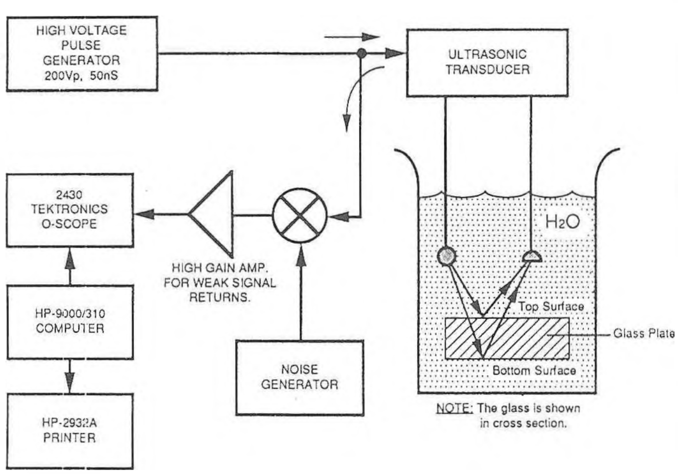

Figure 1. Equipment schematic.

pulse from the noise. Originally it was felt that this powerful computer could extract the pulse from the noise more rapidly than the scope could perform the averaging function. Both modes of operation were examined. Various software configurations were tested to examine the time required to complete the acquisition, transmission and display (or printout) task. Using the scope to perform the averaging function yielded the faster overall processing time. Data acquisition of a single plotting point consisting of 256 "pings" per location, the averaging of the data by the scope, transmitting the averaged data to the computer and finally the plotting of the point required an approximate time of 0.6 seconds.

This article provides some of the coding that was developed and describes the "pitfalls" that were encountered. For example, the computer-scope interface requires that the End Or Identify (EOI) status switch be set (manually) as opposed to use of a simple line feed (LF) recognition command.

Also the scope front panel switch settings and scale factors (volts per centimeter, seconds per centimeter) are transmitted from the scope to the computer in a single ASCII string. This string must be included in the plotting sub-program and accurately transmitted to the printer to enable correct scale factors to be printed.

Structured programming, wherein each major task, such as interrogating the scope or plotting the data points, is written as a sub-program. With a library of sub-programs, new research tasks can be solved more readily.

Before operation, the IEEE-488 bus address for each device must be established. Most Hewlett-Packard programmable test equipment contains rear panel mounted dip switches. One of the functions of these switches is to enable the user to set the address of the unit. The Tektronix 2430 oscilloscope address is set as a second level setting from a scope front panel switch. For each of the enclosed sub-programs, the scope address used was "30" or more completely "730".

For the waveforms shown in Figures 2 through 7, the following descriptors are used:

from Figure 3...

"1 Sep 1988, 12:14:52" => Date and time that the data was acquired.

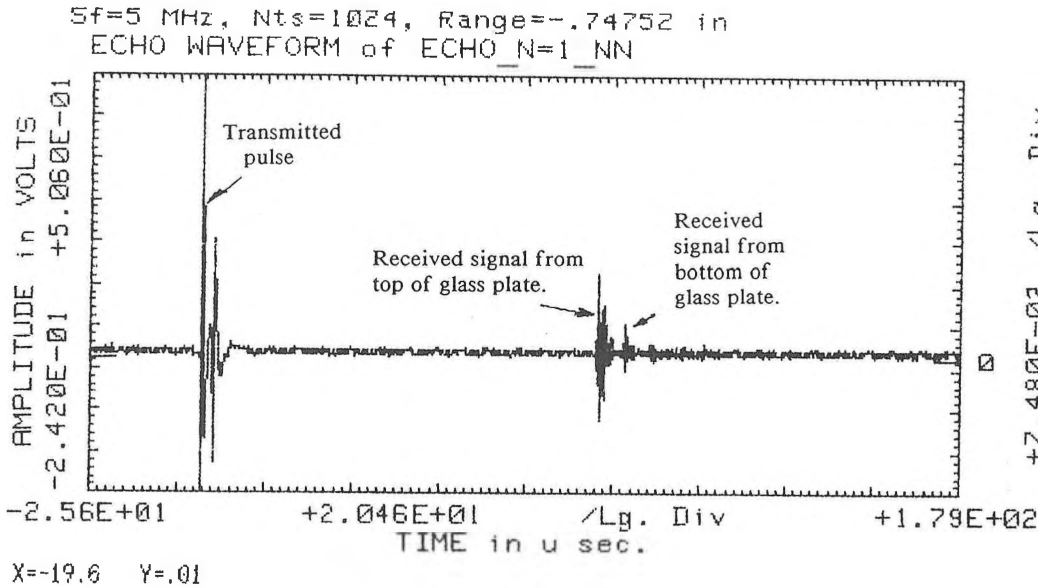

Figure 2. Signal With No Noise.

"sf = 5 MHz" => Rate at which the Tektronix 2430 Oscilloscope is sampling the incoming data.

"Nts = 1024" => Number of equally spaced (in time and spatially for the scope raster display) of eightbit sample points used by the Tektronix Scope.

"Range = -.74752 in" => With the outgoing energy pulse as a reference, the "range" represents the distance from the beginning of the trace to the left hand edge of the waveform portrayed on the screen.

"Echo waveform of ECHO-N=256-WN" => "Echo-N"is name of file where data representing the 256 individual points to be averaged at a specific location on the displayed waveform, is stored.

Figure 2 is a computer generated printout of a series of captured transmitted, reflected and received ultrasonic waveforms. The burst shown on the left of the waveform, is the outgoing "ping" from the transducer. The second burst (on the right) is the captured received waveform. It should be emphasized that although the waveforms shown appear to be singular, they are representative of the result of the scope's averaging of 256 bursts. Of course, when there is noise present, the more outgoing bursts that are employed, the more well defined the portrayed data will be. Figure 3 is an expanded view of the captured, received waveform of Figure 2 using the delayed trigger oscilloscope mode and an increased sampling rate of 100MHz.

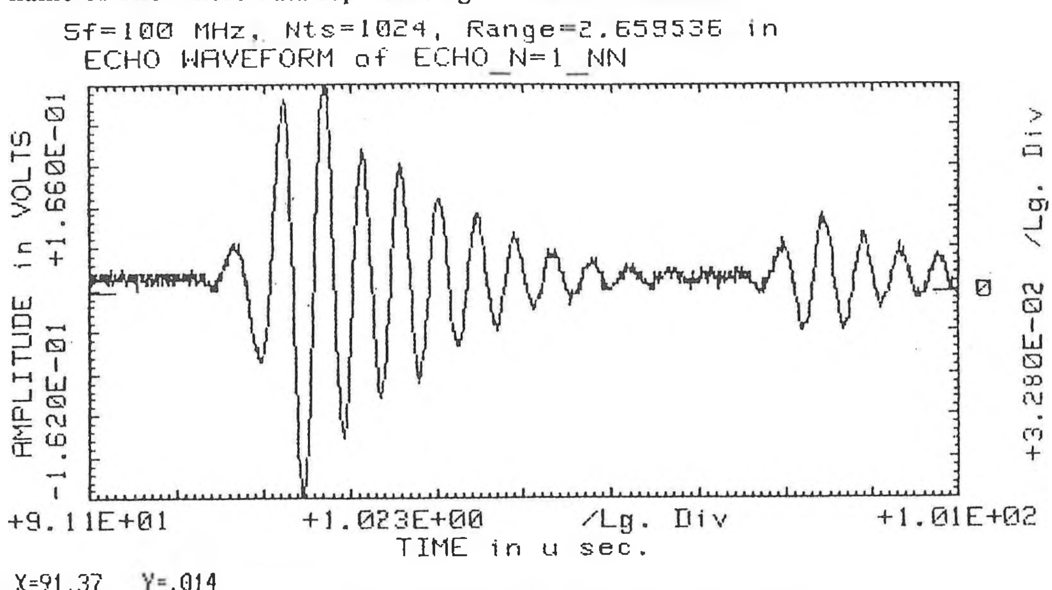

Figure 3. Expanded view of received pulse.

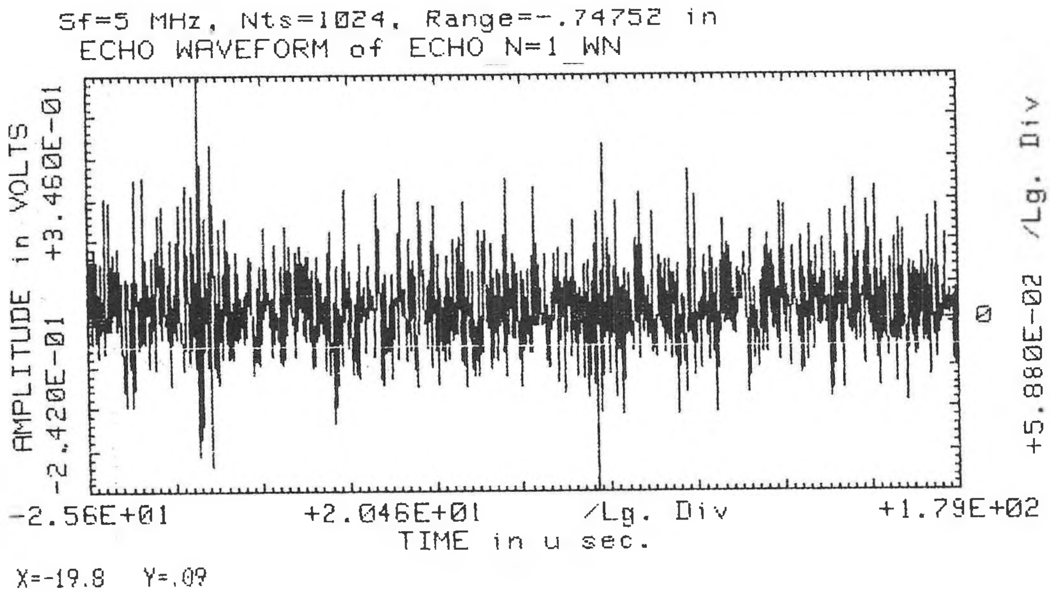

Figure 4. Outgoing and incoming pulses with noise.

Figure 4 is similar to Figure 2 with the exception that the computer printout is displaying both the captured, transmitted and received waveforms along with noise that has been deliberately introduced into the system. The purpose of the introduced noise is to stimulate the actual operating conditions under which a transducer may be employed. For the data displayed in Figure 4, the ratio of the peak transmitted "ping" signal (measured in volts-peak) to R.M.S. noise is approximately 0.3, i.e. Vsp/VN R.M.N. 0.3.

Figure 5 is a computer generated printout of the captured , received waveform. The time scale has been expanded considerably. We note that with the number of samples taken and the undesirable signal to noise ratio, the received signal is still discernable.

Figure 6 and 7 are the results of repeating the experimental procedures of Figures 4 and 5 with the excception that the sccope has been programmed to sample, store, and average the data from the 256 waveforms before forwarding these data to the somputer for curve plotting.

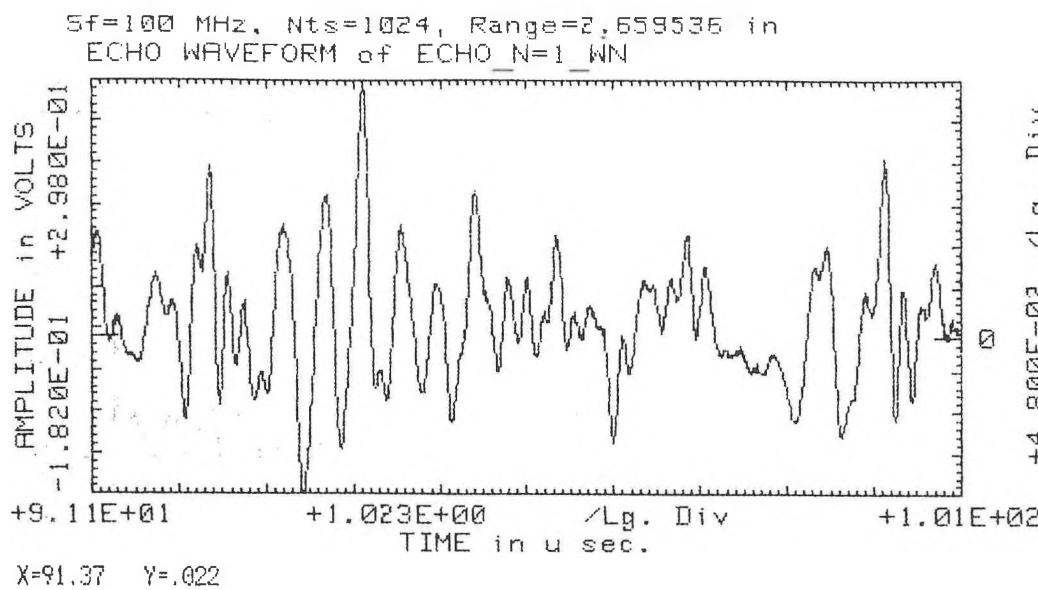

Figure 5. Expanded and received pulse with noise.

