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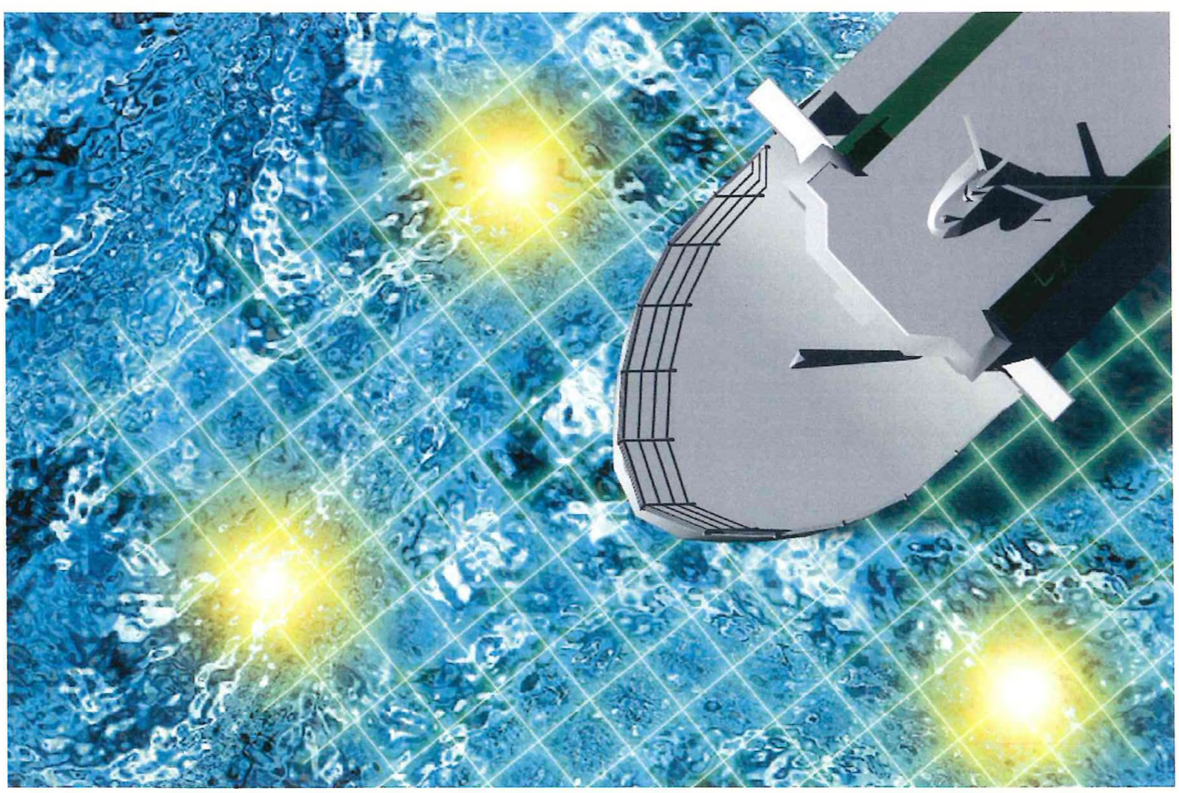

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MESSAGE FROM THE PRESIDENT / MESSAGE DU PRÉSIDENT

CAA the Secret Society

Sometimes I think of the CAA as a secret society. No, I don't mean one of those groups with secret rituals, secret handshakes and scary motives. I am thinking more that CAA is such a good secret that we are reluctant to tell anyone about it.

Well, maybe it is time to share the secret. CAA is one of the world's more successful acoustical associations. Of course, we are not a big international organisation but we are one of the most successful national acoustical groups. Few other countries can boast an acoustical society with the longevity and continuing success of CAA.

CAA has had a long string of ever more successful annual conferences, a growing journal and more student prizes than any other similar sized organisation. And the real secret is that it's getting better every year.

We have just had another very successful conference in Charlottetown. Again it was a wonderful blend of new innovations and CAA traditions. Most of all it was the same warm CAA atmosphere, that those of us who are in on the secret, are used to.

Very few other national acoustical groups have their own journal. Most would be envious of the history and continuing growth of Canadian Acoustics. With a complete Canadian Acoustics index on our web site, it is more than ever a valuable record of acoustical activity in Canada.

So, spread the secret and get a new member signed up today.

John Bradley

L'ACA – une société secrète

Parfois je pense de l'ACA comme une société secrète. Pas comme les groupes avec des rites secrets, ni des poignées de mains secrètes ou des motifs effrayants. Mais, plutôt, l'ACA est tellement une bonne secrète, que nous n'avons pas envie d'en parler à personnes.

C'est peut-être le temps maintenant pour partager le secret. L'ACA est une des associations d'acoustiques du monde le plus prospère. Bien sûr, nous ne sommes pas une grande organisation internationale, mais, nous sommes un des groupes d'acoustiques nationaux le plus prospères. Peu d'autres pays peuvent vanter une société acoustiques avec la longévité et le succès qui continuent avec l'ACA.

L'ACA a une liste de conférences annuelles jamais plus prospères, un journal grandissant et plus d'étudiants croissant que d'autres organisations semblablent. Le vrai secret est qu'il améliore a chaque année.

Nous venons justement de compléter une conférence avec succès à Charlottetown. Celui-ci était un mélange merveilleux d'innovations nouvelles ainsi que traditionnelles. De plus, l'atmosphère était chaleureux dont ceux qui connaissent le secret sont déjà au courant.

Très peu d'autres groupes d'acoustiques nationaux ont leur propre journal. La plupart des autres groupes seraient envieux de l'histoire et la continuation de croissance de l'acoustique canadienne. Avec l'index d'acoustique canadien complet sur notre site-web, c'est plus que jamais une activitée d'acoustique valable parmi le Canada.

Etaler le secret et encourager un nouveau membre d'y engager aujourd'hui.

John Bradley

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ARRAY ELEMENT LOCALIZATION OF A BOTTOM MOORED HYDROPHONE ARRAY

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ABSTRACT

In ocean acoustics, rapidly deployable, autonomous, bottom moored hydrophone arrays allow for quick, cost effective deployment, but result in poor knowledge of sensor positions. Because advanced array processing techniques, such as Matched Beam Processing, are highly sensitive to errors in sensor location, an accurate assessment of hydrophone positions is necessary. This paper discusses array element localization (AEL) and its use in localizing the ULITE array, a horizontal array deployed in the Timor Sea during the 1998 RDS-2 trial. The ill-posed inverse problem of determining source (imploded light bulbs) and receiver positions from the relative arrival times of source transients is solved through regularized linearized inversion. The inversion solution fits the data to high precision and provides individual hydrophone position estimates that provide the smoothest array shape that is consistent with the acoustic data.

RÉSUMÉ

Les systémes acoustiques marins qui sont rapidement deployés au fond de la mer, et qui fonctionnent avec autonomie, offrent une méthode de recherche qui est de faible cout, mais qui donne une pauvre connaissance de les positions des récepteurs. Pacreque la validité des manipulations des donnés, comme celles obtenues par le *Matched Beam Processing*, est fortement dépendente sur la location des instruments, une précise determination de la position de l'instrument est nécessaire. Ce papier décrit la méthode de Localization des Éléments d'Étalage (AEL) et son utilization dans la localization du systéme ULITE, un étalage horizontal déployé dans la mer de Timor pendant l'essai RDS-2 de l'an 1998. La question iverse mal posée, celle de la determination des positions de les sources (des ampoules implosées) et les récepteurs par les tems d'arivee relatifs des transients de source, est resolu par l'inversion linéale regularisée. La solution d'inversion est une excellente réprésentation de les donnés, et donne les positions de chaque hydrophone en accordance avec un model qui donne la forme optimale a l'étalage acoustique, et qui est consistent avec les donnés acoustiques.

1. INTRODUCTION

Accurate sound source localization in underwater environments has long proven to be a challenging but important endeavour. Modern developments in this field include the deployment and monitoring of large, autonomous bottom mounted vertical and/or horizontal hydrophone arrays. The benefit of this sensor autonomy comes at a cost—uncertainty in hydrophone location. Arrays are commonly deployed from surface vessels and lowered to depth, and as such, sea state, currents, and ship drift all combine to create uncertainty in the final resting position of each hydrophone.

Modern array processing techniques for source localization, such as matched field processing (MFP) and matched beam processing (MBP) involve correlating the received acoustic field with simulated fields computed using a numerical propagation model together with environmental parameters and source/receiver locations [1,2]. Receiver location errors have been shown to lead to significant degradation of both MFP and MBP performance [2], especially at higher frequencies (a commonly accepted rule suggests receiver positions must be known within $\lambda/10$, where λ is the wavelength at the frequency of interest, to achieve losses ≤ 1 dB in array processing [3]). As such, accurate array element location (AEL) is an important component of effectively processing acoustic field data. This paper will discuss the methodology and results of AEL for acoustic survey data collected for a bottom-moored, ultra-light (ULITE) horizontal array.

A common approach to AEL involves measuring arrival times of transient signals from controlled sources deployed around the array. Glass light bulbs mechanically imploded at depth have proven to be a particularly useful sources due to their low cost, low environmental impact, and clean, repeatable signals [4]. If the source transmission instants and source positions are known and the ocean has a uniform (known) sound speed, the array elements can be located through a straightforward triangulation procedure. However, measuring source instants requires the sources and recording system be synchronized, which can be difficult and costly for at-sea deployments. Further, in practical AEL applications, the uncertainties in source positions are generally significant, and often represent the limiting factor in the accuracy of AEL inversion [5]–[7]. In addition, errors in the ocean sound speed can be significant: although measured sound-speed profiles are usually accurate in a relative sense, bias errors of up to 2 m/s due to imprecise calibration are not uncommon [8]. Finally, neglect of acoustic ray curvature due to refraction in a realistic, non-uniform ocean can also be a significant source of AEL error.

AEL represents a nonlinear inverse problem. Although such problems are sometimes treated as an optimization (i.e., determining the set of model parameters that minimizes the mismatch to measured data), a more complete approach to inversion involves determining the simplest solution that fits the measured data and *a priori* information to within their estimated uncertainties, together with an estimate of the uncertainties of the recovered parameters. A regularized AEL algorithm, based on iterated linearization, has recently been developed to accomplish this, and to treat the general case of ray-based inversion with unknown source instants, source positions, and sound-speed bias [5]–[7], [9],[10]. The regularized inversion yields the smoothest array shape (i.e., the shape with minimal curvature or changes in direction) that fits the acoustic data and prior position estimates to a statistically appropriate level. This minimum-structure solution includes all array-shape structure that is resolved by the data, but no structure that is unconstrained [5]. In contrast, minimizing the misfit often results in over-fitting data, introducing spurious (non-physical) structure into the model in an attempt to fit the noise on the data [5],[11]–[13]. The regularized approach is based on iterated linearized inversion, which provides an efficient AEL algorithm that is generally not sensitive to the initialization [5].

The translation of errors in the data, source positions and sound speed into errors in the sensor positions is determined by the AEL inverse problem; simple estimates based on forward calculations are not generally correct [7] (e.g., a 1-ms travel-time error in an ocean of sound-speed 1500 m/s does *not* imply a 1.5-m positioning error). Uncertainties in the recovered hydrophone positions are estimated here from the (linearized) model covariance matrix and through nonlinear Monte Carlo appraisal.

AEL has been carried out previously for the Timor Sea deployment of the ULITE array by the Defence Science and Technology Organization (DSTO) and the Space and Naval Warfare Systems Center (SPAWAR) [14]. The acoustic data were inverted by DSTO using simulated annealing optimization and by SPAWAR using the downhill simplex method [15]. In both cases source and hydrophone positions were treated as unknowns, although a uniform ocean with known sound speed was assumed and no uncertainty estimates were provided.

Following this introduction, the paper discusses the inverse and ray theory employed in the regularized linear inversion algorithm. Next, the RDS-2 experiment is described, followed by presentation of the UVic AEL solution for the ULITE array and a comparison with the DSTO and SPAWAR solutions. Finally, simulation is presented to demonstrate the sensitivity of matched beam processing to errors in array element location.

2. AEL INVERSION ALGORITHM

This section provides an overview of the inversion and ray theory which form the basis of the regularized AEL inversion algorithm. More complete treatments of AEL inversion can be found in [5]–[7],[9],[10], and of general inverse theory in [11]–[13].

2.1 Inverse Theory

The acoustic arrival times $\mathbf{t}$ measured in an AEL survey can be written in general vector form as

$$\mathbf{t} = \mathbf{T}(\mathbf{m}) + \mathbf{n}. \tag{1}$$

In (1), the forward mapping $\mathbf{T}$ represents computation of the travel times of acoustic signals along ray paths between sources and receivers (considered in Section 2.2). The model $\mathbf{m}$ of unknown parameters consists of three-dimensional (3-D) position variables (x, y, z) for each sensor, 3-D position variables and transmission instants for each source, and an unknown bias for the measured sound-speed profile. Finally, $\mathbf{n}$ represents additive errors (noise), with the assumption that the error n_i on datum t_i is due to an independent, Gaussian-distributed random process with zero mean and standard deviation σ_i.

The inverse problem of determining an estimate $\tilde{\mathbf{m}}$ of $\mathbf{m}$ is functionally nonlinear. However, a local linearization can be obtained by expanding $\mathbf{t}(\mathbf{m}) = \mathbf{t}(\mathbf{m_0} + \delta\mathbf{m})$ in a Taylor series to first order about an arbitrary starting model $\mathbf{m_0}$. Rearranging terms, this expansion can be written

$$\mathbf{J}\,\mathbf{m} = \mathbf{t} - \mathbf{t}(\mathbf{m_0}) + \mathbf{J}\,\mathbf{m_0} \equiv \mathbf{d}, \tag{2}$$

where $\mathbf{d}$ represents modified data defined in terms of known quantities and $\mathbf{J}$ is the Jacobian matrix of partial derivatives $J_{ij} = \partial T_i(\mathbf{m_0})/\partial m_j$ (given in Section 2.2). Equation (2) represents a linear inverse problem which can be solved for $\tilde{\mathbf{m}}$ as described below. Since nonlinear terms are neglected, the linearized inversion must be repeated iteratively until the solution converges.

The standard least-squares solution for linear inversion is determined by minimizing the χ^2 misfit

$$\chi^2 = |\mathbf{G}\,(\mathbf{J}\,\mathbf{m} - \mathbf{d})|^2 \tag{3}$$

with respect to $\mathbf{m}$, where $\mathbf{G}=\text{diag}[1/\sigma_i]$, with solution

$$\tilde{\mathbf{m}} = \left[\mathbf{J}^T\mathbf{G}^T\mathbf{G}\,\mathbf{J}\right]^{-1}\mathbf{J}^T\mathbf{G}^T\mathbf{G}\,\mathbf{d}. \qquad (4)$$

However, treating both source and receiver positions as unknown leads to an ill-posed AEL inversion such that the matrix to be inverted in (4) is ill-conditioned. This ill-conditioning indicates that the data alone do not constrain the solution, and additional *a priori* information is required.

The method of regularization provides a powerful approach to include *a priori* information in linear inverse problems. This is accomplished by minimizing an objective function ϕ that combines the data misfit with regularizing terms that impose the prior information. Two forms of prior information are typically available in AEL problems, and can be imposed by including two regularization terms:

$$\phi = |\mathbf{G}\,(\mathbf{J}\,\mathbf{m}-\mathbf{d})|^2+\mu_1|\mathbf{H}_1\,(\mathbf{m}-\hat{\mathbf{m}}_1)|^2+\mu_2|\mathbf{H}_2\,(\mathbf{m}-\hat{\mathbf{m}}_2)|^2. \qquad (5)$$

In (5), the first term represents the χ^2 data misfit, and the remaining terms represent regularizations (described below) with the variables μ_1 and μ_2 representing trade-off parameters (Lagrange multipliers) which determine the relative importance of the three terms in the minimization.

The first regularization term in (5) applies *a priori* parameter estimates for the source and receiver positions as available from the deployment procedure. Hence, $\hat{\mathbf{m}}_1$ consists of the prior estimates for these parameters and the regularization matrix $\mathbf{H}_1$ is of the form

$$\mathbf{H}_1=\text{diag}[1/\xi_j], \qquad (6)$$

where ξ_j represents the standard deviation of an assumed Gaussian uncertainty distribution for jth parameter estimate $\hat{m}_j$. The second regularization term applies the *a priori* expectation that the array shape is well approximated by a smooth function of an independent variable u, which can be applied using $\hat{\mathbf{m}}_2=\mathbf{0}$ and $\mathbf{H}_2$ consisting of the tridiagonal matrix with non-zero entries on jth row given by

$$\mathbf{H}_2 = \text{tridiag}\left[\frac{-1}{(u_{j+1}-u_j)^2},\ \frac{u_{j+2}-u_j}{(u_{j+2}-u_{j+1})(u_{j+1}-u_j)^2},\ \frac{-1}{(u_{j+2}-u_{j+1})(u_{j+1}-u_j)}\right]. \qquad (7)$$

Each row of $\mathbf{H}_2$ in (7) represents a discrete approximation to the second derivative operator $\partial^2/\partial u^2$. This regularization is applied to sensor positions along each segment of the array as a function of distance u along the segment. Hence, $|\mathbf{H}_2\,\mathbf{m}|^2$ provides a measure of the total curvature or roughness of the array shape, and the regularization produces the simplest array shape that is consistent with the acoustic data and prior position estimates. Since the smoothness term (7) depends on the prior information about the inter-sensor spacings, in cases where these are very poorly known, it may be preferable to omit this regularization to aid convergence.

The regularized solution is obtained by setting $\partial\phi/\partial\mathbf{m}=0$, leading to

$$\mathbf{m} = \hat{\mathbf{m}}_1 + \left[\mathbf{J}^T\mathbf{G}^T\mathbf{G}\,\mathbf{J} + \mu_1\,\mathbf{H}_1^T\mathbf{H}_1 + \mu_2\,\mathbf{H}_2^T\mathbf{H}_2\right]^{-1}\cdot \left[\mathbf{J}^T\,\mathbf{G}^T\mathbf{G}\,\mathbf{d} - \mathbf{J}\hat{\mathbf{m}}_1\right]. \qquad (8)$$

The regularization terms within the first set of brackets overcome ill-conditioning of the matrix, providing a well-posed inversion.

The implementation of the AEL inversion algorithm consists of an iterative application of the regularized solution (8), typically initiated from a starting model coinciding with the prior parameter estimates. Convergence of the algorithm is based on two criteria. First, the measured data must be fit to a statistically appropriate level such that the χ^2 misfit achieves its expected value of $\langle\chi^2\rangle=N$ for N data. Note that although (8) is derived based on the χ^2 misfit for the linear inverse problem, the convergence of the inversion algorithm must be judged in terms of the nonlinear misfit

$$\chi^2 = |\mathbf{G}(\mathbf{T}(\mathbf{m}) - \mathbf{t})|^2. \qquad (9)$$

Second, a stable solution must be obtained such that the root-mean-square (RMS) change in the receiver positions between iterations is small compared to the expected accuracy of the solution (less than 0.1 m for the present application). A straightforward approach to assigning values to the trade-off parameters μ_1 and μ_2 to control the balance between the data misfit and *a priori* information leading to stable convergence is described in [5].

An important aspect of solving any inverse problem is to estimate the uncertainty of the solution. Two approaches are considered here. First, for linear inverse problems with Gaussian-distributed errors and prior estimates, the model covariance matrix is given by

$$\mathbf{C} = [\mathbf{J}^T\mathbf{G}^T\mathbf{G}\,\mathbf{J} + \mathbf{H}_1^T\,\mathbf{H}_1]^{-1}, \qquad (10)$$

with the ith diagonal element of $\mathbf{C}$ representing the variance of the ith parameter $\tilde{m}_i$. For nonlinear inverse problems solved via iterated linearized inversion, the covariance matrix can be approximated by (10) with $\mathbf{J}$ evaluated at the final model solution. The validity of this approach depends on the degree of nonlinearity of the inverse problem, but has been found to be a good approximation for AEL inversion [7].

The second approach to parameter uncertainty estimation involves a Monte Carlo appraisal [5], [15]. In this procedure, the source and receiver positions determined via inversion of the measured data are assumed to define the true positions for a synthetic inverse problem, and acoustic arrival-time data are computed. A series of independent inversions are then carried out, each with different random errors applied to the computed data and to the prior position estimates and starting model (these errors are drawn from Gaussian distributions with standard deviations equivalent to the corresponding estimated uncertainties of the data and prior). Standard deviations about the true sensor positions can then be computed from the ensemble of inversion results. Advantages of the Monte Carlo approach are that it represents a fully nonlinear analysis, and that uncertainties can be computed in an absolute or relative (sensor-to-sensor) sense. The disadvantage is increased computation time due to the multiple inversions.

Note that uncertainty estimation methods described above can be applied to predict AEL uncertainties for simulated cases in that they do not require measured data or prior estimates but only uncertainties for these quantities. Hence they provide a method to predict the localization accuracy for a particular scenario or to compare accuracies for different scenarios, as described in detail in [7]. This approach was used to consider the information content of surface-reflected arrivals as is discussed in Section 5.

2.2 Ray Theory

This section briefly describes the ray theory applied to compute the acoustic travel times and partial derivatives for the AEL inversion algorithm. Consider an acoustic source and receiver in the ocean at (x_j, y_j, z_j) and (x_i, y_i, z_i), respectively, with $z_j < z_i$ (source above receiver is assumed here with $z = 0$ at the surface and positive downward; for the reverse, a negative sign is required in all integrals below). The horizontal range between source and receiver is given by

$$r = \left[(x_i - x_j)^2 + (y_i - y_j)^2\right]^{1/2}. \qquad (11)$$

Expressions for the range r and arrival time T along a ray path between source and receiver follow from applying Snell's Law to an infinite stack of infinitesimal layers [14]

$$r = \int_{z_j}^{z_i} \frac{p\, c(z)\, dz}{\left[1 - p^2 c^2(z)\right]^{1/2}}, \qquad (12)$$

$$T = \tau + \int_{z_j}^{z_i} \frac{dz}{c(z)\left[1 - p^2 c^2(z)\right]^{1/2}}, \qquad (13)$$

where τ represents the source transmission instant and $c(z)$ the ocean sound speed profile. In (12) and (13), the ray parameter $p = \cos\theta(z)/c(z)$, derived from the grazing angle at the source, is constant along a ray path, and determining the correct value of p that connects source to receiver defines the take-off (grazing) angle at the source. The ray parameter for an eigenray connecting source and receiver is determined by searching for the value of p which produces the correct range using (12). An efficient procedure of determining p for direct-path eigenrays is based on Newton's method [5]. An initial estimate p_0 is calculated assuming straight-line propagation at the harmonic mean of the sound-speed profile between source and receiver

$$c_H = (z_i - z_j) \Big/ \int_{z_j}^{z_i} dz/c(z). \qquad (14)$$

An improved estimate p_1 is obtained by expanding $r(p)$ in a Taylor's series about p_0 and neglecting nonlinear terms to give

$$p_1 = p_0 + \left[\frac{\partial r(p_0)}{\partial p}\right]^{-1} (r(p) - r(p_0)). \qquad (15)$$

In (15), $\partial r/\partial p$ is determined by differentiating (12)

$$\frac{\partial r}{\partial p} = \int_{z_j}^{z_i} \frac{c(z)\, dz}{\left[1 - p^2 c^2(z)\right]^{3/2}}. \qquad (16)$$

If $r(p_1)$ computed from (12) is within the tolerance of the desired range, the procedure is complete. If not, the starting value is updated, $p_0 \leftarrow p_1$, and the procedure repeated iteratively until a satisfactory value is obtained.

