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canadian acoustics
acoustique canadienne

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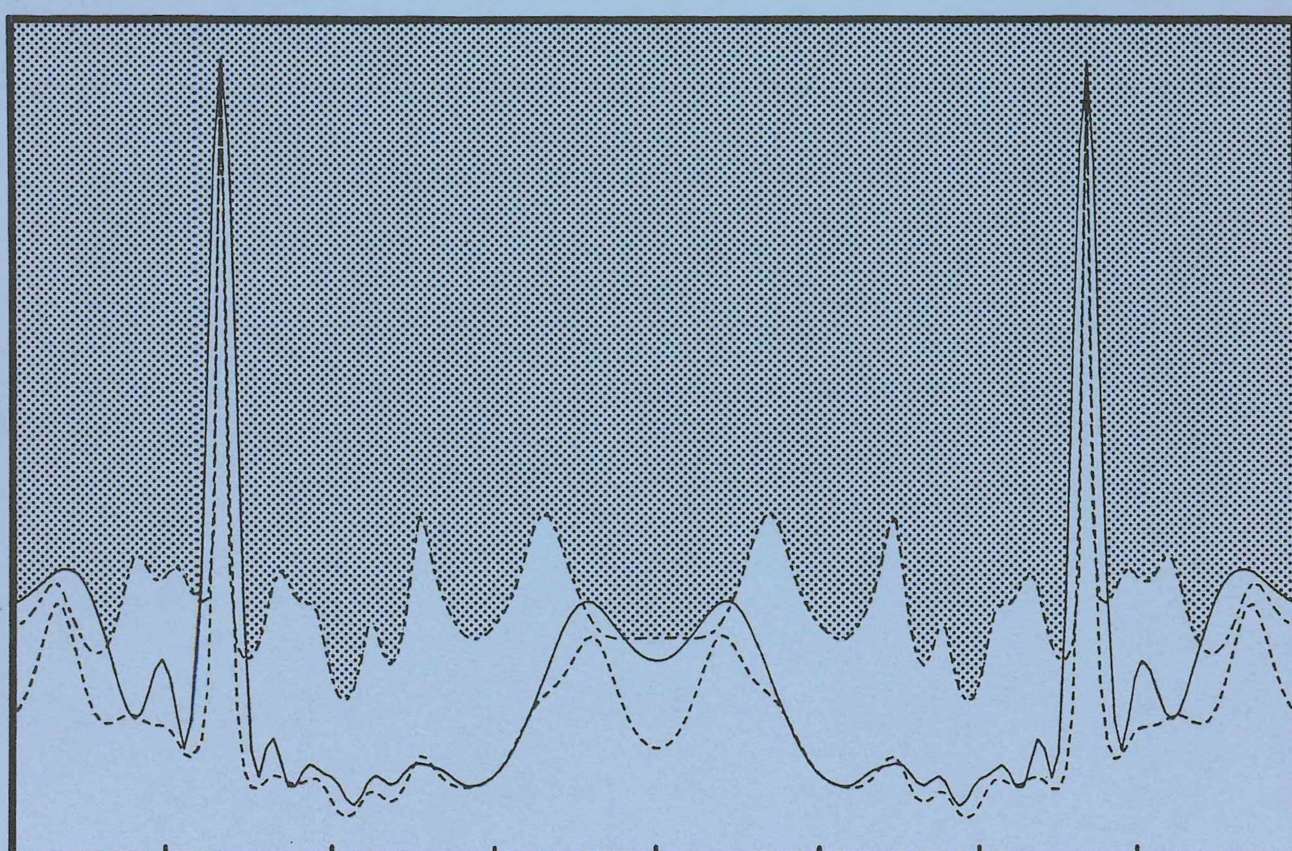

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acoustique canadienne

The Canadian Acoustical Association
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Prix: $4.00 (affranchissement inclus)

Articles an all aspects of Acoustics and Vibration in English and French are welcome, and should be addressed to any editor. All papers are reviewed.

Vous êtes invités à soumettre des articles sur tous les domaines de l'Acoustique et des Vibrations, en français ou en anglais. Prière de les envoyer à un des rédacteurs. Tout article est révisé.

EDITORIAL

Issue number 3 brings some new initiatives from your editorial staff as well as continuing efforts in some other areas. We would still like to encourage more libraries to subscribe to CANADIAN ACOUSTICS but so far our mass mailings have brought little response. If your institution has a library, why not talk to your librarian today?

More recently, we have started a campaign to increase the number of advertisers in CANADIAN ACOUSTICS. So far, 85 potential advertisers have been contacted by mail. We don't expect a large response, but a few more advertisers would allow us to consider options such as type setting to improve the appearance of CANADIAN ACOUSTICS. As always, we encourage you to let our advertisers know that you read their advertisements. Next time a salesman visits, suggest to him that he advertise his product in CANADIAN ACOUSTICS! Get him to telephone Tim Kelsall right away.

It has been suggested that we should encourage the publication of more short technical notes. Two or three pages describing a more interesting project or perhaps a novel solution to a practical problem could make interesting reading and would keep us all better informed of acoustical activities in Canada. Rather than referee them rigorously, they would be judged more as to whether they were informative and interesting.

Finally, we have polled a number of interested parties concerning a possible survey of Canadian acoustical consultants to be published in CANADIAN ACOUSTICS. The results would be published as the responses to questionnaires with a disclaimer that CANADIAN ACOUSTICS was not responsible for the accuracy of the information. So far, only one negative reply has been received, but we would

EDITORIAL

Dans ce numéro vous trouverez quelques initiatives de la part du comité de rédaction. On nous a suggéré de continuer la publication de notes techniques. Ceux-ci peuvent décrire en deux ou trois pages un projet spécial ou une solution innovative et pratique à un problème particulier. La publication de ces notes serait jugée sur leur intérêt plutôt que par un arbitrage rigoureux.

Nous continuons d'inciter les bibliothèques à s'abonner à l'ACOUSTIQUE CANADIENNE. Cependant la réponse à notre lettre circulaire a été maigre. Nous pensons qu'il faudrait un effort personnel de la part des membres afin d'encourager la bibliothèque de votre institution à s'abonner.

Nous avons amorcé une campagne pour augmenter le nombre de publicitaire dans l'ACOUSTIQUE CANADIENNE. A date nous avons écrit à 85 annonceurs éventuels. Avec seulement quelques annonceurs publicitaires de plus notre revenue serait suffisamment augmenté pour avoir l'ACOUSTIQUE CANADIENNE composé professionnellement; ce que améliorerait la présentation du journal. Les publicitaires interessés doivent communiquer avec Tim Kelsall.

Nous avons enquêté sur la possibilité de publier un aperçu des maisons d'ingénieurs conseils en acoustique. Ceci serait sous forme de réponses à un questionnaire accompangnées d'un désaveu de la part de l'ACOUSTIQUE CANADIENNE de toutes responsabilités. Nous avons seulement reçu une opinion défavorable mais nous aimerions avoir d'autres avis avant d'avancer avec ce projet. Vous pouvez obtenir une copie du questionnaire en nous écrivant.

Le comité organisateur du congrès de Québec a reçu quelques 55 communications.

like some more comments before proceeding further. If you would like a copy of the proposed questionnaire or have any comments, please write.

Don't forget to read about the 12th ICA, the Quebec meeting and Annabel Cohen's efforts to increase our membership. Why not take a new member to Quebec City?

Ceci est un bon signe précurseur d'un congrès intéressant. D'ailleurs le comité fait le point sur le congrès dans ce numéro. Vous trouverez aussi des nouvelles de l'ICA-12 et de la compagne d'adhésion à l'association d'Annabel Cohen.

INTER-NOISE 85 TO BE HELD IN MUNICH

INTER-NOISE 85, the fourteenth in a series of international conferences on noise control engineering, will be held at Munich University in Munich, Federal Republic of Germany from Wednesday, September 18 to Friday, September 20, 1985. A large lecture hall seating 600 has been reserved for the opening ceremony and six smaller halls have been reserved for the parallel sessions. Plenary papers, invited papers and contributed papers will be presented at the conference. The working language of the Congress will be English.

It is also planned to arrange a special exhibition of materials and instrumentation for noise control engineering in the foyer of the lecture hall. A social gathering will be held at one of the evenings of INTER-NOISE 85.

Prior to INTER-NOISE 85, a one-week tour of the Federal Republic of Germany will be organized in order to give foreign participants the opportunity of visiting the most important centers of acoustic research.

On the day following the Congress, the Munich October festival (Oktoberfest) will be opened. INTER-NOISE 85 participants may be interested in a visit to this famous festival. Hotel rooms for this visit should be reserved as early as possible.

A call for contributed papers for INTER-NOISE 85 will be issued at the end of 1984. Nevertheless, suggestions for papers or pre-applications may be submitted at any time to INTER-NOISE 85 Secretariat, c/o VDI-Kommission Lärmminderung, Postfach 1139, D-4000 Düsseldorf 1, Federal Republic of Germany.

GRADUATE STUDIES, RESEARCH AND DEVELOPMENT IN SHERBROOKE

The G.A.U.S. (Groupe D'Acoustique de l'université de Sherbrooke) offers grants to students (francophone or anglophone) who would pursue studies at the master or doctorate level, in Sherbrooke, Quebec. The G.A.U.S. main research activities are related to outdoor sound propagation, predictive acoustics of halls, simulation of acoustic materials performance, sound intensity and sound reduction techniques. A grant at post-doctorate level is also available. For more information, contact J. Nicolas, G.A.U.S., Génie mécanique, Université de Sherbrooke, Sherbrooke, Québec, J1K 2R1, Tel.: (819) 565-4479.

ÉTUDES SUPÉRIEURES, RECHERCHE ET DÉVELOPPEMENT Â SHERBROOKE

Le G.A.U.S. (Groupe d'Acoustique de l'université de Sherbrooke) offre des bourses d'études au niveau de la maîtrise ou du doctorat, études poursuivies à Sherbrooke, pour des étudiants francophones ou anglophones. Les principaux domaines de recherche du G.A.U.S. sont la propagation du son à l'extérieur, l'acoustique prévisionnelle des locaux, la modélisation des performances des matériaux acoustiques, l'intensimétrie et les techniques de réduction du bruit. Une bourse pour chercheur au niveau post-doctorat est aussi disponible. Pour plus d'information, contactez J. Nicolas, G.A.U.S., Génie mécanique, Univesité de Sherbrooke, Sherbrooke (Québec), J1K 2R1, Tél.: (819) 565-4479.

HAND-ARM VIBRATION SYMPOSIUM TO BE HELD IN FINLAND -- MAY 1985

The Finnish Institute of Occupational Health is arranging the Fourth International Symposium on Hand-Arm Vibration, to be held 6-8 May 1985 at the Hanassaari Cultural Center near Helsinki. the symposium will provide a forum for the presentation of recent research in the area of hand-arm vibration. Its purpose is also to clarify risks associated with power tools, to examine exposure limits and design goals for future tools, to improve measurement techniques, and to stimulate further research. Sessions will be held on diagnosis and treatment syndrome; epidemiological studies of exposure to vibration; power tool vibration studies and industrial processes involving exposure to vibration; models of the hand-air system; compounding effects of vibration-induced disorders; medical and level implications of exposure to vibration. Details can be obtained from I. Pyykkö, Institute of Occupational Health, Laajaniityntie 1, 01620, Vantaa 62, Finland.

ULTRASONICS INTERNATIONAL '85 TO BE HELD IN ENGLAND

The organizers of "Ultrasonics International" series of conferences have announced that the next meeting will be held at Kings College, London, 2-4 July 1985. Some innovations are planned for this conference, i.e., a number of structured sessions will be held where invited speakers will discuss previous work and the present status in specific subject areas. These areas will include material characterization, underwater acoustics, and acousto-optics. These structured sessions will be conducted in addition to the usual contributed papers sessions. Detailed information can be obtained from the conference organizer, Z. Novak, Ultrasonics, P.O. Box 63, Westbury House, Bury Street, Guildford, Surrey GU2 5BH, England.

INCE TECHNICAL ACTIVITIES DAY TO FOLLOW INTER-NOISE 84

At its February 16 meeting, the Steering Committee of the INCE Technical Activities Board (TAB) announced plans for Technical Activities Day which will be held on the day following INTER-NOISE 84 in Honolulu. The dates for INTER-NOISE 84 are Monday-Wednesday, December 3-5. The special technical activities to be organized by TAB will take place Thursday, December 6.

As in the past, the formal program of INTER-NOISE 84 will include technical sessions consisting of invited and contributed papers as well as poster sessions and an exhibition of the latest equipment and instrumentation for noise control. The members of the TAB feel there is a need for a less formal program to encourage the exchange of information between individuals who are concerned with the engineering aspects of noise control. INCE technical activities are now being pursued by 16 INCE Groups which are arranged in three divisions. Fred Kessler, INCE Vice President - Technical Activities and TAB Chairman, is counting on 100% participation by the INCE Groups and is looking forward to a very exciting Technical Activities Day in Hawaii. He expects that this day will be the first of many to be organized by INCE in the future. The Technical Groups and Information Groups will organize informal technical discussions, panels, demonstrations, and reviews of progress which have been reported in their specialized technical areas.

Speaking for the groups in the Technical Division, divisional director Tony Embleton remarked: "It is imperative that all Technical Groups assess the latest developments in their respective areas." One unique sessions that is in the planning stage is to demonstrate the quieting of a new consumer product. Nancy Timmerman is the divisional director of the Information Division. She noted after the February 16 Steering Committee meeting: "We anticipate full participation from all seven Information Groups. These activities will range from informal critiques of the INTER-NOISE 84 formal presentations to a "Masters' Symposium" which will be chaired by INCE President Jim Seebold."

While the INCE Coordination division has not yet formulated its plans, it is expected that each of the Groups in this new division will take part in the activities of the day. The next meeting of the Technical Activities Board is scheduled for May 5 in Williamsburg, Virginia. At that meeting, the final plans for Technical Acitivities Day will be formulated.

SHORT COURSE ON UNDERWATER ACOUSTICS AND SIGNAL PROCESSING

A short course on Underwater Acoustics and Signal Processing will be held 22-26 October 1984 at The Pennsylvania State University. The course is designed to provide a broad, comprehensive introduction to important topics in underwater acoustics and signal processing. The primary goal is to give an appreciation of current research and development activities.

Further information may be obtained by writing Alan D. Stuart, Course Chairman, at the Applied Research Laboratory, The Pennsylvania State University, P.O. Box 30, State College, PA 16801; or by telephoning (814) 863-4128.

ASTM NEWS

A new task group on field tests on enclosures and a new task group on loudspeakers for open office tests were organized during the meetings of American Society for Testing and Materials (ASTM) Committee E33 on Environmental Acoustics in Jacksonville, FL, April 9-11.

The task group on field tests on enclosures will develop a method to measure the sound isolation of installed enclosures, such as audiometric booths, translation booths, and other personnel enclosures.

The task group on loudspeakers for open office tests seeks to identify loudspeakers that satisfy the requirements of various tests that are performed in open plan spaces.

Subcommittee 2 on Open Plan Spaces held its first meeting in Jacksonville. The scope of the new Subcommitee is "the development of test methods and practices relating to materials, products, and systems used for the control of acoustics in open plan spaces, such as offices, schools, etc." The Subcommittee has set up five task groups to work on different aspects of open plan acoustics.

Two task groups of Subcommittee 2 are organizing round robin test series. The test series will provide information about the precision of proposed tests on office screens and ceiling systems.

Subcommittee 6 on International Standards is organizing the U.S. delegation to the plenary meeting of International Organization for Standardization, Technical Committee 43 Subcommittee 2 (ISO/TC43/SC2) on Building Acoustics in West Berlin on October 31. The ASTM Subcommittee formulates U.S. positions on draft standards produced by the ISO Subcommittee.

The task group on ceiling suspension systems is polling manufacturers about problems with interfacing new grid systems and ceiling boards. The task group is also considering problems that occur when ceiling systems are used in special environments where the atmosphere is humid or corrosive.