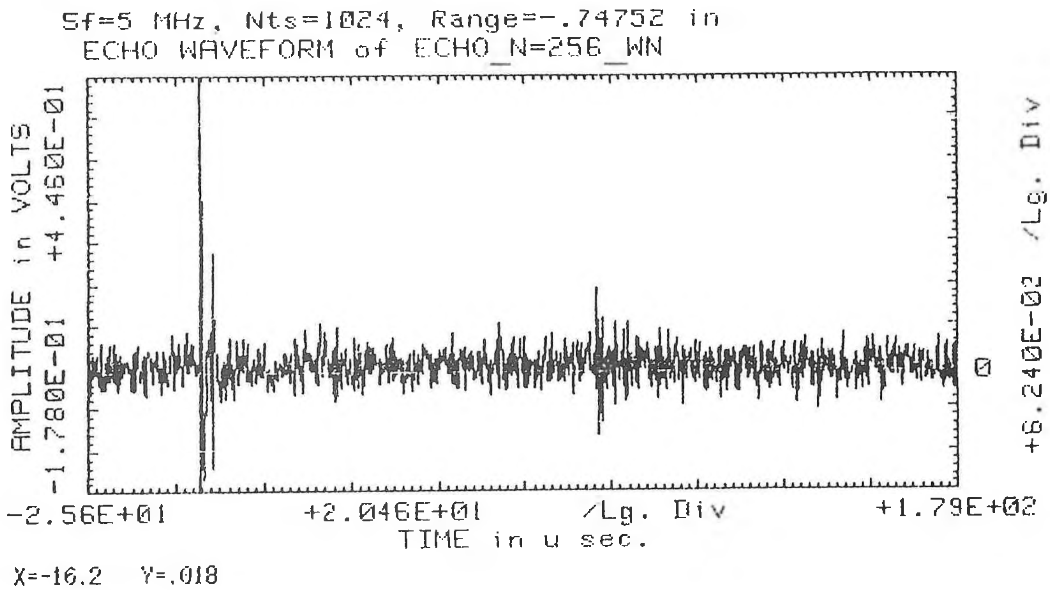

Figure 6. Averaged transmitted and received pulse.

We note that that the signal-to-noise ratio has improved by a factor of 256 as compared with data displayed in Figures 4 & 5. The reflected wavelets can now be distinguished within the residual noise.

To assist any reader who may be contemplating a similar interconnection of a Tektronix 2430 oscilloscope to a Hewlett-Packard 9000\300 computer, the following programming subroutines are provided. This code was written in Hewlett-Packard BASIC. The name given to the subroutine performing the transfer of the data from scope to computer is "Rb_scope1."

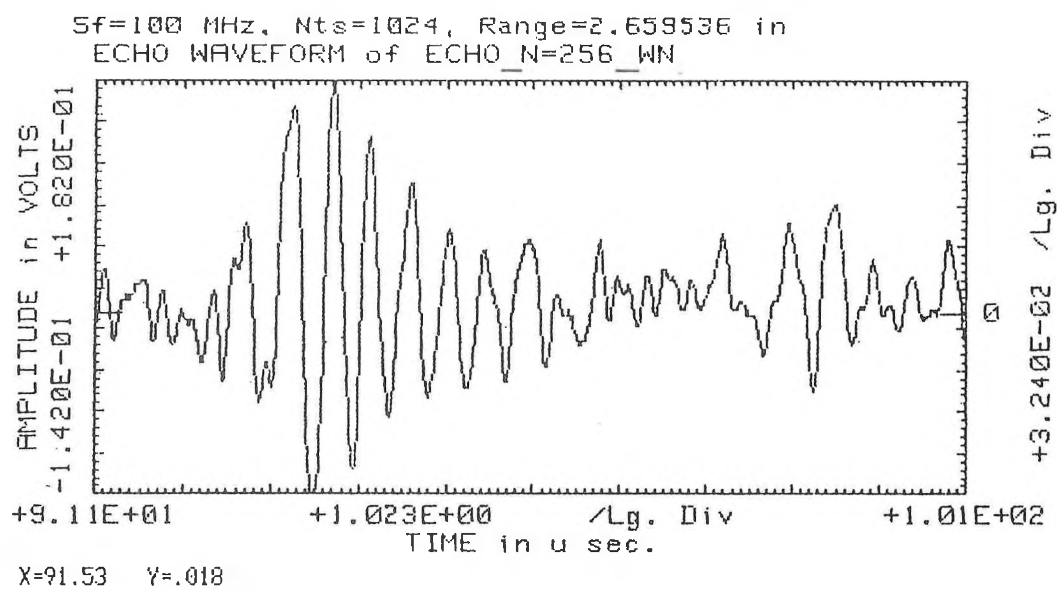

Figure 7. Expanded presentation of averaged, received pulse.

```
10     SUB Rb_scope1(Ydat(*),Np,Ton,Tinc)
20     !
30     ! Ydat(*)= CHAN. #1 VOLTAGE DATA ARRAY
40     ! Np=Number of sample points DATA FORMAT IS BINARY
50     ! Ton=ONSET TIME of the waveform in sec. MEASURE FROM the TRIGGER
60     ! Tinc=Time between sample points
70     !
80     !
90     ALLOCATE W$[160],H$[80],T$[80]
100    INTEGER I,J,K,Dlen
110    !
120 ASSIGN @Scope TO 730;FORMAT ON ! SYMBOLIC ADDRESS FOR TEK. 2430 SCOPE
130 !
140 ! INITIALIZE THE SCOPE
150 !
160 CLEAR @Scope
170 OUTPUT @Scope;"DEBUG ON"
180 OUTPUT @Scope;"DATA ENC:ASC"   ! GPIB FORMAT IS ASCII
190 OUTPUT @Scope;"DATA SOURCE:CH1"   ! SELECT CH. #1 FOR DATA SOURCE
200 !
210 !
220 OUTPUT @Scope;"DLYT DEL:OFF"
230 OUTPUT @Scope;"DLYE MOD:OFF"
240 !
250 OUTPUT @Scope;"PATH ON"
260 OUTPUT @Scope;"WFM?"   !Returns scope switch settings to computer
270 ENTER @Scope;W$
280 !
290 X=POS(W$,"XINCR:")
300 X=X+6
310 Xs=POS(W$,",YMULT:")
320 Xa$=W$[(X);(Xs-X)]
330 Tinc=VAL(Xa$)       ! TIME INTERVAL BETWEEN SAMPLE POINTS
340 !
350 Y=POS(W$,"YMULT:")
360 Ya$=W$[(Y+6);8]
370 Ymult=VAL(Ya$)   ! Y  SCALE FACTOR TO CONVERT SAMPLE VALUSE TO VOLTS
380 !
390 Yof=POS(W$,"YOFF:")
400 Yofe=POS(W$,",YUNIT:")
410 Yoff$=W$[(Yof+5);(Yofe-(Yof+5))]
420 Yoff=VAL(Yoff$)    !  VALUE Y OFFSET DUE TO POSITION KNOB
430 !
440 T=POS(W$,"PT.OFF:")
450 Tend=POS(W$,",PT.FMT:")
460 Tr$=W$[(T+7);(Tend-(T+7))]
470 Ntrig=INT(VAL(Tr$))   !  MARKING THE  LOCATION OF TRIGGER IN MEMORY
480 !
490 OUTPUT @Scope;"PATH OFF"
500 OUTPUT @Scope;"DLYT? DLY1"
510 ENTER @Scope;T$     ! DELAY VALUE IN SEC.
520 !
530 OUTPUT @Scope;"HOR? MOD"
540 ENTER @Scope;H$    !  SWEEP MODE
550 OUTPUT @Scope;"PATH ON"
560 !
570 Ton=-Ntrig*Tinc
```

```
580 IF H$="BSWEEP" THEN Ton=VAL(T$)-Ntrig*Tinc  ! IF IN DALAY SEEP ADD TH
590 !
600 Np=1024 ! # OF DATA POINTS
610 !
620 !  NOW BRING IN THE DATA
630 !
640 Nb=1036 ! NUMBER OF BYTESTS TO BE TRANSFERED
650 INTEGER Temp(520) BUFFER
660 ASSIGN @Buff TO BUFFER Temp(*);BYTE
670 RESET @Buff
680 !
690 OUTPUT @Scope;"DATA ENC:RIB"
700 OUTPUT @Scope;"CURV?"
710 ASSIGN @Scope TO 730;FORMAT OFF
720  T1=TIMEDATE
730 TRANSFER @Scope TO @Buff;COUNT Nb,WAIT
740 T2=TIMEDATE
750 ASSIGN @Scope TO 730;FORMAT ON
760 OUTPUT @Scope;"DATA ENC:ASC"
770 !
780 !PRINT "TIME=";T2-T1
790 !
800 T3=TIMEDATE
810 GOSUB Unpack
820 T4=TIMEDATE
830 !PRINT "TIME TO UNPACK=";T4-T3
840 !
850 DEALLOCATE W$,T$,H$
860 GOTO 1060
870 !
880 !
890 Unpack: !
900         X=Yoff*256
910         Y=Ymult/256
920         J=4
930         FOR I=0 TO 1022 STEP 2
940         Ydat(I)=Y*(SHIFT(Temp(J),-8)-X)
950         J=J+1
960         NEXT I
970         !
980         J=5
990         FOR I=1 TO 1023 STEP 2
1000        Temp(J)=ROTATE(Temp(J),8)
1010        Ydat(I)=Y*(SHIFT(Temp(J),-8)-X)
1020        J=J+1
1030        NEXT I
1040        !
1050        RETURN
1060 SUBEND
```

BBC GUIDE TO ACOUSTIC PRACTICE, 2nd edition

by KEITH ROSE

This book is a reorganised and extended version of earlier editions, and is written by Keith Rose who is employed as an acoustic architect by the BBC in the United Kingdom. As claimed in the associated publicity, the book is certainly unique, and it does contain a wealth of information for those involved in buildings for broadcasting. While this very narrow focus may be a significant selling feature for those working on this type of building, others may not wish to pay 30 pounds sterling (over $70. Canadian) for such a specialized book.

The book consists of 144 pages in a spiral binding and is well illustrated with many architectural drawings and some black and white photographs. It is divided into seven sections (or chapters) and includes a glossary of acoustical terms, a short list of reference texts, and an index. The bulk of the material is presented in the first three chapters entitled *Noise*, *Sound Insulation*, and *Room Acoustics*. Later chapters include *Guidelines on Sound Control Room Layouts*, *The Acoustic Effect of Studio Furniture*, and *Timing of Acoustic Tests*.

The first chapter, titled "Noise", contains considerable detail on this topic, including everything from construction noise to noise produced by studio clocks. The construction noise section even includes a one and a half page statement that is included in BBC construction contracts concerning the control of noise at construction sites. Although much of the information will be of use to readers in other countries, the dependence on references to several British Standards and only passing reference to North American noise rating procedures would certainly be a drawback to Canadian readers. Quite detailed noise criteria and tolerances are given in terms of the ISO Noise Rating procedure. NC curves are mentioned in passing, but Beranek's newer version of these curves and the ASHRAE RC curves are not mentioned.

The second chapter on Sound Insulation is also packed with details. In fact, the same details concerning techniques for sealing cracks and holes seem to be repeated over and over again. Material is presented as architectural descriptions of each type of construction rather than explanations of the physical principles involved. This chapter includes an enormous table of sound level differences between 30 types of rooms. Each of the 450 cells of this table contains 6 numbers that permit the reader to construct an ideal noise reduction contour. Obviously, an enormous amount of work went into constructing this table, but can the author really be confident enough to prescribe 450 different noise reduction contours? Why must it be so complicated? Surely a small number of noise reduction contour shapes (perhaps six) and weighting factors to shift the contour up or down for each situation would have been much simpler.