In addition to travel times, the inversion algorithm requires partial derivatives of travel time with respect to source and receiver coordinates, source instant, and sound-speed bias. Consider first the partial derivative with respect to x_i. Employing the chain rule

$$\frac{\partial T}{\partial x_i} = \frac{\partial T}{\partial p}\frac{\partial p}{\partial r}\frac{\partial r}{\partial x_i} = \frac{\partial T}{\partial p}\left[\frac{\partial r}{\partial p}\right]^{-1}\frac{\partial r}{\partial x_i}. \qquad (17)$$

The three partials on the right side of (17) can be calculated from (13), (12) and (11), respectively, yielding

$$\frac{\partial T}{\partial x_i} = p\,(x_i - x_j)/r. \qquad (18)$$

Similar expressions are easily obtained for other horizontal derivatives. The partial derivative of T with respect to vertical coordinate z_i can be determined by differentiating (13) to give

$$\frac{\partial T}{\partial z_i} = \int_{z_j}^{z_i} \frac{p\, c(z)\, dz}{\left[1 - p^2 c^2(z)\right]^{3/2}}\frac{\partial p}{\partial z_i} - \frac{1}{c(z_i)\left[1 - p^2 c^2(z_i)\right]^{1/2}}. \qquad (19)$$

An expression for $\partial p/\partial z_i$ can be obtained by noting that

$$\frac{\partial r}{\partial z_i} = 0 = \int_{z_j}^{z_i} \frac{c(z)\, dz}{\left[1 - p^2 c^2(z)\right]^{3/2}}\frac{\partial p}{\partial z_i} - \frac{p\, c(z_i)}{\left[1 - p^2 c^2(z_i)\right]^{1/2}}. \qquad (20)$$

Solving for $\partial p/\partial z_i$ and substituting into (19) yields

$$\frac{\partial T}{\partial z_i} = \frac{1}{c(z_i)}\left[1 - p^2 c^2(z_i)\right]^{1/2}, \qquad (21)$$

with a similar derivation for $\partial T/\partial z_j$. To account for bias in the measured sound-speed profile, let $c(z) = c_t(z) + c_b$, where $c_t(z)$ is the true sound speed and c_b is the bias. Differentiating (13) with respect to c_b leads to

$$\frac{\partial T}{\partial c_b} = -\int_{z_j}^{z_i} \frac{dz}{c^2(z)\left[1 - p^2 c^2(z)\right]^{1/2}}. \qquad (22)$$

Finally, the derivative of T with respect to the source instant τ in (13) is simply given by $\partial T/\partial\tau = 1$.

To implement the above equations, it is assumed that the measured sound-speed profile represents a series of layers with a linear sound-speed gradient in each layer. Sea surface or bottom reflections are modelled using the method of images, i.e., representing the reflected path by a direct ray path from an image source located above the surface or below the bottom, respectively. In the following, let $\{z_k, c_k\}$ represent the sound-speed profile, $\{c'_k\}$ be the corresponding sound speed gradients, and z_j and z_i be the source and receiver depths, respectively. The integrals in equations (12), (13), (16) and (22) can then be evaluated analytically as following, where $w_k \equiv (1 - p^2 c_k^2)^{1/2}$,

$$r = \sum_{k=j}^{i-1} \frac{w_k - w_{k+1}}{p\, c'_k}, \tag{23}$$

$$T = \tau + \sum_{k=j}^{i-1} \frac{1}{c'_k} \left[\log_e \frac{c_{k+1}\,(1 + w_k)}{c_k\,(1 + w_{k+1})} \right], \tag{24}$$

$$\frac{\partial r}{\partial p} = \sum_{k=j}^{i-1} \frac{w_k - w_{k+1}}{p^2\, c'_k\, w_k\, w_{k+1}}, \tag{25}$$

$$\frac{\partial T}{\partial c_b} = \sum_{k=j}^{i-1} \frac{1}{c'_k} \left[\frac{w_{k+1}}{c_{k+1}} - \frac{w_k}{c_k} \right]. \tag{26}$$

3. EXPERIMENT

In November, 1998, a multi-national experiment to study rapidly deployable systems, called RDS-2, was carried out to test and demonstrate advanced deployable array technologies, data recovery methods, and rapid array deployment techniques [16]. RDS-2 was conducted in the Timor Sea, 160 km west of Darwin, Australia. Bathymetry of the trial site indicates a very flat bottom (clay-sand with slope $\approx 0.1\%$) at 107 m depth.

The experiment employed three separate arrays, including an ultra-light horizontal array (ULITE) designed and deployed by SPAWAR. ULITE consists of three arms extending from a central node, each comprised of 32 hydrophone elements in three distinct 'nests' along its 470 m length. Element spacing was 7.8 m in the first nest, 15.6 m in the second, and 31.3 m in the third. The trial deployment plan involved fully extending each arm along radials separated by 120°, using three surface vessels to lower the array to the sea floor. However, high sea state, unequal cable tensions applied by the deployment vessels, and strong subsurface currents all conspired to produce an actual deployment pattern that is estimated to differ significantly from the intended array geometry (Fig. 1).

Prior estimates of hydrophone positions for the AEL inversion are chosen from the intended deployment pattern of the ULITE array. Due to poor control of the deployment procedure, a 5000 m horizontal uncertainty is assigned to the estimates of phone positions (essentially unconstrained) in the algorithm. Prior estimates of hydrophone depth are restricted to 107± 1 m, by virtue of the uniform bathymetry.

After array deployment, 23 light bulbs were lowered from a surface vessel and imploded at selected locations at an estimated depth of 52 m (Fig. 1). This source geometry was based on the intended array position. However, because of the disparity between intended and actual array positions, the source locations were less than ideal.

Bulb implosions were recorded at each hydrophone and relative travel times were determined by picking the time of the peak of the direct path arrival (Fig. 2). To increase the accuracy of picking peak arrivals, the digitally recorded data, sampled at 510.621 Hz, were upsampled by a factor of four. Subsequently, the highest interpolated point and it's two neighbours were then fit with a parabola, the peak of which was picked as the direct path arrival time. A data error of $\sigma = 0.5$ ms is assigned to arrival times for the inversion algorithm.

Prior estimates of the source positions are assigned the P-code GPS position of the Zodiac boat from which they were lowered. An x-y uncertainty of 10 m is assigned to account for GPS error and horizontal drift of the bulb at depth. The implosions were conducted over two different days, and although the sound speed profile did not differ appreciably, the very different surface conditions of those two days necessitated applying different vertical uncertainties to the sources for each day. Estimated depth of the first nine bulbs, imploded under higher seas, is 52±10 m, and the remain-

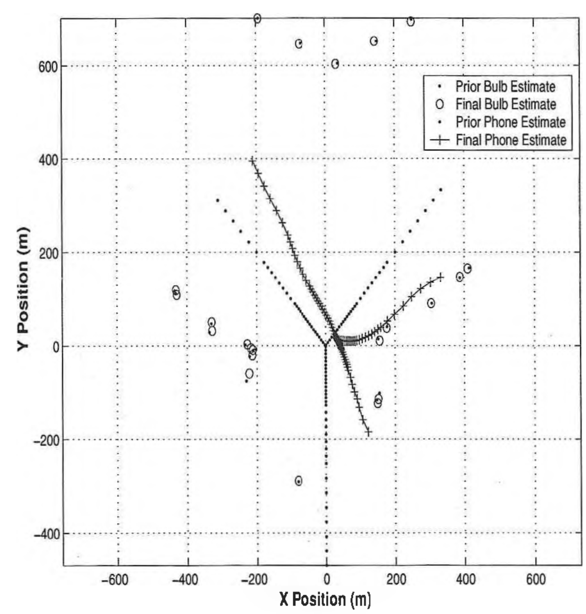

Fig. 1 Plan view of intended and recovered ULITE array positions including GPS fixed and recovered light bulb positions.

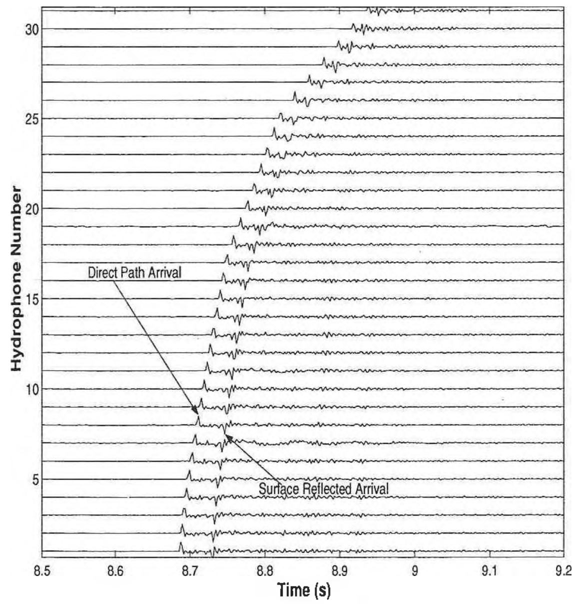

Fig. 2 Light bulb implosion acoustic arrivals for one arm (32 hydrophones) of ULITE array.

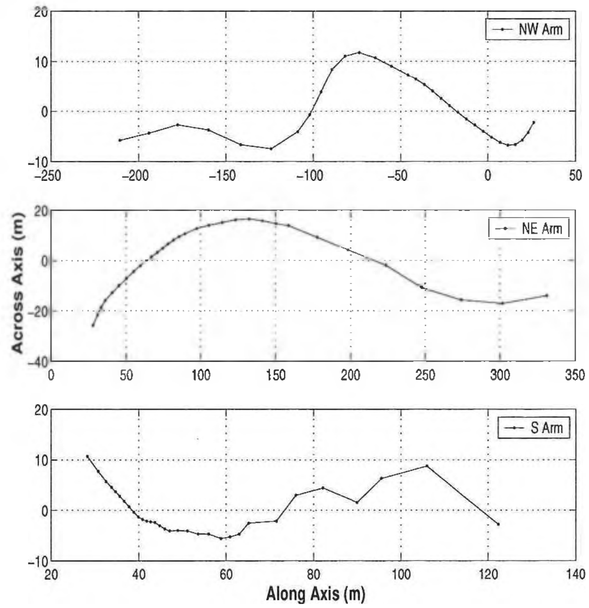

Fig. 3 Array structure shown in terms of the displacement from a straight line approximation of each arm.

der are assigned 52±5 m. Examination of the direct and surface reflected implosion arrivals reveals that the first three implosions were considerably shallower than planned, with the first implosion close to a depth of 30 m. Probable cause for this disparity is attributed to wind and swell conditions inducing significant drift of the Zodiac boat conducting the AEL survey. Because the implosions were so shallow, the arrivals of the direct and surface reflected signals overlap, resulting in the peak of the direct arrival being corrupted by the reflected arrival. For this reason, the first implosion is excluded from the AEL analysis. Fig. 2 illustrates the convergence of the two arrivals at longer ranges. Finally, a sound-speed bias uncertainty of 2 m/s was included.

4. RESULTS

4.1 Inversion Solution

The data set from the AEL survey consisted of 22 sources and 95 receivers (the end hydrophone of the NW arm was excluded due to movement caused by a tethered surface buoy), yielding $N = 2090$ equations for $M = 373$ unknowns from (12) and (13). Due to the large uncertainties of the hydrophone position prior estimates, five iterations were required to reduce the χ^2 misfit from the initial 18,484,570 to $N = 2090$, while concurrently decreasing the rms model change below the 0.1 m threshold. The result of the linearized inversion provides the simplest solution (*i.e.* minimal array structure), while fitting both the acoustic data and the prior estimates to a statistically appropriate level. A processing time of approximately 15 min was required to run the algorithm on a 400 MHz PC using a Unix OS.

The AEL inversion solution indicates that the actual position of the ULITE array was both shifted and rotated in relation to the planned layout. Prior receiver estimate residuals (the difference between prior estimates and recovered receiver positions) average 39.8 m in x, 88.1 m y, and 0.1 m in z. Maximum and minimum individual horizontal displacements of 310 m and 19 m are observed (Fig. 1). It appears that none of the three arms were fully extended to their 470 m length, with cumulative inter-element spacings totalling 440 m for the NW arm, 343 m for the NE arm, and only 225 m for the S arm. Fig. 3 depicts the structure in each arm as a function of element offset from a straight line (least squares) approximation to each arm. As expected from the short inter-element spacing, the south arm shows the most structure due to low cable tension during deployment.

Prior estimate residuals for source positions average 3.9 m in x, 3.4 m in y, and 1.7 m in z. As previously explained, the recovered positions of the first two implosions differ significantly from prior estimates, with vertical and horizontal displacements of approximately 20 m and 10 m, respectively. The recovered sound-speed bias of approximately 0.1 m/s was negligible.

4.2 Uncertainty Estimates

Absolute uncertainty estimates for receiver positions from both the linearized inversion and Monte Carlo appraisal, are presented in Fig. 4. Mean standard deviations of the linearized inversion solution are 2.4 m in x and y, and 0.6 m in z. Positional uncertainties increase

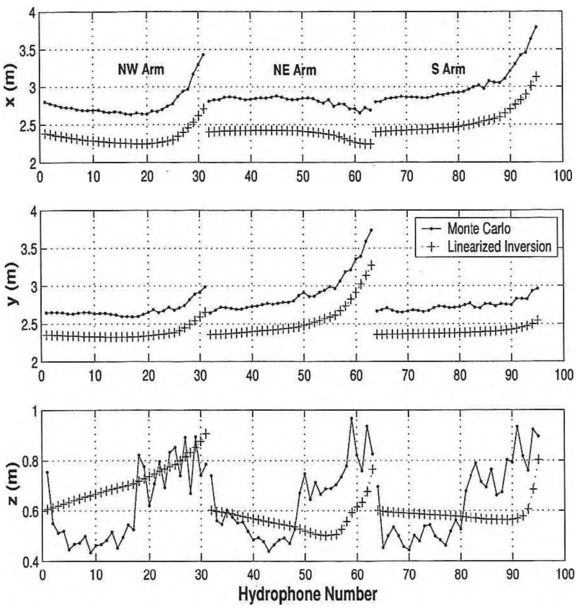

Fig. 4 Absolute hydrophone positional uncertainties using linearized inversion and Monte Carlo appraisal (one standard deviation).

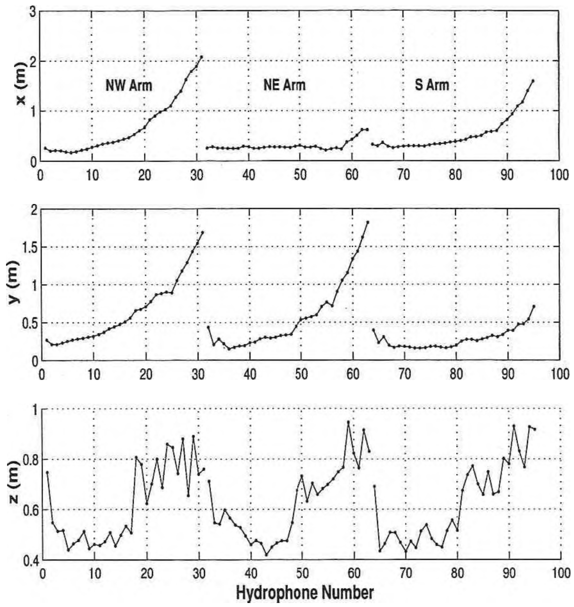

Fig. 5 Relative hydrophone positional uncertainties using Monte Carlo appraisal (one standard deviation).

towards the end of each arm due to the source-receiver geometry [7]. Linearized absolute uncertainties are in good agreement ($<$ 20% difference) with those generated by a Monte Carlo appraisal involving 50 random realizations.

Fig. 5 shows the relative uncertainties in receiver position as estimated from the Monte Carlo appraisal. These values exclude translational errors of the entire array and represent the inter-element positional errors which severely impact acoustic field processing. The average standard deviation of these errors is 0.5 m in x and y, and 0.6 m in z, roughly equal to $\lambda/10$ at 250 Hz, the highest frequency used in MBP of the RDS-2 data.

5. AEL SOLUTION COMPARISONS

AEL for the ULITE array was previously conducted in independent studies by both SPAWAR and DSTO. This section presents a comparison of their results with the UVic AEL solution presented in this paper, as illustrated in Fig. 6.

SPAWAR used the same direct arrival time picks employed here, but assumed a constant sound velocity profile and straight line propagation. The inverse problem was solved using the downhill simplex method [15], which seeks to minimize travel-time errors through a series of geometric steps. A two-step inversion was applied. For the first step, source positions were fixed, providing a rough solution. The second step, using the rough solution as a starting model, allowed source movement in the final solution determination.

Using the method of simulated annealing [14],[15], DSTO sought to minimize error between modelled and actual arrival times for both direct-path and surface-reflection arrivals in a constant sound speed environment. To assess the value of including surface reflections in our method, we computed linearized sensor-position uncertainties for a case that included ideal surface reflections (eq. 10), and found only 10 cm and 20 cm improvement in horizontal and vertical standard deviations, respectively. The reason for such little improvement is that surface-reflected arrivals follow the same horizontal paths as the direct arrivals, and hence provide little new information in x and y [10], while the vertical position z is well constrained by the prior knowledge of water depth. Because of this and the fact that the observed direct/reflected arrival overlap at long ranges, we chose not to use reflected arrivals.

Fig. 6 presents the plan view of all three solutions, while Fig. 7 displays the x and y differences between the hydrophone positions. Examination of the figures reveals close similarity between the UVic and SPAWAR solutions with differences increasing towards the ends of the array arms to a maximum of 3.4 m in x and 2.6 m in y. Comparatively, larger differences are observed between the UVic and DSTO solutions. The DSTO solution appears shifted SW and rotated clockwise in relation to our array position, resulting in maximum x and y differences of 15.8 m and 14.5 m, respectively. As with the SPAWAR solution, DSTO element positions diverge from ours along the arms, and due to the apparent rotation about an axis near the array node, this divergence is amplified. Ref. 14 compares the DSTO solution with that achieved by

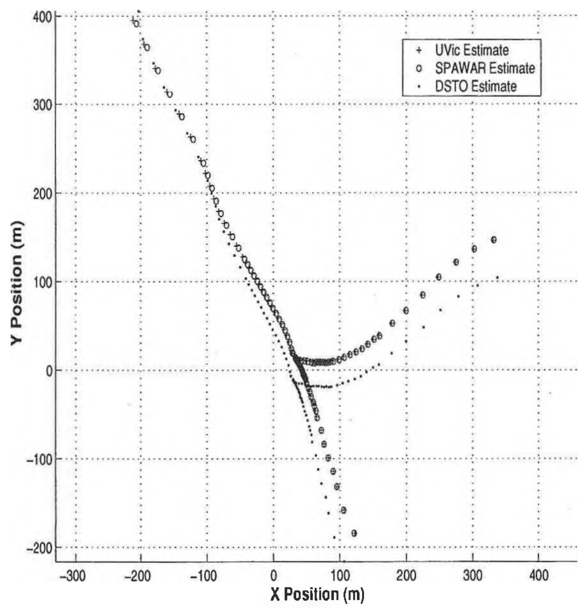

Fig. 6 Comparison of UVic, SPAWAR, and DSTO AEL solutions.

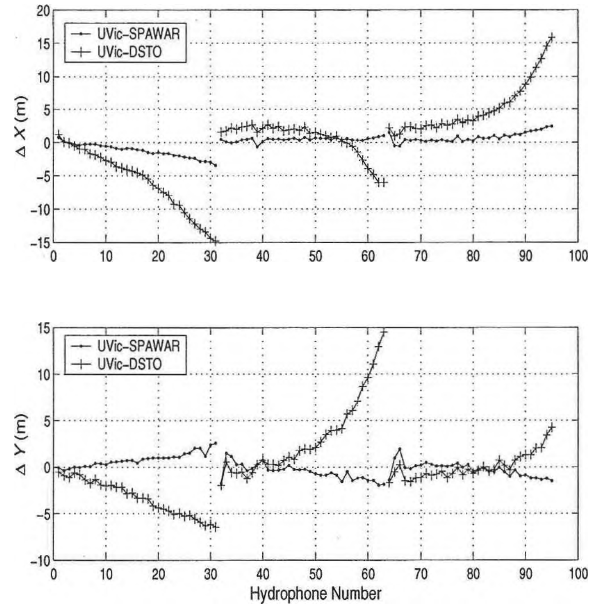

Fig. 7 Differences in relative sensor positions between UVic-SPAWAR and UVic-DSTO array estimates.

SPAWAR, attributing the shift and rotation to the use of large uncertainties allowed in the simulated annealing method. Additionally, DSTO's application of uniform, vice Gaussian uncertainties for prior position estimates allow a stronger influence from outliers.

Objective measures of the quality of an AEL solution involve assessing how well the solution fits the data and how smooth the solution is. On average, arrival time data were fit to within 0.38 ms for the UVic solution, 0.45 ms for the SPAWAR solution, and 0.90 ms for the DSTO solution. Array smoothness, or conversely structure, provides a measure of how simple a given solution to the problem is. Fig. 8 illustrates the structure in the S arm of the array as a function of hydrophone displacement from a straight line approximation to the respective solutions for the array arm. The DSTO solution can be seen to contain the most structure (e.g., zig-zags in the array shape), followed by the SPAWAR solution, while the UVic solution is the smoothest. Although not shown, solution smoothness was similar for the NE and NW arms, with DSTO showing the most structure and UVic the least.

6. AEL IMPACT ON SOURCE LOCALIZATION

To demonstrate the impact of inaccurate AEL, a example is presented in which MBP is applied to simulated receptions from the recovered positions of the NE and NW ULITE arms. For the simulation, a 200 Hz source is located at 50 m depth, 80° (ref. true north) from the ULITE node, at a range of 3 km. Simulated acoustic data was generated using the ORCA normal mode propagation model [17], to which Gaussian random errors were added resulting in a signal to noise ratio of 20 dB.

Fig. 9 depicts the range, bearing, and depth correlations between the simulated *true* model (receiver positions are exact), and *estimated* model in which Gaussian-distributed errors of specified standard deviations have been added to the receiver positions. For the first run (solid line), *estimated* receiver positions are the same as *true* positions, thus a high correlation (0.99) is achieved at the correct bearing, range, and depth. Random horizontal errors drawn from a Gaussian distribution with standard deviation equal to that of the relative errors for the AEL inversion are added to the *estimated* receiver positions for the second run (dashed line). The correlation is reduced slightly to 0.92 and the peaks remain at the correct bearing, range and depth. Doubling the standard deviation of the hydrophone perturbations begins producing range and depth estimation errors, and by the third run (dotted line) in which the standard deviation of induced errors is tripled ($\leq$ 7 m), significant degradation is seen in both range and depth. The source is falsely located at range 2.75 km and depth 10 m. Finally, using the prior hydrophone positional estimates in the MBP precluded any meaningful localization in range, bearing, or depth (not shown).