The next meetings of Committee E33 will be in Norfolk, VA, October 15-17, 1984. For more information about E33 activities, contact David R. Bradley, ASTM Standards Development Division, 1916 Race Street, Philadelphia, PA 19103, telephone (215) 299-5504.

NEW BOOKS

"Music, Mind, and Brain: The Neuropsychology of Music"
Manfred Clynes (Ed.)
Plenum Publishing Co., New York, 430 p.

"Acoustical Imaging, Volume 12"
E.A. Ash and C.R. Hill (Eds.)
Plenum Publishing Co., New York, 776 p.

"Introduction aux théories de l'acoustique"
M. Bruneau
Université du Maine (France), 640 p.
(See review in next issue.)
(Voir critique dans la prochaine édition.)

"Stage Sound"
D. Collison
Drama Book Publishers, New York, 192 p.

"The Finite Element in Engineering 1982"
S.S. Rao
Pergamon Press, Oxford, 625 p.

"Receptive Mechanisms of Sound in the Ear"
Yasuji Katsuki
Cambridge University Press, 155 p.

"Noise-Con '83 Proceedings"
R. Lotz (Ed.)
Noise Control Foundation, Box 3469, Poughkeepsie, New York 12603, U.S.A.

"Acoustical Measurements: Methods and Instrumentation"
H.B. Miller (Ed.)
Benchmark Papers in Acoustics, Hutchinson Ross, Stroudsburg, PA, U.S.A.

"Automatic Speech Analysis and Recognition"
Jean-Paul Haton (Ed.)
D. Reidel Publishing Co., Dordrecht, The Netherlands, 371 p.

CALENDAR 1984/85

25-28 July 1984
Tenth International Symposium on Nonlinear Acoustics
Kobe, Japan

5-10 August 1984
7th World Congress on Linguistics
Brussels, Belgium

21-24 August 1984
Fourth FASE Congress
Sandefjord, Norway

26-30 August 1984
17th International Congress on Audiology (ICA)
University of California Campus
Santa Barbara, CA, U.S.A.

1-4 October 1984
Aerodynamics and Acoustics of Propellers
Toronto

8-12 October 1984
Acoustical Society of America
Minneapolis, MN, U.S.A.
(Deadline for abstracts 22 June 1984)

22-26 October 1984
CAA Annual Meeting and Seminars
Quebec City, Quebec

4-6 November 1984
Institute of Acoustics Autumn Conference
Windemere, U.K.

3-5 December 1984
INTER-NOISE 84
Honolulu, Hawaii, U.S.A.
(Deadline for abstracts 15 March 1984)

9-13 December 1984
ASME Symposium on Flow-Induced Vibration
New Orleans, U.S.A.

15-17 April 1985
Institute of Acoustics Spring Conference
York, England

22-26 April 1985
International Symposium on Acoustical Imaging
The Hague, The Netherlands

6-8 May 1985
International Symposium on Hand-Arm Vibrations
Helsinki, Finland

2-4 July 1985
Ultrasonics International '85
Kings College, London, England

4-9 August 1985
International Congress on Education of the Deaf
Manchester, England

18-20 September 1985
INTER-NOISE 85
Munich, West Germany

26-27 September 1985
Canadian Acoustical Association Symposium
Ottawa, Ontario

NEW RESEARCH CONTRACTS

To Canadian Institute of Guided Ground Transport, Kingston, Ontario, $245,000, for "Study of vibration in track structure and development of a superior geotextile." Awarded by the Department of Agriculture.

To Ambrex International Incorporated, Port Coquitlam, B.C., $20,000, for "Built, test and evaluate a speech compression hearing aid device." Awarded by the Department of Communications.

To Sy-Tech Research Limited, Sidney, B.C., $4,860, for "Study of acoustic scattering parameters in Arctic waters." Awarded by the Department of Fisheries and Oceans.

To Tacel Engineering Limited, Toronto, Ontario, $4,580, for "Noise reduction feasibility study of National Research Council MK 1.5 experimental air bed." Awarded by the National Research Council.

To Canadian Astronautics Limited, Ottawa, Ontario, $117,412, for "Feasibility study of Canadian Forces sonobuoy position using Doppler measurement techniques." Awarded by the Department of National Defence.

To W.R. Davis Engineering Limited, Ottawa, Ontario, $14,845, for "Study on primary pump vibration under accident condition." Awarded by the Atomic Energy Control Board.

To Seimac Limited, Bedford, N.S., $8,784, for "Develop instructions and specifications for the collection and analysis of data from 30KHZ echo sounding transducers on the CSS Baffin." Awarded by the Department of Fisheries and Oceans.

To University of Hawaii at Monoa, Honolulu, Hawaii, U.S.A., $390,000, for northern Juan de Fuca ridge system and Vancouver Island continental slope. Awarded by the Department of Fisheries and Oceans.

To Sy-Tech Research Limited, Sidney, B.C., $1,200, for "Documentation of acoustic system from coastal zone oceanography field trials." Awarded by the Department of Fisheries and Oceans.

To Barman, Coulter, Swallow Associates, Rexdale, Ontario, $6,950, for "Investigation of gymnasium floor vibration at the University of Toronto." Awarded by the National Research Council.

To Harford, Kennedy Limited, Vancouver, B.C., $41,005, for "Subjective rating of party wall sound insulation." Awarded by the National Research Council.

To University of Quebec, Verdun, Quebec, $34,000, for "Study of adaptive transform coding algorithm of speech for computer applications." Awarded by the Department of Communications.

To LGL Limited, Toronto, Ontario, $118,232, for "Study of sound physics and the responses of marine mammals to Arctic marine transportation - phase I." Awarded by the Department of Indian and Northern Affairs.

To Arctic Sciences Limited, Sidney, B.C., $8,993, for "Study of echo sounding from high speed hydrographic launches." Awarded by the Department of Fisheries and Oceans.

To Canadian Astronautics Limited, Ottawa, Ontario, $735,388, for "Continuous through-the-ice sounding engineering feasibility study and prototype development." Awarded by the Department of Fisheries and Oceans.

To Seimac Limited, Bedford, N.S., $17,435, for "Study of radiated propeller/shaft noise on CSS Hudson." Awarded by the Department of Fisheries and Oceans.

To Ocean Ecology Limited, Vancouver, B.C., $191,991, for "Development and recording of a prototype acoustic burner for the in-situ combustion of oil spills." Awarded by the Department of the Environment.

To Wycove Systems Limited, Dartmouth, N.S., $6,780, for "Study of acoustic propagation loss for shallow water sites." Awarded by National Defence.

To Arctic Sciences Limited, Sidney N.S., $12,998, for "Preparation and testing of acoustic equipment and recording systems for the OERD project to determine acoustic scattering parameters in Arctic waters." Awarded by the Department of Fisheries and Oceans.

To W.R. Davis Engineering Limited, Ottawa, Ontario, $48,512, for "Development of an acoustic suspended sediment profiler." Awarded by the National Research Council.

To LGL Limited, Toronto, Ontario, $134,485, for "Study of sound physics and the responses of marine mammals to arctic marine transportation - phase II." Awarded by the Department of Indian and Northern Affairs.

To University of Victoria, Victoria, B.C., $2,000, for "Study of tidally forced flow over the sill in observatory inlet using acoustic and other data (H. Dosso, Department of Physics)." Awarded by the Department of Fisheries and Oceans.

To Jasco Research Limited, Sidney, B.C., $1,250, for "Preliminary study to determine various aspects of undersea acoustic technique to determine rainfall." Awarded by the Department of Fisheries and Oceans.

To Memorial University of Newfoundland, St. John's, Nfld., $13,705, for "Effects of small scale seafloor roughness on acoustic reflectivity measurements on the Newfoundland shelf (Dr. A. Zielinski, Faculty of Engineering)." Awarded by the Department of Energy, Mines and Resources.

To Mesotech Systems Limited, Port Coquitlam, B.C., $60,605, for "Development, installation and testing of a sonar system to operate with a Dart underwater vehicle." Awarded by the Department of National Defence.

To Pacerlabs Limited, Bedford, N.S., $54,660, for "Feasibility study of a sonobuoy reliability monitoring program." Awarded by the Department of National Defence.

To Canadian Marconi Company, Kanata, Ontario, $68,971, for "Development of an advanced development model aircraft synthesized voice caution and warning system suitable for flight test evaluation." Awarded by the Department of National Defence.

To CIRPA/ADISQ Foundation, Toronto, Ontario, $180,375, for "Develop an interactive music processor." Awarded by the Department of Communications.

12th INTERNATIONAL CONGRESS ON ACOUSTICS
TORONTO, CANADA

July 24 to August 1, 1986

The 12th International Congress on Acoustics will be held in Toronto, Canada, from July 24 to August 1, 1986. In keeping with tradition, the Congress will provide an open scientific forum in all fields of acoustics. As part of the Congress, it is planned to hold three Symposia on specific topics immediately before or after the Toronto meeting. The present status of these Symposia is:

— Speech Communication (Specific topic to be selected), in Montreal, Quebec, on July 21-22.
— Underwater and Imaging Acoustics, in Halifax, Nova Scotia.
— Acoustics and Theatre Planning for the Performing Arts, in Vancouver, British Columbia.

INTERNOISE-86 is to be held in the eastern United States immediately before the Congress (July 21-23). Congress participants may also be interested in TRANSPO '86, a second category international exposition, to be held in Vancouver, British Columbia, May-October, 1986. Other associated meetings will be announced as they are organized.

ACTIVITIES

The Congress will include Special Lectures, Structured Sessions, Contributed Papers, Poster Sessions, Workshops and an Exhibition. The Special Lectures will be presented by internationally recognized scientists and will cover a wide variety of acoustical topics. The Technical Programme Committee solicits contributed papers from all areas of acoustics to be arranged into sessions of related topics.

PUBLICATIONS

The Congress Proceedings will include the Special Lectures, and authors' summaries of contributed papers accepted for the Programme. Authors may bring to the Congress more complete versions of their papers for dissemination there. The Congress Programme, the Exhibition Catalogue and the Proceedings will be provided to registered participants upon arrival in Toronto.

TECHNICAL VISITS AND SOCIAL ACTIVITIES

Technical visits will be organized in the Toronto area and elsewhere. Excursions of general interest will also be arranged particularly for persons accompanying the Congress participants.

PROVISIONAL REGISTRATION FORM

To receive further circulars and final registration forms you must ensure that you are on the Congress mailing list. It is suggested that you return the attached provisional registration form to the 12 ICA Secretariat in Toronto now, and certainly not later than September 1, 1984. You should indicate which of the Symposia you may wish to attend.

12th International Congress on Acoustics
Secretariat
Box 123, Station 'Q'
Toronto, Canada
M4T 2L7

12ième CONGRÈS INTERNATIONAL D'ACOUSTIQUE
TORONTO, CANADA

24 Juillet au ler Août, 1986

Le Douzième Congrès International d'Acoustique se tiendra au Canada, à Toronto, du 24 Juillet au 1er Août, 1986. Selon la tradition, le Congrès permettra des discussions scientifiques libres dans tous les domaines de l'acoustique. La planification actuelle prévoit trois symposia faisant partie du Congrès, sur des sujets spécifiques. Ces symposia seront tenus immédiatement avant ou après la rencontre de Toronto. Présentement l'agenda de ces symposia de ces symposia se lit comme suit:

— Communication parlée (thème spécifique à être sélectionné), à Montréal, Québec, les 21 et 22 Juillet.
— Acoustique sous-marine et visualisation acoustique, à Halifax, Nouvelle-Ecosse.
— L'acoustique des salles de spectacle et l'agencement théâtral, à Vancouver, Colombie-Britannique.

INTERNOISE-86 doit se dérouler dans l'est des Etats-Unis immédiatement avant le Congrès (21 au 23 Juillet). Participants du Congrès seront peut-être intéressés à TRANSPO '86, une exposition internationale de seconde catégorie, qui aura lieu à Vancouver, Colombie-Britannique de Mai à Octobre, 1986.

ACTIVITES

Le Congrès comportera des conférences spéciales, des séances structurées, des communications, des présentations par tableaux, des ateliers et une exposition. Les conférences spéciales seront présentées par des spécialistes de réputation internationale, sur une grande variété de sujets traitant d'acoustique. Le Comité du Programme Technique sollicite des communications dans tous les domaines de l'acoustique, pour inscription lors de séances sur des sujets connexes.

PUBLICATIONS

Le Compte rendu du Congrès comprendra les Conférences Spéciales ainsi que les résumés, par les auteurs, des communications acceptées pour le programme. Les auteurs auront la possibilité d'apporter eux-mêmes des textes plus complets pour distribution sur place. Le Programme du Congrès, le Catalogue de l'Exposition ainsi que le Compte rendu seront distribués aux participants inscrits, dès leur arrivée à Toronto.

VISITES TECHNIQUES ET EXCURSIONS

Des visites techniques seront organisées dans la région de Toronto ainsi que dans d'autres régions. Des excursions d'intérêt général seront aussi disponibles spécialement pour les accompagnateurs.

INSCRIPTION DE PRINCIPE

Afin de recevoir d'autres renseignements ainsi que le bulletin final d'inscription, vous devez être sur la liste d'envoi du Congrès. Il est suggéré que vous retourniez le bulletin d'incription de principe ci-joint, au Secrétariat du 12ième CIA à Toronto au plus tard le 1er Septembre, 1984, tout en indiquant les Symposia auxquels vous pourriez assister.

12th International Congress on Acoustics
Secretariat
Box 123, Station 'Q'
Toronto, Canada
M4T 2L7

SEMAINE CANADIENNE D ACOUSTIQUE
Québec 22 au 26 octobre 1984
(Hotel Château Frontenac)

PROGRAMME (préliminaire)

Lundi 22 octobre:

- 8h30 Enregistrement aux séminaires [1] et [2] (Université Laval)
- 9h30 Début des séminaires
- 11h30 Buffet (Université Laval)
- 19h30 C.S.A. Chairmen's Meeting (Hôtel Château Frontenac)

Mardi 23 octobre:

- 9h00 C.S.A. Main Committee (Hôtel Château Frontenac)
- 9h30 Début de la deuxième session des séminaires (Université Laval)
- 11h30 Buffet (Université Laval)
- 13h00 Reprise des séminaires
- 16h30 Table ronde sur l'intensimétrie acoustique (Université Laval)
- 19h30 CAC/ISO-TC43/SC2 Committee (Hôtel Château Frontenac)

Mercredi 24 octobre:

- 8h00 Enregistrement au Symposium (Hôtel Château Frontenac)
- 9h00 Ouverture de l'exposition technique
- 9h00 Début des sessions 1, 2 et 3 des conférences (Hôtel Château Frontenac)
- 12h00 Buffet (Restaurant Le Champlain, compris dans l'inscription)
- 13h30 Reprise des sessions 4, 5 et 6
- 20h00 C.A.A. Directors' Meeting (Hôtel Château Frontenac)

Jeudi 25 octobre:

- 9h00 Poursuite des sessions, 7 et 8 (Hôtel Château Frontenac)
- 12h00 Buffet (Restaurant Le Champlain, compris dans l'inscription)
- 13h30 Conférence plénière (salle Jacques-Cartier)
- 16h30 Assemblée annuelle de l'Association (salle Jacques-Cartier)
- 19h30 Banquet annuel et concert (salle de bal du Château)

Vendredi 26 octobre:

- 9h00 Poursuite des sessions 9, 10 et 11 (Hôtel Château Frontenac)
- 13h30 Associate Committee for Machinery Noise (Château Frontenac)
- 17h00 Fermeture de l'exposition technique

SYMPOSIUM 84

Le Symposium se tiendra cette année au Château Frontenac à Québec les 24, 25 et 26 octobre.

Les conférences seront données de 9h00 à 16h30 en deux ou trois sessions parallèles, en tenant compte des thèmes suivants:

- techniques d'identification des sources de bruit (J. Nicolas)
- réduction du bruit à la source (Y. Champoux)
- bruit urbain et environnemental (J.-G. Migneron)
- écrans et enceintes anti-bruit (M. Amram)
- acoustique prévisionnelle des locaux industriels (G. Lemire)
- acoustique architecturale (J. Rennie)
- bruit et vibration (G. Ostiguy)
- analyse de la parole (M. Boudreault)
- métrologie acoustique (G. Wong)
- physio et psycho-acoustique (R. Hétu)
- ultrasons et hydro acoustique (D. Cheeke)

De plus, l'après-midi du 25 octobre sera consacrée à une conférence plénière qui réunira différents conférenciers invités de 13h30 à 16h30.