Canadian readers may find references to a more or less normal stud wall as a "Camden Partition" a little quaint. While there is discussion of the influence of the mass of partition surfaces and the benefits of multiple layers, the importance of sound absorption in the wall cavity is not heavily stressed and there is no mention at all of the detrimental effects of Mass-Air-Mass resonances that can significantly degrade the low-frequency performance of this type of wall construction. There is also no mention at all of the use of resilient channels to improve the performance of walls even though they are quite common in conventional residential construction in Canada.

In this chapter, there is frequent reference to the average insulation of a partition (average transmission loss). This is not a particularly useful quantity and has not been included in standards for many years. It is much more informative to refer to the STC rating of the wall or its ISO equivalent if a single number rating is desired. There is also mention of the problem of sound propagation through ceiling plenums where walls extend only to the underside of the suspended ceiling. However, there is not a clear discussion of the benefits of different types of ceiling tiles to minimize this problem.

The third chapter, Room Acoustics, is largely about reverberation time, with some mention of other details such as flutter echoes, resonances, and comb filter effects. Reverberation time criteria are given in great detail along with associated tolerances for various types of broadcast rooms. The specification that reverberation times should be measured using pulsed warble tones seems a little archaic. Various absorption modules are described in detail and their acoustical performance given. This may be of considerable value to readers that are not able to repeat the extensive testing that went into the development of these modular absorbers.

The book seems to be largely intended for architects and, despite attempts to make it more generally useful, often reads like an in-house BBC document specifying their requirements for constructing broadcast buildings. There are a few passing references to acoustical consultants, but there is no strong recommendation that they play a significant role in such projects. While the book seems to be written for architects, I personally would guess that it is a little too technical for most architects and not technical enough for acoustical consultants. This confusion as to the intended readers is perhaps best exemplified in the Glossary of Acoustic Terms. Acoustics is first defined, suggesting that the intended audience is non-technical. However, terms such as Pink Noise are explained in quite technical terms: "Noise whose power spectral density is inversely proportional to frequency".

This book would probably be an invaluable asset to anyone involved in the design and construction of various studios or other aspects of broadcast buildings. Because it is so specific, and because the acoustical information is not always complete, up to date, and international in flavour, it would be of less value to others.

(This book is available from BBC Architectural and Civil Engineering Dept., Room 510, Henry Wood House, London W1A 1AA, United Kingdom)

Reviewed by J.S. Bradley, National Research Council, Ottawa

REPORT ON THE ANNUAL MEETING OF THE YOUTH SCIENCE FOUNDATION/FONDATION SCIENCES JEUNESSE

J.S. Bradley

National Research Council, Ottawa

One of the major activities of the Youth Science Foundation, YSF, is to organize an annual Canada-wide science fair. My memories of being a participant at the first Canada Wide Science fair many years ago made it impossible for me to refuse to represent CAA at the annual meeting of the YSF in Ottawa. The following is a very brief report of the activities of the YSF.

The YSF is a largely volunteer-run organization with a million dollar a year budget. YSF organizes the annual Canada-Wide Science Fair which includes financial support for student participants and a large number of prizes. The organization also supports regional science fairs, the Science Olympics Program, and a national science club network called Young Scientists Canada. The YSF is supported by 50 corporations, 50 associations and about 40 individuals. Approximately one-third of its funding comes from the federal government and the rest from other sources including a number of significant contributions from private corporations.

The meeting saw the replacement of Robert Picard (Vice President, Human Resources, Shell Canada) by Alexander Flack (Principal, Dartmouth High School) as president of the organization. The treasurer reported that after several years of large deficits, the organization had had a small surplus and intended to do so again in the coming year. Dr. Richard Goldbloom addressed the meeting on behalf of the Science Culture Canada Programme. His talk included comments concerning the dangers of dehumanizing science, and adapting science to the benefit of third world countries.

The CAA has presented an award at the Canada Wide Science Fair in the past and intends to do so again at the next fair in Vancouver. CAA has made no further commitment to supporting YSF.

Getting involved in YSF is an excellent way to help to make young people aware of the importance of science as well as to encourage some to go on to pursue science as a career. Most of the work of the YSF goes on at the grass roots level. If you wish to contribute, get in touch with local groups organizing science fairs and science olympics in your community. Should you wish further information from the national office, contact:

Youth Science Foundation
151 Slater Street, Suite 904
Ottawa, Ontario
K1P 5H3
Telephone: (613) 238-1671
Fax: (613) 238-1677

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Avez-vous des nouvelles que vous aimeriez partager avec les lecteurs de l'*Acoustique Canadienne*? Si oui, écrivez-les et envoyer le formulaire à:

Jim Desormeaux, Ontario Hydro, 757 McKay Road, Pickering, Ontario L1W 3C8

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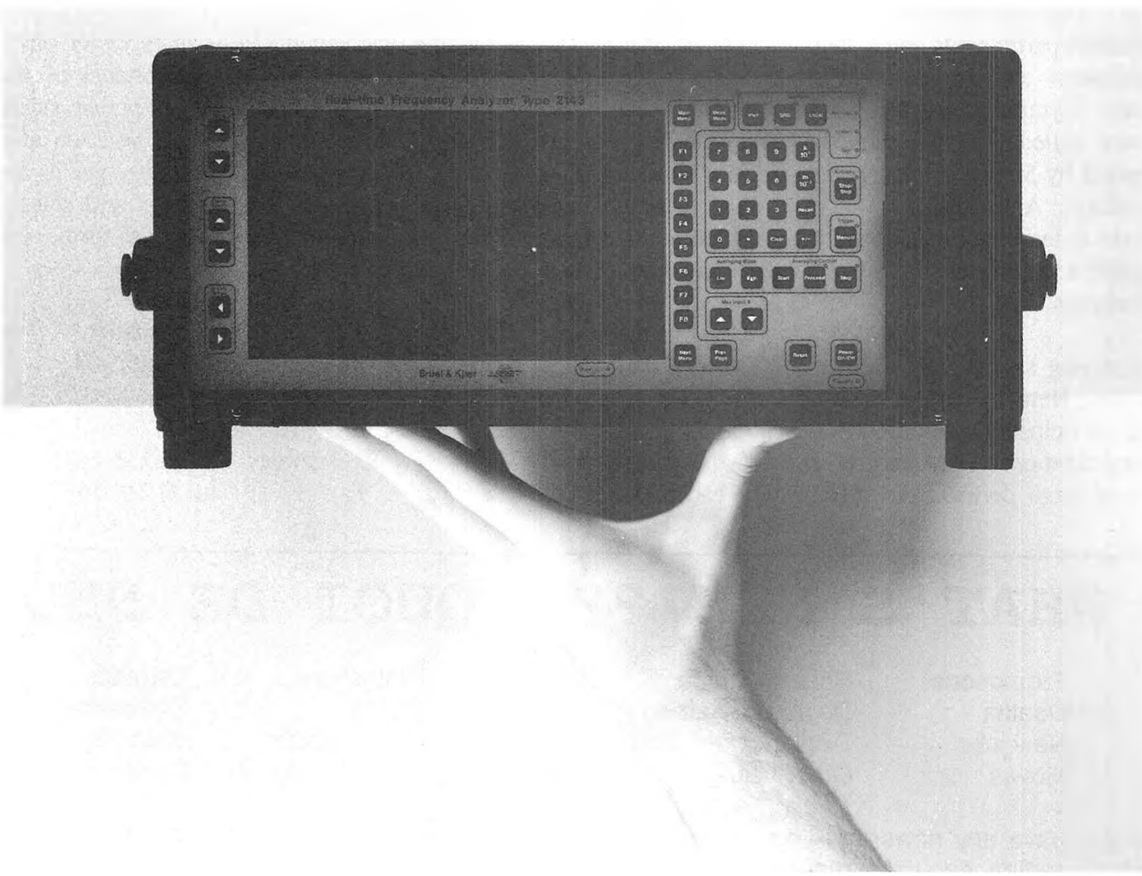

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CALL FOR PAPERS

Acoustics Week In Canada
October 7-10, 1991

Acoustics Week in Canada, 1991, will be held at the Ramada Renaissance Hotel, Edmonton, Alberta. The week will begin with two days of technical seminars on modern advances in electroacoustic techniques, active noise control as well as noise and vibration control in buildings. Specific details and registration for these courses will be published in the April issue of Canadian Acoustics. The technical program will take place on October 9 and 10, following the seminars.

There are no events scheduled for Friday, October 11. However, for those interested participants, a weekend bus tour through the scenic Rocky Mountains is planned commencing on this day. As well, out-of-town guests will have an opportunity to enjoy the local attractions before heading home.

TECHNICAL PROGRAM
October 9 and 10, 1991

The technical program will include keynote speakers in special plenary sessions which will be followed by the general sessions. Authors are invited to submit abstracts for presentation in these general sessions on all aspects of acoustics, however, papers in specific areas are especially encouraged. These include:

- architectural acoustics with emphasis on both large and small rooms including speech intelligibility
- acoustic measurements and testing including acoustic intensity, signal analysis and processing, electroacoustic systems
- environmental and community noise standards with emphasis on rural noise problems, occupational health concerns
- speech and hearing including speech production and perception, auditory rehabilitation, normal and disabled speech communication, assistive listening devices
- noise and vibration control specifically active and passive systems, low frequency problems in HVAC, building and ground vibrations

The organizers intend to develop several structured sessions around a particular theme and invite ideas from potential authors. Group submissions will be reviewed as a complete package. Papers submitted independently will be placed into appropriate categories for presentation.

All submissions will be reviewed to ensure suitability and accepted abstracts will be published in a booklet available at the conference as well as in Canadian Acoustics. Abstracts should be limited to 300 words and must be received by April 30, 1991. Submitted abstracts must be prepared in accordance with the Instructions for the Preparation of Abstracts as directed in this issue of Canadian Acoustics. Completed abstracts and information on technical sessions should be directed to:

Dr. M.G. Faulkner, Department of Mechanical Engineering,
University of Alberta, Edmonton, Alberta, T6G 2G8
Telephone: (403) 492-3446 FAX: (403) 492-2200

STUDENT AWARDS

Students are particularly invited to participate. In addition to the student awards for papers available from the CAA, a limited number of assistance grants for student travel and housing will be available.

APPEL AUX COMMUNICATIONS

Semaine de'Acoustique Canadienne
le 7-10 octobre, 1991

La semaine de l'Acoustique Canadienne 1991 aura lieu à l'hôtel Ramada Renaissance d'Edmonton, Alberta. La semaine débutera avec deux jours de séminaires techniques traitant d'avances en techniques électro-acoustiques, contrôle actif du bruit, ainsi que le contrôle du bruit et des vibrations dans le bâtiment. Les détails ainsi que le formulaire d'inscription seront publiées dans le numéro d'avril de l'Acoustique Canadienne. Le programme technique suivera les 9 et 10 octobre, 1991.

La journée de vendredi, le 11 octobre est libre afin que ceux qui le désirent puissent participer à une excursion scénique des Montagnes Rocheuses ou tout simplement de jouir d'Edmonton.

PROGRAMME TECHNIQUE
le 9 et 10 octobre, 1991

Le programme technique débutera avec des communications invitées en session plénière suivi de sessions générales. Vous êtes invités à soumettre des résumées de communications dans tous les domaines de l'acoustique. Cepandant, les domaines suivants sont particulièrement encouragées:

- l'acoustique architecturale de petites et grandes salles avec emphase sur l'intelligibilité de la parole
- les méthodes de mesures acoustiques tel que l'intensimétrie,l'analyse des signaux,les systèmes électro-acoustiques
- le bruit environnemental et communautaire; surtout les problèmes de bruit rural, la santé du travail
- la parole et l'audition tel que la production et perception de la parole, réhabilitation auditoire, la communication orale, technologie d'assistance auditive
- le contrôle du bruit et des vibrations, spécifiquement le contrôle actif et passif, problèmes de basse fréquences dans les systèmes de ventilation, vibrations du sol et du bâtiment.

L'organisateur développera plusieurs séssions structurées autour d'un thème particulier et invite des idées à ce sujet. Les soummisions de groupe seront arbitrées ensemble comme une unité. Les communications indépendantes seront regroupées dans les catégories appropriées.