Simulations were also run using source frequencies of 50 and 100 Hz demonstrating that for lower frequencies, larger receiver positional errors are tolerated. For a 50 Hz source, errors on order of four standard deviations ($\leq$ 10 m) for the *estimated* model positions are tolerated by the matched beam processor before false maxima are observed in the correlation plots. Simi-

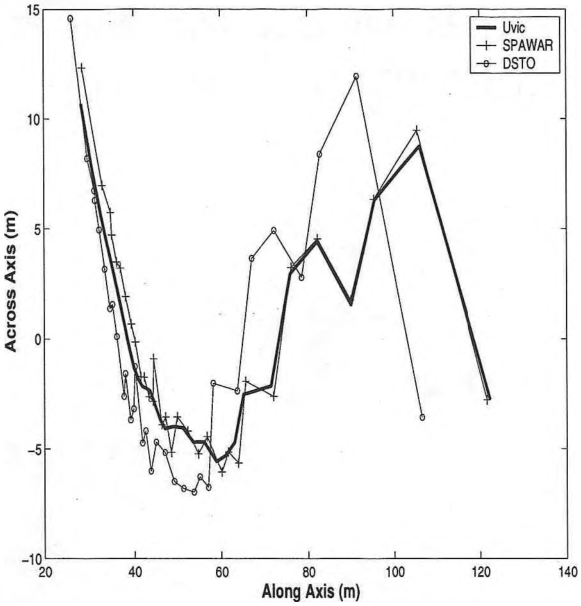

Fig. 8 Array structure of S arm in terms of displacement from straight line approximations of UVic, SPAWAR, and DSTO solutions

larly, MBP of the 100 Hz fields begins showing false maxima with receiver perturbations of three standard deviations.

7. CONCLUSION

This paper demonstrates the application of regularized inversion in the challenging problem of accurately localizing the individual hydrophones of an autonomous, remotely deployed array. Due to complicating factors during array deployment in the RDS-2 trial, the final resting position of the ULITE array was virtually unknown. To localize the array, submerged light bulb implosions were conducted around the array and the relative arrival times of the transient signals were measured. Determining source and receiver positions from this data set represents an ill-conditioned inverse problem which is stabilized by assigning *a priori* estimates to source and receiver positions, and seeking the smoothest solution in the iterative linearized inversion algorithm. Relative element position errors are within acceptable ranges to allow subsequent source localization processing, with average standard deviations of 0.5 m horizontally and 0.6 m vertically.

8. ACKNOWLEDGEMENTS

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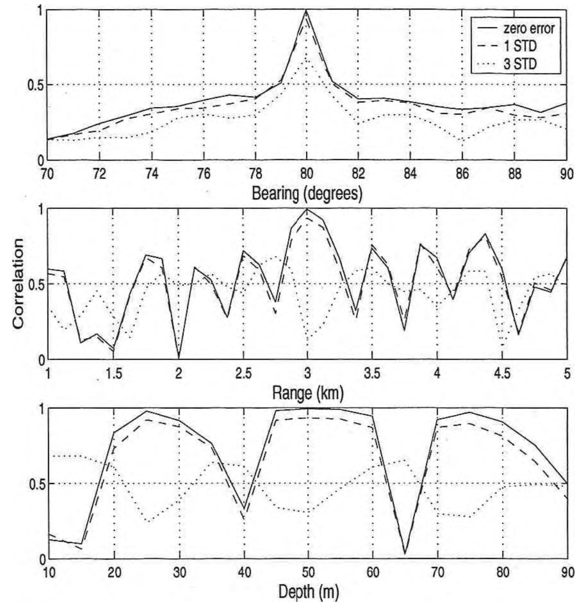

Fig. 9 MBP Simulation. Bearing, range, and depth correlations as a function of receiver positional error. Solid line represents zero error applied to estimated receiver positions; dotted and dashed lines represent errors of 1 and 3 standard deviations as estimated by the Monte Carlo appraisal.

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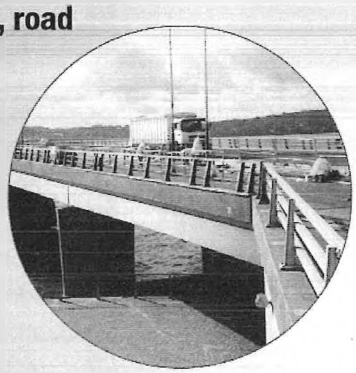

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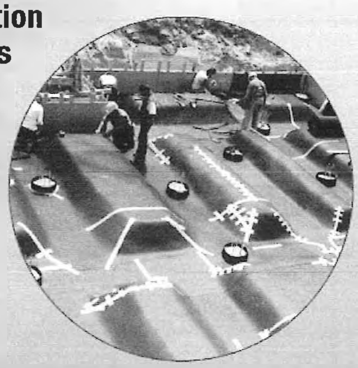

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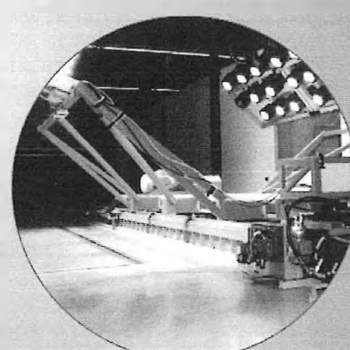

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Influence Of The Traffic Composition And Traffic Flow On Noise Emitted By Typical Brazilian Roads

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ABSTRACT

This paper treats the problem of traffic noise in roads which have been transformed into big avenues in the city of Curitiba and its impacts on the community. Simultaneous measurements of noise levels, vehicle flow, and traffic composition were made around the main roads inside the urban perimeter of Curitiba. Mathematical models were then developed to estimate sound pressure levels. The measured levels were compared with the mathematical models as well as with the results using the German Standard RLS-90. The validity of the developed mathematical models was thus confirmed as well as the applicability of the calculation method adopted by the German Standard RLS-90. Finally, the traffic noise levels around these roads were assessed by the application of the noise urban limits of the municipal law 8583/1995.

SOMMAIRE

Cet article a rapport au problème du bruit causé par le trafic dans les rues qui ont été tranformées en grandes avenues dans la ville de Curitiba, en ce qui concerne la mensuration des niveaux de bruits et les conséquences causée à la communauté. Des mesures simultanées on été conduites dans plusieures avenues dedans le périmètre urbaine de Curitiba en ce qui regarde les niveaux de bruit, le flux de véhicules et la composition du trafic. Avec les résultats des modèles mathématiques on été construits pour estimer les niveaux de pression sonore. Ensuite, les niveaux de bruit mensurés on été comparés à ceux obtenus par les modèles mathématiques et le *standard* RLS-90 allemand. Par cette comparaison, il a été confirmé la validité des modèles mathématiques construits et l'application de la méthode utilisé par le *standard* RLS-90 allemand. A la fin, les niveaux de bruit du trafic autour de cettes avenues et les limites des bruits urbains de la loi municipale 8583/1995 on été comparés et il a été confirmé que les personnes qui habitent ou travaillent à ces lieux sont exposés à des niveaux de bruit plus haut que ceux permis par la legislation.

1. INTRODUCTION

Curitiba, with a population of 1.6 million, is one of the most ancient and populated cities in Brazil. Its economical growth has been very strong during the last 30 years due to the industrial development encouraged by the Brazilian government. Indeed, this fact have lead to deep structural changes in the city. Some of them are:

- Migration of people from country areas to urban areas in search of more lucrative jobs;
- Increase in circulating number of vehicles in the city;
- Increase in civil construction activities for the construction of new homes for the new inhabitants.

The increase in the population and in the number of circulating vehicles has led to an increase in the urban noise levels. The need therefore for studies regarding the urban noise pollution and its consequences over the environment have motivated various researches on the problem in several countries (Burgess, 1977; Barbosa, 1992; Zheng 1996; Arana, 1998 ; Suksaard , 1999; Abdel-Raziq, 2000; Zeid 2000; Zannin et. al., 2001; Zannin et. al., 2001).

A recent survey carried out by Calixto (Calixto et. al., 2000) in the city of Curitiba, in which the answers collected from 860 questionnaires distributed among the population were analyzed, with the intention of verifying the impact of the urban noise over the people. The results of the survey are summarized in Figure 1. This study has shown that the noise generated by the traffic of vehicles is the most annoying noise source. Among all the respondents that felt annoyed by the noise generated in his/her street, 73% points the traffic as the main noise source.

The great population increase in the city of Curitiba has also

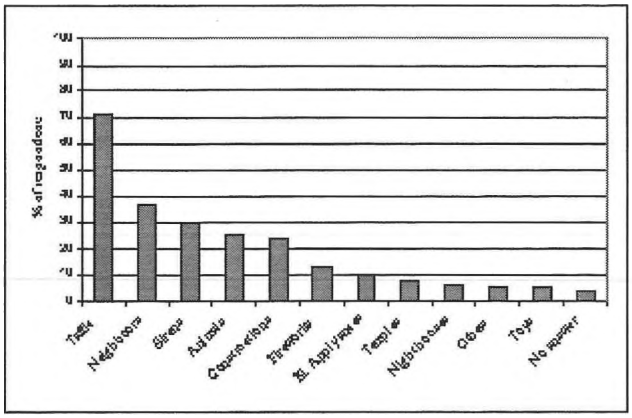

Figure 1. Results of Noise Annoyance Survey.

resulted in the intense occupancy of peripheral areas of the city, expanding the urban limits of the city. One of the consequences of this was the fact that the previously free areas along road margins have gotten to be highly occupied, severely increasing the demographic density by the road margins. So, these roads, which were intended only to serve the traffic that was arriving, departing or crossing the city, are now serving the purposes of normal traffic flow for those who want to go work or home. These roads have passed through a great functional change, as they now play the role of important avenues with intense traffic, but without losing its main role of serving as a road. In conclusion, these roads present characteristics of normal traffic due to its vehicle flow, the percentage of different vehicle classes, the average speed and the distance between traffic lights, which differ them from both a typical road and a normal avenue.

The objectives of this survey are many. The statistical and equivalent noise levels generated by the traffic circulating in the roads which has been transformed into big avenues will be presented first. The second one is to estimate the noise pressure levels emitted by the traffic through mathematical models, starting from the knowledge of the traffic flow and composition. Another objective is the comparison between the measured values and the ones predicted by the mathematical models so that the applicability of these models could be verified. The measured results will also be compared to the methodology adopted by the German standard RLS-90 (Richtlinien für Lärmschutz and Straβen, 1990) in order to verify its applicability to the Brazilian conditions.

Finally, the measured levels will be compared to the maximum allowed levels according to the legislation valid in the city, and then classify the acoustic quality of those areas.

2. METHODOLOGY

Brown and Lam have presented different strategies for evaluating the environmental noise in a city. They conclude that there are two main points to consider: measuring the noise levels in several points organized in an approximately regular grid and measuring the noise levels according to a previous classification of the urban noise according to the area usage, demographic density or the importance of the urban streets. The second strategy has been applied for the current investigation because its main goal is to evaluate the traffic noise generated by the roads BR-116 and BR-277. These two roads have previously been classified as the main roads which had been used as big avenues inside the urban limits of the city.

A total of 100 samples along the two roads were taken. For each sample the following parameters were simultaneously measured:

- The duration of each measurement, in seconds;
- The quantity of cars, motorcycles, trucks and buses that have passed by the observer during the time interval of each measurement;
- The equivalent and statistical levels in dB(A): L_{eq}, L_{10} and L_{90}, emitted by the traffic at a distance of 25 meters from the center of the nearest road band to the observer. Brüel & Kjaer 2238 sound level meter has been used for these measurements;
- The imission equivalent noise levels, in dB(A), at a distance of 40 meters from the center of the nearest road were with a Brüel & Kjaer 2260 sound level meter.

Every measurement was carried out in the fast response mode. In order to group the obtained results for the several measurement points in a single data matrix, some variables of the process has been fixed. Every measurement site had the following characteristics:

- Roads paved with smooth asphalt and in good conservation;
- Constant average traffic speed was 55 km/h, with an appropriate multiplying factor for the heavy vehicles;
- Longitudinal inclination less than 5%, i.e., the road was a flat stretch;
- Straight stretch;
- Flat nearby terrain, characterizing an open field, with no reflecting objects.

The total amount of input data was thus reduced to vehicle flow and traffic composition. As the traffic flow and composition cannot be controlled parameters, the only way to get a significant change in the input parameters was to perform measurements in different times and week days.The duration of time for each measurement has also been changed so that the sampled traffic conditions could approach the conditions of a regular traffic flow. The vehicle flow varied between 973 and 3680 vehicles per hour, and the percentage of heavy vehicles varied between 6.9% and 76.9%. Heavy vehicles, according the German standard RLS-90, are those that weighs more than 2,800 kg. The obtained mathematical expressions are therefore non-complex, and the data acquisition in the field is not difficult.

Finally, the acoustic qualification of the sampled regions was established by applying the noise limits established by the law number 8583 adopted in Curitiba from January 10th of 1995.

3. RESULTS AND DISCUSSION

The mean values of the main process variables are presented in Table 1 and the correlation coefficients among these variables are shown in Table 2. The correlation coefficients shown in Table 2 indicate that they are dominant in the determination of the equivalent and statistical noise levels generated by the road traffic under the considered conditions. However, the percentage of heavy vehicles in the road traffic is also an important factor.

The vehicle flow is the sum of the light vehicle and heavy vehicle flow that passes at a road during a certain time interval. As a heavy vehicle generates more noise than a light vehicle, mainly under speeds considered in this survey, a pondering factor, *n*, has been considered for such vehicles, so that an equivalent value could have been achieved for the traffic flow, Q_{eq}. By considering Q as the real hourly vehicle flow, VP as the percentage of heavy vehicles and *n* as the pondering factor, we get:

VARIABLE	DISCRIMINATION	MEAN VALUE
X1	Vehicle flow, Q	2239.5 vehicle/h
X2	10 log Q	33.3
X3	Percentage of heavy vehicles, VP	31.2 %
X4	10 log VP	14.7
X5	L_{10}	76.3 dB(A)
X6	L_{90}	65.2 dB(A)
X7	L_{eq}	73.1 dB(A)
X8	Imission at 40 m	68.2 dB(A)

Table 1. Description and mean values of the variables.

	X1	X2	X3	X4	X5	X6	X7	X8
X1	1.000	0.955	0.216	0.302	0.629	0.532	0.676	0.551
X2	0.955	1.000	0.232	0.325	0.612	0.511	0.660	0.556
X3	0.216	0.232	1.000	0.928	0.548	0.456	0.589	0.488
X4	0.301	0.325	0.928	1.000	0.599	0.458	0.642	0.523
X5	0.629	0.612	0.548	0.599	1.000	0.586	0.936	0.829
X6	0.532	0.511	0.456	0.458	0.586	1.000	0.679	0.603
X7	0.675	0.660	0.589	0.642	0.936	0.679	1.000	0.883
X8	0.551	0.556	0.488	0.523	0.829	0.603	0.883	1.000

Table 2. Matrix of coefficient correlation among all the variables

$$Q_{eq} = Q\,(1 + n * VP / 100) \qquad (1)$$

So, the term 10 log(Q_{eq}) will be transformed into 10 log [Q(1 + *n* * VP / 100)].

The pondering factor value, *n*, is estimated so that the largest correlation coefficients result between the noise levels and the factor 10 log [Q(1 + *n* * VP / 100)].

By varying the pondering factor among 4 and 10, the largest correlation coefficients between L_{eq} and the above term, and between L_{10} and the same term, are found when $n = 9.5$, and they are 0.8192 and 0.7692. On the other hand, as the influence of the heavy vehicle over the L_{90} is smaller, the pondering factor is also smaller, $n = 5$. For this case the correlation coefficient between L_{90} and the term 10 log [Q(1 + *n* * VP / 100)] is 0.6275.

A mathematical model for the determination of the traffic equivalent noise level is schematically shown in Figure 2. The model considers the vehicle flow, Q, and the percentage of heavy vehicles, VP, and will be based on this strong correlation factor between these parameters, which its coefficient is 0.8192. For L_{10} the coefficient is 0.7692 and for L_{90}, 0.6275. Both of them are smaller than the coefficient for L_{eq}, but they are still very significant.

3.1. Development of the Mathematical Models:

In order that the mathematical models is able to predict, in a satisfactory manner, the equivalent and statistical noise levels, it is necessary that the models:

- Be simple enough so that they can be used by those responsible for urban planning;
- Only easily obtained data be necessary for the noise level calculus;
- Obtain accurate results according to the subjective perception of the noise.

Any mathematical model will only be an approximate estimation as there are many factors involved in the analysis. The mathematical models for the determination of the road traffic noise levels can be represented as follows:

Once the vehicle flow, Q, the percentage of heavy vehicles, VP, and the equivalent noise levels, L_{eq} have been measured, and the most adequate pondering factor has been deter-

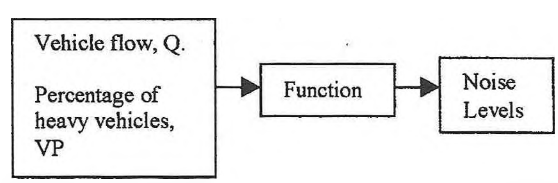

Figure 2. Graphical representation of the mathematical model.

mined, n=9.5, the values for L_{eq} and 10 log [Q.(1 + 9,5 * VP / 100)] have been plotted on a graph, shown in Figure 3. Then, by means of the least-squared method, a curve has been adjusted to the measured points. Mathematically, this curve can be represented by:

$$y = a \cdot x + b \quad (2)$$

By applying the variables on the straight-line equation, we get:

$$L_{eq} = a * 10 \log [Q(1 + 9.5 * VP / 100)] + k \quad (3)$$

The values for the constants a and k, found after the statistical methods of linear regression had been applied, are:

a = 0.76; k = 42.964

This way, the expression that mathematically represents the adjusted curve and can predict the equivalent levels for the road noise is:

$$L_{eq} = 7.7 \log [(Q(1 + 0.095 * VP)] + 43 \quad (4)$$

where:

L_{eq} is the equivalent noise level emitted by the road traffic, measured at 25 meters, in dB(A);
Q is the vehicle flow (vehicles per hour);
VP is the percentage of heavy vehicles, compared to the total number of vehicles.

By taking the same proceedings adopted for the equivalent levels, mathematical expressions have been obtained for the determination of the statistical levels L_{10} and L_{90}. They are as follows:

$$L_{10} = 6.2 \log [Q(1 + 0.095 * VP)] \quad (5)$$

$$L_{90} = 10.2 \log [Q(1 + 0.050 * VP)] + 27.1 \quad (6)$$

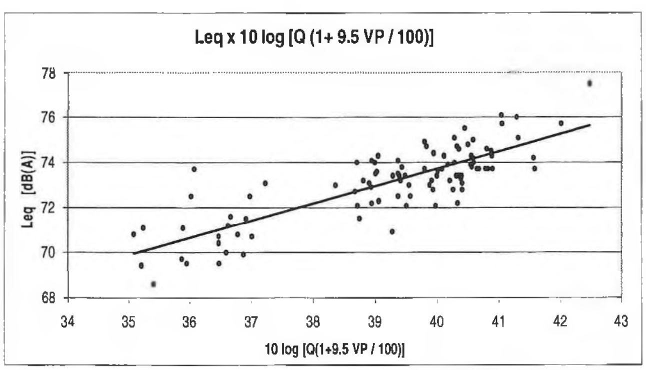

Figure 3. Adjusted curve for L_{eq} x 10 log [Q (1 + 9.5 * VP / 100)]

However, as the measured levels are intended to be compared to the local legislation valid in the city, and it concerns only the equivalent levels, the statistical levels L_{10} and L_{90} will not receive further treatment in this research.

3.2 Leq Evaluation

Table 3 presents the averages, standard deviations, maximuml positive variations and maximal negative variations of the differences between the calculated and measured values.

Figure (4) shows comparisons between the measured values and calculated ones according to the mathematical model (Eq. (4)) and by the German standard RLS-90, by considering a speed of 55 km/h.

The calculated values do not get significantly distant from the measured values. This fact allows us to affirm that the Eq. (4) is able to satisfactorily predict the equivalent noise levels generated by the vehicle flow in roads.

Furthermore, it allows us to say that the methodology adopted by the German standard RLS-90 can be applied to the Brazilian conditions, as it gives very close results to the ones

Statistical Parameter	Model-Measurements	RLS 90 – Measurements	Model-RLS 90
Average	-0.005	0.3	-0.3
Standard deviation	1.821	1.081	0.559
Maximal Positive Variation	2.261	1.5	1.8
Maximal Negative Variation	2.994	3.9	0.3

Table 3: Statistics of the differences between the calculated and measured values for L_{eq} [dB(A)]

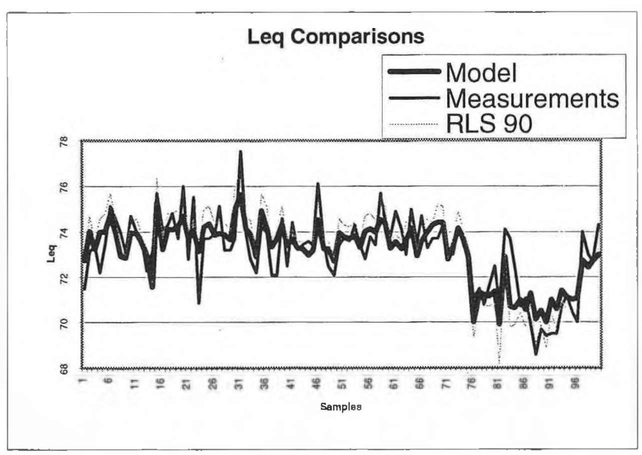

Figure 4. Calculated and measured values for 25-meter emission.

calculated by the Eq. (4), as well as the values obtained during the measurements.

3.3. Noise Levels Evaluation

The municipal law number 8583 from 01/10/1995 states about the limits for the urban noise in the city of Curitiba, according to a classification of areas called urban zoning.

Table 4 presents the allowed limits for the equivalent noise levels in some urban zones of the city for the period from 7 a.m. to 7 p.m., during which the measurements were carried out.

According to the mean values of the traffic flow and percentage of heavy vehicles, the mean equivalent level for the traffic noise, at a distance of 25 meters, is 73.7 dB(A).

4. CONCLUSIONS

The German standard RLS-90 seems to fit well with the calculation of the road traffic noise emitted by the vehicles, situated inside the urban limits of Curitiba. Consequently, the computer softwares developed according to the German standard RLS-90 can be used to calculate the traffic imission and emission on the Brazilian roads.

Mathematical models for predicting the equivalent and statistical levels generated by the road traffic can be developed by using the statistical methods of linear regression. The noise levels calculated by these models are nearly as precise as the ones calculated by the German standard RLS-90, and

ZONE	DESCRIPTION	ALLOWED L_{eq} [dB(A)]
ZR-1	Residential Zone (strictly)	55
ZR-2	Low density Residential Zone	55
ZR-3	Medium Density Residential Zone	55
ZR-4	Medium Density Residential Zone (mixed)	60
SE	Structural Sector	65
ZE	Service Special Zone	70
ZS	Service Zone	70
AV	Green Area	55
SR-2	Santa Felicidade Residential Sector	55

Table 4. Allowed equivalent noise levels according to the municipal law number 8583

satisfactorily correspond to the measured values.

The average value for the road traffic emission equivalent level measured by the roads situated inside the Curitiba urban limits is L_{eq} = 73.7 dB (A).

The roads that pass inside the urban limits of Curitiba cross, in the majority, ZR`s and ZS areas. According to the limits stated by the legislation, the allowed day noise emission inside the residential zones (ZR`s) is 55 dB(A). So, the average equivalent noise level generated by the traffic in these areas surpasses the maximum allowed noise level stated by the legislation in 18.2 dB(A) in the average, at a distance of 25 meters. For the Service Zone (ZS) the maximum allowed noise emission for the day is 70 dB(A). This level is surpassed by 3.1 dB(A) at a distance of 25 meters.