Tel que mentionné dans la revue de l'Association, **les résumés des communications sont attendus pour le 31 mai** et les auteurs devront prévoir un article sommaire de 2 pages relatifs à leur exposé, de telle manière que l'on puisse distribuer les notes correspondantes à tous les participants avant le début du Symposium.

Les frais d'inscription au Symposium sont de $125.00, incluant les notes des conférences, les pauses café, les buffets des 24 et 25 octobre et le banquet annuel du jeudi 25 au soir.

Le banquet annuel se tiendra dans la grande salle de bal du Château Frontenac et sera accompagné d'un concert de musique de chambre organisé par le Conservatoire de musique de Québec.

Une exposition technique d'équipements de mesure et de matériaux acoustiques est prévue parallèlement au Symposium, plusieurs compagnies ont été approchées à cet effet.

SEMINAIRE [1]

ACOUSTIQUE GENERALE ET CONTROLE DU BRUIT

Coordonnateur: Yvan Champoux

Ce séminaire s'adresse aux professionnels, principalement du Québec, qui oeuvrent dans les domaines du génie, de l'architecture et de l'urbanisme. Il sera donné **en français** et se tiendra les 22 et 23 octobre de 9h30 à 17h00 à l'Université Laval.

PROGRAMME (préliminaire)

- Introduction à l'acoustique (Yvan Champoux)
- Normes, effets du bruit, protection des travailleurs (Raymond Hétu)
- Réduction du bruit (Jean Nicolas)
- Acoustique architecturale (James Rennie)
- Acoustique urbaine (Jean-Gabriel Migneron)
- Matériaux acoustiques (Yvan Champoux)

Frais d'inscription Séminaire [1]: $175.00
(incluant les notes de cours, les deux buffets servis à l'Université Laval et l'autobus entre le Château Frontenac et l'Université).

Inscription après le 1er septembre: $200.00

SEMINAIRE [2]

L'INTENSIMETRIE ACOUSTIQUE ET SES APPLICATIONS

Coordonnateur: Jean Nicolas

Ce séminaire s'adresse à tous les membres de l'Association intéressés par l'intensimétrie, ses théories et techniques et ses nouvelles applications. Il sera donné **en anglais** et se tiendra les 22 et 23 octobre de 9h30 à 17h00 à l'Université Laval. Plusieurs compagnies ont été approchées pour fournir du matériel de démonstration et éventuellement participer aux conférences. Suite à la présentation des applications par différents invités, il est prévu que la session se termine sur une table ronde qui confrontera les différentes expériences et approches.

PROGRAMME (préliminaire)

- Introduction théorique (Jean Nicolas): définitions, calculs, précision en champ progressif ou non-progressif, instrumentation (spectre croisé et filtres digitaux, sondes, calibration).
- Applications (deuxième journée avec conférenciers invités: (J.F. Allard (France), M.J. Crocker (Etats-Unis), G. Krishnappa (Canada), etc.): identification des sources, mesures de puissance, mesures de transmission, interrelation bruit et vibration, mesure du coefficient d'absorption, et holographie acoustique.
- Table ronde (à 16h30).

Frais d'inscription Séminaire [2]: $325.00
(incluant les notes de cours, les deux buffets servis à l'Université Laval et l'autobus entre le Château Frontenac et l'Université).

Inscription après le 1er septembre: $375.00

COMITE ORGANISATEUR

Jean-Gabriel Migneron (organisation générale)
Jean Nicolas (conférenciers)
Cameron Sherry (président A.C.A.)

SECRETARIAT

Line Pouliot (toute correspondance)
Centre de recherches en aménagement et en développement
1624 Pavillon Félix-Antoine-Savard
Université Laval
Québec, P.Q.
G1K 7P4
Tél.: (418) 656-7558

INFORMATIONS

Organisation générale:	Jean-Gabriel Migneron (418) 656-7558 (418) 839-0101 (soir)
Conférences:	Jean Nicolas (819) 565-4479
Séminaire [1]:	Yvan Champoux (819) 565-4492
Séminaire [2]:	Jean Nicolas (819) 565-4479
Exposition technique:	Jean-Gabriel Migneron (418) 656-7558

FORMULE D'INSCRIPTION PRELIMINAIRE
SEMAINE CANADIENNE D'ACOUSTIQUE
Québec 22 au 26 octobre 1984

NOM: ______________________

COMPAGNIE OU ORGANISME: ______________________

ADRESSE: ______________________

____

CODE POSTAL: __________ TELEPHONE: __________

SIGNATURE: ______________________

DATE: __________

Prière de m'inscrire aux activités suivantes:

SEMINAIRE [1] (acoustique et contrôle du bruit)*	$175.	☐
SEMINAIRE [2] (l'intensimétrie et ses applications)*	$325.	☐
SYMPOSIUM (incluant les notes des conférences, deux repas et le banquet annuel)	$125.	☐
SYMPOSIUM (statut d'étudiant régulièrement inscrit)	$ 50.	☐
Inscription supplémentaire pour le banquet annuel	$ 30.	☐
Exemplaire supplémentaire des notes de conférences	$ 10.	☐
TOTAL:	____	

Je compte réserver une chambre au Château Frontenac - nuit simple: $63.** ☐
(les cartes de réservation de l'Hôtel seront envoyées à tous les membres dans le courant de l'été)

Je compte venir accompagné(e) ☐

Je suis intéressé(e) à diverses activités touristiques:
- visite de l'Ile d'Orléans ☐
- visite du Vieux-Québec ☐
- autre (spécifier) ______________________

Les membres qui le désirent peuvent s'assurer tout de suite de leur inscription en joignant un chèque à l'ordre de:
"Semaine Canadienne d'Acoustique - Québec 1984"
à l'attention de Jean-Gabriel Migneron
CRAD, 1624, pavillon Félix-Antoine-Savard
Université Laval
Québec, P.Q., G1K 7P4

(*) Après le 1er septembre les frais d'inscription à ces deux activités seront portés respectivement à $200. et $375.
(**) Le prix spécial pour une occupation double est de $77. Après le 22 septembre, les réservations au prix spécial dépendront de la disponibilité de l'hôtel.

ACOUSTICS WEEK IN CANADA

October 22-26, 1984
Quebec City
(Château Frontenac Hotel)

PROGRAM
(preliminary version)

Monday October 22:

0830 Registration Seminars [1] and [2] (Laval University)
0930 Seminars begin
1130 Buffet (Laval University)
1930 C.S.A. Chairmen's Meeting (Château Frontenac)

Tuesday October 23:

0900 C.S.A. Main Committee (Château Frontenac)
0930 Seminars - Day 2 (Laval University)
1130 Buffet (Laval University)
1300 Seminars continue
1630 Round table on Acoustical Intensimetry (Laval University)
1930 CAC/ISO-T43/SC2 Committee (Château Frontenac)

Wednesday October 24:

0800 Symposium Registration (Château Frontenac)
0900 Exhibition opens
0900 Sessions 1, 2 and 3 of Symposium (Château Frontenac)
1200 Buffet (Restaurant Le Champlain, included in registration fee)
1330 Sessions 4, 5 and 6 of Symposium
2000 C.A.A. Directors' Meeting (Château Frontenac)

Thursday October 25:

0900 Sessions 7 and 8 of Symposium
1200 Buffet (Restaurant Le Champlain, included in registration fee)
1330 Plenary session (Jacques-Cartier Hall)
1630 C.A.A. Annual General Meeting (Jacques-Cartier Hall)
1930 Annual Dinner (Château Frontenac Ball-room)

Friday October 26:

0900 Sessions 9, 10 and 11 of Symposium (Château Frontenac)
1330 Associate Committee for Machinery Noise (Château Frontenac)
1700 Exhibition closes

1984 SYMPOSIUM

This year the Symposium will be held in Quebec City on October 24, 25 and 26.

Papers will be given from 0900 to 1630 in two or three parallel sessions and will deal with the following topics:

- Noise Source Identification Techniques (J. Nicolas)
- Quieting the Noise Source (Y.Champoux)
- Urban and Environmental Noise (J.-G. Migneron)
- Barriers, Screens and Shielding (M. Amram)
- In-plant Noise Control and Models (G. Lemire)
- Architectural Acoustics (J. Rennie)
- Noise Emission and Vibration (G. Ostiguy)
- Speech Analysis (M. Boudreault)
- Acoustical Metrology (G. Wong)
- Physio and Psychological Acoustics (R. Hétu)
- Ultrasonics and Underwater Acoustics (D. Cheeke)

In addition, the afternoon of October 25 will be devoted to a three-hour plenary session for all participants from 1330 to 1630.

As announced in the Association Journal, **summaries of papers are expected to be in by May 31** and authors should also prepare a 2-page article summarizing their paper so that these can be distributed to participants before the beginning of the Symposium.

Registration fees (including summaries of papers, coffee breaks, buffet dinners on October 24 and 25 and one dinner ticket for the CAA annual dinner on October 25) are $125.00.

The annual dinner will take place in the Grand Ball-room of the Château Frontenac and will be accompanied by a concert of chamber music organized by the Quebec Conservatory.

An exhibition of acoustical materials and measuring instruments will be held at the same time as the Symposium. Several companies have been contacted in this domain.

SEMINAIRE [1]

GENERAL ACOUSTICS AND NOISE CONTROL

Seminar Leader: Yvan Champoux

This seminar is intended for professionals working in the fields of Engineering, Architecture and Urbanism (mainly in Québec). It will be given **in French** on October 22 and 23 from 0930 to 1700 at Laval University.

COURSE OUTLINE (preliminary version)

- Introduction to Acoustics (Yvan Champoux)
- Norms, Effects of Noise, and Protection of Workers (Raymond Hétu)
- Noise Reduction (Jean Nicolas)
- Architectural Acoustics (James Rennie)
- Urban Acoustics (Jean-Gabriel Migneron)
- Acoustical materials (Yvan Champoux)

Course fee: $175.00
(included course notes, 2 buffet dinners at Laval University and transportation between the university and the Château Frontenac)

Fee for registration after September 1: $200.00

SEMINAR [2]

ACOUSTICAL INTENSIMETRY AND ITS APPLICATIONS

Seminar Leader: Jean Nicolas

This seminar is intended for those interested in intensimetry, both on the level of theory and technique and on that of new practical applications. It will be given **in English** October 22 and 23 from 0900 to 1700, at Laval University. Several companies have been contacted to provide materials for demonstrations and, if possible, participate in the seminar. After the presentation of practical applications, the seminar will end with a round table where the various experiments and approaches can be confronted.

COURSE OUTLINE (preliminary version)

- Theoretical introduction (Jean Nicolas): definitions, calculation, precision in progressive and non-progressive field, instrumentation (cross-spectrum and digital filters, microphones, calibration)
- Applications - the second day, guest lecturers (J.F. Allard (France), M.J. Crocker (Etats-Unis), G. Krishnappa (Canada), etc.) will discuss: source identification, intensity measurement, transmission measurement, interrelation between noise and vibration, measurement of absorption coefficients, acoustical holography
- Round table (until 1630).

Course fee: $325.00
(includes course notes, 2 buffet dinners at Laval University and transportation between the university and the Château Frontenac)

Fee for registration after September 1: $375.00

ORGANIZING COMMITTEE

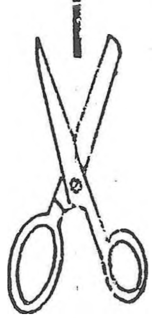
Jean-Gabriel Migneron (overall organization)
Jean Nicolas (lecturers)
Cameron Sherry (CAA president)

SECRETARY

Line Pouliot (all correspondence)
Centre de recherches en aménagement et en développement
1624 Pavillon Félix-Antoine-Savard
Université Laval
Québec, P.Q.
G1K 7P4
Tel.: (418) 656-7558

INFORMATION

General:	Jean-Gabriel Migneron (418) 656-7558 (418) 839-0101 (evenings)
Lectures:	Jean Nicolas (819) 565-4479
Seminar [1]:	Yvan Champoux (819) 565-4492
Seminar [2]:	Jean Nicolas (819) 565-4479
Exhibition	Jean-Gabriel Migneron (418) 656-7558



PRELIMINARY REGISTRATION FORM
ACOUSTICS WEEK IN CANADA
Quebec City, October 22-26, 1984

NAME: ______________________

COMPANY OR ORGANIZATION: ______________________

ADDRESS: ______________________

____

POSTAL CODE: ____________ TELEPHONE: ____________

SIGNATURE: ______________________

DATE: ____________

Please register me for the following activities

SEMINAR [1] (Acoustics and Noise Control)*	$175.	☐
SEMINAR [2] (Intensimetry and its Applications)*	$325.	☐
SYMPOSIUM (including lecture notes, 2 meals and annual dinner)	$125.	☐
SYMPOSIUM (student registration)	$ 50.	☐
CAA Annual Dinner (extra tickets)	$ 30.	☐
Extra copy of lecture notes	$ 10.	☐
TOTAL:	____	

I plan to reserve a room at the Château Frontenac - single room: $63.** ☐
(reservation slips for the Château Frontenac will be sent out to all members this summer)

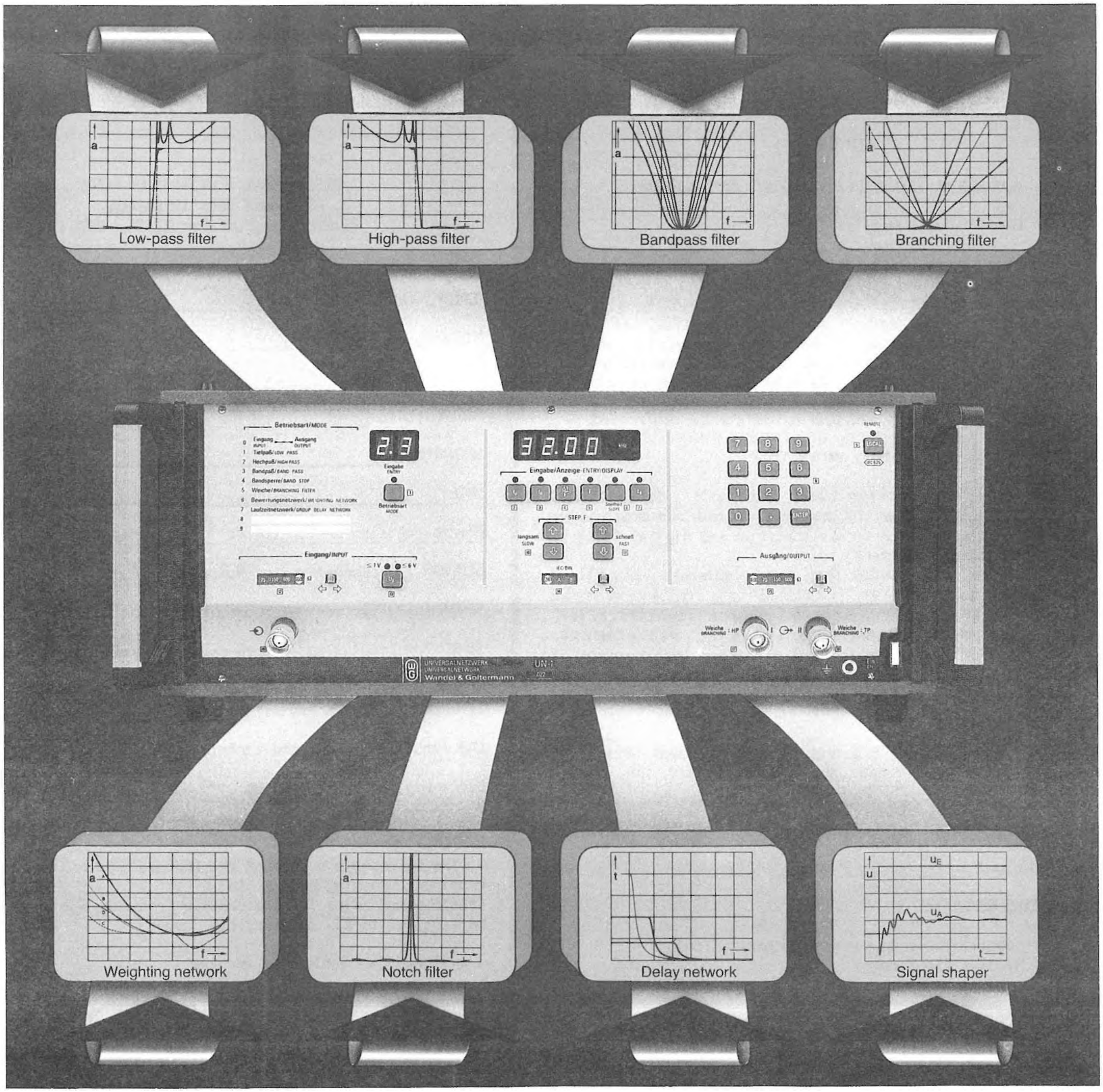
I will need accomodations for two ☐

I would like to do some touring:
- Island of Orleans ☐
- Old Quebec ☐
- other (specify)______________________

Those who wish can register immediately by enclosing a cheque payable to:
"ACOUSTICS WEEK IN CANADA - QUEBEC CITY 1984"
and forwarding it to Jean-Gabriel Migneron
CRAD, 1624 Pavillon Félix-Antoine-Savard
Université Laval
Québec, P.Q., G1K 7P4

(*) After September 1, registration fees for the seminars will be $200.00 and $375.00 respectively.