Toutes les soummisions seront arbitrées et les résumées acceptées seront publiées dans un livret disponible à la conférence ainsi que dans l'Acoustique Canadienne. Les résumées devront être limitées à moins de 300 mots, se conformer aux instructions publiées dans cet épisode de l'Acoustique Canadienne et être reçu avant le 30 avril, 1991. Tous les résumées et questions au sujet du programme technique doivent être addressés à:

Dr. M.G. Faulkner, Department of Mechanical Engineering,
University of Alberta, Edmonton, Alberta, T6G 2G8
Telephone: (403) 492-3446 FAX: (403) 492-2200

PRIX ETUDIANT

Les étudiants sont fortement encouragés à participer. À cette fin un certain nombre de subventions de voyage sont disponibles en plus des prix de l'ACA pour les présentations.

Instructions for the Preparation of Abstracts for Papers to be Presented at the 1991 Meeting of the Canadian Acoustical Association

1. Quadruplicate copies of an abstract are required for each meeting paper; one copy should be an original. Send the four copies to the Technical Program Chairperson, Gary Faulkner, Dept. of Mech. Eng., University of Alberta, Edmonton, T6G 2G8, in time to be received by April 30, 1991. Either English or French may be used. A cover letter is not necessary.

2. Limit the Abstract to 300 words, including title and first author's name and address; names and addresses of coauthors are not counted. Display formulas set apart from the text are counted as 40 words. Do not use the forms "I" and "we"; use passive instead.

3. Title of abstract and names and addresses of authors should be set apart from the abstract. Text of abstract should be one single, indented paragraph. The entire abstract should be typed *double spaced on one side* of 8 1/2 x 11 in. or A4 paper.

4. Be sure that the mailing address of the author to receive the acceptance notice is complete on the abstract, to insure timely deliveries.

5. Do not use footnotes. Use square brackets to cite references or acknowledgements.

6. Underline nothing except what you wish to be italicized.

7. If the letter l is used as a symbol in a formula, loop the letter l by hand and write "lc ell" in the margin of the abstract. Do not intersperse the capital letter O with numbers where it might be confused with zero, but if unavoidable, write "capital oh" in the margin. Identify phonetic symbols by appropriate marginal remarks.

8. At the bottom of an abstract give the following information:

   (a) If the paper is part of a special session, indicate the session.
   (b) Name the area of acoustics most appropriate to the subject matter: Auditory Rehabilitation, Speech Perception and Recognition, Large Room Acoustics, Small Enclosures, Acoustical Testing of Building Components, Underwater Acoustics, Environmental and Community Noise, Electroacoustics, Mechanical Noise and Vibration Control or other.
   (c) Telephone number, including area code, of the author to be contacted for information. non-Canadian authors should include country.
   (d) If more than one author, name the one to receive the acceptance notice.
   (e) Overhead projectors and 35-mm slide projectors will be available at all sessions. Describe on the abstract itself any special equipment needed.

[Adapted from Acoustical Society of America Guidelines]

THE CANADIAN ACOUSTICAL ASSOCIATION
L'ASSOCIATION CANADIENNE D'ACOUSTIQUE

INVENTORY OF ASSOCIATION PROCEEDINGS AND PUBLICATIONS

The Association has recently received several requests to purchase CAA conference proceedings and publications. These, it seems, are scattered all over the country, mainly in the hands of past conference organizers. We would now like to locate all of these documents in order to offer them for sale. We would appreciate if anyone in possession of CAA proceedings or publications would get in contact with Murray Hodgson. Tel: 613-993-0102 Fax: 613-954-5984.

THE CANADIAN ACOUSTICAL ASSOCIATION
L'ASSOCIATION CANADIENNE D'ACOUSTIQUE

1990 PRIZE WINNERS / RÉCIPIENDAIRES 1990

Edgar and Millicent Shaw Postdoctoral Prize

Li Cheng, Université de Sherbrooke

"Acoustic quietening of plates: Vibro-acoustic modelling of a circular stiffened shell ended by a panel and coupled to an acoustic cavity"

Alexander Graham Bell Prize in Speech Communication and Behavioural Acoustics

Bradley Frankland, Dalhousie University

"The role of contour in music stream segmentation"

Directors' Awards / Prix des Directeurs

Professional / Professionel: **Thomas Moore, Queen's University**
Zygmunt Reif, University of Windsor

"The effect of non-uniform insert pitch on noise generation during face-milling operations"

Student / Etudiant: **K.R. Tough, University of Toronto**

"A reciprocity-based technique for investigating contralaterally stimulated oto-acoustic emissions"

Student Awards / Prix Etudiant

Laurie Fitzgerald, University of Calgary

"Identification of the /R-W/ contrast by normally developing children"

André L'Espérance, Université de Sherbrooke

"Modelling of long range sound propagation via a geometrical ray model"

Roland Woodcock, Université de Sherbrooke

"New pseudo-macroscopic approach for the characterization of poro-elastic materials"

CONGRATULATIONS / FÉLICITATIONS

PROGRAMMES OF EDUCATION IN ACOUSTICS AND VIBRATION

A subcommittee of the Board of Directors has been given the task of compiling a list of educational opportunities in Acoustics and/or Vibration available in Canada. We are interested in programs given at all levels, whether high school or graduate school, degree or non-degree. If you know of or are involved in such a program, please fill out and mail the short questionnaire below.

Name and title of respondent:

Affiliation of respondent:

Telephone number of respondent:

Location of program:

Brief description of program:

Contact person for program information:

Please return this form to:

PROGRAMMES DE FORMATION DANS LES DOMAINES DE L'ACOUSTIQUE ET DES VIBRATIONS

Un sous-comité du conseil d'administration a reçu le mandat de dresser une liste de milieux qui offrent des programmes de formation dans le domaine de l'acoustique et/ou des vibrations au Canada. Nous sommes intéressés par les programmes de formation de tout niveaux, que ce soit au niveau collégial ou universitaire, menant ou non à un diplôme. Si vous connaissez ou si vous êtes impliqué dans un tel programme, s'il-vous-plaît, complétez et postez le court questionnaire qui suit.

Nom et titre du répondant:

Affiliation du répondant:

Numéro de téléphone du répondant:

Lieu du programme de formation:

Brève description du programme:

Personne à contacter pour information:

S'il-vous-plaît, retournez ce questionnaire à:

Dr. Sharon M. Abel
Hearing Research Laboratory, Rm. 843
Samuel Lunenfeld Research Institute
Mount Sinai Hospital
600 University Avenue
Toronto, Ontario
Canada M5G 1X5

THE CANADIAN ACOUSTICAL ASSOCIATION
L'ASSOCIATION CANADIENNE D'ACOUSTIQUE

MINUTES OF THE BOARD OF DIRECTORS MEETING

October 3rd, 1990, 2:00 p.m.
Salle Executif, Holiday Inn, Crown Plaza, Montreal, Quebec

Present:	S.M. Abel	B. Dunn	J.G. Migneron
	C. Andrew	D. Chapman	W.V. Sydenborgh
	A. Behar	A.J. Cohen	M. Zagorski
	G. Bolstad*	M. Hodgson	H. Forester
	L. Brewster	C. Laroche	(* Guest)
Regrets:	M. Faulker	T. Embleton	

1. <u>The President's Introduction</u> - B. Dunn

   The president welcomed the members of the board present and set the agenda with a minor change, to move the Convenor's Report forward.

2. <u>Convenor's Report</u> - H. Forester

   The Convenor announced that registration for the symposium is 100. The financial report final is expected to have no surprises. He hopes to show a small profit.

3. <u>Minutes</u> of the previous meeting read and accepted without changes. Moved by S.M. Abel, seconded by A. Behar and B. Dunn. Motion carried.

4. <u>Secretarial Report</u> - W. Sydenborgh

   The Secretary reported that the business end of the CAA has been changed somewhat for smoother administration. The 1991 membership renewals will be mailed around the end of November, together with the 1990 receipts. The annual fee paid for registration under the Canada Corporations Act Section 113 has been fulfilled. The upcoming G.S.T. will not be levied on membership fees. The organization, however, is eligible for a 50% rebate of the G.S.T. portion paid on supplies. Registration will have to be made. The Secretary will look into this.

5. <u>The Treasurer's Report</u> - C. Andrew

   The Treasurer regrets that at this time only the preliminary auditor's report is available, which indicates that this year we have a small surplus in the General Operating Fund. Explanation is given in regard to advertising revenue increases over the previous year. The President thanked the Treasurer for all the work he has done and the decision was made to publish the full auditor's report and financial statements in the journal since it would not be ready in time for the Annual General Meeting.

6. <u>Editor's Report</u> - M. Hodgson

   The editor reported that he was able to publish within budget and estimates that the requirement for 1991 will be the same. The published questionnaire did not get the hoped for number of returns.

7. <u>Membership Chairman</u> - M. Zagorski

   Status of membership as of September 30, 1990: An increase of 5% was realized, mainly due to an increase of student members and subscriptions - see Appendix A.

8. Directors Awards

Discussions by Chairperson, Chantai Laroche; Postdoctoral Prize by S. Abel as Chairperson; Bell Speech Prize by L. Brewster; Underwater Acoustics by D. Chapman; Student Presentations (A. Behar).

All of the above reports were received and winners will be notified by the respective chairpersons and, in the case of the Postdoctoral prize, presentation will be made at the annual banquet.

9. Canada Wide Science Fair

This report was published in the Journal.

10. Inter-Noise '92 - T. Embleton

Reports are available to all officers and directors. This convention will be held in Toronto's Inn on the Park on July 20 to 22, 1992. See Appendix B.

11. Report by B. Dunn on the upcoming annual conference in Edmonton, October 1991.

12. Future Meetings Winnipeg 1992

13. The President announced that Gary Faulkner and Jean-G Migneron have fulfilled their terms as Directors. The President thanked then for their work in the past four years.

The Nominations Committee headed by S. Abel proposed Stan Forshaw (British Columbia) and John Hemingway (Alberta). They will be nominated for positions of Directors. Our Treasurer, Chris Andrew, completed his term and Eugene Bolstad was nominated to take his place. The President thanked Chris Andrew for his faithful work as Treasurer of our Association over the years.

14. Other Business

A. Report of the Education Committee - S. Abel

B. Status of partial travel reimbursement. Recommendation was made to set this at $75.00 per provincial border. So moved by A. Behar. Seconded by M. Hodgson. Passed.

C. Broadening of Awards - will be referred to the AGM.

D. Incoming letters from Beijing China re I.C.A., Ultra Science Congress, Dec. 12-14 in India.

15. Adjournment

Moved by S. Abel. Seconded by A. Behar

16. The President closed the meeting at 6:00 p.m.

Reported by W.V. Sydenborgh

MINUTES OF THE ANNUAL GENERAL MEETING

October 4th, 1990, 5:00 p.m.
Gouverneur I and II, Holiday Inn, Crown Plaza, Montreal, Quebec

1) The President's Welcome by Bruce Dunn.
2) Minutes of the 1989 Annual Meeting, Halifax, N.S., accepted as published in the Journal. Moved by E. Bolstad. Seconded by A. Behar and B. Dunn.
3) Secretarial Report, W.V. Sydenborgh. Some changes in the timing of 1991 invoices are to be made. The 1990 tax receipts will be mailed together with the 1991 membership renewal invoices in December 1990.
4) The Treasurer's Report, C. Andrew. Only the auditor's preliminary report is available at this time. The Treasurer elaborated on the Capital Fund, earnings which go into prizes and awards and the General Operating Fund which pays for the Journal and other operating expenses. The operating fund shows a small surplus. The full auditor's report will be published when available.
5) Editor's Report, M. Hodgson. Publication of the Journal - 4 publications at a cost of $2500 per issue. Advertising revenue, sustaining membership revenues were also well ahead of last year. Reprints also contributed to offset the cost of the Journal. No cost increases are foreseen in 1991 volume publications.
6) Membership Chairperson, M. Zagorski. The available report is based on a tabulation dated September 30, 1990. This creates some confusion in comparison to the previous year since the count was done in May 1989. Suggestion is to revert back to the May 31 figures. This will be done.
7) Election Committee: Directors. Nominated: Stan Foreshaw to replace Gary Faulkner; John Hemingway to replace Jean-G. Migneron. Treasurer: Eugene Bolstad to replace Chris Andrew.