It is clear then that the environmental noise pollution problem caused by the traffic noise in the main roads situated inside the urban limits of Curitiba exists. The inhabitants living in these areas are bound to suffer from health impairments and low life quality. Under a technical point of view, it is necessary to take several measures in order to reduce the noise levels. Controlling the noise generation means adopting the necessary measures to reduce the sound power emitted by the vehicles when they pass on a road. In order to do so, measures should be considered as follows:

- Reduction of the speed limit, mainly near residential areas, schools and hospitals.
- Propose a new legislation for the reduction of the vehicle emission limits determined by the Brazilian standard NBR 8433/84, and offer incentives to the vehicle manufacturers to develop new systems in order to reduce the sound power emission.
- Limiting the vehicle flow and reducing the percentage of heavy vehicles. In order to achieve this, it is necessary that:

i) The conclusion of the new roads that are intended to circulate the city. These roads have already been in construction for 10 years;
ii) Quality and quantity improvements of existing public transportation, like: operating quality, safeness, rapidity, comfortable transportation and low cost. These factors constitute good reasons to make the population use them more often;
iii) Implementation of subways (metros);
iv) For short distances, incentive the of the use of bicycles or walking;

To control noise transmission intermediary obstacles such as noise barriers can be installed. These noise barriers, although they are normally made of concrete, can have improved external appearance by putting vegetation on its surface covering the whole barrier. The barriers can thus be integrated in the natural environment, without affecting the psychological aspect of the population.

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CANADIAN STANDARDS ASSOCIATION ACTIVITY IN ACOUSTICS

2002 UPDATE

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ABSTRACT

This article gives an update of Canadian Standards activities in Canada, especially those of the Canadian This article is an update for 2002 of Canadian Standards activities in Canada, especially those of the Canadian Standards Association. CSA currently have 11 Acoustics Standards and two more with significant acoustics content. Two committees are responsible for these standards. Z94 is responsible for one standard. Z107, through a variety of subcommittees involving many Canadian acousticians and industry representatives write and review most other standards for the Canadian Acoustics commmunity. An update is given of the main activities and future directions of these groups

SOMMAIRE

Cet article présente une mise a jour des activités de normalisation au Canada pour 2002, tout particulièrement celles de l'Association canadienne de normalisation (ACNOR). L'ACNOR a présentement 11 normes acoustiques et deux autres comportant un contenu acoustique important. Deux commités sont responsables pour ces normes. Z94 est responsable pour une norme. Z107, par divers sous-comités comprenant plusieurs acousticiens canadiens et représentants de l'industrie rédigent et passent en revue la plupart des autres normes pour la communauté acoustique canadienne. Une vue d'ensemble de leurs activités premières ainsi que de l'orientation future de ces groupes y est présentée.

Introduction

The Canadian Standards Association is the largest standards writing body in Canada and one of the largest in the world. There have been CSA standards in Acoustics for over 25 years. The Z94 Protective Devices Committee and the Z107 Committee on Acoustics and Noise Control are active in many areas. Many Canadian acousticians put in a great deal of volunteer effort each year in writing and reviewing acoustics standards. This article is intended to give an update for 2002 of acoustics standards activity in Canada, concentrating on CSA acoustical standards.

Committee Activities

There are two CSA Technical Committees in Acoustics :

Z94 – Hearing Protection

Z94 is responsible for the Hearing Protection Standard Z94.2 which defines Type A, B, and C type hearing protectors and is widely referred to in occupational noise regulations. They have recently approved a major new version of this standard in light of changes to the US hearing protector standards and procedures. This will mean the introduction of user-fit hearing protector measurements, similar to those used by ANSI and now recognized as being more representative of how hearing protectors are used in practice than the old technician-fitted testing methods.

Z107 Acoustics and Noise Control

Z107, the Acoustics and Noise Control Technical Committee, is responsible for all other CSA Acoustics standards and liaises with Canadian activities on ANSI, ASTM, IEC and ISO standards. Several members belong to these organisations' committees or Z94 and provide liaison to them.

The committee meets twice a year, once during the Canadian Acoustics Week and once in the spring. The latest meeting at the PEI conference was well attended. It reviews progress by each subcommittee and votes on any new work proposals. The main committee is the last technical hurdle for a standard. The CSA will then have their editors put it into final form. The steering committee, to which the main committee reports, approves work and reviews completed standards, however they cannot make technical changes.

New members are encouraged and anyone interested may contact Cameron Sherry, the Chairman, or the author, the vice chair. Those interested in a particular working group should contact the working group chairs listed below.

Table 1 shows all the Canadian Standards currently in force and also lists two standards whose Acoustics sections were written with the assistance of the Z107 committee. This table will also soon be found at the CAA website and will be kept up to date there. Meanwhile the list can be found at

http://www.csa-intl.org/onlinestore/GetCatalogDrillDown.asp?Parent=430

Most of the work of the committee is carried out by its subcommittees who are responsible for the following standards:

Hearing Measurement, chaired by Tang Chow, responsible for **CAN3-Z107.4-M86** Pure Tone Air Conduction Audiometers for Hearing Conservation and for Screening and **CAN/CSA-Z107.6-M90** Pure Tone Air Conduction Threshold Audiometry for Hearing Conservation

Vibration, chaired by Tony Brammer, which provides liaison between Z107 and the Technical Advisory Committee of Standards Council on ISO standards on vibration. Tony is active on the ISO group for ISO 2631

Powered Machines, which no longer has standards of its own but recommends adopting or endorsing ANSI, SAE or ISO standards.

Industrial Noise, chaired by Tim Kelsall, responsible for the following standards :

Z107.51-M1980 (R1994) Procedure for In-Situ Measurement of Noise from Industrial Equipment. A group is looking at replacing this standard with a series of ISO standards.

Z107.52-M1983 (R1994) Recommended Practice for the Prediction of Sound Pressure Levels in Large Rooms Containing Sound Sources. This standard is in need of major updating and a chair is being sought to do this work.

Z107.53-M1982 (R1994) Procedure for Performing a Survey of Sound Due to Industrial,Institutional, or Commercial Activities. This standard will be replaced with ISO1996. A working group chaired by Chris Krajewski and including several Ontario consultants is examining using 1996 as a way of updating the way tonal and impulse sounds are handled in community noise[1]. They are currently running round robin tests of the procedures with various sample sounds[2]. Stephen Keith of Health Canada is acting as liaison with the ISO committee. The Canadian version will include an informative annex relating the standard to the Canadian context.

CAN3-Z107.54-M85 (R1993) Procedure for Measurement of Sound and Vibration Due to Blasting Operations. A working group, chaired by Ramani Ramakrishnan, is revising this standard. This activity is just getting started.

CAN/CSA-Z107.55-M86 Recommended Practice for the Prediction of Sound Levels Received at a Distance from an Industrial Plant. A joint CSA/ANSI working group co-chaired by Rich Peppin and Tim Kelsall is looking at ISO9613 for adoption or endorsation. This standard was originally written by an ISO working group chaired by Joe Piercy. It may ultimately replace or become the basis for a revised version of Z107.55.

Z107.56-94 Procedures for the Measurement of Occupational Noise Exposure is referenced in Federal and some provincial regulations and is being updated by a working group chaired by Alberto Behar.

Z107.58-2002 Guidelines For Machinery Noise Emission Declarations Levels was written by a group chaired by Stephen Bly and should be available by the time this article is published[3]. It is a voluntary guide on noise emission declarations for machinery to be used in Canada and is compatible with European regulations to allow Canadian machinery to be sold into that market.

> A Noise Emission Declaration is a statement of sound levels produced by equipment, which would usually be included with the instruction or maintenance manual. Measurements are made according to ISO standards and include estimates of the likely variability of the measurements. Canada recommends use of a declaration stating the level and uncertainty as two numbers, although in some cases they may be added together into a single number.

In addition, the committee undertakes reviews of proposed federal and provincial regulations,often at the request of the regulators, and other activities affecting industrial noise. At the last meeting a review of recent research on the effect of low frequency sounds on worker health by Health Canada was discussed. The subcommittee agreed with the conclusion that there was no evidence at present requiring a change in standards.

Transportation Noise, chaired by Soren Pedersen, responsible for **CAN/CSA-Z107.9-00:** Standard for Certification of Noise Barriers. This standard is an adaptation of the Ontario MTO Highway Noise Barrier specification. It provides municipalities, developers, road and highway departments, railways and industry with a standard specification which can be used to define the construction of barriers intended for long term use in Canadian conditions.

Specific manufacturers' barrier designs are certified as complying with the standard in such areas as: materials used, weathering and corrosion resistance testing, STC, NRC, etc. Each barrier installation is reviewed and certified for compliance with such items as footings design, material sample testing, welding, caulking, backfilling, etc.

The US Highway Barrier Design Manual is already harmonised with the CSA standard, as is the Ontario Provincial Standard.

Editorial, chaired by Alberto Behar, (which reviews all proposed standards) and is responsible for reviewing and endorsing ANSI S1.1-1994 Acoustical Terminology.

Building Acoustics, chaired by David Quirt, does not have its own standards, but endorses or adopts other standards, mostly from ASTM.

Instrumentation and Calibration,chaired by George Wong, which liases with Canadian activities on ANSI, IEC and ISO instrumentation standards and endorses or adopts these standards.

Liaison with the Canadian Steering Committee for ISO TC43 and TC43(1), chaired by Krish Krishnappa.

Reviewing other standards

A large part of the committee and subcommittee work is reviewing standards written by other standards writing bodies, such as ANSI or ISO, for adoption or endorsation by Canada. Whenever possible, as global harmonisation becomes more important, CSA adopts or endorses international standards rather than writing their own. In areas where standards apply to goods coming from or going to other countries, use of international standards makes considerable sense.

Adopting a standard, i.e. republishing it, with changes or additions if necessary, costs less than half the cost of writing a new standard. Endorsing, which means that the standard has been reviewed and found suitable for Canadian use is the least expensive option, but less useful because the standard is not so readily available.

Currently there are 24 standards from ANSI, ISO and ASTM endorsed. They are listed in Table 1 following the CSA standards.

Table 1- CSA Acoustics Standards

CAN3-Z107.4-M86 Pure Tone Air Conduction Audiometers for Hearing Conservation and for Screening / Audiomètres tonals à conduction aérienne pour la préservation de l'ouïe et pour le dépistage

CAN/CSA-Z107.6-M90 Pure Tone Air Conduction Threshold Audiometry for Hearing Conservation

CAN/CSA-Z107.9-00: Standard for Certification of Noise Barriers

Z107.51-M1980 (R1994) Procedure for In-Situ Measurement of Noise from Industrial Equipment

Z107.52-M1983 (R1994) Recommended Practice for the Prediction of Sound Pressure Levels in Large Rooms Containing Sound Sources

Z107.53-M1982 (R1994) Procedure for Performing a Survey of Sound Due to Industrial,Institutional, or Commercial Activities

CAN3-Z107.54-M85 (R1993) Procedure for Measurement of Sound and Vibration Due to Blasting Operations / Méthode de mesure du niveau sonore et des vibrations émanant des opérations de dynamitage

CAN/CSA-Z107.55-M86 Recommended Practice for the Prediction of Sound Levels Received at a Distance from an Industrial Plant / Pratique recommandée pour la prévision des niveaux sonores reçus à une distance donnée d'une usine

Z107.56-94 Procedures for the Measurement of Occupational Noise Exposure / Méthode de mesure de l'exposition au bruit en milieux de travail

Z107.58-2002 Guidelines For Machinery Noise Emission Declarations

Z94.2-02 • Hearing Protection Devices - Performance, Selection, Care, and Use / Protecteurs auditifs

Standards with Acoustics Component:

Z62.1-95 Chain Saws

CAN/CSA-Z412-M00 Office Ergonomics / L'ergonomie au bureau

Endorsed Standards

ANSI S1.1-1994 Acoustical Terminology(R1999)

ANSI S1.4-1983 Specification for Sound Level Meters (R2001)

ANSI S1.11-1986 Specifications for Octave-band and Fractional (R1998) Octave-band Analog and Digital Filters

ANSI S1.13-1995 Measurement of Sound Pressure Levels in Air (R1999)

ANSI S12.31-1990 Precision Methods for the Determination of (R1996) Sound Power Levels of Broad-band Noise Sources in Reverberation Rooms

ANSI S12.32-1990 Precision Methods for the Determination of (R1996) Sound Power Levels of Discrete-frequency and Narrow-band Noise Sources in Reverberation Rooms

ANSI/ASTM Standard Test Method for Sound Absorption and C423:00 Sound Absorption Coefficients by the Reverberation Room Method

ANSI/ASTM Standard Test Method for Laboratory E492-90 (1996) E1 Measurement of Impact Sound Transmission Through Floor-ceiling Assemblies Using the Tapping Machine

ASTM C384-98 Standard Test Method for Impedance and Absorption of Acoustical Materials by the Impedance Tube Method

ASTM E90-99 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

ASTM E336-97 Standard Test Method for Measurement of Airborne Sound Insulation in Buildings

ASTM E596-96 Standard Test Method for Laboratory Measurement of the Noise Reduction of Sound-isolating Enclosures

ASTM E795-00 Standard Practices for Mounting Test Specimens During Sound Absorption Tests

ASTM E966-99 Standard Guide for Field Measurement of Airborne Sound Insulation of Building Facades and Facade Elements

ASTM E989-89 Standard Classification for Determination of (1999) Impact Insulation Class (IIC)

ASTM E1007-97 Standard Test Method Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-ceiling Assemblies and Associated Support Structures

IEC 60651-2001 Sound Level Meters

ISO 4872-1978 Acoustics – Measurement of Airborne Noise Emitted by Construction Equipment Intended for Outdoor Use – Method for Determining Compliance with Noise Limits

ISO 6393:1998 Acoustics – Measurement of Exterior Noise Emitted by Earth-moving Machinery – Stationary Test Conditions

ISO 6394:1998 Acoustics – Measurement at the Operator's Position of Noise Emitted by Earth-moving Machinery –Stationary Test Conditions

ISO 6395-1988 Acoustics – Measurement of Exterior Noise Emitted by Earth-moving Machinery – Dynamic Test Conditions

ISO 6395:1998 Acoustics – Measurement of Exterior Noise Emitted by Earth-moving Machinery – Dynamic Test Conditions – Amendment 1

SAE J919-1995 Sound Measurement – Off-road Work Machines – Operator Singular Type

SAE J1096-2000 Measurement of Exterior Sound Levels for Heavy Trucks under Stationary Conditions

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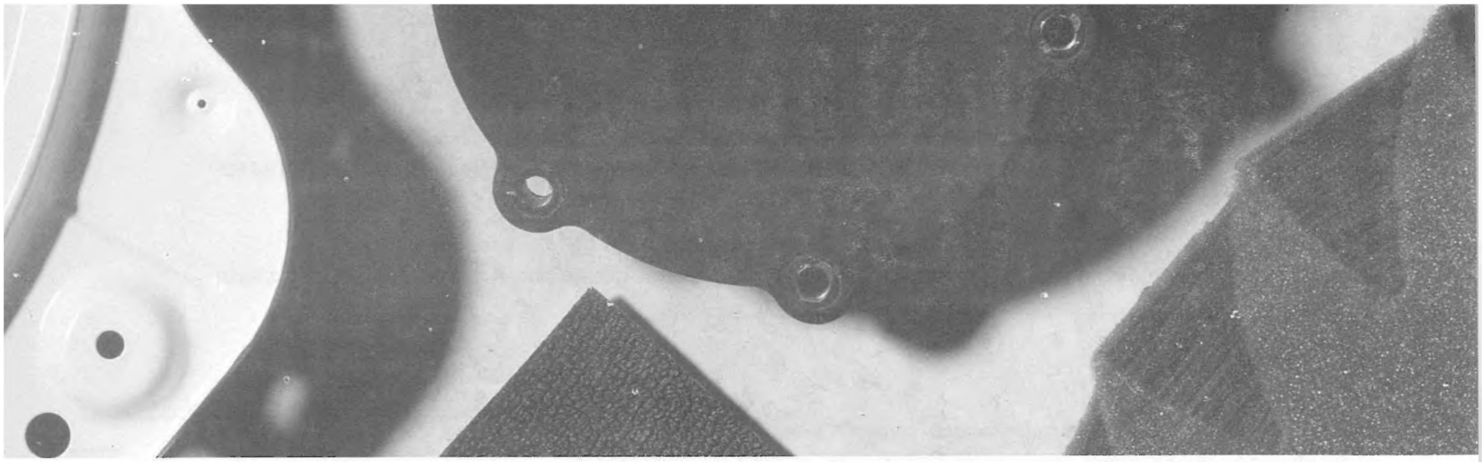
Stephen Keith, Stephen Bly, Tim Kelsall, A preview of the Draft CSA Guideline – Noise Emission Declarations for Machinery, Canadian Acoustics, Volume 29, No. 3, September, 2001



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MEASURING ACOUSTIC TRANSMISSION LOSS USING THE 3-POINT METHOD

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1. Introduction

The use of dual simultaneous microphone measurements has been known to produce very good results that are just as accurate as single traveling microphone techniques, and much faster. The best use of this is the measurement of the normal incidence absorption coefficient of sound absorbing materials with the standing wave impedance tube (1). It is this methodology of dual simultaneous microphone measurements that can be applied to the measurement of transmission loss in silencer systems to eliminate the requirement of a replacement, un-silenced section (as the current methods require).

This paper covers the derivation and use of the 3-point method for measuring transmission loss where dual simultaneous measurements are taken to obtain the incident sound pressure levels.

2. Theory

The definition of transmission loss is the ratio of the incident intensity of sound to the transmitted intensity. Since intensity is difficult to measure, we typically make use of the proportionality of intensity to the mean square pressure. As long as the inlet and outlet regions of the silencer are of the same cross section, and the properties of the fluid (density, temperature) do not significantly change, then the *TL* can be expressed as:

$$TL = SPL_i - SPL_t \quad (1)$$

where it is understood that SPL_i is measured without the silencer in place, and SPL_t is measured with the silencer in place, on the exhaust side of the silencer. This method (hereafter referred to as the *traditional* method) is how most standards call for the *TL* to be measured (2,3). The standards usually require the use of an anechoic or reverberation chamber for testing.

The derivation of the 3-point method incorporates the auto and cross power spectrum which can be obtained by most dual channel simultaneous measurement systems. We begin with the general solution to the 1-D wave equation for points 1 and 2 (4):

$$P_1 = \left(P_i e^{-ikx_1} + P_r e^{ikx_1}\right) \quad P_2 = \left(P_i e^{-ikx_2} + P_r e^{ikx_2}\right) \quad (2a,b)$$

where: $k = 2pf/c$ (wave number) (1/m)
w = frequency (rad/s)

Figure 1 illustrates the location of the 3 points used as well as the incident, P_i, reflected, P_r, and transmitted, P_t, pressure waves.

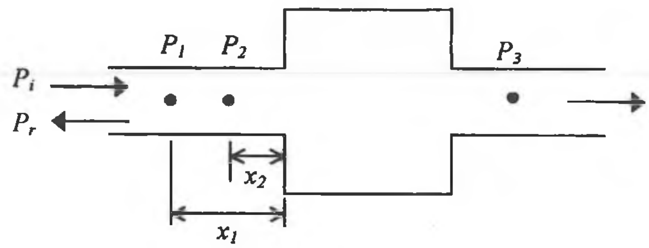

Figure 1. 3-point *TL* measurement locations

For transmission loss, only P_i is required. This quantity cannot, however, be measured at a single point, since P_r will also be present. To overcome this problem and the difficulty in measuring the complex values for P_1 and P_2, one can obtain the following auto and cross power spectrum from points 1 and 2 with a dual channel, simultaneous data acquisition system:

$$P_{11} = P_1 P_1^* \qquad P_{22} = P_2 P_2^* \qquad P_{12} = P_1 P_2^* \quad (3a,b,c)$$

where $P_1{}^*$ and $P_2{}^*$ denote the complex conjugates of P_1 and P_2 respectively. These quantities of P_{11}, P_{22}, and P_{12} (represented by capitals because they are vectors in the frequency domain) can be readily measured. By substituting Eqs. (2a,b) into Eqs. (3a,b,c) a system of three equations and three unknowns can be formed for the auto power spectra of the incident and reflected waves (P_{ii}, P_{rr}) along with the cross power spectra between the two (P_{ir}). By knowing x_1, x_2, and k, the system of equations can be solved for P_{ii} (since only the incident portion of the wave is of interest):

$$P_{ii} = \frac{P_{11}(E - DB) + P_{22}(DA - E) + P_{12}(B - A)}{(B - A)(C - D)} \quad (4)$$

where:

$$A = e^{2kx_1}\left(e^{-i} + e^{i}\right) \quad B = e^{2kx_2}\left(e^{-i} + e^{i}\right) \quad C = e^{-ik(x_1 - x_2)}$$

$$D = e^{ik(x_1 - x_2)} \quad E = e^{k(x_1 + x_2)}\left(e^{-i} + e^{i}\right)$$

Once P_{ii} is known, the third point can be used to measure P_{tt}. Finally, the transmission loss can be calculated by:

$$TL = 10\log_{10}\left|\frac{P_{ii}}{P_{tt}}\right| \quad (dB) \quad (5)$$

The important thing to note is that the measurements at points 1 and 2 **must** be taken simultaneously. This is necessary in order to obtain the proper phase in the cross product between the two.

3. Discussion of Results

All testing for this work was conducted using a custom built model of a duct silencer system. The system, shown in Fig. 2, consisted of a source end with a straightening section (for plane wave propagation), a test section with variable parallel baffle configurations, and a termination section with an anechoic termination (to prevent reflected waves from returning after the sound has left the test section).

The *traditional* method was used as the standard by which the 3-point method would be compared. To accomplish this, the incident sound pressure (P_i) was measured with the test section completely empty, and then baffles of sound absorbing material were installed for the transmitted sound pressure measurement (P_t). This same baffle configuration was used for the three sound pressure level measurements used for the 3-point method (P_1, P_2, P_3).

Figure 3 displays the results (presented using 1/3 octave analysis) of the *traditional* and 3-point methods for a section with one 10cm thick baffle of yellow fiberglass insulation, along with the difference between the two. Two dashed lines have been placed on the graph to illustrate a ± 3dB region. This region has been chosen as the range in which no perceptible difference between methods would be noticed by the end user, and as a region in which repeatable test results can be expected. It can be seen that for all of the useful frequency range, the differences between the two methods are very small, and follow the center (0dB difference) line very well.

Various Microphone locations were tested to determine which locations would give the best results. The two upstream mics were found to give the best results when they were kept quite close to each other (less than 5cm center-to-center gap) and as close to the test section as reasonably possible. Similarly, it was found that the location of the downstream mic did not have an appreciable impact on the results, as long as it was located as close to the test section as was reasonably possible.

4. Summary and Conclusions

Traditional measurement of transmission loss (*TL*) involved measuring sound pressure levels with and without the silencing element in place. Proposed in this paper was a method for measuring *TL* that can be performed entirely while the silencing element is in place. In order to accomplish this, two measurement points are used upstream of the silencing element to obtain the pre-silencing conditions (two points needed to resolve the incident and reflected portions of the sound waves) and a third is used downstream to obtain the post-silencing conditions. This 3-point method has been shown to match the results of the *traditional* method very well. With this method, silencers can be tested for *TL* in field (*"in-situ"*) conditions for easier post-installation evaluation.