(**) The special rate for a double room is $77.00. After September 22, the special rate will be conditional on the availability of rooms.



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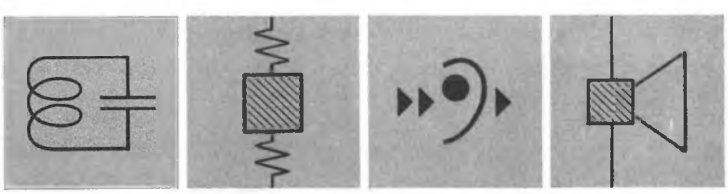

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MEMBERSHIP EXPANSION: REACHING OUR POTENTIAL

Annabel J. Cohen
Membership Chairperson
Department of Psychology, University of Toronto
1265 Military Trail, Scarborough, Ontario M1C 1A4

The Office of Membership, new this year, aims to decrease the large discrepancy between actual and potential membership in the CAA.

In the past months, foundations for a membership campaign have been laid. A document on membership policy was drafted,* a flyer, and poster were developed, and a program of presenting the CAA at related organizations was initiated.

The CAA Executive strongly endorses personal contact as the single most effective way in increasing membership. Will you help? The following are actions which you can take to augment membership through personal contact.

1. Tell a potential member about the CAA and ask him or her to complete the application form found at the back of this journal and to mail it to Deirdre Benwell.
2. Write me for the "invitation" to non-members which provides a brief background and goals of the CAA, lists nine benefits to members, and includes a membership application form. Distribute this to a colleague or organization you think should know about the CAA.
3. If you do not want to initiate a contact yourself, send me the name of the colleague or organization; I will send the information on.
4. Speak to a few colleagues in your local area about the possibility of setting up a regional chapter. Write to Alberto Behar (Safety Service Department, Ontario Hydro, 757 McKay Road, Pickering, Ontario, L1W 3C8) or Winston Sydenborgh (H.L. Blachford Ltd., 2323 Royal Windsor Drive, Mississauga, Ontario, L5J 1K5), who will provide you with the information on the origin of the Toronto Regional Chapter and the handling of programming, circulation, etc.
5. Write me that you are willing to act as a liaison between the CAA and another organization, institution, or geographical area. I will send you material which will help inform the liaison group. Please appreciate that if you do not do this, someone else might not either.

Complementing the above approaches are three challenging projects which require a joint National effort: the development of a directory of Canadian Acoustics Professions, the development of a directory of academic course offerings in acoustics throughout Canada, and the composition of an audio-visual slide presentation representing Canadian acoustics. If any of these projects interest you, write to me.

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*Copies available from Annabel Cohen.

Finally, if you are interested in helping to direct the evolution of the membership in general, please consider joining the Membership Committee itself. Send me your name.

In conclusion, through our joint efforts we can help to raise the profile of Canadian Acoustics and surmount the barriers between disciplines, institutions, and geography which have separated Canadian acousticians in the past. The diversity in our field can emerge as a source of strength rather than of weakness. Membership growth of the CAA will enhance all acoustics professions in Canada and will lead to new opportunities in research, applications, employment, and social services related to acoustics.

A few minutes of <u>your</u> time in following through with one or more of the recommended actions will have far-reaching benefit. Your suggestions are always welcomed.

HIGHLIGHTS OF 1982 SURVEY ON OCCUPATIONAL NOISE AND HEARING CONSERVATION REGULATIONS IN CANADA*

D.A. Benwell
Non-Ionizing Radiation Section
Radiation Protection Bureau
Environmental Health Centre, Room 233
National Health and Welfare
Ottawa, Ontario

Abstract

The Canadian Standards Association Task Force on Occupational Noise conducted a survey on occupational noise and hearing conservation regulation in Canada by sending out a questionnaire in January 1982 to 148 representatives of government, regulators, employers, labour, consultants, universities, and hospitals. All representatives were selected due to their interest in the subject. The questionnaire requested information on noise levels, hearing protection, audiometry, warning signs, noise surveys, and workers' compensation criteria and benefits. As of March 1983, 68 completed questionnaires were returned, and 6 letters sent in lieu of completed

questionnaires. Of the 68 completed questionnaires, 25 were returned by employers, 2 by labour, 23 by government or regulators, the remaining 18 were from consultants, universities, associations, etc. The majority of replies were primarily a personal view, although over half of these also reflected the views of their organization.

The results of the questionnaire clearly demonstrate a concensus for a national guideline on occupational noise and hearing conservation standards (over 80% of those that answered this question were agreed on this). In addition in all but one or two questions, most of the replies agreed on the details of the technical contents required.

Sommaire

Le Groupe de travail sur les bruits professionnels de l'Association canadienne de normalisation a effectué un sondage portant sur la règlementation des bruits professionnels et la préservation de l'ouïe au Canada en faisant parvenir, en janvier 1982, un questionnaire à 148 représentants du gouvernement, d'organismes de réglementation, d'employeurs, de travailleurs, d'experts-conseils, d'universités et d'hôpitaux. Tous les représentants ont été choisis à cause de leur intérêt pour le sujet. Le questionnaire demandait de l'information sur les niveaux de bruit, la protection de l'ouïe, l'audiométrie, signes d'avertissements, les sondages sur le bruit et les critères d'admissibilité des travailleurs et les indemnités. En mars 1983, 68 questionnaires dûment remplis ont été retournés et 6 lettres envoyées à la place des questionnaires remplis. Parmi les 68 questionnaires dûment remplis, 25 ont été retournés par des employeurs, 2 par des travailleurs, 23 par le gouvernement ou des organismes de réglementation; les 18 autres provenaient d'experts-conseils, d'universités, d'associations, etc. La majorité des réponses présentaient surtout un point de vue personnel, mais plus de la moitié d'entre elles reflétaient également l'opinion de l'organisme représenté.

Les résultats du questionnaire traduisent manifestement un consensus pour une directive nationale sur des normes de bruits professionnels et de préservation de l'ouïe (plus de 80% des personnes qui ont répondu à cette question étaient en accord). A part une ou deux questions, la majorité des réponses concordaient sur les détails du contenu technique nécessaire.

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*A copy of this report may be obtained by writing to the author.
Une copie de ce rapport peut être obtenue en écrivant à l'auteur.

THE ANALYSIS OF ARRAYS USING STARPAK

M. J. Wilmut and W. W. Wolfe
Royal Roads Military College
FMO Victoria, B. C.
VOS 1BO

ABSTRACT

Some of the main features and a typical application of STARPAK (Simulation for Testing Array Response) is presented. STARPAK is a package of Fortran subroutines designed to study the performance of an arbitrary planar array in a variety of Gaussian signal-noise environments. Array data with the appropriate statistics are simulated and then processed using the conventional, optimal and Bienvenu techniques.

SOMMAIRE

Quelques uns des traits principaux ainsi qu'une application pratique de "STARPAK" sont présentés. "STARPAK" est un ensemble de sous-routines en language "Fortran" qui a pour but d'étudier le fonctionnement d'un groupe quelconque de détecteurs en présence d'un signal et d'un bruit gaussien. Les signaux recueillis par les détecteurs de même que les données statistiques sont simulés, et, par la suite, analysés en se sevant des techniques: conventionnel, optimal et "Bienvenu".

1. Introduction

The detection of sinusoidal signals in ocean ambient noise is an important problem in underwater acoustics[1]. The acoustic energy radiated by ships, submarines and torpedoes are examples of such sinusoidal signals. The data available upon which to make a decision (signal or no signal present) are often those received at an array of hydrophones which is located in the ocean. The detection of signals using array data is a very complex problem[2] and many questions can only be answered using numerical simulation during the analysis. STARPAK[3] is a package of Fortran programs useful in such a study.

Herein we describe the user friendly input-output features of STARPAK and indicate how the program package may be employed to generate random array data for an important class of real world sinusoidal signal-ocean noise scenarios. STARPAK contains efficient algorithms for three methods often suggested for use in the detection of signals using arrays. Finally some comparisons are made of these processing techniques.

2. Theory

a) Statement of the Problem

We assume we have a planar array of n hydrophones located at arbitrary positions in the plane. The signals are sinusoidal and hence a first step in the analysis is to transform the data to the frequency domain. In this domain signals and noise are assumed to be complex Gaussian variables. The noise is modell d as he sum of white, cylindrical and spherical noises with arbitrary powers. Spherical noise is noise generated by a large number of discrete sources uniformly distributed on a sphere whose radius is much larger than the dimensions of the array. Cylindrical noise is noise generated by a large number of discrete sources uniformly distributed over the surface of a cylinder whose radius is much larger than the dimensions of the array and whose axis is normal to the array plane. White noise is due to a large number of discrete sources which are located close to each sensor, and is independent from sensor to sensor. The signals are plane waves of a specific power and direction arriving in the plane of the array.

Our aim is to simulate data received at an array for the above signal-noise scenario and then process the data with algorithms suitable for signal detection in such situations.

b) Data Simulation

At each hydrophone the data are zero mean Gaussian. Hence the data received at the array are completely decribed by its covariance matrix Q. The functional form of Q depends on the signal-noise scenario[3,4]. Let E be an n dimensional vector of independent complex zero mean Gaussian random variables. Subroutines are available to simulate such data. Also suppose Q = U*U is a Cholesky decomposition[5] of the covariance matrix. Here * denotes complex conjugate transpose. In such a decomposition U is a lower triangular matrix. Then X = U*E is a vector sample with the required statistics. An important quantity in the following section is the sampled covariance matrix, $\hat{Q}$. It is defined as the average of a number of XX* samples.

c) Array Processing

The advantages of an array over a single sensor are numerous. One of the most important features is its directional property - which enables it to discriminate between signals arriving from different directions. The direction we are interested in at a particular instant is called the "look direction". The central task of array processing is to investigate techniques which reduce the effect due to noise from "non-look" directions. STARPAK examines three such methods. All require knowledge of the sampled covariance matrix and one, the single frequency version of Bienvenu's detection test technique[3,6] assumes a priori knowledge of the noise only covariance matrix, Q_N. The conventional[2] (Bc), optimal[2] (Bo) and Bienvenu (Bb) beam outputs for direction Θ are:

$$Bc(\Theta) = C^* D^*_\Theta \hat{Q} D_\Theta C \qquad (1)a$$

$$Bo(\Theta) = n^2/(C^* D^*_\Theta \hat{Q}^{-1} D_\Theta C) \qquad (2)a$$

$$Bb(\Theta) = \frac{C^* D^*_\Theta \hat{Q}^{-1} D_\Theta C}{C^* D^*_\Theta \hat{Q}^{*-1} Q_N \hat{Q}^{-1} D_\Theta C} \qquad (3)a$$

where C = [1,...1]* and D_Θ is the diagonal steering matrix in the look direction.

A complete description of these processors and their properties is beyond the scope of this paper. However some of their characteristics are noted here. In conventional beamforming the phases of the sensor inputs are adjusted so that a signal from the look direction adds coherently. An optimal beamformer results when we process the data so that a constant signal response is maintained in the look direction and the power from non-look directions is minimized. An optimal beamformer is <u>not</u> in general optimum for the detection question posed here. The Bienvenu statistic is based on the theory of hypothesis testing[7]. If the data are noise only $\hat{Q}$ will in general be close to Q_N and the beam output close to one. In the case where a signal is present $\hat{Q}$ will in general be different than Q_N and the Bienvenu beam output greater than one for the look directions containing signals.

It is easily verified that the above formulae can be written as:

$$Bc(\Theta) = |\hat{U}D_{\Theta}C|^2 \qquad (1)b$$

$$Bo(\Theta) = n^2/(Y^*Y) \text{ where } \hat{U}^*Y = D_{\Theta}C \qquad (2)b$$

$$Bb(\Theta) = (Y^*Y)/(Z^*Z) \text{ where } Z = BX \text{ and } \hat{Q}X = D_{\Theta}C \qquad (3)b$$

and where $Q_N = B^*B$ and $\hat{Q} = \hat{U}^*\hat{U}$ are Cholesky decompositions.

Using the second set of equations we are able to obtain the beam outputs without evaluating the inverse of $\hat{Q}$, a very difficult numerical problem. In our implementation once $\hat{Q}$ and Q_N have been Cholesky decomposed the beam outputs are calculated by carrying out forward and backward substitution in two systems of linear equations and performing a number of matrix multiplications. The result is a fast and accurate method to obtain the required quantities.

3. <u>Implementation and Examples</u>

The input to STARPAK consists of an array geometry and signal-noise scenario to be investigated. As well, an a priori noise matrix is required for Bienvenu's method. Finally, the number of samples to be averaged in the sampled covariance matrix is set. This number will be referred to as the number of samples averaged in the following. A menu type format is used to input these parameters. After execution we obtain the processor beam outputs. See Figure 1.

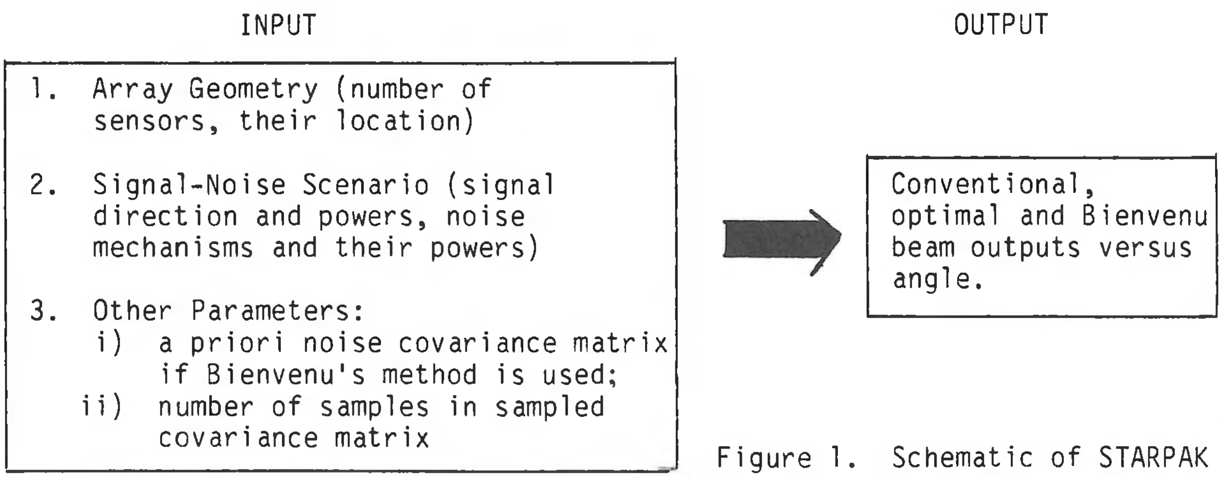


Figure 1. Schematic of STARPAK

We present one example to illustrate some of the main features of STARPAK. The reader can envision many more. Consider a 16-element equispaced linear array with interelement spacing $d = .4\lambda$ where λ is the wavelength of the signal. Imbedded in cylindrical noise of power 1. and white noise power .1 is one signal at 60° of power .4 (signal-to-noise ratio -4.41dB). We have assumed Q_N is white and cylindrical of the appropriate powers. Typical results are shown in Figure 2 where the beam output for the three methods is plotted versus angle. All curves have been normalized to have a maximum value of one. Figures 2(b), (c) and (d) present examples when 32, 64 and 128 samples respectively have been averaged. We note the left-right ambiguity of linear arrays, that is the signal also appears at 300°.