   All other officers are nominated for a one year term. No other nominations from the floor. All declared elected.
8) Prizes and Awards Committee. Respective Chairpersons of the different committees will announce the recipients at the banquet. A. Behar announced that 13 students are competing for 3 prizes of $300.00 each. Winners will be announced Friday afternoon.
9) Education Committee Report. The committee members are S. Abel, A. Cohen, M. Hodgson. Reports to be published in the Journal.
10) Annual Meetings. A report came in from Halifax that the 1989 Meetings held in Halifax had a profit of approximately $3,000. The Convenor for Montreal, Harold Forester, announced that 100 registrations for the Symposium were received. He sees no great surprises, financially, and hopes to break even or show a small profit. 1991 Edmonton - the Convenor, Eugene Bolstad, announced that they are ready. Be there! Acoustics Week 1992 - Orest Serwylo invites us to Winnipeg, Manitoba. Accepted.
11) Proposed by D. Chapman - to add one more prize, to a young researcher under 30 years of age. Moved by D. Chapman. Seconded by A. Cohen. Accepted and referred to an overall review committee headed by A. Behar. Amendment asked for by R. Johnston that the committee's findings not be written in stone.
12) Reported by B. Dunn that the Society of Audiologists requested a joint meeting of our groups in 1994. To be deferred to the next meeting for further study.
13) The President asked for ideas for the Annual Meeting. A. Behar asked that the cost of the meeting be kept down in order to attract more members. This led to the following motion by C. Sherry, seconded by G. Wong and D. Zagorski, that the seed money to Edmonton shall be $3000.00 and that the Edmonton group be instructed that their expenses shall exceed revenue by that amount in order to keep member fees down. General vote: 23 for, 4 opposed, 1 abstention. Carried.
14) Adjournment. Moved by B. Dunn. Seconded by E. Bolstad

Prepared by W.V. Sydenborgh

APPENDIX A

MEMBERSHIP STATUS AS OF SEPTEMBER 30, 1990 (1989)

Members	280	(279)	66.5%
Student Members	49	(39)	12.0%
Sustaining Members	24	(22)	5.5%
Subscriptions	68	(48)	16.0%
TOTAL	421	(398)	

MEMBERSHIP BY PROVINCE AS OF SEPTEMBER 30, 1990 (1989)

	Total 1990	Total 1989	Difference
British Columbia	15	(23)	-8
Alberta	31	(29)	+2
Saskatchewan	2	(2)	-
Manitoba	7	(10)	-3
Ontario	187	(183)	+4
Quebec	61	(60)	+1
New Brunswick	7	(5)	+2
Nova Scotia	36	(28)	+8
P.E.I.	0	(0)	-
Newfoundland	6	(6)	-
Canadian Total	352	(342)	+10
Non-Canadian	69	(56)	+13
TOTAL	421	(398)	+23

APPENDIX B

INTER-NOISE 92 - TORONTO

1. INTER-NOISE 92 will be held at the Inn on the Park Hotel, Toronto, during July 20 to 22, 1992.
2) A contract has been signed with the hotel. Space is reserved for a seminar from July 16 onwards, and BOD meetings, etc., on July 19.
3) This is a Four Seasons hotel, in extensive park-like and landscaped grounds and has a character more like a resort than a city hotel.
4) Room rates are $125 run of the house, single or double occupancy in 1992 Canadian dollars.
5) Secretariat and Treasury functions will be handled by INCE/USA; Technical Program by Gilles Daigle et al. at the National Research Council in Ottawa; and Facilities, Social Functions, etc. in Toronto. Phil Schwartz is Exhibits Chairman. The Proceedings may be printed in Michigan by the usual printers of INCE Proceedings or in Ottawa by Beauregard Press.
6) Planning is based on an attendance of 600, six parallel technical sessions, two or three plenary talks Monday and Tuesday mornings, briefing dinner for session chairmen on Sunday evening, social functions on Monday and Tuesday evenings (the Tuesday function with liquor courtesy of the hotel).
7) The near future will be devoted to selection of an organizing committee and assignment of responsibilities, the development of a budget, and arrangement for lower-priced accommodation in university residences.
8) Frequent bus service past the hotel connects to the subway system allowing easy access to any part of the city, specifically to the heart of the downtown area in 35 to 40 minutes. Access to and from the airport is by taxi ($35 to 40) or by public transport (about $10 and involving two changes).
9) This hotel was selected after a review of all hotels in the Toronto area, as to suitability for an INTER-NOISE meeting, and a site inspection of the four finalists.

REPORT ON INTERNATIONAL INSTITUTE OF NOISE CONTROL ENGINEERING

The Board of Directors met on 12 August 1990 at Chalmers University, Gothenburg, Sweden, immediately before the start of INTER-NOISE 90 and the I-INCE General Assembly was held late on 15 August following the close of the conference.

1. The Brazilian Society of Acoustics has now been formed and held its first meeting in December 1989 attended by several invited speakers from abroad.
2) Two new national acoustical societies - Indian and Yugoslavia - have become member societies of I-INCE, bringing the total to 29 societies.
3) I-INCE will sponsor conferences on Noise Control Engineering in countries unable to conduct the entire meeting in English provided that no less than 50% of the papers and printed proceedings are in English (this is in addition to the annual INTER-NOISE Conferences which are totally in English).
4) INTER-NOISE 90 in Gothenburg, Sweden, was very well organized and well attended with over 800 registrants.
5) INTER-NOISE 91 in Sydney, Australia, will be held on the campus of the University of New South Wales, December 2 to 4, 1991 and will be preceded by the Western pacific Regional Acoustics Conference IV in Brisbane, Australia, November 26 to 28.
6) INTER-NOISE 92 in Toronto, Canada, will be held at the Inn on the Park Hotel, July 20 to 22.
7) INTER-NOISE 93 will be held in Louvain, Belgium, most probably at the Catholic University of Louvain during July 1993.
8) The income and expenditure of I-INCE are approximately in balance for the year 1990. Income comes from the dues of Member Societies and of Sustaining Members, and from a fraction of the after sales of INTER-NOISE Conference Proceedings.

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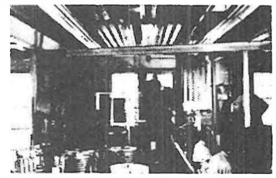

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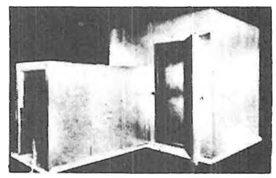

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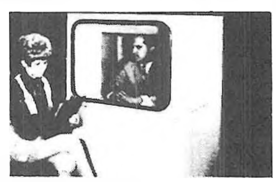

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THE CANADIAN ACOUSTICAL ASSOCIATION
L'ASSOCIATION CANADIENNE D'ACOUSTIQUE

AUDITOR'S REPORT

To the Members of The Canadian Acoustical Association

I have examined the Balance Sheets of The Canadian Acoustical Association as of **August 31, 1990** and the Statement of Receipts and Disbursements and Surplus of the Capital and General Operating Funds, for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests and other procedures as I considered necessary in the circumstances.

In as much as it was not practicable for the Association to control its receipts and disbursements prior to the initial entry in the accounting records, my examination relating to receipts and disbursements was limited to the amounts recorded in the accounts.

In my opinion, these statements present fairly the financial position of the Association as at **August 31, 1990** and the recorded income and expenditures for the year ended and are in accordance with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

G.A. Tipping
Certified General Accountant

Calgary, Alberta
October 9, 1990

BALANCE SHEET

CAPITAL FUND

STATEMENT 1

ASSETS

	1990	1989
CURRENT ASSETS		
Cash on deposit	$ -	$ 23
Accrued interest receivable (note 4)	2,314	2,314
Due from General Operating Fund (note 3)	2,000	-
Investment certificate due within the next year (note 4)	4,000	-
	8,314	2,337
LONG-TERM INVESTMENTS (note 4)	38,500	42,500
	$46,814	$44,827

LIABILITIES AND CAPITAL

	1990	1989
CURRENT LIABILITIES	$ -	$ -
CAPITAL SURPLUS (Statement 3)	46,814	44,837
	$46,814	$44,837

STATEMENT OF RECEIPTS AND DISBURSEMENTS

CAPITAL FUND

STATEMENT 2

	1990	1989
RECEIPTS		
Interest earned	$4,417	$ 9,437
Scholarship donation	2,000	-
Symposium surplus - 1986	-	3,925
	6,417	13,362
DISBURSEMENTS		
Directors awards and prizes	6,300	2,830
EXCESS RECEIPTS OVER DISBURSEMENTS	$ 117	$10,532

STATEMENT OF CAPITAL SURPLUS

CAPITAL FUND

STATEMENT 3

	1990	1989
OPENING BALANCE, beginning of year	$44,837	$38,500
Add:		
Excess receipts over disbursements (Statement 2)	117	10,532
	44,954	49,032
Appropriation of surplus funds to (from) General Operating Fund	1,860	(4,195)
CLOSING BALANCE, end of year	$46,814	$44,837

BALANCE SHEET

GENERAL OPERATING FUND

STATEMENT 4

ASSETS

	1990	1989
CURRENT ASSETS		
Cash on hand	$ -	$ 451
Cash on deposit	47,624	38,686
Accounts receivable - CAA '89 conference	4,395	-
	$52,019	$39,137

LIABILITIES AND CAPITAL

	1990	1989
CURRENT LIABILITIES		
Due to Capital Fund (note 3)	$ 2,000	$ -
CAPITAL SURPLUS (Statement 6)	50,019	39,137
	$52,019	$39,137

STATEMENT OF RECEIPTS AND DISBURSEMENTS

GENERAL OPERATING FUND

STATEMENT 5

	1990	1989
RECEIPTS		
Association's conference	$24,139	$28,140
Memberships	11,552	8,349
Surplus - Standards Council	-	3,627
Sustaining subscription	3,639	2,621
Reprints and proceedings	1,634	1,628
Royalties	352	665
Interest	4,346	268
Manuals	-	200
Advertisements	3,716	147
	49,378	45,645
DISBURSEMENTS		
Association's conference	19,744	26,160
Journal printing and preparation	9,782	20,677
Professional fees	1,500	1,900
CAA '90 advance	3,000	1,500
General expense	1,838	1,000
Membership promotion	250	600
Meeting expense	150	538
INCE membership	249	242
Returned memberships	110	60
Bank charges	13	16
	36,636	52,693
EXCESS RECEIPTS OVER DISBURSEMENTS	$12,742	
EXCESS DISBURSEMENTS OVER RECEIPTS		$ 7,048

STATEMENT OF GENERAL OPERATING SURPLUS

GENERAL OPERATING FUND

STATEMENT 6

	1990	1989
OPENING BALANCE, beginning of year	$39,137	$41,990
Add:		
Excess receipts over disbursements	12,742	-
Deduct:		
Excess disbursements over receipts	-	7,048
	51,879	34,942
Appropriation of surplus funds from (to) Capital Fund	(1,860)	4,195
CLOSING BALANCE, end of year	$50,019	$39,137

NOTES TO FINANCIAL STATEMENTS

1. REGISTERED CHARITABLE ORGANIZATION
The Canadian Acoustical Association is registered as a charitable organization with the Government of Canada and operates as a non-profit organization.

2. SIGNIFICANT ACCOUNTING POLICIES
A) Accrual Accounting
The financial statements are prepared using the accrual basis for accounting.

B) Capital and General Operating Accounts
The Association operates both a Capital and General Operating Fund. The Capital Fund was established by the board of Directors in 1989 wherein specific funds were appropriated for the purpose of earning income that would be awarded to individuals for their achievements in the field of acoustics.

C) Revenue Recognition
As memberships and the attendance of conferences is generally considered to be on a voluntary basis, revenues are recorded only as monies are received by the association.

3. AMOUNT DUE FROM GENERAL OPERATING
During the year the Association received a $2,000 donation from Eckel Industries Ltd., the first in a series of donations to be set aside as a scholarship fund. The funds were deposited into the General Operating Fund.

4. LONG-TERM INVESTMENTS
The Association has in safekeeping with Canada Trust in Calgary, Alberta, the following guaranteed investment certificates. Interest is paid annually and has been accrued to August 31, 1990.

Certificate #	Expiry	Rate %	Principal	Accrued Interest
1132404	Mar 31/93	10.00	$30,000	$1,258
1134024	Oct 01/91	10.75	8,500	836
1136040	Mar 02/91	11.00	4,000	220
			$42,500	$2,314
Reclassify certificate #1136040 as a current asset			4,000	
			$38,500	

NEWS / INFORMATIONS

CONFERENCES

Sixteenth Annual Meeting of the National Hearing Conservation Association: San Antonio, TX. February 21-23, 1991. Contact: Michele Johnson, Executive Director, 900 Des Moines St., Suite 200, Des Moines, IA 50309. Tel: 515-266-2189.

Prediction of Noise Radiated by Vibrating Structures - Present State of the Art: Cetim-Senlis, France. March 26-28, 1991. Contact: SFM, 10 avenue Hoche, 75008 Paris, France.