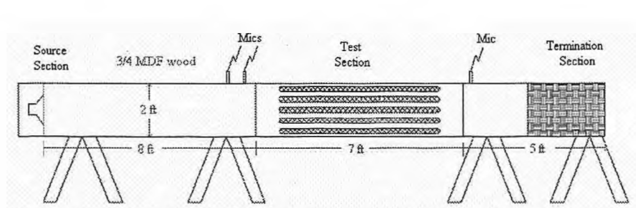

Figure 2. Physical Model of Acoustical Duct Silencer System.

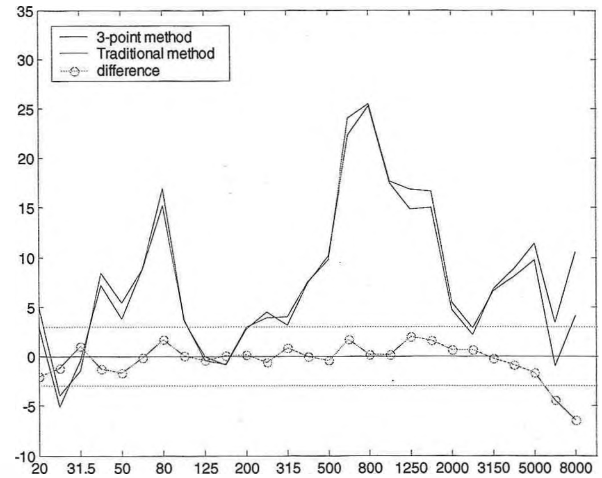

Figure 3. TL of traditional and 3-point methods for single baffle of 10cm thick yellow fiberglass insulation.

5. Acknowledgements

The authors would like to thank the Natural Sciences and Engineering Research Council of Canada (NSERC), the Department of Mechanical Engineering, University of Alberta and ATCO Noise Management for the financial support for this work.

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The Effect of Meteorology and Terrain on Noise Ppropagation - Comparison of Five Modelling Methodologies

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Rowan Williams Davies & Irwin, Inc., 650 Woodlawn Road West, Guelph, Ontario, N1K 1B8

1. Introduction

Meteorological conditions can have important effects on noise propagation. For relatively short source-receiver distances, these effects are small and generally ignored, as a conservative assumption. However, when considering noise impacts from large industrial complexes, such as petrochemical facilities and electrical power plants, the potential impact zone and corresponding source-receiver distances can be quite large (>2 km). Not including meteorological and terrain effects can result in severe over- or underestimations of off-site sound levels, affecting mitigation requirements and project costs.

This paper illustrates the effects of these parameters (and of model selection) on predicted noise levels, by comparing modelling results from five calculation algorithms, including basic modelling (considering distance attenuation and barrier effects only), basic modelling including atmospheric attenuation, ISO-9613 [1,2], ISO-9613 with CONCAWE meteorological effects [3,4], and the Environmental Noise Model (ENM) [5]. A quick review of meteorological conditions affecting noise propagation is given. A comparison is made between the five techniques based on a modelled electrical power plant. Finally, the effect of meteorological conditions on hourly sound levels throughout the day is illustrated.

2. Review of Meteorology and Terrain Parameters that Affect Sound Propagation

The meteorological and terrain parameters which affect sound propagation can be broken down into four main categories including temperature effects, wind effects, air absorption, and ground effects. When these are combined with the effects of geometric spreading, barriers, and other shielding factors, a detailed prediction of environmental noise impacts can be made.

2.1 Temperature Effects

Atmospheric temperature gradients in the air can refract sound waves either towards or away from the ground. These temperature gradients are termed the "lapse rate". A positive lapse rate indicates that temperature is increasing with height - also known as an atmospheric thermal "inversion". Because sound velocity increases with increasing temperature, under normal negative temperature gradient conditions, sound waves are diverted away from the ground, creating a sound "shadow zone". Under inversion conditions, sound waves are diverted towards the ground, increasing sound levels. This effect is shown schematically in Figure 1 [1].

Atmospheric lapse rates are inherently incorporated into Pasquill-Gifford (P-G) Stability Classes, which are widely used in air pollution dispersion modelling. As such, this information is generally available directly from most meteorological services, such as Environment Canada. These values can also be estimated based on available weather data for the area or direct measurements. Experienced meteorologists or firms specializing in atmospheric dispersion modelling can provide assistance. Table 1 presents the ranges of allowable wind speeds and lapse rates versus stability classes [4,6].

2.2 Wind Effects

Wind and sound velocities are direction dependant and additive. As a result, sound propagation is faster with the wind, and slower against the wind. Wind speeds vary with height, due to the friction effects of the earth's surface. The result-

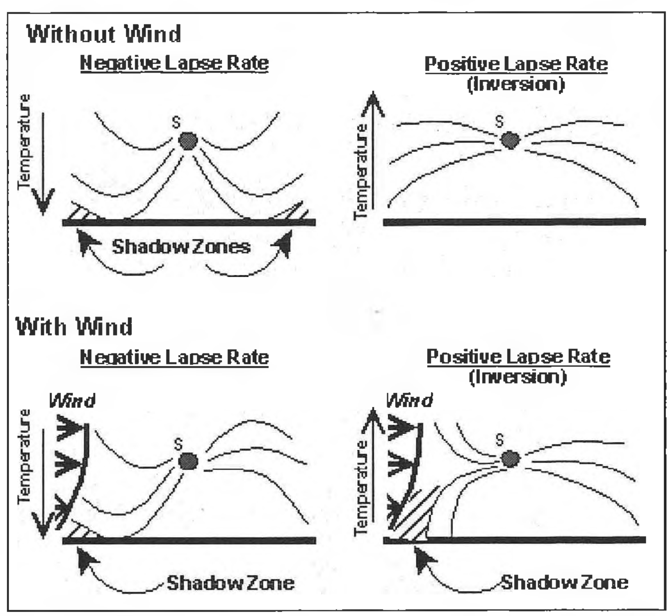

Figure 1: Schematic representation of the effects of air temperature gradients and wind on sound propagation [1].

Table 1: Pasquill-Gifford (P-G) Stability Classes Based on Lapse Rates and Wind Speeds [4,6]

Stability Class	Range of Vertical Temperature Gradient (°C/100m)	Range of Allowable Wind Speeds (m/s)	(km/h)
A (1)	< -1.9	≤ 3	≤ 11
B (2)	-1.9 to -1.7	≤ 5	≤ 18
C (3)	-1.7 to -1.5	≥ 2	≥ 7
D (4)	-1.5 to -0.5	≥ 3	≥ 11
E (5)	-0.5 to 1.5	≤ 5	≤ 18
F (6)	1.5 to 4 0	≤ 2	≤ 7
G (7)	> 4.0	≤ 2	≤ 7

ing variation in sound propagation speed with height and direction creates a sound shadow zone. Sound level attenuations of up to 30 dB are possible [5]. Wind effects are illustrated in Figure 1. Note that sound propagating in the direction of the wind is bent back towards the earth. This can reduce or completely eliminate any barrier attenuation

Most advanced noise propagation algorithms, including the CONCAWE and ENM models, assume that temperature and wind effects are additive (see Figure 1) [4,5].

2.3 Air Absorption

Atmospheric absorption results from the absorption of sound energy by molecules making up the air – most notably nitrogen, oxygen, and water vapour. Atmospheric absorption results in relatively negligible attenuation at low frequencies, but can produce extremely significant attenuation for mid to high frequencies over relatively short distances (>500 m) [1].

2.4 Ground Effects

Ground attenuation results from the "absorption" and scattering effects of the ground plane, as well as from the interference between the ground reflected ray and the direct ray. Both theoretical and empirical models can be used to characterize ground attenuation effects [2,4,5].

3. Comparison of Modelling Methodologies

Noise impacts from a typical power plant have been modelled using five different modelling algorithms:

- "Basic" attenuation model (geometric spreading and barrier effects only);
- "Basic" model including atmospheric attenuation [1];
- ISO-9613 [1,2];
- ISO-9613 with CONCAWE meteorological effects [3,4]; and
- ENM [5].

The attenuation effects considered by each model type are summarized in Table 2.

Table 2: Attenuation Effects Considered by the Models

Parameter	Model: Basic Model	Basic Model With Atm. Absorp.	ISO-9613	CONCAWE [1]	ENM
Geometric Spreading	✔	✔	✔	✔	✔
Barrier Effects	✔	✔	✔	✔	✔
Atmospheric Absorption		✔	✔	✔	✔
Ground Attenuation			✔	✔	✔
Temperature Gradients			✔ [2]	✔	✔
Specific Wind Speed/ Directions				✔	✔

Notes: [1] ISO-9613 with "Cmet" parameter replaced with "Kmet" parameter from CONCAWE
[2] ISO-9613 results represent values under well-developed temperature inversions

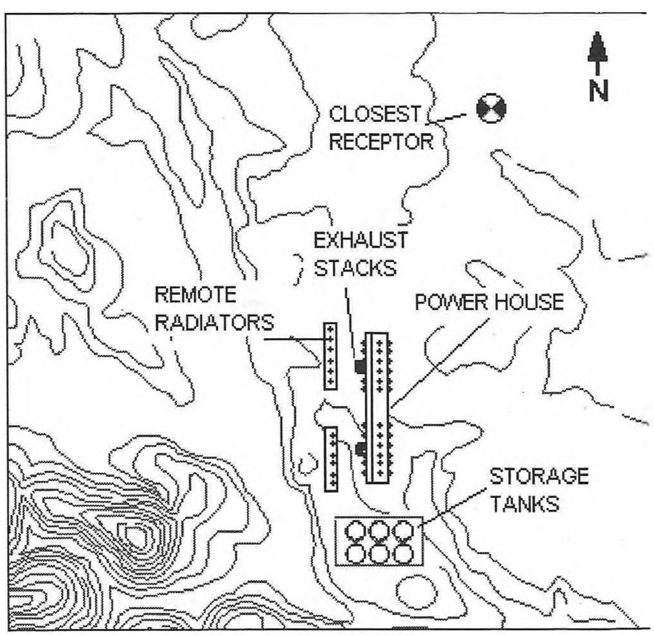

Figure 2: Plant Layout with Elevation Contours

The ISO-9613 model was designed to be representative of mild temperature inversion conditions, for light winds blowing from the source to the receiver, and does not consider specific wind speeds or directions [2]. Ground attenuation in the ISO-9613 model is based on empirical data, while ENM model uses a theoretical framework. Meteorological attenuation in the "CONCAWE" model is based on the P-G Stability Class [4]. Wind speed, wind direction, and lapse rate are entered directly into the ENM model as input parameters.

Table 3: Modelled Meteorological Parameters

Stability Class	Modelled Temperature Gradient (°C/100m) [1]	Modelled Wind Speeds (m/s)	(km/h)
A (1)	- 2.0	3	11
B (2)	- 1.7	5	18
C (3)	- 1.5	5	18
D (4)	- 1.0	5	18
E (5)	1.0	5	18
F (6)	2.5	2	7
G (7)	4.0	2	7

Notes: [1] Stability Class used as CONCAWE model input, not lapse rate.

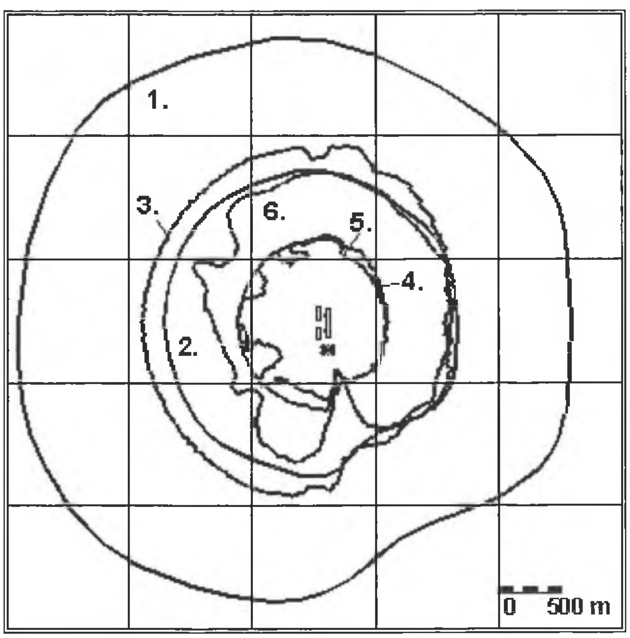

Figure 3: Modelling results, calm winds, 50 dBA contours shown. Each square is 1 km by 1 km. *1.* Basic modelling; *2.* Basic modelling with atmospheric attenuation; *3.* ISO-9613, ground attenuation G=0; *4.* ISO-9613, with G=1; *5.* ISO-9613, G=1, complex terrain; *6.* ENM with soft ground, calm winds and E stability class.

The modelled facility is a 300 MW power plant powered by 24 diesel-fired engines. A plan view is shown in Figure 2. The major noise sources are the exhaust stacks and remote radiators, which are all located to the west of the powerhouse building. Combustion and ventilation air intakes are located long the west and east facades of the powerhouse building. Modelled meteorological parameters are shown in Table 3. Contour 3 shows the ISO-9613 prediction for the plant for hard ground conditions (G=0), and highlights an issue with the model. The major plant noise sources are located to the west (left), and are unscreened (no barriers). The contour to the west of the plant extends farther than the Contour 2 basic model case. This is due to the effect of the "mid-ground" A_m component of the ground attenuation factor A_{gr}, which, depending on source-receiver geometry, can add up to 3 dB to the predicted levels. We believe that this is the component meant to simulate thermal inversion effects when no barriers are present.

The contour to the east (right) of the plant pulls inward to just within the base case Contour 2. In the easterly direction, the plant is acting as a noise barrier for the dominant stack and remote radiator noise sources. In the ISO-9613 model, the ground attenuation term A_{gr} is cancelled out when a barrier is modelled. The A_{bar} barrier attenuation term incorporates a "K_{met}" meteorological correction factor, which is intended to simulate the effects of thermal inversions on barrier effectiveness. If this parameter was working properly, Contour 3 would be expected to extend past Contour 2 in the easterly direction as well.

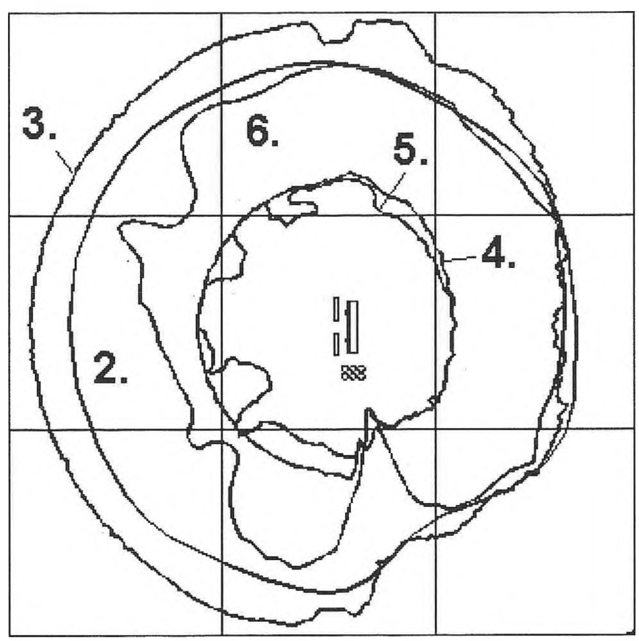

Figure 4: Detail of modelling results. *2.* Basic modelling with atmospheric attenuation; *3.* ISO-9613, ground attenuation G=0; *4.* ISO-9613, with G=1; *5.* ISO-9613, G=1, complex terrain; *6.* ENM with calm winds and E stability class.

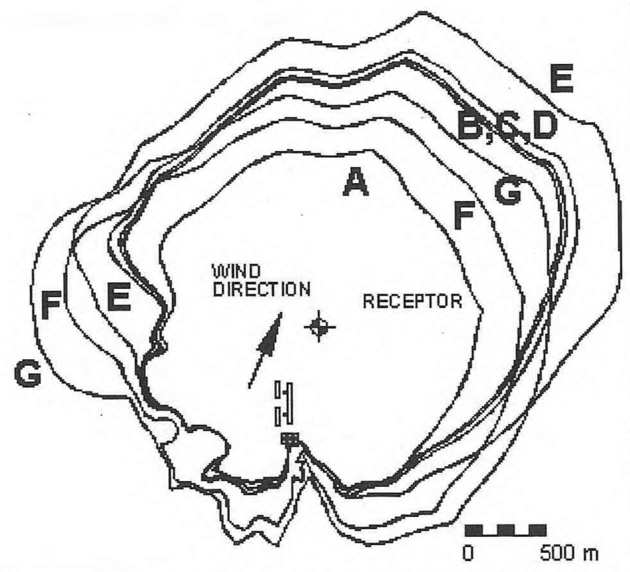

Figure 5: ENM modelling results all stability classes, SSW winds, meteorological conditions as per Table 3.

Contours 4 and 5 were predicted using the ISO-9613 algorithm assuming soft ground. Contour 5 shows the effects of complex terrain on the calculation results. Contour 6 is calculated using ENM, and assumes calm winds and an E stability class (mild inversion)

Figure 5 shows contours predicted using ENM, for SSW winds, based on the meteorological data presented in Table

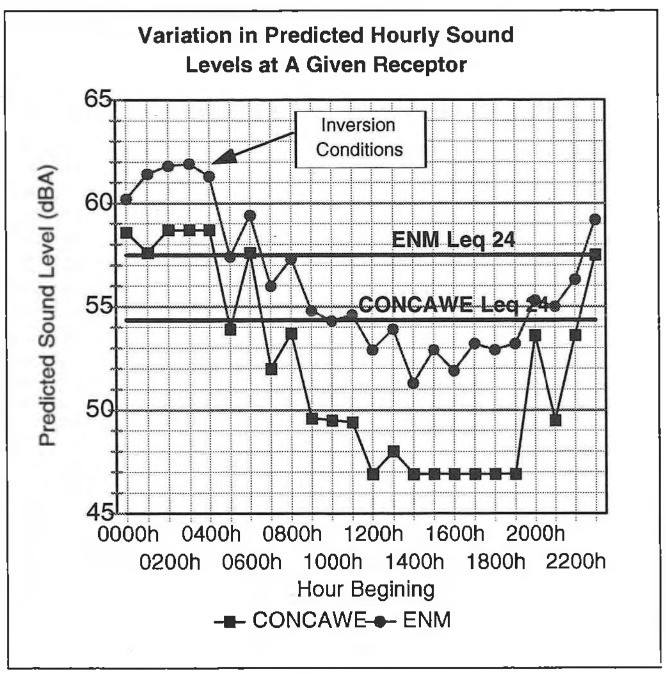

Figure 6: Comparison of ENM and CONCAWE results at a typical receptor over a typical summer day. Heavy lines show resulting L_{eq} 24 levels.

3. The effects of temperature inversions and wind speeds can be clearly seen. The E stability class results are worst-case, in that they extend the farthest out. While F and G stabilities have higher magnitude lapse rates, wind speeds under these classes are much less, resulting in contours covering less area than for the E stability class.

Figure 6 shows a comparison of predicted results from the "CONCAWE" and ENM models, for a single receptor over a typical summer day, covering a variety of stability classes, wind speeds and wind directions. The ENM results are considerably greater, ranging from 2 to 6 dB, depending on meteorological conditions.

4. Conclusions

Significant differences in predicted noise levels can result, depending on which noise propagation algorithm is used in the modelling. Noise modellers should be aware of the limitations of the models they use. It should always be kept in mind that "all models are wrong, but some are useful." Over the distances involved, no model could be expected to be completely accurate. Still, the differences between the ENM and CONCAWE results seem to be extreme. Verification modelling and measurements of the facility of interest are always recommended.

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Calibrating Calibrators

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"When Numbers speak, even Gods listen." - Andracius

"Knowledge is based on measurements." - J. Danielson

1. Calibrators and Calibration

Calibrators are battery-driven devices, where a speaker-like piston generates known sound pressure. They are different from the pistonphones, where two small pistons driven by an electric motor perform the same action. Both, calibrators and pistonphones, are used for the calibration of acoustic measurement instruments, including sound level meters (SLMs). Calibrators are discussed below as they are widely used due to their lower prices.

Calibrators must satisfy the requirements of the IEC942 Standard (1988): Sound Calibrators. As an example, Table 1 shows some characteristics claimed by three manufacturers of calibrators (Data extracted from manufacturer's catalogs.)

Table 1: Characteristics of some Calibrators

	B&K	Quest	Castle
Model	4230	QC-10	G
Accuracy	0.3 dB	0.3 dB	0.5 dB
Frequency	1.5%	2%	—
Distortion	1%	1%	3%

There are some 20 practicing acoustical consultants in Ontario with considerable field measurements. They all possess SLMs of different accuracy as well as calibrators for their calibration. There are also some 100 Industrial Hygienists in Ontario, who, among other tasks, perform sound level measurements. Most of them possess also SLMs and calibrators. Finally, there are close to 300 Safety Officers or safety related personnel at different industrial establishments, who also use SLMs and calibrators. All in all, there are several hundreds sound measuring devices and calibrators used in field measurements in Ontario alone.

Most calibrators are seldom used and almost never calibrated, the assumption being that the SLMs are "OK" (which may be true, but it is not proven).

Since calibrators are not self-calibrating devices, they also have to be periodically checked. There are no standards regarding how often this should be done. Rule of thumb is that the calibrators should bevcalibrated every two, and preferably every year (ISO 9000 Audit requires all instruments to be calibrated once a year).

The calibration of the calibrator is basically a measurement, where the sound level from the device is compared to a sound generated, usually, by a calibrator of a higher accuracy. It is assumed that the "master" calibrator, in turn, has also been calibrated and that the process could ultimately be traceable to a Standard Institution such as the NRC in Ottawa or the NPL in UK. (There is an international net of standard institutions around the world that participate in periodic Round Robin Tests, to ensure the ultimate accuracy of their standards and measurement procedures). Calibrators are not inexpensive nor are their calibration as can be seen in Table 2.

Table 2. Calibrators Price and Calibration Cost.

Manufacturer	A	B	Services
Calibrator	$1077	$696	NA
Calibration	$405	$168	$100

It can be seen that there is a wide range among prices for calibrators as well as for their calibration.

2. To Calibrate or not to Calibrate

The accuracy of a field sound level measurement is +/2 dB (Behar, A., et al: Accuracy in the Measurement of Sound Levels "In Situ" with Sound Level Meters. App. Acous. 8), even when a Type 1 SLM is used. The above variation may be due to many reasons such as the exact location of the microphone, the variation of the sound level of the source and, in the case of an outdoor measurement, wind and ground reflection. The accuracy of the instrument itself is much higher. Therefore, the accuracy of the calibrator is higher than that of the SLM and much higher than that of the field sound level measurement result.

With the advance of the electronic (and digital) technology, SLMs and calibrators have become very stable devices, with little or no drift with time. This is the experience of every acoustician who calibrates his SLM and observes that year after year there is no variation in the calibration. The exception is when something goes wrong with one of the other. In this case, realizing that the calibrator or the SLM has a problem is something very simple, most often linked to low batteries. That is, perhaps, why users are reluctant in sending their calibrators for an annual (even a biannual) check.