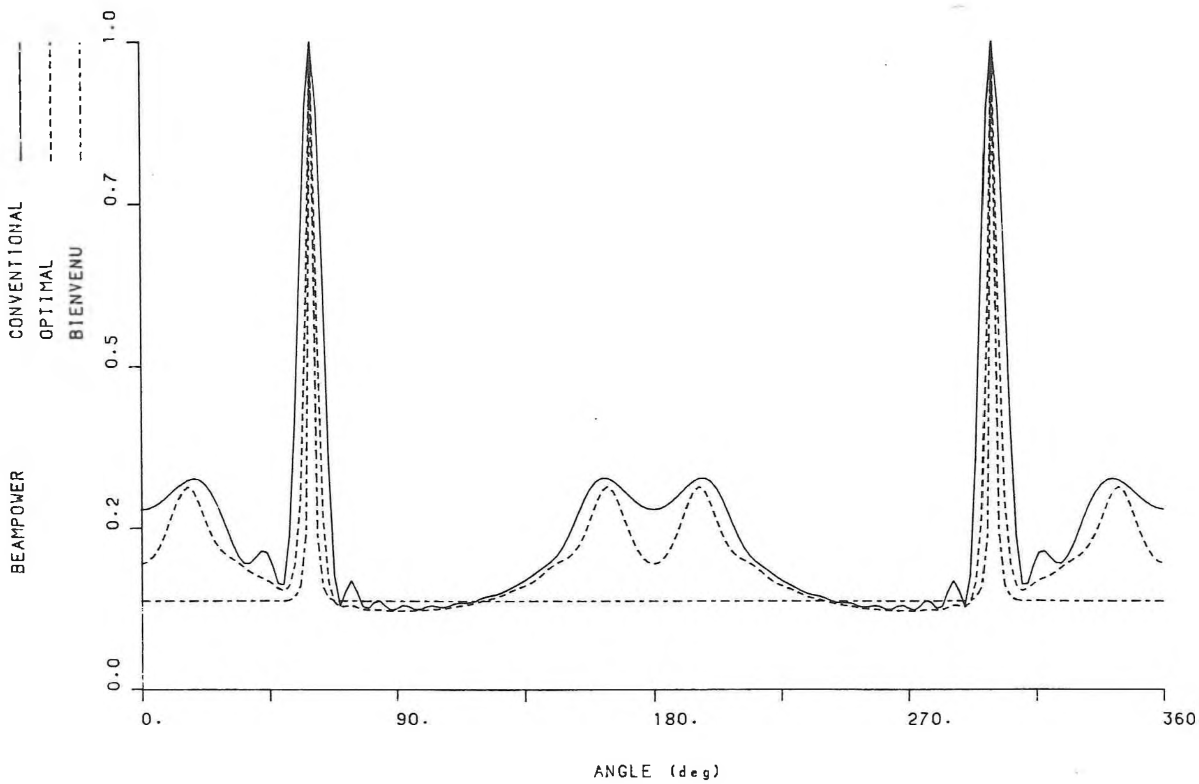
Two measures are useful when comparing processing methods when various numbers of samples are averaged. Signal beamwidth, BW, is defined as the width of the signal at its -3dB point and signal-to-background noise ratio, SBN, as the peak signal level divided by the background noise. Signals processed by an ideal technique would have a BW of zero and SBN proportional to their signal-to-noise ratios. In practice we expect BW to decrease and SBN increase as the number of samples averaged increases. Table I illustrates these trends for our data. As the number of samples averaged increases $\hat{Q}$ approaches Q and best performance is attained. This is referred to as the deterministic case. See Figure 2(a) and Table I for these values in our example.

Number of Samples in Covariance Matrix	Beamwidth			Signal to Background Noise Ratio		
	Bc	Bo	Bb	Bc	Bo	Bb
32	10°	5°	28°	5.2	7	2.04
64	9°	4°	4°	5.4	5.6	2.75
128	10°	3.5°	2°	5.3	5.62	4.18
∞ (deterministic case)	10°	5°	< 1°	5.76	6.98	7.31

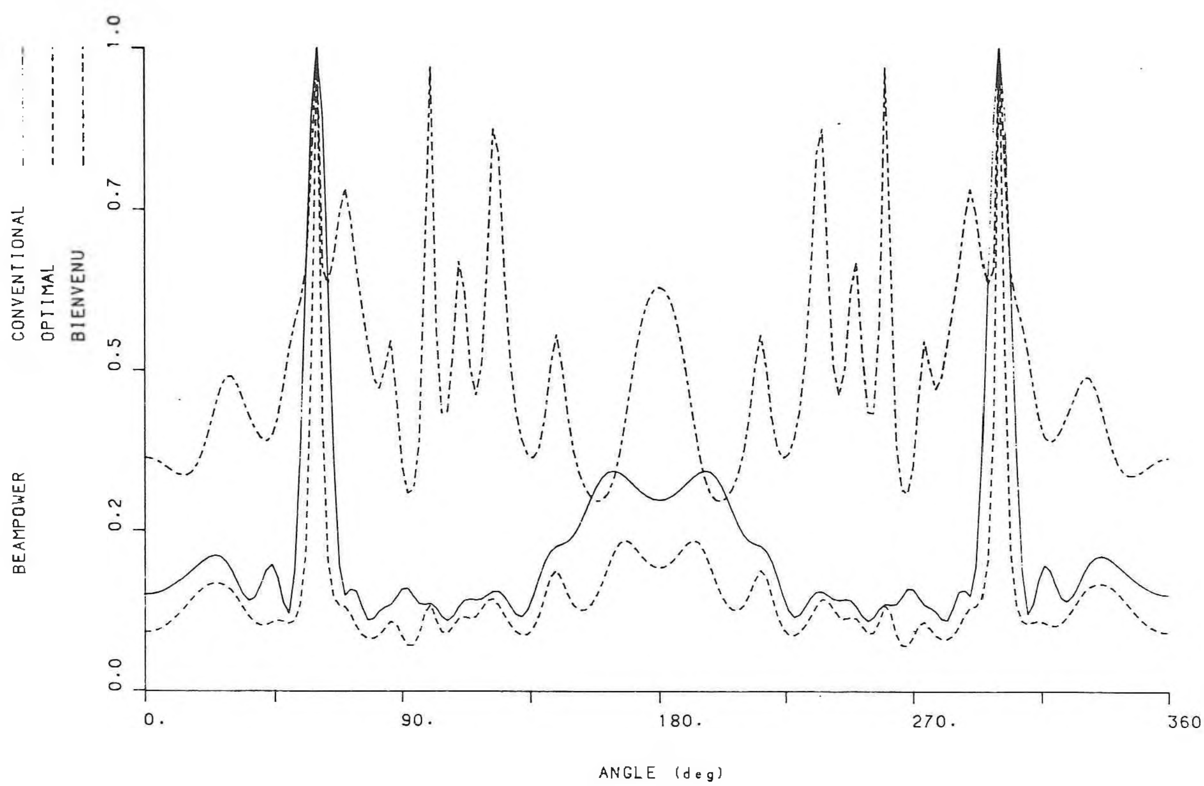
Bc is Conventional, Bo is Optimal, and Bb is Bienvenu Processing

Table I. Signal beamwidth and signal-to-background noise ratio for the cases illustrated in Figure 2.

Using these measures we observe that optimal processing is better than conventional. When the number of samples is at least 64 (at least four times the number of array elements) Bienvenu processing is preferred to optimal. It has an acceptable SBN ratio and superior resolution (smaller BW). Our experience shows "this rule of thumb" holds in a wide variety of cases. When fewer than 64 samples are available for averaging Bienvenu processing is worse than optimal. This occurs due to the form of the Bienvenu statistic which is a quotient of two random variables as given in equation 3(a). Even small fluctuations in both variables about their means cause large fluctuations in the overall statistic.

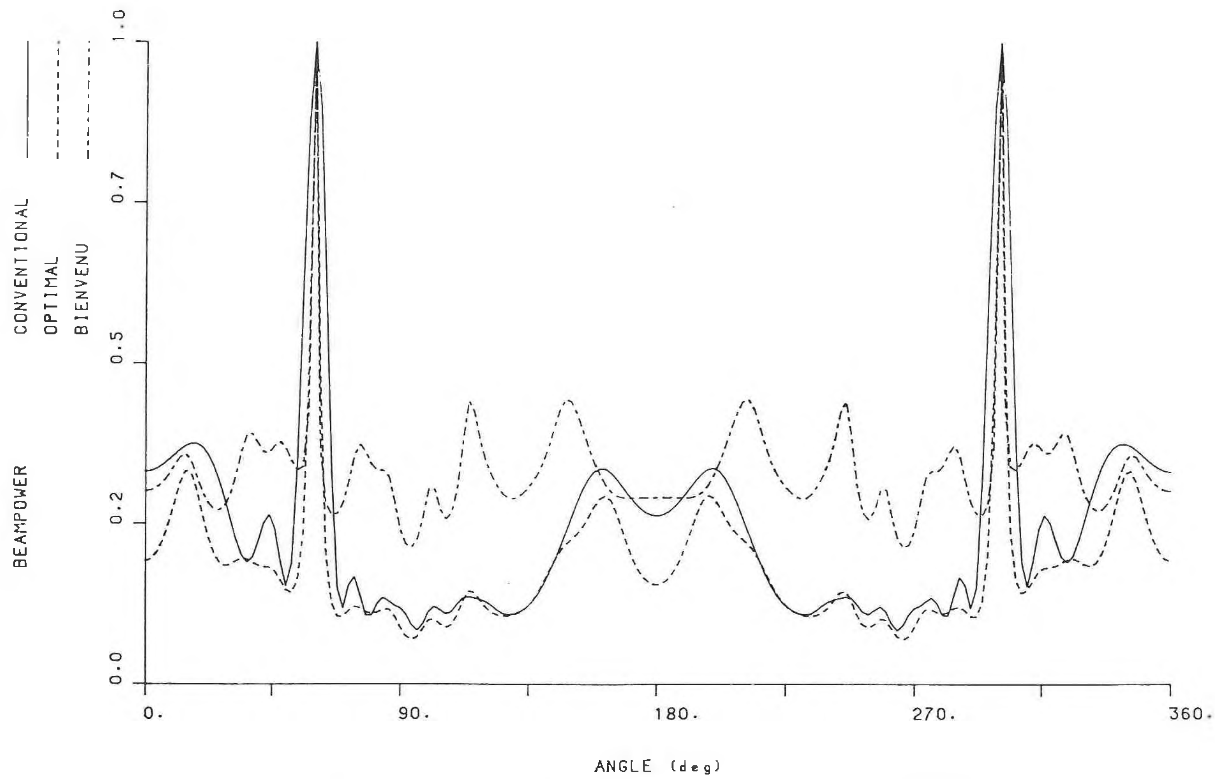


(a) Deterministic covariance matrix.

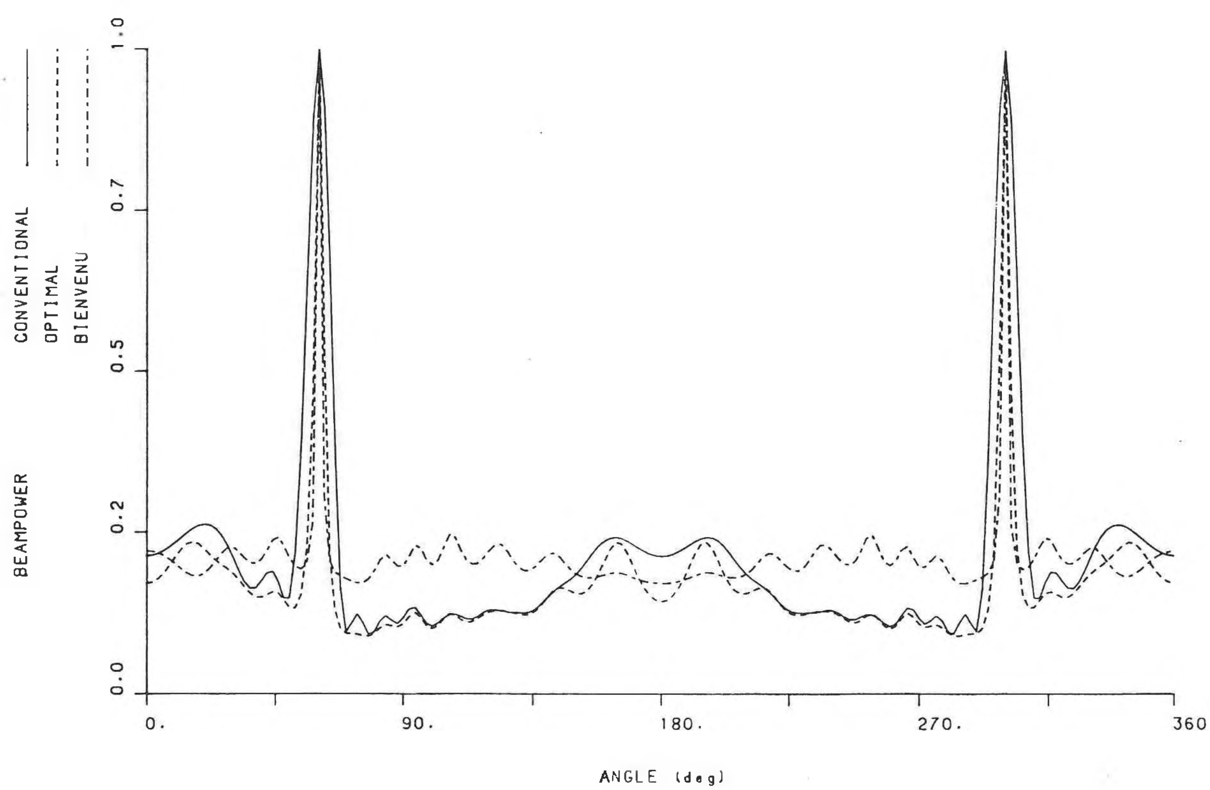


(b) Sampled covariance matrix using 32 samples.

Figure 2. Beam output versus angle for text example.



(c) Sampled covariance matrix using 64 samples.



(d) Sampled covariance matrix using 128 samples.

Figure 2. Beam output versus angle for text example.

4. Summary

STARPAK is a powerful, versatile tool in the study of an important class of real world signal detection problems using arrays. The algorithms used in STARPAK are very efficient. Its user friendly input-output features make it accessible to both the novice and experienced researcher.

Beamwidth and signal-to-background noise ratio are two useful quantities when comparing detection capabilities of array processing methods. Optimal processing is usually better than conventional. Bienvenu processing was superior to optimal when the noise field is "almost" known exactly and a large number of samples are averaged to form the sampled covariance matrix.

STARPAK is available from the authors. This work was supported by a grant from Defence Research Establishment Pacific, Victoria.

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THE EFFECTS OF NOISE ON SPEECH INTELLIGIBILITY IN TELEPHONE COMMUNICATION

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SUMMARY

This paper presents the subjective ratings of speech intelligibility in broadband ambient noise as a function of signal level for telephone communication. The appraisals were evaluated for English messages in an acoustic studio by Asian subjects conversant in the language. To present the necessary signal levels for satisfactory intelligibility under different levels of steady and fluctuating noise fields, two speech interference criteria expressed separately in terms of the preferred speech interference level (PSIL) and L_{50} were proposed.