Active Control of Sound and Vibration: Tokyo, Japan. April 9-11, 1991. Contact: Dr. Hideki Tachibana, Secretary of the Symposium, University of Tokyo. Tel: +81-3-3479-0257 or Fax: +81-3-3379-1456.

Acoustical Society of America Meeting: Baltimore, Maryland. April 29 to May 3, 1991. Contact: Orest Diachok, Mechanical Engineering Department., The Catholic University of America, Washington, DC 20064. Tel: 202-319-5170.

Recent Advances in Underwater Acoustics: Hotel Prince Regent, Weymouth, England. May 20-22,1991. Contact: Dr. G.W. Neal MIOA, Marconi Underwater System Ltd., Leanne House, Avon Close, Grandby Estate, Weymouth, Dorset DT4 9UX, England. Tel: 305-760716.

Noise-Con 91 Seminar: Tarrytown, New York. July 12-13, 1991. Contact: Institute of Noise Control Engineering, P.O. Box 3206 Arlington Branch, Poughkeepsie, New York 12603.

INCE Fundamentals and Professional Examinations: Tarrytown, New York. July 14, 1991. Contact: Institute of Noise Control Engineering, P.O. Box 3206, Arlington Branch Poughkeepsie, New York 12603.

COURSES

Acoustics and Signal Processing: Pennsylvania State University, June 1991 (four weeks). Contact: Dr. Alan D. Stuart, Summer Program Coordinator, The Penn State Graduate Program in Acoustics, P.O. Box 30, State College, PA 16804. Tel: 814-863-4128.

Sound Intensity: AVNC, June 24-28, 1991. Contact: Continuing Education Division, 250 Shagbark Drive, R.D. #1, Cheswick, PA 15024

CONGRES

16e réunion annuelle de la National Hearing Conservation Association: San Antonio, TX. du 21 au 23 février, 1991. Contacter: Michele Johnson, Executive Director, 900 Des Moines St., Ste 200, Des Moines, IA 50309. Tél: 515-266-2189.

La prévision du bruit rayonné par les structures vibrantes - la technologie actuelle: Cetim-Senlis, France. du 26 au 28 mars, 1991. Contact: SFM, 10 avenue Hoche, 75008 Paris, France.

Active Control of Sound and Vibration: Tokyo, Japon. du 9 au 11 avril, 1991. Contacter: Dr. Hideki Tachibana, Secretary of the Symposium, University of Tokyo. Tél: +81-3-3479-0257 or Fax: +81-3-3379-1456.

Réunion de l'Acoustical Society of America: Baltimore, Maryland. du 29 avril au 3 mai, 1991. Contacter: Orest Diachok, Mechanical Engineering Dep't., The Catholic University of America, Washington, DC 20064. Tél: 202-319-5170.

Recent Advances in Underwater Acoustics: hôtel Prince Regent, Weymouth, Angleterre. du 20 au 22 mai,1991. Contacter: Dr. G.W. Neal MIOA, Marconi Underwater System Ltd., Leanne House, Avon Close, Grandby Estate, Weymouth, Dorset DT4 9UX, England. Tél: 305-760716.

Congrès Noise-Con 91: Tarrytown, New York. les 12 et 13 juillet, 1991. Contacter: Institute of Noise Control Engineering, P.O. Box 3206 Arlington Branch, Poughkeepsie, New York 12603.

INCE Fundamentals and Professional Examinations: Tarrytown, New York. le 14 juillet, 1991. Contacter: Institute of Noise Control Engineering, P.O. Box 3206 Arlington Branch, Poughkeepsie, New York 12603.

COURS

Acoustics and Signal Processing: Pennsylvania State University, juin 1991 (quatres semaines). Contacter: Dr. Alan D. Stuart, Summer Program Coordinator, the Penn State Graduate Program in Acoustics, P.O. Box 30, State College, PA 16804. Tél: 814-863-4128.

Sound Intensity: AVNC, du 24 au 28 juin, 1991. Contacter: Continuing Education Division, 250 Shagbark Drive, R.D. #1, Cheswick, PA 15024

PEOPLE IN THE NEWS

Deidre A Morrison has left the field of acoustics to take up the position of Chief, Product Safety Division, Environmental Health Directorate, Health Protection Branch, Health and Welfare Canada in Ottawa.

Jean Nicolas, full professor and head of the Department of Mechanical Engineering at the University of Sherbrooke has been named North American editor of the journal *Applied Acoustics*.

Dr. R.W.B. Stephens. It is with sadness that we have to inform you that Raymond Stephens, reknown British acoustician, has died at the age of 87.

NEW PRODUCTS

The final volume of the comprehensive five-volume *Encyclopedia of Architecture/Design, Engineering and Construction* has been published by John Wiley and Sons Inc.

The new *Noise and Vibration Measurement Catalogue* is available from Scantek, Inc. It includes the product lines of Rion and Norwegian Electronics and can be obtained fron Richard J. Peppin, Scantek Inc., 51 Monroe Street, Suite 1606, Rockville, MD. Tel: 301-279-9308.

LES GENS QUI FONT LA MANCHETTE

Deidre A. Morrison a laissé le domaine de l'acoustique pour prendre la tête de la Division de la sécurité des produits, Direction hygiène du milieu, Direction générale de la protection de la santé, Santé et Bien-être Social Canada.

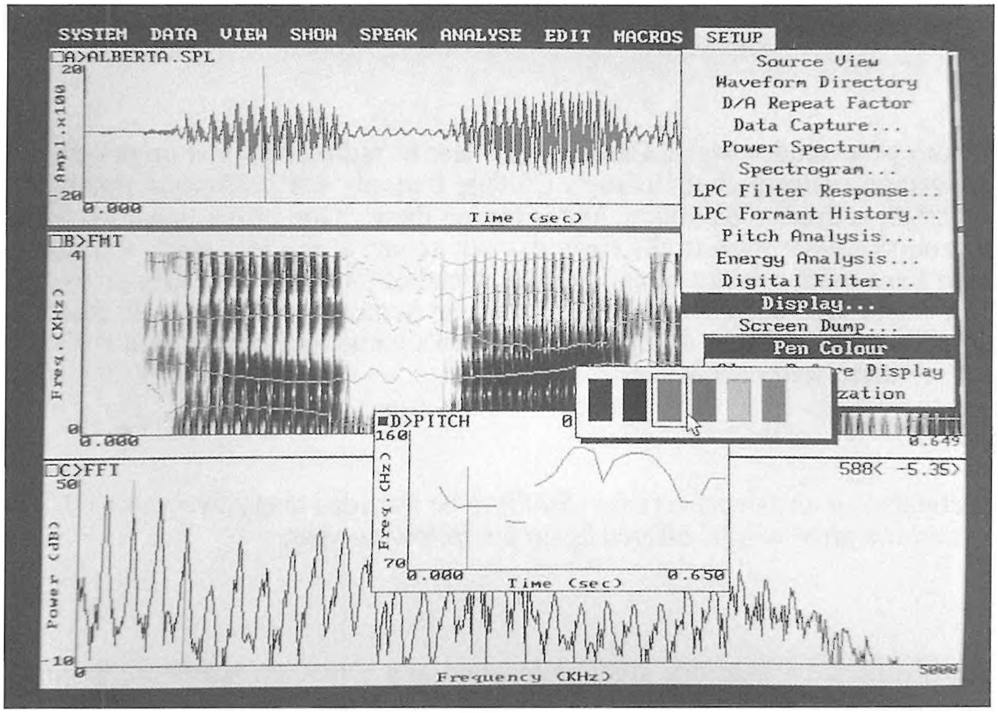
Jean Nicolas, professeur titulaire et directeur du département de génie méchanique de l'Université de Sherbrooke, est le nouveau rédacteur pour l'amérique du nord de la revue Applied Acoustics.

Dr. R.W.B. Stephens. C'est avec regret que nous annonçons le décès, à l'âge de 87 ans, de R.W.B. Stephens, acousticien brittanique renommé.

NOUVEAUX PRODUITS

Le dernier des cinq volumes de l'*Encyclopedia of Architecture/Design, Engineering and Construction* vient de paraître chez John Wiley and Sons Inc.

Le nouveau *Noise and Vibration Measurement Catalogue* est maintenant disponible de la companie Scantek, Inc. Il comprends les produits de Rion and Norwegian Electronics. Pour le commander, contacter Richard J. Peppin, Scantek Inc., 51 Monroe Street, Suite 1606, Rockville, MD. Tél: 301-279-9308.



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CSL with IBM compatible computer, monitor, microphone and mouse.

The CSL is also designed as an ideal companion for Kay's DSP Sona-Graph speech workstation, model 5500. The DSP Sona-Graph's true real-time processing and scrolling graphics can be used to acquire, analyze and preview signals. These stored signals can be easily shared with the CSL to accommodate more than one user. Conversely, signals acquired using CSL can be easily uploaded to the 5500 making these two systems highly complementary - a perfect combination for your speech laboratory.

*To find out how the **CSL** can turn your IBM®PC AT or compatible into a speech analysis system **call one of Kay's Product Specialists today at 1-800-289-5297.***

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THE CANADIAN ACOUSTICAL ASSOCIATION
L'ASSOCIATION CANADIENNE D'ACOUSTIQUE

THE FESSENDEN STUDENT PRIZE IN UNDERWATER ACOUSTICS
Instructions to Applicants

Preamble

Reginald Aubrey Fessenden was a Canadian pioneer of radio and sonar engineering born in East Bolton, Québec and educated at Bishop's College School. He performed much of his research work in the USA, retired to Bermuda, and is buried there. One of his inventions was a powerful underwater sound source used in the early days of sonar; a modern sonar transducer expert has described the *Fessenden oscillator* as "decades ahead of its time". The Organizing Committee of the 12th ICA Associated Symposium on Underwater Acoustics, who initiated this student prize in underwater acoustics, feel that attaching Fessenden's name to the prize is a fitting tribute to his contributions to underwater acoustics.

Award

The award consists of a cash prize (about $400) to be awarded every two years (1). If not awarded in a given year, the prize will be offered again the following year.

Eligibility (2)

The candidate must be a graduate student enrolled at a Canadian academic institution pursuing studies in underwater acoustics or in a branch of science closely connected to underwater acoustics. A candidate may receive the prize only once. Preference will be given to Canadian citizens or landed immigrants intending to pursue a career in Canada.

Application Procedure

Along with the attached form, candidates must submit a written proposal (no more than 500 words) for the research work to be done during their graduate program. Send to: The Secretary, Canadian Acoustical Association, P.O. Box 1352, Station F, Toronto, Ontario, M4Y 2V9.

Selection Process

All applications will undergo a review by a Subcommittee named by the President and Board of Directors of the CAA, at least one member of which shall be actively involved in underwater acoustics research. Applications will be reviewed on the merits of the research proposal, the novelty of the work, and the potential contribution to the field of underwater acoustics. Decisions made by the review Subcommittee will be final and may not be appealed.

Deadline

Candidates must submit the attached form and research proposal to the Secretary of the CAA by the end of February of the year the prize is to be given. The successful candidate will be notified in writing before the end of May and will be announced in *Canadian Acoustics*. The prize itself will be awarded by the CAA through the recipient's academic department.

Notes

1. The award is funded through an endowment contributed by the organizing committee of the 12th ICA Associated Symposium on Underwater Acoustics (Halifax, Nova Scotia, July 1986) from the surplus generated by the Symposium. The amount and frequency of the award is based on a two-year investment return on the endowment. The fund may be augmented by individuals or organizations wishing to make donations to it.
2. Candidates who wish to explore the possibility of an exemption from one or more requirements should contact the President of the CAA in writing well in advance of the deadline for receipt of applications.

CAA / Chapman & Desharnais 6 nov 90

THE CANADIAN ACOUSTICAL ASSOCIATION
L'ASSOCIATION CANADIENNE D'ACOUSTIQUE

LE PRIX ETUDIANT FESSENDEN EN ACOUSTIQUE SOUS-MARINE
Directives aux postulants

Préambule

Reginald Aubrey Fessenden, pionnier de l'ingénierie de la radio et du sonar, est né à East Bolton, Québec. Il a étudié au Collège Bishop, a poursuivi ses recherches principalement aux Etats-Unis, puis s'est retiré aux Bermudes, où il est décédé. Parmi ses inventions, on retrouve une puissante source sous-marine qui fut utilisée lors de la sortie des premiers sonars. Un expert en transducteurs sonar modernes a décrit l'*oscillateur Fessenden* comme étant en avance de plusieurs décades sur son temps. Le Comité d'organisation du 12e symposium associé de l'ICA sur l'acoustique sous-marine, instigateur du prix étudiant en acoustique sous-marine, a voulu souligner les contributions de Fessenden en associant le nom de ce dernier au prix.