Another reason (that applies to any calibration) is that the procedure is good for obtaining the certificate only. The check itself is valid for only the day of calibration and at the premises of the laboratory where the operation is performed. There is no guaranty that this will be the situation for the 365 days following the calibration.

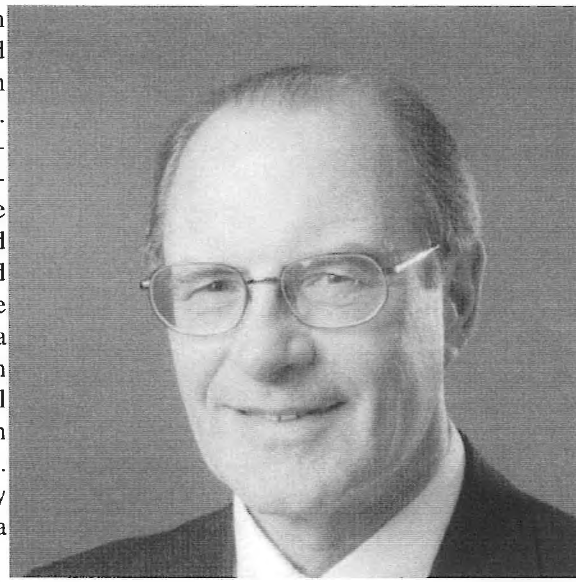
3. Conclusion

There is no obvious conclusion from the above. Calibrators must be checked to insure their output is correct. And they have to be used always, at least before performing a sound level measurement, even though our experience indicates that SLMs are stable. However, institutions that perform calibrations should help users by charging reasonable fees and by insuring a fast turn-around times. Then users will be less reluctant in checking their calibrators.

CANADIAN NEWS.... / NOUVELLES CANADIENNES....

Alfred C.C. Warnock - Recipient of the W.C. Sabine Silver Medal

Compiled by
J. David Quirt and Steven M. Brown
IRC, National Research Council, Ottawa, Ontario, Canada



Alfred C.C. Warnock was born in Glasgow, Scotland, in 1942, and excelled in school, graduating from Strathclyde University with a Ph.D. in plasma physics in 1967. A post-doctoral term in Saskatoon established his strong allergy to the ubiquitous dust of the prairies, and also suggests a milder acquired allergy to plasma physics – he moved from studies of plasma pinch effects to a position in applied acoustics at the National Research Council of Canada in Ottawa, and has never looked back. Alf joined the Acoustical Society of America in 1973 and became a Fellow in 1984.

He entered building acoustics in 1971 under the tutelage of T.D. Northwood – a previous recipient of the Wallace Clement Sabine Medal – and quickly adapted to both the subject matter and Tom Northwood's perspective on the role of technical standards. There are many parallels between their blending of science and its public application. Alf has dedicated three decades to improving noise control in our built environment, but is eternally torn between his love of studying how sound is transmitted through buildings, and his drive to get such information into widespread use.

Alf's research has covered many topics pertinent to noise control in buildings, with a strong emphasis on the application of reverberation room measurements to characterize the transmission, emission and absorption of sound. His research has consistently focused on developing practical results to manage problems such as noise transmission between units in commercial and multi-family residential buildings. His extensive parametric studies of airborne sound transmission through common cavity wall systems have provided the benchmarks both for scholarly models and for prescriptive building codes – and have also provided the transmission loss data base routinely used today in designing buildings. Alf's studies of footstep noise have moved from subjective studies (which established the significance of peak levels to annoyance), through evaluation of the driving forces (the impact velocity and impedance of human footfalls), to carefully structured comparisons of transmission through typical floor systems with a broad range of impact sources, and on to the compilation of a complete set of impact sound transmission data for commonly used floor/ceiling structures.

And the list goes on...including sound-absorption test methodology, porous block sound transmission measurements, the low-frequency acoustical behavior of building structures, computer resources and "free-ware" for acousticians, and open plan office privacy measurements (this last an area in which Alf worked early in his career and again very recently – contributing seminal information on both occasions). In all of this Alf demonstrates the same enthusiasm and artistry he brings to his abiding passion for per-

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Contd. from Page 35

forming Celtic music, another acoustical interest.

But Alf does not stop with research studies and publications (or Celtic music) – he adapts his research findings to promote their practical use. His articles for the applied acoustician, the architect, and the general public are just as extensive as his professional publications. A central fact in the design of architectural projects is the constant tension between the acoustician and the developer, with the one trying to achieve an appropriate sound environment and the other trying to contain costs. Acoustical consultants routinely apply data developed in Alf's research in successfully designing acoustical environments and in justifying the expense of such good design.

In addition to technical papers, Alf has written seven textbook chapters since 1990 and frequently writes articles for construction industry trade journals. He performs a cross-continent seminar tour on noise control in buildings (typically 10-15 cities) every decade, including several presentations in French. He just completed his fourth such seminar tour in November. He also assumed a leadership role as head of the building acoustics group at NRC Canada from 1980 to 1987, but decided he would rather focus on the technical aspects of the job, and returned to the lab. During his management phase, Alf played a significant role both in the Technical Committee on Architectural Acoustics (Chair from 1983-85) and in organizing conferences for Acoustical Society of America, the Institute of Noise Control Engineering and the International Congress on Acoustics. But his primary focus has remained on the science of building acoustics and the development of technical standards providing a basis for the systematic evaluation and improvement of noise control in buildings.

Alf has played a major role on American Society for Testing and Materials International's Committee E-33 on Environmental Acoustics since the early 1970's, serving as Chair for three terms (1988-1993) and chairing the subcommittee on sound transmission in buildings for the rest of last three decades. He has played a leading role in drafting and refining the standards used to specify noise control requirements for all North American building codes. The significance of this role has been recognized by several awards, including the ASTM Award of Merit, the Wallace Waterfall Award, and an ASTM Fellowship. Over the same period Alf has participated actively in developing many of the corresponding standards in the International Standards Organization. He has also been a member (and Chair 1996-1998) of American Society of Heating Refrigeration and Air-Conditioning Engineers committee TC2.6 dealing with the measurement of sound power and noise emission from ventilation and air conditioning systems. These roles, as in ASTM, have blended committee work with fundamental research studies to develop acoustical standards that influence acoustical and architectural practice internationally.

The foundation for this influence is Alf's skill as an experimental scientist who knows and understands both the experimental and theoretical literature in their full breadth. He has a knack for getting to the very core of an issue and for asking the critical questions that will advance our understanding. He designs the crucial experiments that answer these questions, refines the experimental tools and protocols, and then performs the systematic studies needed to replace "expert opinion" and folklore with an extensive, consistent accurate, and substantiated knowledge base. This is why Alf is counted as one of the genuinely knowledgeable people in architectural acoustics by his peers in research and why the applied practitioners continually turn to him for help and guidance – help and guidance which he gives freely.

Alf Warnock has indeed contributed strongly both to the knowledge of Architectural Acoustics and to its practical application.

News Item / Rubriquenouvelles

BOARD AWARDS 2.5 C.M. POINTS TO PARTICIPANTS AT THE CHARLOTTETOWN CONFERENCE

Announcement by A. Behar, Director CAA

The American Board of Industrial Hygienists is awarding participants at the Canadian Acoustical Conference in Charlottetown (October 9 – 11, 2002) 2.5 Certification Maintenance (C.M.) points. The approval number (to be quoted on the CM Worksheet, under the Meetings and Education Programs category) is 02-3148.

NEWS / INFORMATIONS

CONFERENCES

The following list of conferences was mainly provided by the Acoustical Society of America. If you have any news to share with us, send them by mail or fax to the News Editor (see address on the inside cover), or via electronic mail to francine.desharnais@drdc-rddc.gc.ca

2002

2-6 December: Joint Meeting: 9th Mexican Congress on Acoustics, 144th Meeting of the Acoustical Society of America, and 3rd Iberoamerican Congress on Acoustics, Cancun, Mexico. Contact: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tel: 516-576-2360; Fax: 516-576-2377; E-mail: asa@aip.org; Web: asa.aip.org/cancun.html

9-13 December: International Symposium on Musical Acoustics (ISMA Mexico City), Mexico City. Fax: +52 55 5601 3210; Web: www.unam.mx/enmusica/ismamexico.html

11-13 December: International Conference on Sonar-Sensors & Systems (ICONS2002), Cochin (Kerala), India. Contact: H.R.S. Sastry, Naval Physical and Oceanography Laboratory, Thrikkakaro, Cochin-682021, Kerala, India; Fax: +91 484 424858; E-mail: root@drnpol.drdo.com

19-21 December: 3rd WSEAS International Conference on Acoustics, Music, Speech and Language Processing, Tenerife, Canary Islands, Spain. Web: www.wseas.org/conferences/2002/tenerife/icamsl/

2003

9-10 January: Calibration and Measurement in Underwater Acoustics, Teddington, Middlesex, UK. Contact: S. Robinson, National Physical Laboratory, Teddington, Middlesex TW11 0LW, UK; Fax: +44 208 943 6217; Web: www.ioa.org.uk/meetings/calibration_2002.html

17-20 March: German Acoustical Society Meeting (DAGA2003), Aachen, Germany. Fax: +49 441 798 3698; E-mail: dega@akuphysik.uni-oldenburg.de

18-20 March: Spring Meeting of the Acoustical Society of Japan, Tokyo, Japan. Contact: Acoustical Society of Japan, Nakaura 5th-Bldg., 2-18-20 Sotokanda, Chiyoda-ku, Tokyo 101-0021, Japan; Fax: +81 3 5256 1022; Web: wwwsoc.nii.ac.jp/asj/index-e.html

24-26 March: 27th International Acoustical Imaging Symposium, Saarbrücken, Germany. Contact: Ms. Y. Spindler, Fraunhofer Institute for Non-Destructive Testing, Bldg. 37, University, 66123 Saarbrücken, Germany; Fax: +49 6819302 5903; Web: www.izfp.fhg.de

6-10 April: IEEE International Conference on Acoustics, Speech, and Signal Processing, Hong Kong, Hong Kong. Contact: Wan-Chi Siu, Hong Kong Polytechnic University, Hong Kong; Web: www.en.polyu.edu.hk/%7Ecassp03

CONFÉRENCES

La liste de conférences ci-jointe a été offerte en majeure partie par l'Acoustical Society of America. Si vous avez des nouvelles à nous communiquer, envoyez-les par courrier ou fax (coordonnées incluses à l'envers de la page couverture), ou par courriel à francine.desharnais@drdc-rddc.gc.ca

2002

2-6 décembre: Rencontres combinées: 9e Congrès mexicain d'acoustique, 144e rencontre de l'Acoustical Society of America, et 3e Congrès ibéro-américain d'acoustique, Cancun, Mexique. Info: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tél: 516-576-2360; Fax: 516-576-2377;Courriel:asa@aip.org; Web: asa.aip.org/cancun.html

9-13 décembre: Symposium international sur l'acoustique musicale (ISMA Mexico City), Mexico, Mexique. Fax: +52 55 5601 3210; Web: www.unam.mx/enmusica/ismamexico.html

11-13 décembre: Conférence internationale sur les capteurs et systèmes sonar (ICONS2002), Cochin (Kerala), Inde. Info: H.R.S. Sastry, Naval Physical and Oceanography Laboratory, Thrikkakaro, Cochin-682021, Kerala, India; Fax: +91 484 424858; Courriel: root@drnpol.drdo.com

19-21 décembre: 3e Conférence internationale WSEAS sur l'acoustique, la musique, la parole et le traitement du langage, Ténérife, Îles Canaries, Espagne. Web: www.wseas.org/conferences/2002/tenerife/icamsl/

2003

9-10 janvier: Mesures et étalonnage en acoustique sous-marine, Teddington, Middlesex, Royaume-Uni. Info: S. Robinson, National Physical Laboratory, Teddington, Middlesex TW11 0LW, UK; Fax: +44 208 943 6217; Web: www.ioa.org.uk/meetings/calibration_2002.html

17-20 mars: Rencontre de la Société allemande d'acoustique (DAGA2003), Aachen, Allemagne. Fax: +49 441 798 3698; Courriel: dega@akuphysik.uni-oldenburg.de

18-20 mars: Rencontre de printemps de la Société japonaise d'acoustique, Tokyo, Japon. Info: Acoustical Society of Japan, Nakaura 5th-Bldg., 2-18-20 Sotokanda, Chiyoda-ku, Tokyo 101-0021,Japan;Fax:+8135256 1022; Web: wwwsoc.nii.ac.jp/asj/

24-26 mars: 27e Symposium international sur la formation d'image acoustique, Saarbrücken, Allemagne. Info: Ms. Y. Spindler, Fraunhofer Institute for Non-Destructive Testing, Bldg. 37, University, 66123 Saarbrücken, Germany; Fax: +49 6819302 5903; Web: www.izfp.fhg.de

6-10 avril: Conférence IEEE internationale sur l'acoustique, la parole, et le traitement de signal, Hong Kong, Hong Kong. Info: Wan-Chi Siu, Hong Kong Polytechnic University, Hong Kong; Web: www.en.polyu.edu.hk/%7Ecassp03

7-9 April: WESPAC8, Melbourne, Australia. Web: www.wespac8.com

28 April – 2 May: 145th Meeting of the Acoustical Society of America, Nashville, TN. Contact: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tel: 516-576-2360; Fax: 516-576-2377; E-mail: asa@aip.org; Web: asa.aip.org

5-8 May: SAE Noise & Vibration Conference & Exhibition, Traverse City, MI. Contact: P. Kreh, SAE International, 755 W. Big Beaver Rd., Suite 1600, Troy, MI 48084; Fax: 724-776-1830; Web: www.sae.org

19-21 May: 5th European Conference on Noise Control (Euronoise 2003), Naples, Italy. Contact: DETEC, University of Naples Federico II, P. le Tecchio 80, 80125 Napoli, Italy; Fax: +39 81 239 0364; Web: www.euronoise2003.it

8-13 June: XVIII International Evoked Response Audiometry Study Group Symposium, Puerto de la Cruz, Tenerife, Canary Islands, Spain. Fax: +34 922 27 03 64; Web: www.ierasg-2003.org

16-18 June: · ACOUSTICS – Modeling & Experimental Measurements, Cadiz, Spain. Contact: Acoustics03, Wessex Institute of Technology, Ashurst Lodge, Ashurst, Southampton SO40 7AA, UK; Fax: +44 238 029 2853; Web: www.wessex.ac.uk/conference/2003/acoustics/index.html

29 June – 3 July: 8th Conference on Noise as a Public Health Problem, Amsterdam-Rotterdam, The Netherlands. Contact: Congress Secretariat, PO Box 1558, 6501 BN Nijmegen, The Netherlands; Fax: +31 24 360 1159; E-mail: office.nw@prompt.nl

7-11 July: 10th International Congress on Sound and Vibration, Stockholm, Sweden. Contact: Congress Secretariat, Congrex Sweden AB; Tel: +46 8 459 66 00; Fax: +46 8 8 661 91 25; E-mail: icsv10@congrex.se; Web: www.congex.com/icsv10

14-16 July: 8th International Conference on Recent Advances in Structural Dynamics, Southampton, UK. Web: www.isvr.soton.ac.uk/sd2003

6-9 August: Stockholm Music Acoustics Conference 2003 (SMAC03), Stockholm, Sweden. Contact: www.speech.kth.se/music/smac03

25-27 August: Inter-Noise 2003, Jeju Island, Korea. Contact: Dept. of Mechanical Engineering, KAIST, 373-1, Kusong-dong, Yusong-gu, Taejon 305-701, Korea; Fax: +82 42 869 8220; Web: www.icjeju.co.kr

1-4 September: Eurospeech 2003, Geneva, Switzerland. Contact: SYMPORG SA, Avenue Krieg 7, 1208 Geneva, Switzerland; Fax: +41 22 839 8485; Web: www.symporg.ch/eurospeech2003

7-10 September: World Congress on Ultrasonics, Paris, France. Web: www.sfa.asso.fr/wcu2003

7-9 avril: WESPAC8, Melbourne, Australie. Web: www.wespac8.com

28 avril – 2 mai: 145e rencontre de l'Acoustical Society of America, Nashville, TN. Info: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tél.: 516-576-2360; Fax: 516-576-2377; Courriel: asa@aip.org; Web: asa.aip.org

5-8 mai: Conférence et exhibition SAE sur le bruit et les vibrations, Traverse City, MI. Info: P. Kreh, SAE International, 755 W. Big Beaver Rd., Suite 1600, Troy, MI 48084; Fax: 724-776-1830; Web: www.sae.org

19-21 mai: 5e Conférence européenne sur le contrôle du bruit (Euronoise 2003), Naples, Italie. Info: DETEC, University of Naples Federico II, P. le Tecchio 80, 80125 Napoli, Italy; Fax: +39 81 239 0364; Web: www.euronoise2003.it

8-13 juin: XVII Symposium international du Groupe expérimental sur l'audiométrie des potentiels évoqués, Puerto de la Cruz, Tenerife, Iles Canaries, Espagne. Fax: +34 922 27 03 64; Web: www.ierasg-2003.org

16-18 juin: ACOUSTICS – Modélisation et mesures expérimentales, Cadiz, Espagne. Info: Acoustics03, Wessex Institute of Technology, Ashurst Lodge, Ashurst, Southampton SO40 7AA, UK; Fax: +44 238 029 2853; Web: www.wessex.ac.uk/conference/2003/acoustics/index.html

29 juin – 3 juillet: 8e conférence sur le bruit, un problème de santé publique, Amsterdam-Rotterdam, Pays-Bas. Info: Congress Secretariat, PO Box 1558, 6501 BN Nijmegen, The Netherlands; Fax: +31 24 360 1159; Courriel: office.nw@prompt.nl

7-11 juillet: 10e Congrès international sur le bruit et les vibrations, Stockholm, Suède. Info: Congress Secretariat, Congrex Sweden AB; Tél.: +46 8 459 66 00; Fax: +46 8 8 661 91 25; Courriel: icsv10@congrex.se; Web: www.congex.com/icsv10

14-16 juillet: 8e Conférence internationale sur les développements récents en dynamique structurelle, Southampton, Royaume-Uni. Web: www.isvr.soton.ac.uk/sd2003

6-9 août: Conférence 2003 d'acoustique musicale de Stockholm (SMAC03), Stockholm, Suède. Info: www.speech.kth.se/music/smac03

25-27 août: Inter-Noise 2003, Île Jeju, Corée. Info: Dept. of Mechanical Engineering, KAIST, 373-1, Kusong-dong, Yusong-gu, Taejon 305-701, Korea; Fax: +82 42 869 8220; Web: www.icjeju.co.kr

1-4 septembre: Eurospeech 2003, Genève, Suisse. Info: SYMPORG SA, Avenue Krieg 7, 1208 Geneva, Switzerland; Fax: +41 22 839 8485; Web: www.symporg.ch/eurospeech2003

7-10 septembre: Congrès mondial sur les ultra-sons, Paris, France. Web: www.sfa.asso.fr/wcu2003

15-17 October: 34th Spanish Congress on Acoustics, Bilbao, Spain. Contact: Sociedad Española de Acústica, Serrano 144, 28006 Madrid, Spain; Fax: +34 91 411 7651; Web: www.ia.csic.es/sea/index.html

10-14 November: 146th Meeting of the Acoustical Society of America, Austin, TX. Contact: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tel: 516-576-2360; Fax: 516-576-2377; E-mail: asa@aip.org; Web: asa.aip.org

11-13 December: 3rd International Workshop on Models and Analysis of Vocal Emissions for Biomedical Applications, Firenze, Italy. Fax: +39 55 479 6767; Web: www.maveba.org

2004

22-26 March: Joint Congress of the French and German Acoustical Societies (SFA-DEGA), Strasbourg, France. Contact: Société Française d'Acoustique, 23 avenue Brunetière, 75017 Paris, France; Fax: +49 441 798 3698; E-mail: sfa4@wanadoo.fr

5-9 April: 18th International Congress on Acoustics (ICA2004), Kyoto, Japan. Web: ica2004.or.jp

24-28 May: 75th Anniversary Meeting (147th Meeting) of the Acoustical Society of America, New York, NY. Contact: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tel: 516-576-2360; Fax: 516-576-2377; E-mail: asa@aip.org; Web: asa.aip.org

23-27 August: 2004 IEEE International Ultrasonics, Ferroelectrics, and Frequency Control 50th Anniversary Conference, Montreal, Canada. Contact: R. Garvey, Datum, 34 Tozer Road, Beverly, MA 01915-5510; Fax: +1 978 927 4099; Web: www.ieee-uffc.org/index2-asp

13-17 September: 4th Iberoamerican Congress on Acoustics, 4th Iberian Congress on Acoustics, 35th Spanish Congress on Acoustics, Guimarães, Portugal. Contact: Sociedade Portuguesa de Acústica, Laboratório Nacional de Engenharia Civil, Avenida do Brasil 101, 1700-066 Lisboa, Portugal; Fax: +351 21 844 3028; E-mail: dsilva@lnec.pt

22-26 November: 148th Meeting of the Acoustical Society of America, San Diego, CA. Contact: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tel: 516-576-2360; Fax: 516-576-2377; E-mail: asa@aip.org; Web: asa.aip.org

15-17 octobre: 34e Congrès espagnole d'acoustique, Bilbao, Espagne. Info: Sociedad Española de Acústica, Serrano 144, 28006 Madrid, Spain; Fax: +34 91 411 7651; Web: www.ia.csic.es/sea/index.html

10-14 novembre: 146e rencontre de l'Acoustical Society of America, Austin, TX. Info: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tél.: 516-576-2360; Fax: 516-576-2377; Courriel: asa@aip.org; Web: asa.aip.org

11-13 décembre: 3e Atelier international sur les modèles et analyse d'émissions vocales avec applications bio-médicales, Florence, Italie. Fax: +39 55 479 6767; Web: www.maveba.org

2004

22-26 mars: Congrès conbiné des Sociétés française et allemande d'acoustique (SFA-DEGA), Strasbourg, France. Info: Société Française d'Acoustique, 23 avenue Brunetière, 75017 Paris, France; Fax: +49 441 798 3698; Courriel: sfa4@wanadoo.fr

5-9 avril: 18e Congrès international sur l'acoustique (ICA2004), Kyoto, Japon. Web: ica2004.or.jp

24-28 mai: 75e rencontre anniversaire (147e rencontre) de l'Acoustical Society of America, New York, NY. Info: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tél.: 516-576-2360; Fax: 516-576-2377; Courriel: asa@aip.org; Web: asa.aip.org

23-27 août: 50e Conférence anniversaire internationale IEEE 2004 sur les ultra-sons, la ferroélectricité et la régulation par la fréquence, Montréal, Canada. Info: R. Garvey, Datum, 34 Tozer Road, Beverly, MA 01915-5510; Fax: +1 978 927 4099; Web: www.ieee-uffc.org/index2-asp

13-17 septembre: 4e Congrès ibéro-américain d'acoustique, 4e Congrès ibérien d'acoustique, 35e Congrès espagnol d'acoustique, Guimarães, Portugal. Info: Sociedade Portuguesa de Acústica, Laboratório Nacional de Engenharia Civil, Avenida do Brasil 101, 1700-066 Lisboa, Portugal; Fax: +351 21 844 3028; Courriel: dsilva@lnec.pt

22-26 novembre: 148e rencontre de l'Acoustical Society of America, San Diego, CA. Info: Acoustical Society of America, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502; Tél.: 516-576-2360; Fax: 516-576-2377; Courriel: asa@aip.org; Web: asa.aip.org

The Canadian Acoustical Association
l'Association Canadienne d'Acoustique

PRIZE ANNOUNCEMENT

A number of prizes, whose general objectives are described below, are offered by the Canadian Acoustical Association. As to the first four prizes, applicants must submit an application form and supporting documentation to the prize coordinator before the end of February of the year the award is to be made. Applications are reviewed by subcommittees named by the President and Board of Directors of the Association. Decisions are final and cannot be appealed. The Association reserves the right not to make the awards in any given year. Applicants must be members of the Canadian Acoustical Association. Preference will be given to citizens and permanent residents of Canada. Potential applicants can obtain full details, eligibility conditions and application forms from the appropriate prize coordinator.