SOMMAIRE

Cet article présente L'évaluation subjective de l'intelligibilité du langage parlé en présence d'un bruit d'ambiance de fréquences étendues à la fonction du niveau du signal pour la communication téléphonique. L'évaluation a été faite par des sujets asiatiques, sur la netteté de la perception des messages anglais, dans un studio acoustique. A fin de présenter les niveaux nécessaires du signal avec une intelligibilité sastifaisante sous des bruits de masque continus et variables, on a proposé deux critères d'interference qui s'experiment séparément en taut que niveau de perception de la parole (PSIL) et L_{50}.

INTRODUCTION

Speech intelligibility is an important factor to be considered in the design of working environments which involve verbal communication. This is specially so in work places such as air traffic control towers, police radio vehicles, classrooms and lecture theatres where good communication is essential. In general there are two main methods of verbal communication, namely by face-to-face conversation and by telephone. In assessing speech intelligibility in noise for these two methods, one has to make the following distinction: whereas sound perception in the former situation is biaural where both ears of the listeners are subjected simultaneously to the signal and ambient noise, in the latter situation, the ambient noise is received largely by one ear with the other ear of the listener being screened to a large extent by the telephone receiver and listening is monaural.

The interference effect of noise on speech intelligibility in the usually encountered face-to-face situation has been extensively studied.[1-5] Based on the preferred speech interference level (PSIL), Webster[4] has proposed a speech interference criterion which has become the most widely used rating for speech interference assessment. More recently ISO[6] has redefined the PSIL and put forward a revised assessment for satisfactory intelligibility.

In this paper, we report the results of speech intelligibility appraisals in telephone communication masked by broadband noise. The ratings evaluated in an acoustic studio by a sample of Asian subjects for various levels of signals and broadband noise were obtained and plotted separately in terms of PSIL and L_{50}. To present the necessary signal levels for satisfactory intelligibility under different levels of steady and fluctuating noise fields, two speech interference criteria were proposed and their significance discussed.

EXPERIMENTAL PROCEDURE

The schematic diagram of the experimental arrangement is shown in Fig. 1.

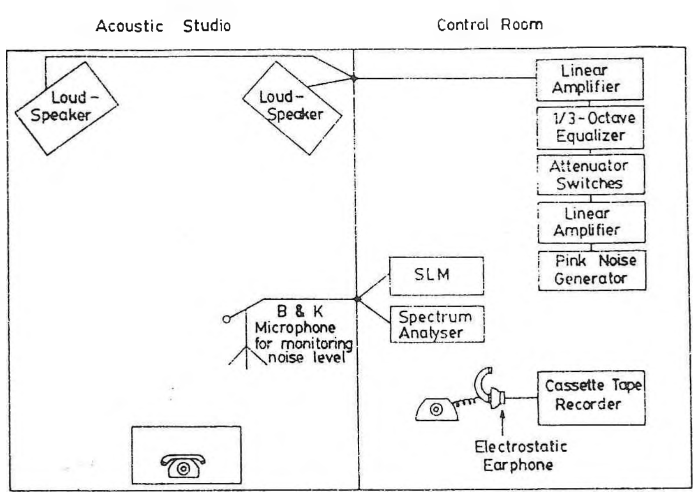

Fig. 1 Experimental Arrangement for Speech Interference Test

For the subjective study, four short telephone messages and a typical broadband noise were generated. The messages, each lasting about 30 sec, were in English and specially composed to contain meaningful sentences with words of vowels and consonants selected from a pool of words compiled by ISO. Each message was first prerecorded at four different levels. During the test, it was played back through the mouth piece of a handset and sent via the telephone exchange to be received by another telephone installed inside the acoustic studio. The four signal levels for each message at the receiving end were measured by an impedance matching IEC artificial ear coupler to be 60 dBA, 70 dBA, 80 dBA and 88 dBA.

The ambient broadband noise was based on a time-averaged noise spectrum (Fig. 2) recorded at the junction of two major roads in the heart of the city.[7]

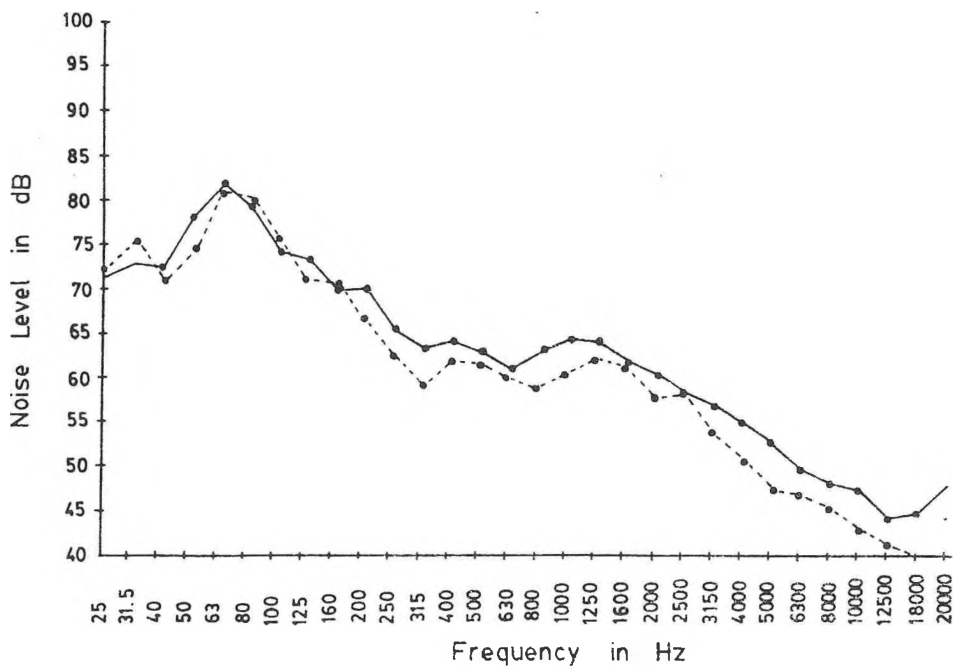

Fig. 2 The solid line is the frequency spectrum of traffic noise and the dotted line is the noise spectrum simulated in the acoustic studio.

As the noise level distribution was found to be normal, the spectrum gave the L_{50} values for the various frequencies. To reproduce the noise, the spectrum was simulated by a pink noise generator in conjunction with a $\frac{1}{3}$-octave equalizer and an amplifier system. It was then played through a pair of high-quality speakers at one of the four chosen (L_{50}) levels of 65 dBA, 70 dBA, 75 dBA and 80 dBA.

The simulated broadband noise was steady without fluctuations or transients, and contained no significant tones. Its spectrum at 75 dBA as measured at ear level about 30 cm from the telephone is also shown in Fig. 2. Comparing with the noise criteria (NC) curves[8], it can be observed that except for frequencies below 100 Hz, the spectrum follows very closely that of NC60 curve. The background noise employed in this investigation can therefore be taken to represent noise from more general noise situations rather than confined solely to noise from steady traffic flow. The set of background noise measured at 65dBA, 70 dBA, 75 dBA and 80 dBA corresponds to the set of noise criteria curves numbering NC50, NC55, NC60 and NC65 respectively, thus it follows that the corresponding PSIL for the chosen background noise levels may be taken respectively as 50 dB, 55 dB, 60 dB and 65 dB.

Intelligibility appraisals were carried out by 86 untrained Asian subjects. All subjects had normal hearing and equal acuity in both ears. They were drawn entirely from the University community and consisted of academic and technical staff, students, secretaries and clerks. The breakdown of their race, sex and age is summarised in Table 1.

Table 1

Age Group \ Race	Chinese		Malay		Indian		Other		Total
	M	F	M	F	M	F	M	F	
18 - 30	11	8	6	4	3	3	1	1	37
31 - 40	12	5	4	1	2		2		26
41 - 50	7	1	1	2	1			1	13
51 - 60	6	1	1		1		1		10
							Grand Total		86

During the appraisals, a subject stood at about 30 cm in front of the telephone box with his/her back facing the noise source. With the background noise on, the subject listened to the telephone messages and assessed the influence of noise on intelligibility using the following multiple Criteria:

Criterion	Rating
Background noise has negligible interference on intelligibility	1 2
Background noise has slight interference on intelligibility	3 4
Background noise has large interference on intelligibility	5 6
Background noise has severe interference on intelligibility	7 8

For improved resolution, two ratings were assigned to each criterion. For the case of normal telephone communication, ratings 1 and 2 correspond to the ideal situation where hearing is clear and precise. Ratings 3 and 4 correspond to acceptable situations where little effort is required for satisfactory intelligibility. Ratings 5 and 6 correspond to the grey region which may be acceptable if conversation is short and the audibility requirement is not stringent. Ratings 7 and 8 correspond to situations in which speech perception is very low and is therefore not acceptable under any circumstances. In a separate experiment, attempts had been made to quantified some of the ratings. This was carried out according to the method described by Beranek[9]. 30 selected sentences[9] were recorded and played back successively through the telephone system in the manner as described earlier. A subject after listening to each sentence was required to write it down and the articulation score was then computed from the number of key words correctly recorded. In this test, rating 4 was found to correspond to a score of approximately 78%. This is a sufficiently high articulation level which, despite the loss of a small part of the message, enables meaning and important points to be extracted from context. This rating, which was accepted by 85% of the subjects as the threshold of satisfactory listening condition, was therefore taken as the basis for the speech interference criteria in telephone communication.

RESULTS AND DISCUSSION

For the various combinations of signal and noise levels, a total of 1376 appraisals were recorded. The data obtained were then processed to yield the average ratings for all the possible predetermined signal/noise situations. To present the results of interest, Fig. 3 was plotted showing four rating curves for varied signal level as a function of PSIL (lower scale) and L_{50} (upper scale).

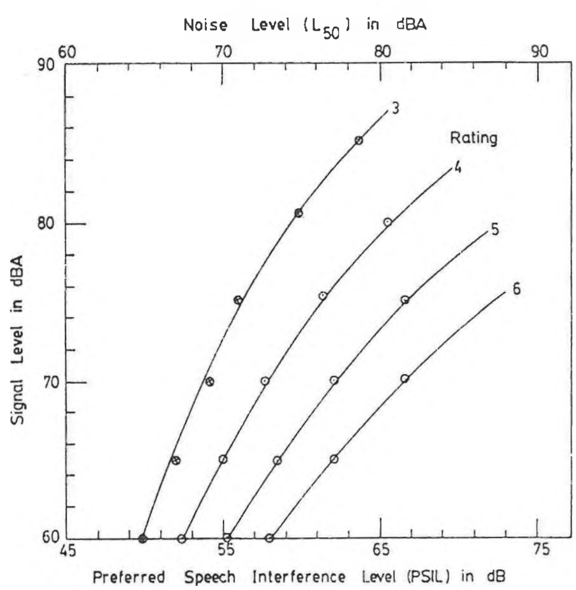

Fig. 3 Variation of signal level with PSIL (lower scale) and L_{50} (upper scale) for ratings 3, 4, 5, 6. This figure is plotted for steady noise fields for which $\Delta L_T = 0$.

It is interesting to note that the variations and inter-spacings of the curves are highly regular. This regularity permits additional information such as that pertaining to intermediate ratings to be obtained if so desired by extrapolation. For the present experiment, this necessity did not arise since rating 4 had been established as the listening condition for satisfactory intelligibility. Based on this rating, two speech interference criteria were proposed for (i) steady background noise and (ii) fluctuating background noise.

Steady background noise. In this case, the noise level is expressed in PSIL. The relation between the signal level and PSIL corresponding to rating 4 may be approximated by the expression:

$$SL_A \geqq 130 \log \left[\frac{1}{10} (PSIL - 23)\right] \qquad (1)$$

where SL_A is the A-weighted signal level of the telephone receiver for satisfactory intelligibility. Its value is to be measured by an IEC artifical ear coupler. In practice, however, SL_A may be approximately correlated to the voice level of the talker which depends to a large extent on the telephone system in use as well as the manner the handset is held by the talker. For example, using the Singapore telephone system, it had been found that to produce a telephone signal level of about 74 dBA as stipulated by Eq. (1) for satisfactory intelligibility against a background noise level of 75 dBA (PSIL = 60 dB), a slightly raised voice level (measured 65 dBA at a distance of one meter) would suffice when the talker speaks into the mouth piece of the handset held in the normal manner.

Fluctuating background noise. A different class of situations exists where the background noise has short-term fluctuations in time. Such fluctuations and, in particular, rapid transients could adversely increase the annoyance perceived and hence increase the interference with speech intelligibility.

To test this effect due to the fluctuating noise, 15 subjects drawn from the original 86 subjects were asked to repeat the appraisals with background noise generated by the original tape recording of the traffic noise. The fluctuation, as given by $\Delta L_T = L_{10} - L_{90}$, was measured by a Bruel and Kjaer statistical noise analyser and found to be approximately 7-8 dBA for the four levels as mentioned earlier. The results of the test showed that noise fluctuations may be interpreted as equivalent to enhancing the steady background level by a margin ΔL_T.

Thus including the enhanced annoyance due to noise fluctuation ΔL_T, the relation between the signal level and L_{50} corresponding to rating 4 takes the following form:

$$SL_A \geqq 130 \log \left[\frac{1}{10} (L_{50} + \Delta L_T - 38)\right] \qquad (2)$$

Since ΔL_T is a variable quantity which may be different for different noise fields, the rating curves in fig. 3 are therefore presented in terms of L_{50} for steady ambient noise for which $\Delta L_T = 0$ (upper scale). For fluctuating noise with $\Delta L_T \neq 0$, the curves are equally valid except in such situation one has to do the necessary adjustment, i.e. to obtain the same level of audibility for a particular rating, the signal has to increase by an amount corresponding to the additional value of ΔL_T for the fluctuating noise level measured in L_{50}.

In this connection, it is interesting to note that the psychoacoustic effect of a fluctuating noise appears to be closely linked to the accepted noise pollution level (L_{NP}) which is defined[10] as

$$L_{NP} = L_{EQ} + \Delta L_T$$

because of the normal distribution of noise levels as mentioned earlier.

Eq. (2) had been subjected to further confirmation by a number of on-site evaluation using telephones installed in exposed telephone booths located at street corners. The appraisals obtained for a variety of fluctuating noise fields showed the same consistent results closely in agreement with Eq. (2).

CONCLUSIONS

This work presents the results of speech intelligibility in telephone communication as appraised by a random selection of Asian subjects. All the subjects are conversant in English and can be taken to represent a cross section of the English speaking population in some Asian cities. Because of the small subject sample, no attempt was made to analyse the effect of age on the appraisal results. Two speech interference criteria for steady and fluctuating noise fields were proposed. They were derived mainly from the experimental data obtained in an acoustic studio and confirmed by on-site evaluations. It is hoped that these criteria can be used as guidelines for the improvement of speech perception in the design and installation of telephone booths in those Asian cities where English is one of the main languages used for telephone communication.