Prix

Le prix consiste en un montant en argent comptant d'environ 400$, qui sera décerné à tous les deux ans (1). Si le prix n'est pas décerné à une année donnée, il sera offert l'année suivante.

Conditions d'admissibilité (2)

Le candidat doit être un étudiant inscrit à une institution académique canadienne, dans une discipline scientifique reliée à l'acoustique sous-marine. Un candidat ne peut recevoir le prix qu'une fois seulement. La préférence sera donnée aux citoyens canadiens ou aux immigrants reçus qui prévoient poursuivre leur carrière au Canada.

Procédure d'application

Les candidats doivent soumettre la formule ci-attachée, ainsi qu'une courte description (maximum 500 mots) de leur projet de recherche d'études graduées. Envoyer à: Le Secrétaire, Association Canadienne d'Acoustique, C.P. 1352, Station F, Toronto, Ontario, M4Y 2V9.

Sélection

Toutes les applications seront analysées par un sous-comité nommé par le président et la Chambre des directeurs de l'ACA, dont au moins un membre devra être impliqué dans des recherches en acoustique sous-marine. Les applications seront considérées selon les mérites de la proposition de recherche, la nouveauté du sujet, et la contribution potentielle au domaine de l'acoustique sous-marine. Les décisons prises par le sous-comité d'évaluation seront finales et sans appel.

Date limite

Les candidats doivent soumettre le formulaire ci-joint ainsi que leur description de projet de recherche au secrétaire de l'ACA, avant le dernier jour du mois de février de l'année à laquelle le prix sera décerné. Le candidat gagnant sera averti avant le dernier jour de mai, et sera annoncé dans le *Acoustique Canadienne*. Le prix lui-même sera décerné par l'ACA par l'entremise du département académique du gagnant.

Notes

1. Ce prix est financé par un don du Comité d'organisation du 12e symposium associé de l'ICA sur l'acoustique sous-marine (Halifax, Nouvelle-Écosse, juillet 86) provenant de surplus générés par le symposium. Le montant et la fréquence du prix sont basés sur les intérêts de l'investissement accumulés sur deux ans. Ce fonds pourra être augmenté par des dons d'individus ou d'organisations voulant y contribuer.
2. Les candidats désireux d'explorer la possibilité d'une exemption de l'une ou de plusieurs des conditions d'admissibilité doivent contacter le président de l'ACA par écrit, bien avant la date limite pour les applications.

CAA / Chapman & Deshamais 6 nov 90

THE CANADIAN ACOUSTICAL ASSOCIATION
L'ASSOCIATION CANADIENNE D'ACOUSTIQUE

THE FESSENDEN STUDENT PRIZE IN UNDERWATER ACOUSTICS
LE PRIX ETUDIANT FESSENDEN EN ACOUSTIQUE SOUS-MARINE

Application Form / Formulaire d'application

1. CANDIDATE'S NAME / NOM DU CANDIDAT ______________________

2A. PERMANENT ADDRESS / ADRESSE PERMANENTE ______________________

____

____

2B. TEMPORARY ADDRESS (if different from 2A) / ADRESSE TEMPORAIRE (si différente de 2A)

____

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3. CITIZENSHIP / CITOYENNETÉ ______________________

4. DEGREES AND DIPLOMAS HELD / DIPLÔMES D'ÉTUDES SUPÉRIEURES

Degree / Diplôme	Institution / Établissement	Discipline	Date

5. ACADEMIC INSTITUTION (and Department) / ÉTABLISSEMENT ACADÉMIQUE (et Département)

____

6. TITLE OF RESEARCH PROPOSAL / TITRE DU PROJET DE RECHERCHE ______________________

____

7. START DATE OF RESEARCH / DATE DU DÉBUT DE LA RECHERCHE ______________________

8. RESEARCH PROPOSAL / PROJET DE RECHERCHE Please attach a statement of the research to be carried out as part of the graduate studies program (maximum 500 words). The usual elements of a well-developed research proposal are: a statement of the topic of investigation, its practical or scholarly interest, the approach and research methods, and the resources required. / Inclure s'il vous plaît un condensé de la recherche poursuivie à l'intérieur du programme d'études graduées (maximum 500 mots). Les éléments habituels d'un projet de recherche bien développé sont: le sujet de votre recherche, son intérêt pratique ou académique, l'approche et les méthodes de recherche, les ressources nécessaires.

9. DATE ______________ 10. SIGNATURE ______________________

11. STATEMENT BY ACADEMIC SUPERVISOR / DÉCLARATION DU SUPERVISEUR ACADÉMIQUE: *"I hereby certify that the above-named candidate, whom I supervise, is currently enrolled in a graduate studies program and that the work described in the attached proposal will be carried out independently by the student as part of the requirements for his/her graduate degree." / "Je certifie que le candidat mentionné ci-haut, que je supervise, fait présentement partie d'un programme d'études graduées, et que le travail décrit dans son projet de recherche ci-inclus fait partie des exigences de son diplôme, et est mené de façon indépendante par l'étudiant."*

NAME / NOM ______________________ SIGNATURE ______________________

Send to: The Secretary, CAA, P.O. Box 1352, Station F, Toronto, Ontario, M4Y 2V9.
Envoyer à: Le Secrétaire, ACA, C.P. 1352, Station F, Toronto, Ontario, M4Y 2V9.

6 nov 90

THE CANADIAN ACOUSTICAL ASSOCIATION
L'ASSOCIATION CANADIENNE D'ACOUSTIQUE

THE CAA ALEXANDER GRAHAM BELL GRADUATE STUDENT PRIZE IN SPEECH COMMUNICATION AND BEHAVIORAL ACOUSTICS

Instructions to Applicants

Award

The award consists of an $800 cash prize to be awarded annually. It is awarded to a graduate student in the field of speech communication or behavioural acoustics.

Eligibility

The candidate must be a graduate student enrolled at a Canadian University pursuing studies in speech communication or behavioral acoustics. Preference will be given to Canadian citizens and landed immigrants. The candidate must be a member or student member of the Canadian Acoustical Association. The candidate is not eligible to receive the prize more than once.

Application Procedure

Applicants must submit a written proposal for the research work to be done as part of their graduate program. A letter from the student's supervisor must accompany the application stating that the work to be undertaken will be the independent work of the student.

Selection Process

All applications will undergo a review by a Subcommittee named by the President and Board of Directors of the Canadian Acoustical Association.

Deadline

Applicants must submit the Alexander Graham Bell Prize application form and all supporting documentation to the Executive Secretary of CAA by the end of February of the year in which the prize is to be awarded.
The successful candidate will be notified in writing before the end of May. The winner of the prize will also be announced in Canadian Acoustics.

THE CANADIAN ACOUSTICAL ASSOCIATION
L'ASSOCIATION CANADIENNE D'ACOUSTIQUE

ALEXANDER GRAHAM BELL GRADUATE STUDENT PRIZE IN SPEECH COMMUNICATION AND BEHAVIORAL ACOUSTICS

Application Form

1. NAME:

2. PERMANENT ADDRESS:

3. PRESENT ADDRESS:

4. CITIZENSHIP:
( ) Canadian citizen
( ) Permanent resident of Canada
( ) National of (country):______________
( ) Landed immigrant since:___________

5. ACADEMIC INSTITUTION TO BE ATTENDED:

6. ACADEMIC SUPERVISOR:

7. TITLE OF RESEARCH PROPOSAL:

8. DATE FOR COMMENCEMENT OF PROGRAM:

9. DEGREES AND DIPLOMAS HELD:

Degree	Institution	Discipline	Date

10. PROPOSED RESEARCH: (Please attach a description of the research to be carried out as part of the graduate program. This proposal should not exceed 500 words. The usual elements of a well developed research proposal should be present: a statement of the problem or topic of investigation, its significance (scholarly and/or practical), the approach and research methods, sources and resources required).

11. ATTACHMENT: Letter from academic supervisor stating that the applicant is enrolled in a graduate program and that the work described in the proposal will be carried out independently by the student.
( ) enclosed
( ) to follow under separate cover

DATE: ____________________

SIGNATURE OF APPLICANT: ____________________________

THE CANADIAN ACOUSTICAL ASSOCIATION
L'ASSOCIATION CANADIENNE D'ACOUSTIQUE

ECKEL AWARD IN NOISE CONTROL

Instructions to Applicants

Preamble

Oliver C. Eckel was a recognized authority in acoustics and mechanical design, and founder of Eckel Industries Inc. He pioneered the design of anechoic chambers and developed panel systems for noise control in enclosures. He authored many papers and patents on the design of noise control products. After his retirement he established an R&D laboratory dedicated to wind turbine design. This award, established by the Eckel family and Eckel Industries of Canada Ltd., and administered by the Canadian Acoustical Association, pays tribute to the many contributions to acoustics and noise control by Oliver C. Eckel.

Award

The award consists of $500 cash to be offered every year. The Association reserves the right not to make the award in any given year.

Eligibility

The candidate must be a graduate student enrolled at a Canadian academic institution, pursuing studies in any discipline of acoustics, conducting research related to the advancement of the practice of noise control, and a member of the Association. An individual may receive the award only once. Preference will be given to Canadian citizens and permanent residents intending to pursue a career in Canada.

Application procedure

Candidates must submit an application form and research proposal. The research proposal (maximum 750 words) must describe the graduate research project and how it advances the practice of noise control. Applications should be submitted to The Secretary, Canadian Acoustical Association, P.O. Box 1352, Station F, Toronto, Ontario M4Y 2V9.

Selection procedure

Applications will be evaluated by the Eckel Award Subcommittee of the Canadian Acoustical Association formed by its board of directors and including a representative of Eckel Industries of Canada. Applications will be evaluated according to the quality and originality of the research, and how it advances the practice of noise control. The subcommittee decision is final and can not be appealed.

Deadlines

Applications must be received by the end of February of the year the award is to be made. The successful candidate will be notified before the end of the following May and will be announced in *Canadian Acoustics*. The award will be given by the CAA through the recipient's academic department.

THE CANADIAN ACOUSTICAL ASSOCIATION
L'ASSOCIATION CANADIENNE D'ACOUSTIQUE

LE PRIX ECKEL EN CONTROLE DU BRUIT

Directives aux postulants

Préambule

Oliver C. Eckel était un expert reconnu en matières d'acoustique et de conception mécanique, et fondateur de Eckel Industries Inc. Il a été le premier à concevoir les chambres anéchoiques et à développer un système de panneaux pour le contrôle du bruit. Après sa retraite, il a fondé un laboratoire de Recherche et Développement dédié à la conception de turbine éolienne. Ce prix, fondé par la famille Eckel et Eckel Industries of Canada Ltd., et administré par l'Association Canadienne d'Acoustique, rend hommage aux nombreuses contributions de Oliver C. Eckel au domaine de l'acoustique et du contrôle du bruit.

Prix

Le prix consiste en un montant en argent comptant de $500.00, qui sera décerné à tous les ans. L'Association se reserve le droit de ne pas décerner le prix à une année donnée.

Eligibilité

Le candidat doit être un étudiant gradué inscrit dans une institution académique canadienne, qui poursuit des études dans le domaine de l'acoustique, et qui mène un projet de recherche relié à l'avancement de la pratique en contrôle du bruit. Il doit également être un membre de l'Association.

Procédures d'application

La proposition de recherche (maximum 750 mots) doit inclure la description du projet et doit décrire comment ce projet fait progresser la pratique en contrôle du bruit. Envoyer à: Le Secrétaire, Association Canadienne d'Acoustique, C.P. 1352, Succursale F, Toronto, Ontario M4Y 2V9

Sélection

Toutes les applications seront analysées par le sous-comité Eckel de l'Association, constitué par ses directeurs et dont un membre devra être le représentant de Eckel Industries of Canada. Les applications seront considérées selon la qualité et la nouveauté de la proposition de recherche et comment la recherche fera progresser la pratique en contrôle du bruit. Les décisions prises par le sous-comité d'évaluation seront finales et sans appel.