Edgar and Millicent Shaw Postdoctoral Prize in Acoustics

This prize is made to a highly qualified candidate holding a Ph.D. degree or the equivalent, who has completed all formal academic and research training and who wishes to acquire up to two years supervised research training in an established setting. The proposed research must be related to some area of acoustics, psychoacoustics, speech communication or noise. The research must be carried out in a setting other than the one in which the Ph.D. degree was earned. The prize is for $3000 for full-time research for twelve months, and may be renewed for a second year. Coordinator: Sharon Abel, Mount Sinai Hospital, 600 University Avenue, Toronto, ON M5G 1X6. Past recipients are:

1999	*Jingnan Guo*	*University of British Columbia*	*2001*	*Frank Russo*	*Queens University*

Alexander Graham Bell Graduate Student Prize In Speech Communication and Behavioural Acoustics

The prize is made to a graduate student enrolled at a Canadian academic institution and conducting research in the field of speech communication or behavioural acoustics. It consists of an $800 cash prize to be awarded annually. Coordinator: Don Jamieson, Department of Communicative Disorders, University of Western Ontario, London, ON N6G 1H1. Past recipients are:

2000	*Janna Rieger*	*University of Alberta*	*2001*	*Ian Wilson*	*University of British Columbia*

Fessenden Student Prize in Underwater Acoustics

The prize is made to a graduate student enrolled at a Canadian university and conducting research in underwater acoustics or in a branch of science closely connected to underwater acoustics. It consists of $500 cash prize to be awarded annually. Coordinator: David Chapman, DREA, PO Box 1012, Dartmouth, NS B2Y 3Z7.

2000	*Vanessa Corre*	*University of Victoria*	*2001*	*Anna-Liesa Lapinski*	*University of Victoria*

Eckel Student Prize in Noise Control

The prize is made to a graduate student enrolled at a Canadian academic institution pursuing studies in any discipline of acoustics and conducting research related to the advancement of the practice of noise control. It consists of a $500 cash prize to be awarded annually. The prize was inaugurated in 1991. Coordinator: Murray Hodgson, Occupational Hygiene Programme, University of British Columbia, 2206 East Mall, Vancouver, BC V6T 1Z3.

2000	*Lillian Ciona*	*University of Western Ontario*	*2001*	*Eva-Marie Nosal*	*University of British Columbia*

Directors' Awards

Three awards are made annually to the authors of the best papers published in *Canadian Acoustics*. All papers reporting new results as well as review and tutorial papers are eligible; technical notes are not. The first award, for $500, is made to a graduate student author. The second and third awards, each for $250, are made to professional authors under 30 years of age and 30 years of age or older, respectively. Coordinator: Kathy Pichora-Fuller, University of British Columbia, Vancouver, BC.

Student Presentation Awards

Three awards of $500 each are made annually to the undergraduate or graduate students making the best presentations during the technical sessions of Acoustics Week in Canada. Application must be made at the time of submission of the abstract. Coordinator: Karen Fraser, CN Rail, Toronto ON , Tel: (416) 217-6466.

The CAA Underwater Acoustics and Signal Processing Student Travel Subsidy

Two $250 awards or one $500 award are made annually to university students traveling to national or international conferences to give oral or poster presentations on underwater acoustics and/or signal processing. The award winners will be selected on a first-come, first served basis. Applications must be received on or before September 30 and apply to attendance at conferences within the following 12 months.

Coordinator: Dave Stredulinsky, DREA, PO Box 1012, Dartmouth, NS B2Y 3Z7.

The Canadian Acoustical Association
l'Association Canadienne d'Acoustique

ANNONCE DE PRIX

Plusieurs prix, dont les objectifs généraux sont décrits ci-dessous, sont décernés par l'Association Canadienne d'Acoustique. Pour les quatre premiers prix, les candidats doivent soumettre un formulaire de demande ainsi que la documentation associée au coordonnateur de prix avant le dernier jour de février de l'année durant laquelle le prix sera décerné. Toutes les demandes seront analysées par des sous-comités nommés par le président et la chambre des directeurs de l'Association. Les décisions seront finales et sans appel. L'Association se réserve le droit de ne pas décerner les prix une année donnée. Les candidats doivent être membres de l'Association. La préférence sera donnée aux citoyens et aux résidents permanents du Canada. Les candidats potentiels peuvent se procurer de plus amples détails sur les prix, leurs conditions d'éligibilité, ainsi que des formulaires de demande auprès du coordonnateur de prix.

Prix Post-Doctoral Edgar et Millicent Shaw en Acoustique

Ce prix est attribué à un(e) candidat(e) hautement qualifié(e) et détenteur(rice) d'un doctorat ou l'équivalent, qui a complèté(e) ses études et sa formation de chercheur, et qui désire acquérir jusqu'à deux années de formation supervisée de recherche dans un établissement reconnu. Le thème de recherche proposée doit être relié à un domaine de l'acoustique, de la psycho-acoustique, de la communication verbale ou du bruit. La recherche doit être menée dans un autre milieu que celui où le candidat a obtenu son doctorat. Le prix est de $3000 pour une recherche plein temps de 12 mois avec possibilité de renouvellement pour une deuxième année. Coordonnatrice: Sharon Abel, Mount Sinai Hospital, 600 University Avenue, Toronto, ON M5G 1X6. Les récipiendaires antérieur(e)s sont:

1999	*Jingnan Guo*	*University of British Columbia*	*2001*	*Frank Russo*	*Queens University*

Prix Étudiant Alexander Graham Bell en Communication Verbale et Acoustique Comportementale

Ce prix sera décerné à un(e) étudiant(e) inscrit(e) dans une institution académique canadienne et menant un projet de recherche en communication verbale ou acoustique comportementale. Il consiste en un montant en argent de $800 qui sera décerné annuellement. Coordonnateur: Don Jamieson, Department of Communicative Disorders, University of Western Ontario, London, ON N6G 1H1. Les récipiendaires antérieur(e)s sont:

2000	*Janna Rieger*	*University of Alberta*	*2001*	*Ian Wilson*	*University of British Columbia*

Prix Étudiant Fessenden en Acoustique Sous-marine

Ce prix sera décerné à un(e) étudiant(e) inscrit(e) dans une institution académique canadienne et menant un projet de recherche en acoustique sous-marine ou dans une discipline scientifique reliée à l'acoustique sous-marine. Il consiste en un montant en argent de $500 qui sera décerné annuellement. Coordonnateur: David Chapman, DREA, PO Box 1012, Dartmouth, NS B2Y 3Z7.

2000	*Vanessa Corre*	*University of Victoria*	*2001*	*Anna-Liesa Lapinski*	*University of Victoria*

Prix Étudiant Eckel en Contrôle du Bruit

Ce prix sera décerné à un(e) étudiant(e) inscrit(e) dans une institution académique canadienne dans n'importe quelle discipline de l'acoustique et menant un projet de recherche relié à l'avancement de la pratique en contrôle du bruit. Il consiste en un montant en argent de $500 qui sera décerné annuellement. Ce prix a été inauguré en 1991. Coordonnateur: Murray Hodgson, Occupational Hygiene Programme, University of British Columbia, 2206 East Mall, Vancouver, BC V6T 1Z3.

2000	*Lillian Ciona*	*University of Western Ontario*	*2001*	*Eva-Marie Nosal*	*University of British Columbia*

Prix des Directeurs

Trois prix sont décernés, à tous les ans, aux auteurs des trois meilleurs articles publiés dans l'*Acoustique Canadienne.* Tout manuscrit rapportant des résultats originaux ou faisant le point sur l'état des connaissances dans un domaine particulier sont éligibles; les notes techniques ne le sont pas. Le premier prix, de $500, est décerné à un(e) étudiant(e) gradué(e). Le deuxième et le troisième prix, de $250 chacun, sont décernés à des auteurs professionnels âgés de moins de 30 ans et de 30 ans et plus, respectivement. Coordonnateur: Kathy Pichora-Fuller, University of British Columbia, Vancouver, BC.

Prix de Présentation Étudiant

Trois prix, de $500 chacun, sont décernés annuellement aux étudiant(e)s sous-gradué(e)s ou gradué(e)s présentant les meilleures communications lors de la Semaine de l'Acoustique Canadienne. La demande doit se faire lors de la soumission du résumé. Coordonnateur: Karen Fraser, CN Rail, Toronto ON, Tel: (416) 217-6466.

Subvention des frais de déplacement pour les étudiants en Acoustique Sous-Marine et Traitement du Signal - Association Canadienne d'Acoustique.

Deux bourses de 250 $ et une bourse de 500 $ sont attribuées chaque année à des étudiants d'université qui se rendent à une conférence nationale ou internationale pour y présenter un article ou un poster dans le domaine de l'acoustique sous-marine et/ou du traitement du signal. Ces bourses sont attribuées aux tous premiers étudiants qui en font la demande. Les candidatures doivent parvenir avant le 30 septembre de l'année en cours et doivent concerner une conférence qui se tient dans les 12 mois suivants.

Responsable: Dave Stredulinski, DREA, P.O. Box 1012, Dartmouth, NS B2Y 3Z7

Canadian Acoustical Association
l'Association Canadienne d'Acoustique

2002 PRIZE WINNERS / RÉCIPIENDAIRES 2002

EDGAR AND MILLICENT SHAW POSTDOCTORAL PRIZE IN ACOUSTICS
PRIX POST-DOCTORAL EDGAR ET MILLICENT SHAW EN ACOUSTIQUE

Desheng Li, University of British Columbia

"Active control of workplace noise exposure"

ECKEL STUDENT PRIZE IN NOISE CONTROL/ PRIX ÉTUDIANT ECKEL EN CONTRÔLE DU BRUIT

Ann Nakashima, University of British Columbia

"Active control of airport run-up noise"

DIRECTORS' AWARDS / PRIX DES DIRECTEURS

Professional ≥30 years / Professionel ≥30 ans:

Gignan Guo, University of Western Australia

"Active control of an off-axis noise source"

Student / Étudiant(e):

Alex Boudreau, Université de Sherbrooke

"Techniques for using ray tracing for complicated spaces"

STUDENT AWARDS / PRIX ÉTUDIANT

Matthew S. Barlee, University of Victoria

"Matched beam processing for localizing an acoustic source on shallow water environments"

Steve Bilawchuk, University of Alberta,

"3-pt method for measuring transmission loss in silencers"

Jérémie Voix, Ecole de technologie supérieure, Montréal

"Filter selection to adapt earplug performances to sound exposure"

Canada Wide Science Fair Award in Acoustics

Natalie Silvanovich, Greater Vancouver

""Detecting stealth aircraft"

CONGRATULATIONS / FÉLICITATIONS

The Future of Quiet ?

Acoustics Week in Canada October 14–17, 2003 Edmonton, Alberta The Westin Edmonton
www.caa-aca.ca/edmonton-2003.html

FIRST ANNOUNCEMENT AND CALL FOR PAPERS

Conference Theme: "*The Future of Quiet ?*": Where is the "happy medium" between privacy and being connected to others? We all appreciate that there are times we need to be by ourselves or in limited company and other times where large numbers of us want to communicate. The 2003 Edmonton Conference of the Canadian Acoustical Association aims to use this underlying theme for the plenary and technical sessions to be held 14-17 October 2003. Whether we work in speech pathology, underwater acoustics, noise control or in the marketing of communication-related products, it always seems to be the finest of lines as to where communication is "wanted" (... I want to hear and understand what you are telling me...) or "unwanted" (... do not disturb ...). Join us as we together, with friends and colleagues from Canada and abroad, explore this and many other aspects of the vital field of "acoustics in Canada".

Scientific and Technical Papers: As in previous Acoustics Week in Canada conferences, the 2003 Edmonton Conference will ensure that all areas of acoustics are represented. The sessions will include plenary lectures, invited and contributed papers, panel discussions and exhibits. To ensure that all areas of acoustics are represented the Technical Chairs are putting together a group of highly-skilled and motivated individuals to act as session chairs. They can only be successful if the membership, including students, attends the conference and deliver/present papers. The following technical areas are proposed:

Industrial Noise	Building/Architectural acoustics	Vibration
Outdoor sound propagation	Speech perception	Occupational hearing loss
Hearing protection	Acoustic materials	Underwater acoustics
Physiological acoustics	Sound quality	Legislation/Environmental noise
Transportation noise	Canadian standards	Instrumentation
Computer applications	Community noise	Musical acoustics

Abstracts: A short abstract (maximum: 250 words) of your paper should be prepared and submitted **by Friday, 30-May-2003**. Your Abstract should be prepared in accordance with the Instructions-to-Authors appearing elsewhere in this Journal. Preparation of abstracts in all common word-processing software can be accommodated. Submission by email is strongly encouraged though submission of an abstract by fax or as a hard-copy or on floppy-disk by regular mail will be accepted. Abstracts will be peer-reviewed. Notification of acceptance of a paper will be by the end of June 2003. Included in this Notification will be a Registration Form. The voluntary 2-page Proceedings copy of your Paper will be required by Friday, 01-August-2003. This deadline is firm for inclusion in the Proceedings Issue (September 2003) of the journal *Canadian Acoustics*. Upon acceptance of Abstracts, these will be posted on the Conference web-site (unless you request non-posting).

Proposals for **Special Sessions** on a particular topic in acoustics are welcome. Please contact the Steering Committee soon if you wish to organize a special session or have a suggestion for a particular session, social event or activity.

Student Participation in Acoustics Week in Canada is strongly encouraged. **Awards** are available to students whose presentations at the conference are judged to be particularly noteworthy. To qualify, students must apply by enclosing an Annual Student Presentation Award form with their abstract. Students presenting papers may also apply for a travel subsidy to attend the meeting if they live at least 150 km from Edmonton. To apply for this subsidy, students must submit an Application for Student Travel Subsidy. Forms are available on the web-site. NB: for either awards or travel subsidy students **must** have membership in CAA ($15).

Accommodation: The Westin Edmonton is located in the heart of downtown Edmonton in the immediate proximity of arts venues (Citadel Theatre, Winspear Concert Hall, Edmonton Art Gallery, etc.), and major retail and recreational high-lights, including Edmonton's famed North Saskatchewan River valley park/trail system. The Westin Edmonton will provide accommodation and meeting space (http://www.thewestinedmonton.com). The special (double/single occupancy) room rate for delegates is $117.00 per night; a block of 60 guest-rooms has been made available to CAA conference delegates. The rate applies for two days prior to and after the conference (subject to availability). To reserve accommodation, please contact the hotel directly by telephone (1-800-WESTIN1; 1-780-493-8999, Fax 1-780-493-8968) or email (tara.jeffery@westin.com) and mention the CAA meeting. The reservation cut-off date is 5 p.m., Friday 12-September-2003. After this date, the special rates are subject to availability. Should the Conference Hotel be fully booked, other hotels, for every budget, are located within walking distance of the Conference site (check the web-site: http://www.edmonton.ca).

Workshops/Seminars: As a tradition, several half-day and full-day workshops may be offered 14- or 18-October, just before or after the technical program and exhibition begins, giving opportunity for continuing education in acoustics. If you are interested in giving a workshop or have a suggested presenter, please contact the Convenor. Check the January-2003 issue of *Canadian Acoustics* or the Conference web-site for updates or developments.

Exhibits: An exhibition of the latest technologies in acoustics and vibration equipment, materials and software will occur Wednesday and Thursday, 15-16 October. Exhibitors will be well integrated into the conference setting and featured in a special session of the conference program. Sponsorship by exhibitors of breaks and/or lunches is also welcome. (Contact the conference Convenor or Izzy Gliener).

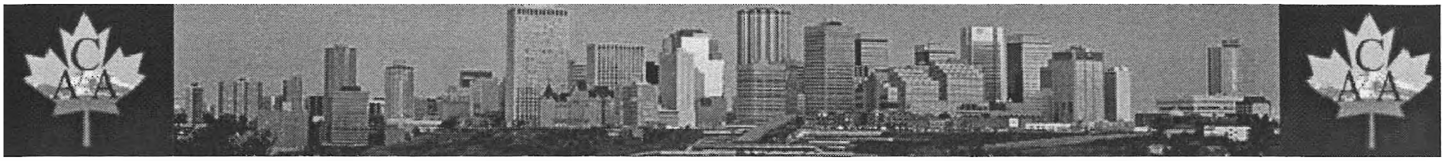
Canadian Standards Acoustics: Canadian Standards Association Committee Z 107 in Acoustics and Noise Control will hold a meeting (organizer: Cameron Sherry, Cwsherry@aol.com). All welcome.

Hospitality: In the tradition of past CAA meetings, preparations are underway for a delegate reception (Tuesday, 14-Oct), some joint lunches and a Conference Banquet with awards-ceremony. As much as feasible, opportunity will be provided for you to personally sample some of the best Edmonton hospitality, entertainment and culture. Remember, weather in Edmonton in October is unpredictable: It may be either mild/late-summer or snowed-in (i.e. bring a sweater ...). For details, check the web-site http://www.edmonton.ca and click on "Enjoying Edmonton" (Warning!: allow lots of browsing time .....)

Important Dates 2003	
Friday, 30-May	Deadline for receipt of abstracts
Friday, 27-June	Notice of acceptance of abstracts
Friday 01-August	Deadline for receipt of summary paper and early registration
Tuesday, 14-October	Acoustics Week in Canada begins: Registration, Workshops & Seminars
Wed.-Fri., 15-17 October	Acoustics Week in Canada: Technical Program and Exhibition

Contacts & Information	
Main Address:	#102, 9920 – 63 Avenue Edmonton, AB, T6E 0G9 Phone: (780) 414-6373 FAX: (780) 414-6376
Web-site address:	http://caa-aca.ca/edmonton-2003.html
e-mail Address	conference@caa-aca.ca
Convenor:	Corjun Buma
Secretary:	Megan Hodge
Co-coordinator Technical Program:	Gary Faulkner
Exhibitor Co-ordinator:	Izzy Gliener
Web-Master:	Steven Bilawchuk
NOTE:	additional email addresses will be activated after 01-January-2003

L'avenir du silence ?



Semaine canadienne d'acoustique, 14–17 octobre 2003, Edmonton, Alberta The Westin Edmonton
www.caa-aca.ca/edmonton-2003.html

PREMIÈRE ANNONCE ET APPEL DE COMMUNICATIONS

Thème du congrès : *" L'avenir du silence ?"* : Peut-on trouver un juste milieu entre l'intimité et les relations interpersonnelles ? La plupart d'entre nous apprécions tout autant les moments de solitude ou en compagnie restreinte que les activités sociales ou professionnelles où nous souhaitons communiquer avec un grand nombre de personnes. Le Congrès 2003 de l'Association Canadienne d'Acoustique (ACA) à Edmonton vise à sonder ce thème fondamental du silence lors des sessions plénières et techniques auront lieu du 14 au 17 octobre 2003. Que nous travaillions dans les domaines de la pathologie du langage, de l'acoustique sous-marine, du contrôle du bruit ou dans le marketing de produits de communications, il semble souvent difficile de tracer cette ligne fine qui sépare les échanges «souhaités» (... je veux entendre et comprendre ce que vous me dites ...) et les «indésirables» (...ne pas déranger ...). Amis et collègues du Canada et d'ailleurs, venez vous joindre à nous pour explorer ce domaine et bien d'autres aspects de «l'acoustique au Canada».

Communications scientifiques et techniques: À l'instar des Semaines Canadiennes d'Acoustique antérieures, le Congrès de 2003 à Edmonton s'assurera que toutes les branches de l'acoustique soient représentées. Le Congrès comprendra des sessions plénières, des conférences invitées et soumises, des discussions de groupe et une exposition. Afin d'assurer une représentation complète de toutes les spécialités reliées à l'acoustique, le Comité du programme scientifique sélectionnera des individus motivés et hautement qualifiés pour agir à titre de Présidents de session technique. Ces derniers ne pourront réussir qu'avec la participation des membres, étudiants inclus, au Congrès. C'est pourquoi nous sollicitons la soumission et la présentation d'articles dans les domaines techniques suivants :

Bruits industriels	Acoustique architecturale	Vibrations
Propagation des bruits d'extérieur	Perception du langage	Perte d'audition professionnelle
Protection de l'ouïe	Matériaux acoustiques	Acoustique sous-marine
Acoustique physiologique	Qualité du son	Réglementation/Bruits environnementaux
Bruits de transport	Normes canadiennes	Instrumentation
Applications numériques	Bruits communautaires	Acoustique musicale

Résumés : Un court résumé (maximum 250 mots) de votre article devrait être soumis **avant vendredi le 30 mai 2003.** Votre résumé devrait être préparé selon les «instructions de rédaction» apparaissant ailleurs dans ce Journal. Tout logiciel courant de traitement de texte peut être utilisé pour la préparation de résumés. Les soumissions par courriel sont grandement préférables, mais les soumissions par fax ou par la poste, sur papier ou sur disquette, seront acceptées. Les résumés seront évalués par des pairs. Les avis d'acceptation de conférence seront rendus avant la fin de juin 2003. Le formulaire d'inscription sera joint à cet avis. Un article facultatif d'au plus 2 pages devra être remis avant le vendredi 1er août 2003, s'il doit être inclus dans les Actes du Congrès. Cette date d'échéance est fixe pour les fins de publication dans le Cahier des Actes (septembre 2003) du journal *Acoustique Canadienne*. Suite à l'acceptation des résumés, ceux-ci seront affichés dans le site internet du Congrès (à moins d'un avis contraire de la part des auteurs).

Les propositions de **Sessions spéciales** traitant de sujets spécifiques en acoustique sont les bienvenues. Si vous souhaitez organiser une session spéciale ou suggérer un sujet de session, un événement ou une activité sociale, veuillez contacter le Comité organisateur dès que possible.

La participation des étudiants à la Semaine Canadienne d'Acoustique est fortement encouragée. Des **prix** seront décernés aux étudiants dont la conférence, lors du Congrès, sera jugée remarquable. Pour participer à cette compétition, les étudiants doivent s'y inscrire en joignant à leur résumé le formulaire «Prix annuels des meilleures présentations étudiantes» dûment rempli. De plus, les étudiants qui vivent à plus de 150 km d'Edmonton peuvent bénéficier d'une aide financière de voyage pour leur permettre de présenter une conférence lors du Congrès. Pour demander cette subvention, les étudiants doivent soumettre le formulaire «Subvention de voyage pour étudiants». Les formulaires sont disponibles sur notre site internet. Note : Seuls les étudiants membres de l'ACA ($15) sont éligibles aux prix et aux subventions de voyage.