ACKNOWLEDGEMENTS

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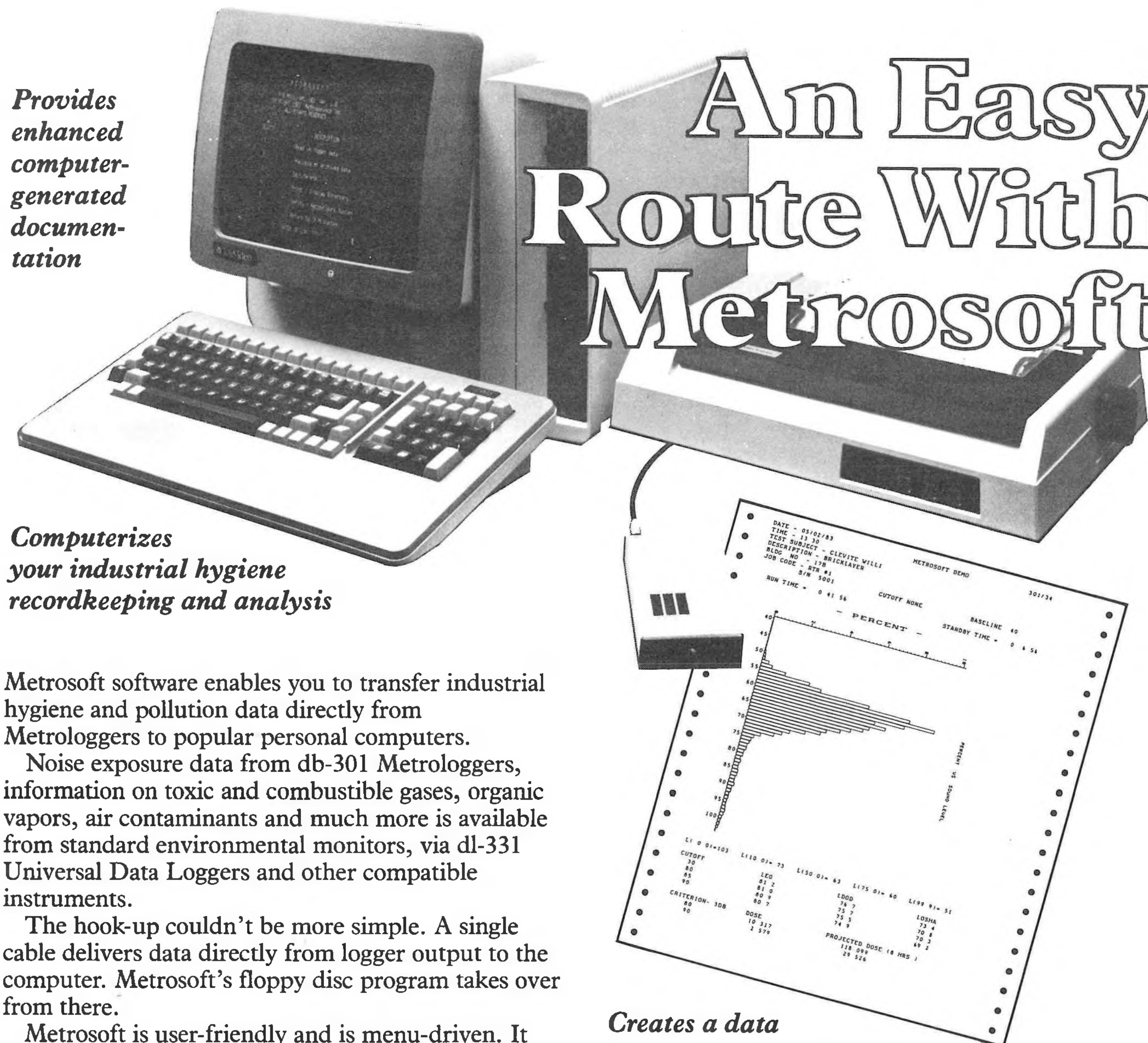

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ACOUSTIC CONTROL OF THE MIXING PROCESSES IN A GAS TURBINE COMBUSTOR

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ABSTRACT

The air mixing processes in a gas turbine combustor control the lifetime of the turbine via the combustor exit plane temperature distribution, as well as the efficient burning of the fuel. Consequently an original technique has been developed to acoustically control the dilution-air jet mixing processes which govern the exit plane temperature distribution. This has resulted in a small combustor of normal design, employing the technique, being successfully tested up to the "half-load" condition. The ability to selectively and progressively control the temperature pattern was convincingly demonstrated. Acoustic driver power requirements were minimal. The pulsed dilution-jet flows develop toroidal vortices and improved mixing is indicated. The pressure loss, the overall combustion efficiency and other combustor performance factors were insignificantly affected by the acoustic drive. The study contributes to the design of combustors such that control may be exercised over the air jet mixing processes.

RÉSUMÉ

Le processus de mélange d'air et de combustible dans la chambre de combustion d'une turbine à gaz contrôle la durée de vie de la turbine par la distribution uniforme de la température à la sortie de la chambre de combustion, de même que l'utilisation efficace du combustible. Par conséquent, on a mis au point une nouvelle technique visant à contrôler acoustiquement le processus de mélange par jets d'air qui règle la répartition de température à la sortie. Cette technique a conduit à l'élaboration d'une petite chambre de combustion de modèle courant qui a été soumise avec succès à des essais dans des conditions de charge atteignant la moitié de sa capacité. Il a été démontré de façon convaincante que l'on peut régler les variations de température de manière sélective et progressive. Les exigences en puissance acoustique se sont avérées minimes. Les jets d'air de dilution créent des tourbillons toroïdaux et il en résulte un meilleur mélange. Les effets de la commande acoustique sur la perte de pression, l'efficacité globale de la combustion ainsi que d'autres facteurs reliés à la performance de la chambre de combustion ont été de peu d'importance. Cette étude contribue à la conception de chambres de combustion à l'intérieur desquelles il est possible de régler le processus de mélange par jets d'air.

NOMENCLATURE

A/F	Air/fuel ratio (by mass flow rate)
f	Frequency
$\dot{m}_a$	Air mass flow rate
$\dot{m}_f$	Fuel mass flow rate
M_{ref}	Reference Mach Number based on maximum I. DIA. of casing
P_2	Inlet static pressure
r	Radial position
S_t	Strouhal Number
T [1]	Temperature
T_2	Inlet temperature
T_3	Exit plane temperature
T_{3m}	Exit plane mean temperature
$T_{31} \ldots T_{36}$	Traversing thermocouples
T_{3r}	Exit plane mean 'radial' temperature
$\bar{T}$	Exit plane dimensionless temperature
$\bar{T}_r$	Exit plane dimensionless 'radial' temperature
w	Thermocouple displacement from inside wall of combustor exit duct
ϕ	Equivalence ratio $\left(\frac{\text{Stoic A/F}}{\text{Actual A/F}}\right)$

INTRODUCTION

A previous study on "The Acoustically Excited Flame" (1)[2] showed that toroidal or ring vortices were shed from a burner nozzle, Fig. 1(a), when the air-fuel mixture flow was modulated with sufficient amplitude by an upstream loudspeaker driver. The vortices strongly disturbed the flame burning at the orifice, Figs. 1(b) and 1(c), and it was apparent that extra air was entrained from the surroundings. It was also indicated that the vortex strength, and induced mixing effects, might be dependent upon the strength of the acoustic pulsations promoting the vortices. An investigation, via high speed schlieren pictures, of the phenomena, Fig. 2, confirmed its physical nature.

An extensive literature on vortex phenomena exists, and the evolution of toroidal vortices in orifice/nozzle jet flows is well known (2), (3), (4). Velocity distributions in vortex rings were studied by Sullivan, et al., (5); they controlled the strength and vortex core size by the duration and amplitude of the flow pulse generated by a loudspeaker driver. Bryer (6) used rotating flat delta plates to produce vortices in air or water vessels thereby improving the mixing efficiency above that of conventional stirrers. Vortex rings agitating atmospheric inversion layers was proposed by Mattingly (7) who also showed, using a model wing to generate wing tip vortices that the

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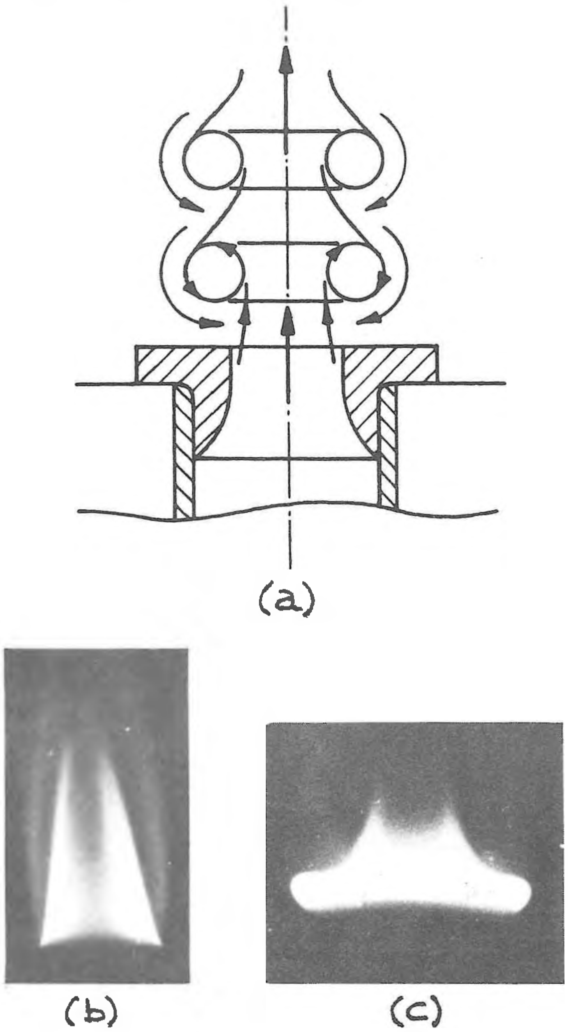
[1] This is strictly stagnation temperature, but because of low flow velocity stagnation temperature closely approximates static temperature and the distinction can be ignored.

[2] Designates a reference at the end of the paper.

vortices could be destroyed by an external vortex propagating through them. Baird, et al., (8) studied the pulsed generation of vortex rings as a design basis for mixing applications.



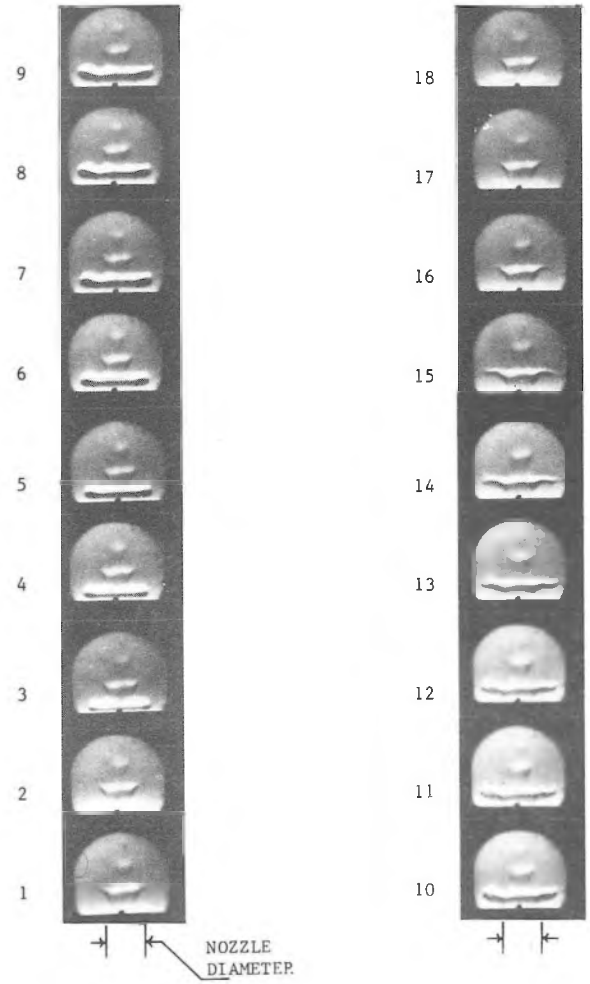


Fig. 1 Pulsating Flow from a Burner Nozzle.
(a) Interpretive Sketch of Flow
(b) Unexcited Flame, $\phi = 1.55$
(c) Excited Flame, f = 250 Hz, $\phi = 1.55$

Fig. 2 High Speed Schlieren Pictures of Pulsating Flame at Burner Nozzle of Fig. 1. f = 250 Hz, $\phi = 1.67$, framing rate 4016/s.

These considerations therefore suggested that it may be possible to acoustically control the jet mixing proceses in a gas turbine type combustor to give beneficial results. In particular the dilution jet flows of such a combustor, used to control the exit plane temperature distribution, might be made more effective by deliberately introducing toroidal vortices with the jet flows. Fig. 3, shows a cross section through the typical tubular combustor used in the latest experimental work, it indicates the air distribution in relation to the primary, secondary and dilution zones. At the entrance to the flame tube, air enters an annulus containing swirl vanes necessary to produce a recirculation zone about the axis, which stabilizes the burning fuel gas (natural gas) injected as shown. Air from the main annulus enters 10 pairs of nozzles in the flame tube wall, to produce jets which mix air with the recirculation zone, in order to bring the combustion to about 80% completion at the end of the primary zone. In the secondary zone 20 more nozzles create air jets to mix air with the combustion products from the primary zone and raise the combustion efficiency to about 100%. The gas temperature at the end of the secondary zone (≅ 1720 K) is too great for exit to the turbine, and must be cooled by mixing more cold air from the annulus by means of the six air jets from the nozzles in the dilution zone. The flame tube walls are kept cool by means of the annular air flows along the walls. There are therefore three zones where air jets carry out mixing in order to control events in the combustor. The dilution-air jets are technically the easiest to acoustically drive, and the mixing events only control the exit plane temperature magnitude and distribution since combustion is complete. A satisfactory temperature distribution is necessary to ensure that the turbine is not exposed to excessive temperatures otherwise its life would be short. Thus it was decided to establish the success of the concept by modulating the dilution-air jets only.

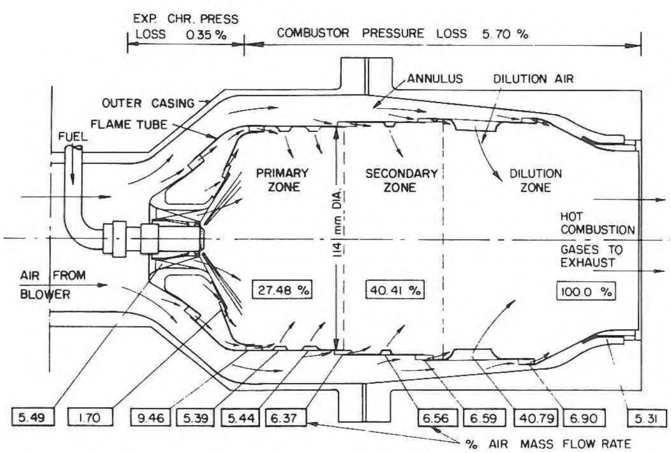


Fig. 3 Cross Section Through Typical Tubular Combustor Showing the Air Distribution.

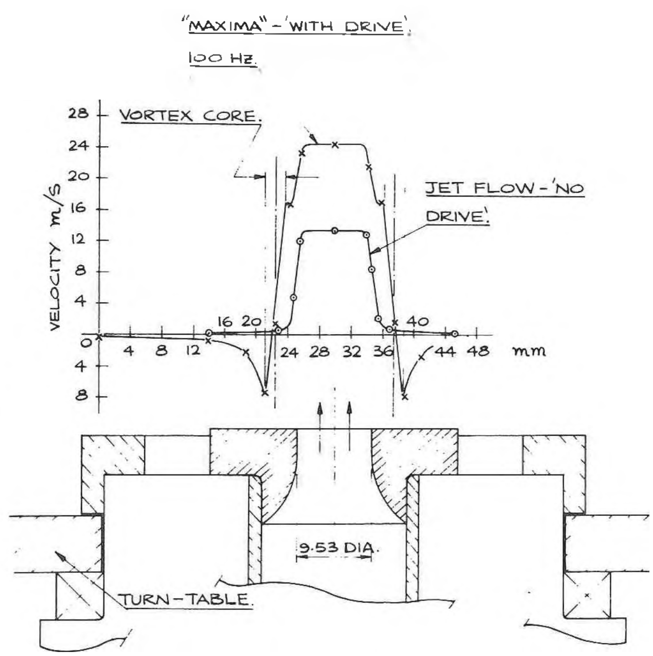


Fig. 4 Flow Velocity Profiles, With and Without Acoustic Drive, for Plane Through Nozzle Axis. Measurements 9.5 mm Above Nozzle Face. Power to Driver 4.8 W.

Two experimental approaches have now been examined (9), (10). The first involved a simple combustor to establish the concept at flow conditions that would be easy to manage. The second developed from the success of the initial concept experiments to utilise a tubular combustor of normal design, Fig. 3, operating at more representative flow conditions. This paper is essentially a review of this work, (9), (10), placed into better perspective by recent literature research.