Date limite

Les applications doivent être soumises avant le dernier jour du mois de février de l'année à laquelle le prix sera décerné. Le candidat gagnant sera averti avant le dernier jour de mai, et sera announcé dans l'*Acoustique Canadienne*. Le prix lui-même sera décerné par l'Association par l'entremise du département académique du récipiendaire.

THE CANADIAN ACOUSTICAL ASSOCIATION
L'ASSOCIATION CANADIENNE D'ACOUSTIQUE

ECKEL AWARD IN NOISE CONTROL
PRIX ECKEL EN CONTROLE DU BRUIT

Application Form / Formulaire d'application

1. CANDIDATE'S NAME / NOM DU CANDIDAT:______________________________

2a. PERMANENT ADDRESS / ADRESSE PERMANENTE:________________________

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2b. TEMPORARY ADDRESS (if different from 2a) / ADRESSE TEMPORAIRE (si différente de 2a):____

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3. CITIZENSHIP / CITOYENNETÉ:____________________________________

4. DEGREES AND DIPLOMAS HELD / DIPLOMES D'ÉTUDES SUPÉRIEURES:

Degree/Diplôme	Institution / Établissement	Discipline	Date

5. ACADEMIC INSTITUTION (and Department) / ÉTABLISSEMENT ACADÉMIQUE (et Département):___

____

6. TITLE OF RESEARCH PROPOSAL / TITRE DU PROJET DE RECHERCHE:____________

7. START DATE OF RESEARCH / DATE DU DÉBUT DE LA RECHERCHE:______________

8. RESEARCH PROPOSAL / PROJET DE RECHERCHE: Attach a statement of the research to be carried out as part of the graduate studies program and how it relates to the advancement of the practice of noise control (maximum 750 words). The usual elements of a well-developed research proposal are: a statement of the topic of investigation, its practical or scholarly interest, the approach and research methods, and the resources required. / Inclure un condensé de la recherche poursuivie à l'intérieur du programme d'études graduées et comment elle fera progresser la pratique en contrôle du bruit (maximum 750 mots). Les éléments habituels d'un projet de recherche bien dévelopé sont: le sujet de votre recherche, son intérêt pratique ou académique, l'approche et les méthodes de recherche, les ressources nécessaires.

9. DATE:____________ 10. SIGNATURE: ____________________________

11. STATEMENT BY ACADEMIC SUPERVISOR / DÉCLARATION DU SUPERVISEUR ACADEMIQUE: *"I hereby certify that the above-named candidate, whom I supervise, is currently enrolled in a graduate studies program and that the work described in the attached proposal will be carried out independently by the student as part of the requirements for his/her graduate degree." / "Je certifie que le candidat mentionné ci-haut, que je supervise, fait présentement partie d'un programme d'études graduées, et que le travail décrit dans son projet de recherche ci-inclus fait partie des exigences de son diplôme, et est menée de façon indépendente par l'étudiant."*

NAME / NOM:____________________ SIGNATURE:__________________________

He or She

THE CANADIAN ACOUSTICAL ASSOCIATION
L'ASSOCIATION CANADIENNE D'ACOUSTIQUE

BY-LAW NO. 1

CORPORATE SEAL

1. The seal of the Corporation shall be in such form as shall be prescribed by the directors of the Corporation.

CONDITIONS OF MEMBERSHIP

2. Membership in the corporation shall be available to all persons interested in furthering the objectives of the corporation and whose applications for admission as members have received the approval of the board of directors.

3. A charge shall be made for membership and shall be levied equally upon all members.

4. Any member may withdraw from the corporation by delivering to the corporation a written resignation and lodging a copy of the same with the secretary of the corporation.

5. Any member may be required to resign by a vote of three-quarters of the members at an annual meeting.

HEAD OFFICE

6. The head office of the corporation shall be located at the City of Ottawa in the Province of Ontario, Canada, at the place therein where the business of the corporation may from time to time be carried on. ✓

7. The corporation may establish such other offices and agencies elsewhere within Canada as the board of directors may deem expedient by resolution.

BOARD OF DIRECTORS

8. The property and business of the corporation shall be managed by a board of eight directors of whom a majority shall constitute a quorum. The board of directors may on literature of the corporation be designated as a board of governors.

9. Directors shall be eligible for re-election at the annual meeting of members for terms of service which do not exceed six years in total.

10. The office of director shall be automatically vacated

    (a) if a director shall resign his office by delivering a written resignation to the secretary of the corporation,

    (b) if he is found to be a lunatic or becomes of unsound mind,

    (c) if he becomes bankrupt or suspends payments or compounds with his creditors,

    (d) if at the annual meeting or special general meeting of members a resolution is passed by three-quarters of the members present at the meeting that he be removed from office,

    (e) on death;

provided that if any vacancy shall occur for any reason in this paragraph contained, the directors may by resolution fill the vacancy with a person in good standing on the books of the corporation as a member.

11. Meetings of the board of directors may be held at any time and place to be determined by the directors provided that five days notice of such meeting shall be sent in writing to each director. No formal notice shall be necessary if all directors are present at the meeting or waive notice thereof in writing.

12. Directors, as such, shall not receive any stated remuneration for their services.

13. A retiring director shall remain in office until the dissolution or adjournment of the meeting at which his successor is elected. A director shall hold office until the next annual meeting of members following his election or appointment.

14. The directors may exercise all such powers of the corporation as are not by the Canada Corporations Act or by these by-laws required to be exercised by the members at general meetings.

15. Upon election at the first annual meeting of members, the board of directors then elected shall replace the provisional directors named in the letters patent of the corporation.

16. A majority of the directors shall have power to authorize expenditures on behalf of the corporation from time to time and may delegate by resolution to an officer or officers of the corporation the right to employ and pay salaries to employees. The directors shall have the power to make expenditures for the purpose of furthering the objects of the corporation. The directors shall have the power to enter into a trust arrangement with a trust company for the purpose of creating a trust fund.

17. The board of directors shall take such steps as they may deem requisite to enable the corporation to receive donations and benefits for the purpose of furthering the objects of the corporation.

OFFICERS

18. The officers of the corporation shall be a president, immediate past president, executive secretary, editor, treasurer, the conveners of the next and last annual meeting of the Association and such other officers as the board of directors may by by-law determine. The offices of executive secretary and treasurer may not be held by the same person. Remuneration, if any, of the officers shall be determined by the board of directors.

19. The president and other officers, apart from the immediate past president and the conveners of the next and last annual meeting, shall be elected at the annual meeting of members.

20. There may be such honorary officer or officers as the board of directors may from time to time consider advisable and they shall hold office for such period of time as may be prescribed by the board.

21. The board may appoint such agents and engage such employees as it shall deem necessary from time to time and such persons shall have such authority and shall perform such duties as shall be prescribed by the board at the time of such appointment.

22. The officers of the corporation shall hold office for one year and/or until their successors are elected or appointed in their stead.

DUTIES OF OFFICERS

23. The president shall be the chief executive officer of the corporation. He shall preside at all meetings of the corporation and of the board of directors. He shall have the general and active management of the business of the corporation. He shall see that all orders and resolutions of the board are carried into effect and he with the executive secretary or other officer appointed by the board for the purpose shall sign all by-laws and other documents requiring the signatures of the officers of the corporation.

24. The past president shall, in the absence or disability of the president, perform the duties and exercise the powers of the president and shall perform such other duties as shall from time to time be imposed upon him by the board. He will prepare a list of candidates for presentation to the Annual General Meeting for consideration by that meeting prior to the conducting of elections.

25. The treasurer shall have the custody of the corporate funds and securities and shall keep full and accurate accounts of receipts and disbursements in books belonging to the corporation and shall deposit all moneys and other valuable effects in the name and to the credit of the corporation and in such depositories as may be designated by the board of directors from time to time. He shall disburse the funds of the corporation as may be ordered by the board, taking proper vouchers for such disbursements, and shall render to the president and directors at the regular meeting of the board, or whenever they may require it, an account of all his transactions as treasurer and of the financial position of the corporation. he shall also perform such other duties as may from time to time be determined by the board.

26. The executive secretary shall attend all sessions of the board and all meetings of the members and act as clerk thereof and record all votes and minutes of all proceedings in the books to be kept for that purpose. When the business of the Association is conducted by the directors by mail he will similarly act as clerk and keep records. He shall give or cause to be given notice of all meetings of the members and of the board of directors, and shall perform such other duties as may be prescribed by the board of directors or president, under whose supervision he shall be. He shall be custodian of the seal of the corporation, which he shall deliver only when authorized by a resolution of the board to do so and to such person or persons as may be named in the resolution.

EXECUTIVE COMMITTEE

27. The board of directors may from time to time elect from among its number an executive committee consisting of such number of members, not less than two, as the board of directors may by resolution determine. Each member of the executive committee shall serve during the pleasure of the board and, in any event, only so long as he shall be a director. The board of directors may fill vacancies in the executive committee by election from among its number. Whenever a vacancy shall exist in the executive committee, the remaining members may exercise all its power so long as a quorum remains in office.

28. During the intervals between the meetings of the board of directors the executive committee shall possess and may exercise (subject to any regulations which the directors may from time to time impose) all the powers of the board of directors in the management and direction of the affairs of the company (save and except only such acts as must by law be performed by the directors themselves) in such manner as the executive committee shall deem best for the interests of the corporation in all cases in which specific directions shall not have been given by the board of directors.

29. Subject to any regulations imposed from time to time by the board of directors, the executive committee shall have power to fix its quorum at not less than a majority of its members and may fix its own rules of procedure from time to time.

30. Meetings of the executive committee may be held at the head office of the company or at any other place in or outside Canada. The executive committee shall keep minutes of its meetings in which shall be recorded all action taken by it, which minutes shall be submitted as soon as practicable to the board of directors.

MEETINGS

31. The annual meeting of the members of the corporation shall be held at the head office of the corporation or elsewhere in Canada as the board of directors may designate. At such meeting the members shall elect a board of directors and the officers and shall receive a report of the directors and the officers.

32. Twenty-eight days prior written notice shall be given to each member of any annual or special general meeting of members. Twelve members present in person at the meeting shall constitute a quorum. Each member present at a meeting shall have the right to exercise one vote.

AMENDMENT OF BY-LAWS

33. The by-laws of the corporation may be repealed or amended by by-laws enacted by a majority of the directors at a meeting of the board of directors and sanctioned by an affirmative vote of at least two-thirds of the members at a general meeting duly called for the purpose of considering the said by-law, provided that the enactment, repeal or amendment of such by-laws shall not be enforced or acted upon until the approval of the Minister of Consumer and Corporate Affairs has been obtained. Such amendments shall be presented to the next annual meeting of the Association for its consideration.

34. A member may appoint as his proxy any other member to vote at any annual or special general meeting provided such appointment is made in writing and the secretary of the Association is so informed.

35. At all meetings of members of the corporation every question shall be determined by a majority of the votes cast at the meeting unless otherwise specifically provided by the Canada Corporations Act or by these by-laws.

36. The financial year of the corporation shall be the year starting on 1st September.

AUDITORS

37. The members shall at each annual meeting appoint an auditor to audit the accounts of the corporation to hold office until the next annual meeting provided that the directors may fill any casual vacancy in the office of auditor. The remuneration, if any, of the auditor shall be fixed by the board of directors.

SIGNATURE AND CERTIFICATION OF DOCUMENTS

38. Contracts, documents or any instruments in writing requiring the signature of the corporation, shall be signed by any two of the president, immediate past president, secretary or treasurer and all contracts, documents and instruments in writing so signed shall be binding upon the corporation without any further authorization or formality. The directors shall have power from time to time by by-law to appoint an officer or officers on behalf of the corporation either to sign contracts, documents and instruments in writing. The seal of the corporation when required may be affixed to contracts, documents and instruments in writing signed as aforesaid or by any officer or officers appointed by resolution of the board of directors.

RULES AND REGULATIONS

39. The board of directors may prescribe such rules and regulations not inconsistent with these by-laws relating to the management and operation of the corporation as they deem expedient, provided that such rules and regulations shall have force and effect only until the next annual meeting of the members of the corporation when they shall be confirmed, and in default of confirmation at such annual meeting of members shall at and from that time cease to have force and effect.

40. In these by-laws the singular shall include the plural and the plural the singular; the masculine shall include the feminine.

41. In these by-laws, the word "corporation" is deemed to refer to the Association.

THE CANADIAN ACOUSTICAL ASSOCIATION — **L'ASSOCIATION CANADIENNE D'ACOUSTIQUE**

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Margins: Top - title page: 1.25"; other pages, .75"; bottom, 1" minimum; sides, .75".

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