Hébergement : Le Westin Edmonton est situé au cœur du centre-ville d'Edmonton, à proximité du district des arts (*Citadel Theatre, Winspear Concert Hall, Edmonton Art Gallery*, etc.) et des lieux majeurs de magasinage et de récréation, incluant le réseau de sentiers du parc *North Saskatchewan River valley*. Le Westin Edmonton fournira l'hébergement et les salles de conférence (http://www.thewestinedmonton.com). Un bloc de 60 chambres à été mis à la disposition des délégués au Congrès de l'ACA; le tarif spécial des chambres (occupation simple /double) pour les délégués est de $117.00 la nuitée. Ce taux sera en vigueur deux jours avant et deux jours après la conférence (selon la disponibilité). Pour réserver, veuillez contacter l'hôtel directement par téléphone (1-800-WESTIN1; 1-780-493-8999), par fax (1-780-493-8968) ou par courriel (tara.jeffery@westin.com) et mentionnez votre participation au Congrès de l'ACA. La date limite de réservation est le vendredi 12 septembre 2003 à 17h00. Après cette date, le tarif spécial dépendra de la disponibilité des chambres. Advenant que l'hôtel du Congrès soit complet, d'autres hôtels, de tarifs divers, sont situés près du site du Congrès (visitez le site internet http://www.edmonton.ca).

Ateliers/Séminaires : Comme le veut la tradition, plusieurs ateliers d'une durée d'une demi-journée ou d'une journée entière peuvent être offerts le 14 ou le 18 octobre, soit juste avant ou après le programme technique et l'exposition. C'est une occasion pour les participants d'obtenir une formation complémentaire en acoustique. Si vous êtes intéressé à animer un atelier ou si vous pouvez recommander un présentateur, veuillez contacter le Président du Congrès. Veuillez vérifier le numéro de janvier 2003 de *Acoustique Canadienne* ou le site internet du Congrès pour connaître les dernières nouvelles et mises à jour.

Expositions : Il y aura une exposition des plus récentes technologies en matière d'équipement, de matériaux et de logiciels d'acoustique et de vibrations, les mercredi et jeudi 15-16 octobre. Les exposants seront bien intégrés au déroulement de la conférence et se distingueront lors d'une session spéciale du programme du Congrès. Nous accueillons les commandites de la part des exposants pour les repas et les pauses (Contactez le Président du Congrès de la conférence ou Izzy Gliener).

Normes Canadiennes en Acoustique : Il y aura une réunion du comité Z 107 en Acoustique et Contrôle du Bruit, de l'Association Canadienne de la Normalisation (organisateur : Cameron Sherry, Cwsherry@aol.com). Bienvenue à tous !

Hospitalité : Dans le respect des traditions des réunions de l'ACA, des préparations sont en cours pour l'accueil des délégués (mardi, le 14 oct.), les dîners conjoints et un banquet avec cérémonie de remise des prix. Dans la mesure du possible, des occasions vous seront fournies pour découvrir ce qu'il y a de mieux en termes d'hospitalité, de divertissement et de la culture d'Edmonton. N'oubliez pas que les conditions météorologiques d'Edmonton au mois d'octobre sont imprévisibles : il pourrait faire un temps de fin d'été, comme il pourrait y avoir de la neige (apportez-vous un chandail !). Pour de plus amples renseignements, visitez le site internet http://www.edmonton.ca et cliquez sur «Enjoying Edmonton» (Attention ! : prévoyez amplement de temps pour magasiner...)

Dates à retenir pour 2003	
Vendredi 30 mai	Échéance pour la réception des résumés courts
Vendredi 27 juin	Avis d'acceptation des résumés
Vendredi 01 août	Échéance pour la réception des articles et l'inscription hâtive
Mardi 14 octobre	Lancement de la Semaine Canadienne d'Acoustique : Inscription, Ateliers & Séminaires
mer.-ven.15-17 octobre	Semaine Canadienne d'Acoustique : Programme technique et exposition

Contacts & Information	
Adresse de correspondance:	#102, 9920 – 63 Avenue, Edmonton, AB, T6E 0G9, Tél.: (780) 414-6373, Fax: (780) 414-6376
Adresse internet:	http://caa-aca.ca/edmonton-2003.html
Courriel:	conference@caa-aca.ca
Président du congrès:	Corjun Buma
Secrétaire:	Megan Hodge
Coordonnateur Programme Technique:	Gary Faulkner
Coordonnateur des exposants:	Izzy Gliener
Web-Master:	Steven Bilawchuk
REMARQUE:	adresses électroniques complémentaires à venir après le 1er janvier 2003

Canadian Acoustical Association
Minutes of the Annual General Meeting
10 October 2002

Charlottetown, PEI

Present: 24 voting members of the Association

Call to Order

President John Bradley called the meeting to order at 16:00 by, with 24 voting members of the Association present. Minutes of the previous Annual General Meeting on 2 October 2001 in Alliston Ontario were approved as printed in the December 2001 issue of Canadian Acoustics. (Moved by Sharon Abel, seconded Alberto Behar, unanimous).

President's Report

John Bradley summarised the results of the executive meeting. The society is in good condition - good meetings, good journal, successful applicants for prizes. The annual meeting is still a great place for students to present papers and learn. The website is considerably improved, thanks to Dave Stredulinsky, and now includes most procedures.

Secretary's Report

David Quirt could not attend. John Bradley summarised his report: the association has 325 members at present, including full members, sustaining members, subscribers and student members. Details are in the report from Board of Directors meeting. The administrative budget includes $1,300 for website and membership correspondence expenses. An itemized account was presented to the Board of Directors. The report was accepted (moved by Sharon Abel, seconded David Havelock carried).

Treasurer's Report

Dalila Giusti reported on the Association finances.

We are in good shape, with $235,000 invested in Ontario Savings Bonds, which gives $7000 to $8000 in annual interest to cover awards.

The journal is the largest expense, costing about $25,000 per year, and is also one of the major benefits of membership. Income for the journal includes funds from subscribers, sustaining subscribers, advertising, etc.

Successful meetings generate extra funds. There has been no need to dip into fixed assets for several years.

We budget each year's expenses and track costs and revenues; this allows us to plan.

(Alberto Behar moved and Harold Forrester seconded acceptance.)

Emeritus Membership

The board is recommending for Emeritus membership, John Foreman (our 4th president, 82 and still active) and Gene Bolstad (who has a long history with CAA, has retired many times, and is very active in the Edmonton meeting organisation). They will be our first emeritus members. This is an honour that gives them the privileges and costs of a student membership. The board intends to nominate 1-2 people to this position each year (no fixed quota).

Editor's Report

Ramani Ramakrishnan gave the Editor's report. Highlights were:

For the first time, this issue has a full colour cover (similar cost to our standard two colour). We are considering a colour back cover ad (moving the Sustaining Subscribers to the inside cover.

Ramani claims he never has to solicit articles. (Some members believe otherwise!)

The possibility of 6 issues a year is being considered; Ramani will bring a cost estimate to the board in the spring. This may require limiting page numbers.

Ramani is looking to partially renew his editorial board this year.

A CD-ROM of the Proceedings will be available from Ramani for those who need better legibility.

Articles will be very welcome and will generally be published within 2-3 months.

Ramani will make sure the journal is linked to journal search engines.

Historically about 25% of papers get rejected. This will be published so that academics realise that the articles are properly refereed.

The aim is that everyone gets Proceedings before the meeting. To save money we will try to only bring a few for those who have not received it by the time of the meeting. We will encourage people to bring their copy with them. There may be a charge for an extra copy at the meeting.

Karen Fraser has been soliciting ads and following up advertising invoices.

(Sharon Abel moved and Keith Wilson seconded accepting the report.)

Award Coordinator's Report

Kathy Pichora-Fuller reported that 8 awards are available.

This year we will award the Shaw Prize, Eckel Prize, and 2 Directors' awards, plus the student paper awards.

Faculty members should encourage their students to apply for awards. The odds of winning are very good.

She acknowledged the hard work of the awards committees. (David Havelock moved and Tony Brammer seconded acceptance of the report.)

Past/Future Meetings

The Association instructs meeting organizers to ensure the meeting provides the features desired by the members, and set the conference registration fee to approximately break even. Historically, people have come regardless of the cost. A surplus may happen, but is not the goal.

Toronto 2001: Dalila reported we made about $14,000 from a successful meeting with lots of participants, exhibitors and papers.

Charlottetown 2002: Annabel Cohen reported many details about the meeting:

The technical program was very well received with numerous papers.

Dave Stredulinsky's website was used for almost all paper submissions, and all were electronic. Ramani was very helpful and flexible in getting the proceedings together, as was Rob Drew of Annabel's lab. Most papers were in on time.

Close to 100 people are attending. We encourage students, recognising that they are subsidised. Some faculty now send their students when they cannot attend. Summer meetings might allow more faculty to attend. (Winter meetings might allow more consultants to attend.) It was suggested that the board consider having the meeting extend on to Saturday. 7 preferred the status quo and 11 prefer including a Saturday in future meetings. Edmonton's dates are committed already, so this will have to be considered for Ottawa in 2004

The hotel attendance was good this year and this has helped financial balance for the meeting. Costs and revenue are similar; it is unclear whether there is a surplus.

The NRC workshop was successful, but few of the attendees stayed on.

We had 5 of our breaks subsidized by exhibitors, who were formally thanked for their support.

We should think about an outreach program for students at future CAA meetings. One class will attend Floyd Toole's talk at PEI.

Dave Stredulinsky was co-chair and Annabel expressed her appreciation for his considerable assistance with the website, the technical program and many other matters. The members present expressed their appreciation to both Annabel and Dave.

Edmonton 2003: The meeting will be at the downtown Westin Hotel and the meeting will be October 15-17. Room rate will be $117; we have 60 rooms set aside and can book more.

Ottawa 2004: The President will recruit a team to coordinate this meeting.

Opportunity in 2005: There will be an ASA meeting in 2005 in Vancouver but we will have a CAA meeting as usual in October. Bids are welcome.

CAA Website

Dave Stredulinsky reported that our website has the operations manual, subscription and membership forms, information update forms, job openings and more. It is clearly becoming the main conduit for members needing information. A complete index of Canadian Acoustics is available on the website. In September we had about 100 visitors a day from 50 different countries. A job wanted page will soon be available and the student awards page will be revised. Dave was thanked for all his hard work.

Past President's Nomination Report

Cameron Sherry nominated John Bradley as President, David Quirt as Secretary, Dalila as treasurer and Ramani as Editor. Alberto Behar and Sharon Abel moved approval. There were no other nominations, so these Directors were acclaimed. Mark Cheng, Christiane Giguère, and Alberto Behar were proposed as new Directors and Rich Peppin moved acceptance, seconded by Tim Kelsall. Approved.

Noureddine Atalla, Kathy Pichora-Fuller and Tim Kelsall were thanked for their efforts as directors for the last 5 years.

Other Business

Sharon Abel recommended that people bring their material for conference papers on floppy or CD rather than laptops. Submitters would have to tell organisers ahead of time of any other requirements. Tim Kelsall recommended presenters bring overheads as backups. Members may have to be asked to bring laptops. Edmonton will look into how this is to be implemented, and will instruct the authors accordingly.

Cameron Sherry moved and David Havelock seconded that the fees remain the same for another year. Carried unanimously.

Dalila Giusti moved and Tim Kelsall seconded that the meeting be adjourned. Carried. Meeting adjourned at 5:16 p.m.

(Notes taken by Tim Kelsall, edited by Dave Quirt based on input from Directors)

Canadian Acoustical Association
Minutes of the Board of Directors Meeting
8 October 2002
Charlottetown, PEI

Present: J. Bradley, D. Giusti, D. Quirt, C. Buma, K. Fraser, T. Kelsall, R. Ramakrishnan, D. Stredulinsky

Regrets: N. Atalla, M. Cheesman, J. Hemingway, M. Hodge, and K. Pichora-Fuller.

Meeting was called to order at 4:10 p.m. Minutes of the Board of Director's meeting on 2 June 2002 were approved as published in the June 2002 issue of Canadian Acoustics, with the clarification that there is a successful applicant for the Shaw prize. (Moved by K. Fraser; seconded by D. Stredulinsky; carried).

President's Report

J. Bradley reported that there have been no major changes or problems in the affairs of the Association. Succession of Directors was identified as an issue for this meeting; three directors must be replaced in September 2002.

Secretary's Report

D. Quirt reported that in FY2001/02 membership (including subscriptions) seems to have dropped back to the level observed before FY2000/2001.

The decrease seems to be mainly due to non-renewal by many of those who paid membership fees as part of registration at the Sherbrooke Conference. As of 26 September, the total paid membership stood at 325. About 80% of the members are located in Canada, with the remaining 20% divided between the USA and overseas.

To ease membership renewal, the Secretary and Treasurer have organized the process to permit membership payments by VISA. New forms have been created for the website, and about half of the recent payments are using VISA. The forms in Canadian Acoustics will be updated before the December 2002 issue, with one side of the form in English and the other in French. (Consensus after brief discussion.)

	FY 2000/01	FY 2001/02	FY 2002/03
Member	227	278	220
Student Member	52	46	44
Indirect Subscribers	33	34	29
Sustaining Subscribers	31	33	32
Total	343	391	325

Member: A professional who is named on the application form. Members are eligible to vote

Student Member: A person in full-time attendance at an academic institution. Eligible to vote.

Subscriber: A company that receives the journal (non-voting)

Sustaining Subscriber: A company or individual who wishes to promote the activities of CAA by paying an increased subscription fee. (non-voting)

All categories receive a copy of the journal.

Sale of the membership list was discussed. It was decided that the list will not be sold, but will be printed annually in Canadian Acoustics. A check-off box will be added to membership application and renewal forms to obtain explicit permission for including names in the published list. (Moved C. Buma; seconded D. Giusti; carried.)

Secretarial operating costs for the fiscal year 2001/02 (to 31 August 2002) were $1300. Major costs were for postal boxes in Toronto and Ottawa, and maintaining the mailing address database including the annual membership renewal process. Costs for the website hosting with Telus were deferred to September; including these costs in future secretarial budgets will increase the annual operating expenses to about $1500. There was $420 dollars in the secretarial account, as of 31 August.

(D. Giusti moved acceptance of Secretary's report; D. Stredulinsky seconded; carried.)

Treasurer's Report

The Treasurer submitted a financial statement prepared by our auditor, Paul A. Busch, for the fiscal year ending August 31, 2002. Revenue exceeded expenses by $12,017 and net assets at year-end have risen to $235,007.

A new list of requirements for the auditor's assessment of CAA was presented; this will require estimates of contributed hours for each member performing significant tasks for the Association; this information will be incorporated in the operations manual.

In accordance with the clarified audit requirements, it was noted that minutes of the June 2002 meeting should be amended to record that interest from the $10,000 Ontario Savings Bond whose purchase was authorized at that meeting shall be deposited to the capital account. (Moved by D. Giusti; seconded by R. Ramakrishnan; carried)

The Treasurer reported that a VISA merchant's account was used to accept payments for registration at the October 2001 conference, and has been introduced for annual membership dues and other payments. A VISA card account will be established for paying CAA expenses, as authorized at the June 2002 meeting.

It was decided to increase revenue by moving $10,000 of the current balance from the capital fund into an investment account with interest payable to the capital fund, and $20,000 of the current balance in the operating fund into an investment account with interest payable to the operating fund. (D.Giusti moved; K. Fraser seconded; carried.)

A draft budget for FY2002/03 was presented and discussed. (R. Ramakrishnan proposed approval of draft budget for presentation to the AGM, with amendment to budget $25,000 for Canadian Acoustics; seconded T. Kelsall; carried.)

(D.Giusti moved acceptance of Treasurer's report; K. Fraser seconded; carried)

Emeritus Membership

Nominations of members for designation as Emeritus Member were discussed. It was agreed that two such nominations should be approved each year, on average, but no rigid quota should be set. After identifying a number of suitable individuals, the Board nominated two distinguished members for this recognition, and the President agreed to write to both of these members, to seek their acceptance of this recognition.

Editor's Report

A number of specific issues related to content, appearance, and publication process for *Canadian Acoustics* were discussed. It was agreed that the Editor should control the layout process for all issues, and Dr. Ramakrishnan was congratulated on the continuing quality of the publication.

Recognition was given to the substantial success of Karen Fraser in handling advertising for *Canadian Acoustics*. Invoices are up to date, and most of the backlog from delayed billing for advertising has been collected. A new advertising opportunity is the possibility of a colour advertisement on the back page, which would require relocation of the list of Sustaining Subscribers. It was agreed that the price should at least match annual revenue from Sustaining Subscribers ($2000 per issue). K. Fraser and R. Ramakrishnan were directed to explore this option with current advertisers and Sustaining Subscribers, and to prepare a proposal for consideration at the next Board meeting.

R. Ramakrishnan reported that he has been evaluating the possibility of publishing six issues of the journal each year. A detailed business plan was requested, for consideration at the next Board meeting in June 2003, and subsequent presentation to the membership at the AGM in October 2003.

(D.Giusti moved acceptance of Editor's report, T. Kelsall seconded, carried.)

Past and Future Conferences

2001 Toronto: The chair, Dalila Giusti, noted that the final surplus of $13,915 has been transferred to CAA.

2002 Charlottetown: Annabel Cohen (conference chair) gave a report. Over 95 papers were submitted, and advance registration was high. Eight exhibitors are participating. Seminars at the beginning of the week had low attendance, but their content was praised. The website was used extensively to support the organizing process, and this major contribution by D. Stredulinsky was specially commended. Twenty students requested travel support; subsidies will be handled by the Treasurer, from the allocation in the CAA budget, according to established process. At this stage, the financial balance for the conference is hard to predict, but a large surplus seems unlikely. It was agreed that the organizers for the 2002 Charlottetown meeting should be congratulated, as the conference has excellent technical sessions, the proceedings issue was produced and distributed in time (with very effective use of the Website and e-mail), and the venue is excellent – satisfying all the primary concerns.

2003 Edmonton: C. Buma provided a report on preliminary arrangements for the 2003 meeting. The organizing committee has confirmed hotel arrangements with the Westin for the week after Thanksgiving – October 15 to 17. Financial commitments are imminent. (C. Buma moved to transfer $2000 seed money to the Edmonton Conference immediately; seconded K. Fraser; carried). A two-page announcement will be ready for the December issue of Canadian Acoustics (others will follow in the next 3 issues), and the website caa-aca.ca will be used extensively, as for the 2002 conference. The Edmonton team were congratulated on their excellent progress.

2004 Ottawa: J. Bradley noted that Ottawa is a likely site for 2004, and many members in the Ottawa area have agreed to participate, although no formal leadership responsibilities have been confirmed. A proposal is expected at the June 2003 meeting of the Board of Directors.

International Conferences: There has been communication about CAA support for an ASA conference in Vancouver in May 2005. No direct commitment by CAA as an organization has been requested, other than formal endorsement, although individual members will be involved in organizing the meeting. This meeting in the spring of 2005 should not interfere with a CAA meeting in the fall of 2005.

Awards

There was discussion based on e-mail reports from members of the Awards Committee. Details of requirements for all prizes are on the CAA web site. Specific progress for various awards was reported:

- Successful applicant for the Shaw Prize.
- Successful applicant for the Eckel Prize.
- No activity was reported for the Hétu Prize.
- Student travel subsidies will again have $2500 allocation (in proposed budget).
- A report concerning the Directors' awards isexpected at the AGM.

Concern was expressed about the infrequent applicants for some prizes. M. Hodge has taken preliminary steps to prepare and distribute a notice to suitable university departments in January/February of 2003.

CAA Website

D. Stredulinsky submitted a report on hosting arrangements and content for the CAA website. Despite some problems in the transition from UWO to Cadvision to Telus, the site is functioning well with 60-100 visits per day. Content is steadily expanding, and now includes the CAA operations manual, information on CAA awards, a contacts page, a job-posting page, a sustaining subscribers' page, and new pages for membership/subscription applications.

A number of specific details were discussed:

- Investigation of establishing a secure website supporting membership payments by VISA has begun. D. Stredulinsky will provide a detailed proposal, with options and their costs to the Board in June.
- Common policy on job advertisements in the journal and website has not been formalized, but advertisements are free (only 2 this year).
- Proposed extensions include a student "job wanted" page and a news area coordinated with Canadian Acoustics.
- Additional help is needed to rebuild and maintain the French area of the website.

Overall, there was enthusiastic support for the continuing significant improvements, including the section used for the annual conference. (K. Fraser moved acceptance of Webmaster's report, D. Quirt seconded, carried).

Change of Directors

Three Directors come to the end of their terms this month. The President recognized the contributions by Noureddine Atalla, Kathy Pichora-Fuller, and Tim Kelsall, and expressed the thanks of the Board for their efforts on behalf of the Association. The President announced a slate of 3 nominees for the positions as Director has been established, with due regard for provincial distribution.

Other Business

Two items were discussed:

- The President reported correspondence he had received from the executive of International INCE concerning nomination of a Canadian representative to the International INCE Study Group on Noise Labeling for Consumer and Industrial Products. It was noted that in principle such members represent the member body (CAA), although past appointments by INCE have been handled directly with chosen individuals. It was agreed that in principle, the Executive of CAA should approve such appointments, and the President was requested to communicate with the candidate identified (Steven Keith), and to report the appointment to the Board at the next meeting.
- Receipts for charitable-donations-in-kind were discussed, as a means to recognize services provided to CAA. After the Treasurer reported the special concerns for auditing and controlling issuing of such charitable receipts, the consensus was not to proceed with such measures.

Adjournment

R. Ramakrishnan moved to adjourn the meeting, seconded by D. Giusti, carried. Meeting adjourned at 9:30 p.m.

Special Action Items (Continuing or Arising from the Meeting)

<u>J. Bradley</u>

Communicate with candidates for Emeritus Member, and report outcome to Board.
Deal with appointment of CAA participant on INCE Working Group on ???.

<u>D. Quirt</u>

Collaborate with D. Giusti to handle membership payments by VISA.

<u>D. Giusti</u>

Proceed with investments, as authorized.
Acquire a corporate credit card for payment of CAA expenses.

<u>R. Ramakrishnan</u>

Prepare and present to the Board in June 2003 a business plan for increasing the frequency of Journal publication from four to six times a year.

<u>D. Stredulinsky</u>

In collaboration with Editor, establish common approach to job advertisements.

Prepare and present to the Board in June 2003 a business plan for use of VISA on the CAA website.

<u>M. Hodge</u>

Prepare and distribute notice re CAA prizes to Canadian university departments

<u>M. Cheesman</u>

Establish a plan for activity re Hétu prize

The Canadian Acoustical Association
l'Association Canadienne d'Acoustique

MEMBERSHIP DIRECTORY 2002 / ANNUAIRE DES MEMBRES 2002

The number that follows each entry refers to the areas of interest as coded below.

Le nombre juxtaposé à chaque inscription réfère aux champs d'intérêt tels que condifés ci-dessous

Areas of interest		Champs d'intérêt
Architectural acoustics	1	Acoustique architecturale
Engineering Acoustics / noise Control	2	Génie acoustique / Contrôle du bruit
Physical Acoustics / Ultrasonics	3	Acoustique physique / Ultrasons
Musical Acoustics / Electroacoustics	4	Acoustique musicale / Electroacoustique
Psycho- and Physio-acoustics	5	Psycho- et physio-acoustique
Shock and Vibration	6	Chocs et vibrations
Hearing Sciences	7	Audition
Speech Sciences	8	Parole
Underwater Acoustics	9	Acoustique sous-marine
Signal Processing / Numerical Methods	10	Traitement des signaux / Méthodes numériques
Other	11	Autre

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