The work of Anderson (2), (3), Becker and Massaro (4), Crow and Champagne (11) and Kibens (12), show that an acoustically excited jet exhibits two instability mechanisms. The first mechanism involves the thin laminar boundary layer which forms around the jet as it issues from the nozzle lip. The boundary layer is unstable and on excitation forms waves which then roll up into toroidal vortices on progression along the jet. The second mechanism concerns the instability of the jet-column, which on excitation develops wave motion growing into a train of toroidal vortices, which at optimum conditions are strong enough to disintegrate the jet column. Depending on the excitation strength the jet column response is strongest for a Strouhal number range S_t from about 0.2 to 0.5. Optimum response occurs at $S_t \cong 0.3$. Coupling between the two modes can occur at a common frequency under favourable jet conditions. For a turbulent boundary layer it would appear that the jet-column mode is the only one possible.

Toroidal vortices have been harmonically produced on an air jet by Sarohia and Massier (13), and Heavens (14), at a 0.6 Mach number and Reynolds numbers in the 10^5 - 10^6 range. Heavens (14) also excited the jet flow by means of an upstream spark generated pulse at 0.8 Mach number and a 2 x 10^5 Reynolds number. In comparison the combustor jet flows represent a more modest flow regime, in terms of excitation, since the maximum Mach and Reynolds numbers are about 0.23 and 10^5 respectively. Excitation frequencies used by other workers have been up to 20 kHz (14). Crow and Champagne (11) showed for a low value of excitation that the entrained volume flow increased 32% over the unexcited case. Binder and Favre-Marinet (15) established that the entrainment rate increased by 90% over the unexcited case for much stronger excitation than (11). Sarohia and Massier (13) deduced from centre-line velocity measurements that toroidal vortices produced by acoustic excitation increased the jet entrainment over the unexcited case, and Bremhorst and Harch (16) made measurements for a fully pulsed subsonic air jet showing that the entrainment and entrainment rate were considerably higher than for a steady jet. Direct measurement of entrained mass flow rates for unsteady jets do not appear to have been carried out. It is clear from the literature therefore that unsteady jet flows and their associated phenomena have superior mixing properties over steady jets for flow conditions of technical interest, and therefore technical applications should be possible.

INITIAL CONCEPT DEVELOPMENT FOR DILUTION-AIR JETS

Pulsed Jet flow Velocity Field Profile

In order to establish some physical "feel" for the nature of a pulsating jet flow an air jet, flowing vertically into the atmosphere at room temperature, was created by a 9.53 mm dia bore nozzle. A loudspeaker driver excited the flow upstream of the nozzle sinusoidally at 100 Hz. Velocity profiles were measured using a DISA hot wire anemometer, for the unexcited flow and for an excitation power at the loudspeaker driver of 4.8 W. The anemometer output was recorded on magnetic tape then played back for oscillographic recording and analysis on a Honeywell 1508 Visicorder. Fig. 4 shows measured velocity profiles across a plane one nozzle diameter downstream of the nozzle exit plane and with the probe traversed normally to and through the nozzle centre line. The velocity profile with acoustic excitation shows "maximum" measured velocities, ie., the peak velocity recorded as the flow pulsation passes through the measurement plane. This profile is what would be expected from a jet flow with superimposed toroidal vortex (17). The measurements indicate that the field of influence of the jet is about quadrupled by the vortex superposition, there is considerable shearing action across the vortex core, and the maximum pulse velocity is about twice the steady jet velocity. The vortex is shown to have induced a downwards flow in the outer field and presumably entrainment from this region into the jet flow. The pulsed flow and vortices were plainly observable at over six nozzle diameters downstream, although turbulent breakdown was evident, hence it may be anticipated that the vortex mixing effects could also persist to this distance. The average velocity of the core flow was not significantly different from that of the unmodulated flow and hence the exit mass flow rate may be considered to be unaffected by the acoustic drive for this case.

Primitive Combustor With Acoustic Control of the Dilution-Air Flows.

A simple combustor was constructed by mounting a flame tube in a small wind tunnel as shown in Fig. 5. For ease of manufacture a hemispherical "pepper pot" stabilised the primary zone where natural gas was burnt. Dilution-air was brought into the flame tube by seven radial stainless steel guide tubes feeding nozzles in the flame tube walls. The mouthpiece, at right angles to the guide tube, channels air to the flame tube whilst the cold end of the guide tube is connected via a drive tube to a loudspeaker driver. The drivers were modulated by means of a three channel amplifier in conjunction with a signal generator. Driver power was measured by means of A.C. voltmeters and ammeters, since the power factor had previously been shown to be close to unity. Temperature profiles at the combustor exit were measured using a shielded thermocouple, and instrumentation was provided to measure fuel and air mass flow rates. Such a combustor is not typical of modern combustors but is adequate as a slave for the dilution-flow modulation experiments.

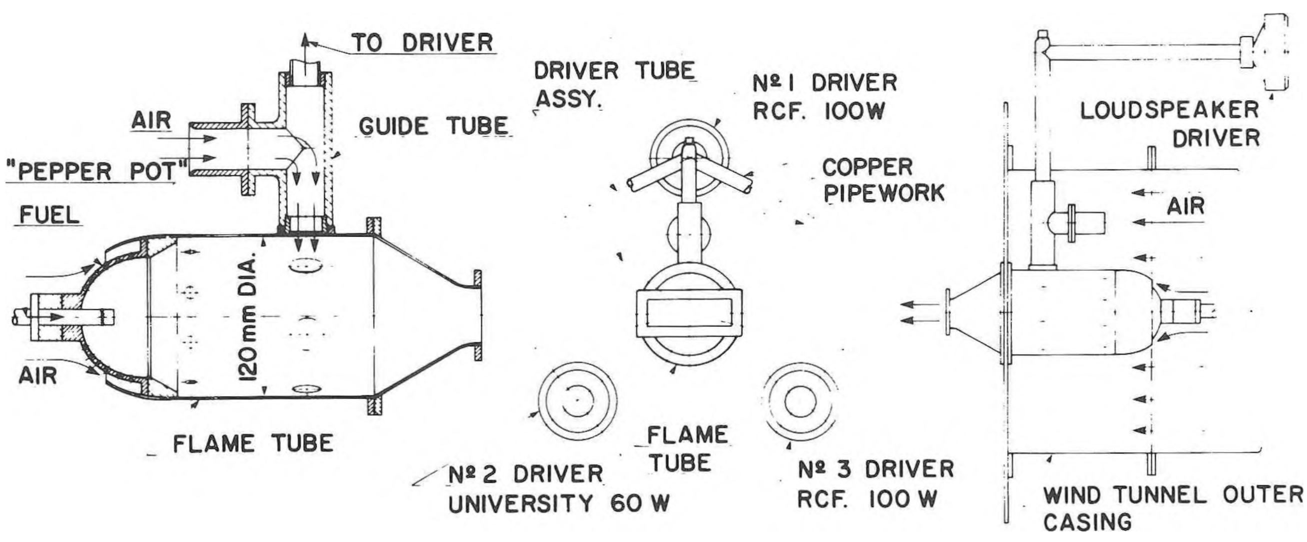


Fig. 5 Primitive Combustor:Flame Tube Assembly, Drive Tubes Arrangement, Flame Tube Mounted in the Wind Tunnel.

The Temperature Profile Measurements.

Fig 6. shows exit plane temperature maps for no acoustic drive and with approximately uniform acoustic drive. The temperature contours were obtained by interpolation from rectangular cartesian measurements, hence experimental points are not shown. The "no-drive" profile shows the combustor to have a very 'peaky' temperature distribution, unacceptable for a gas turbine combustor, but ideal for demonstration of the acoustic control concept. Thus for the 'with-drive' condition it is readily seen from Fig. 6 that considerable "flattening" of the temperature distribution has been achieved, and appears to depend on frequency. At 104 Hz the acoustic drive has reduced the temperature peak by about 165°C, at 120.5 Hz a spectacular reduction of about 545°C was achieved, and at 135 Hz about 335°C reduction occurred. The enhanced effectiveness at 120.5 Hz is probably due to the fact that this was the "organ pipe" resonance frequency of the driver tube assemblies. The difference in effectiveness between the 104 Hz and 135 Hz tests may not be simply due to the frequency response of the loudspeaker-drive tube system but also may be due to the frequency response of the fluid processes. Increasing the driver power at 135 Hz progressively flattened the temperature distribution; the temperature profiles being shown in ref. (9). Overall it may be concluded that acoustic modulation of the dilution-air flows can progressively control the exit plane temperature distribution for the modest flow conditions tested.

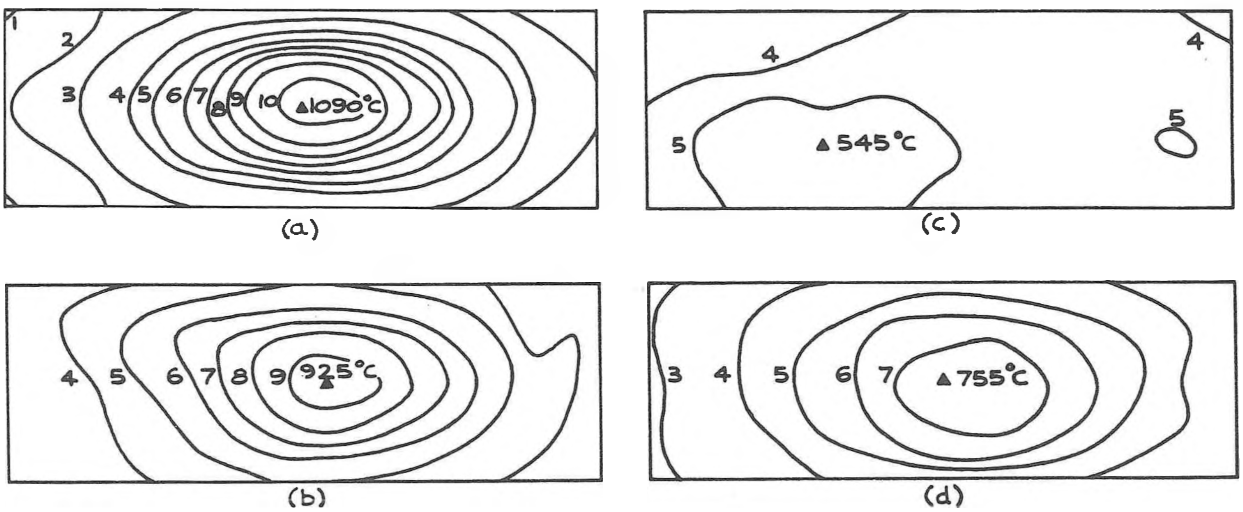


Fig. 6 Exit Plane Temperature Maps (100°C Contours), A/F = 81.
(a) No-Drive
(b) f = 104 Hz, Total Driver Power 73 W
(c) f = 120.5 Hz, Total Driver Power 70 W
(d) f = 135 Hz, Total Driver Power 76 W

CONCEPT DEVELOPMENT FOR DILUTION-AIR JETS IN A PRACTICAL GAS TURBINE COMBUSTOR

The initial concept work was limited by the fact that the combustor was not typical of modern practice and the flow reference Mach number, M_{ref} only corresponded to one tenth of "full-load" conditions. Thus a test rig was built to test a small typical tubular combustor, Fig. 3, up to "half-load" conditions, based on M_{ref} (loading was limited by the air blower available). M_{ref}, as is usual, was calculated at the maximum inside diameter of the casing (142.9 mm dia.) for cold flow.

The Combustor Test Rig and Acoustic Control Method.

Air for combustion was supplied by a small centrifugal blower to a venturimeter thence to the combustor. Natural gas, from high pressure bottles, was metered by a choked orifice before injection into the swirl stabilised primary zone. Full instrumentation was provided to assess the performance of the combustor, and in particular the exit plane temperature distribution was measured by six, shielded, radially traversed thermocouples circumferentially spaced at 30°. The temperature was measured at 11 points across each of the six diameters so defined, giving a total of 66 measurement positions. This number and the radial position specified for each measurement ensured that an accurate analysis of the combustor performance could be made.

The combustor geometry presented difficulties to devising a method for acoustically controlling the dilution-air flows. However, after some experimentation success was finally achieved by rerouting the dilution-air such that it was tapped-off upstream of the combustor inlet, run through 6 tubes parallel to the combustor axis outside of the casing, then each tube turned inwards to pass normally to the axis, through the casing, and connect with a dilution hole in the flame tube. Thus air from the annulus no longer

TABLE NUMBER I
RELAVANT TEST CONDITIONS

Test	$\dot{m}_a$ kg/s	A/F [3]	ϕ Overall	T_2K	P_2kP$_a$	M_{ref}	Driver No. and "Max" Power W @ 220 Hz		
							1	2	3
9	0.0984	62.9	0.272	308	90.28	0.0172	57.4	54.2	57.4
10	0.1344	67.3	0.255	307	90.15	0.0239	59.0	59.1	59.0
11	0.0981	62.5	0.275	309	89.76	0.0174	18.1	19.3	18.1
13	0.0978	62.7	0.274	309	89.57	0.0174	-	-	71.7
14	0.0974	63.7	0.269	310	89.09	0.0174	-	-	12.4
15	0.1693	90.5	0.190	307	90.42	0.0302	-	-	73.5
22	0.0983	55.7	0.308	307	90.30	0.0170	-	-	12.6
23	0.0984	90.3	0.190	306	90.25	0.0170	-	-	12.5
Theoretical Full Load Nominal	1.1657	60.4	0.286	476	395.4	0.057	STANDARD COMBUSTOR		

[3] Stoichiometric A/F = 17.16

entered the dilution holes. Air by-pass tube pairs were connected by 'T' junctions to a driver tube and loudspeaker, which allowed for easy variation of frequency and power for modulating the flow. Fig. 7 shows details of the arrangement. To prevent acoustic energy passing upstream via the by-pass tubes Helmholtz resonators were attached as shown in Fig. 7. Unfortunately, despite bench testing of a driver tube by-pass tubes system, the Helmholtz resonators proved to be ineffective. However, the system was still capable of modulating the dilution-air flows, and the strongest resonance mode of the full assembly was found to be at 220 Hz by progressively changing the drive frequency (keeping power constant) and observing the effect on the exit plane temperature distribution. Table I presents the range of test conditions used and clearly shows that "half-load" conditions, based on M_{ref}, were not exceeded. Also the table shows that the combustor was tested over approximately its full range of air:fuel ratios (A/F).

The exit plane chromel-alumel thermocouples could be positioned to within ± 0.3% of the exit diameter (85.39 mm) and they measured temperature to within ±1½% over the experimental range. The air and fuel mass flow rates were accurate to ± 1½% and ± 3% respectively.

The same signal generator supplied a sinusoidal voltage to the loudspeaker amplifiers, and input power to a loudspeaker was measured by an A.C. voltmeter and ammeter; the "maximum" power was then computed from the product of current and voltage.

Test Results - Temperature Patterns.

The objectives of the temperature profile measurements were to

(a) establish that the temperature pattern was satisfactory and typical without acoustic drive,

(b) establish that the temperature pattern remained approximately constant with reasonable changes of running condition, and

(c) establish the magnitude of changes in the temperature distribution caused by the acoustic drive.

For ease of comparison the temperature maps are presented in terms of the dimensionless local temperature defined by

$$\bar{T}\% = \frac{T_3 - T_{3m}}{T_{3m} - T_2} \times 100$$

Also the six readings at one radial position were averaged, non-dimensionalised in terms of

$$\bar{\bar{T}}_r = \frac{T_{3r} - T_{3m}}{T_{3m} - T_2}$$

and plotted against radial position to give dimensionless 'radial' temperature profiles. These indicate approximately the radial temperature profiles in the annular channel upstream of the nozzle guide vanes and eventually 'seen' by the turbine blades.

Figs. 8 to 10 show sample 'no-drive' exit plane dimensionless temperature maps, and their similarity is readily seen as was the case for the other tests. Fig. 11 typifies the 'no-drive' 'radial' temperature profiles, good similarity between tests having been obtained. Repeatability between tests of similar $\dot{m}_a$ and A/F was satisfactory, and the results show a temperature pattern that is acceptable and typical for this type of combustor without acoustic drive.

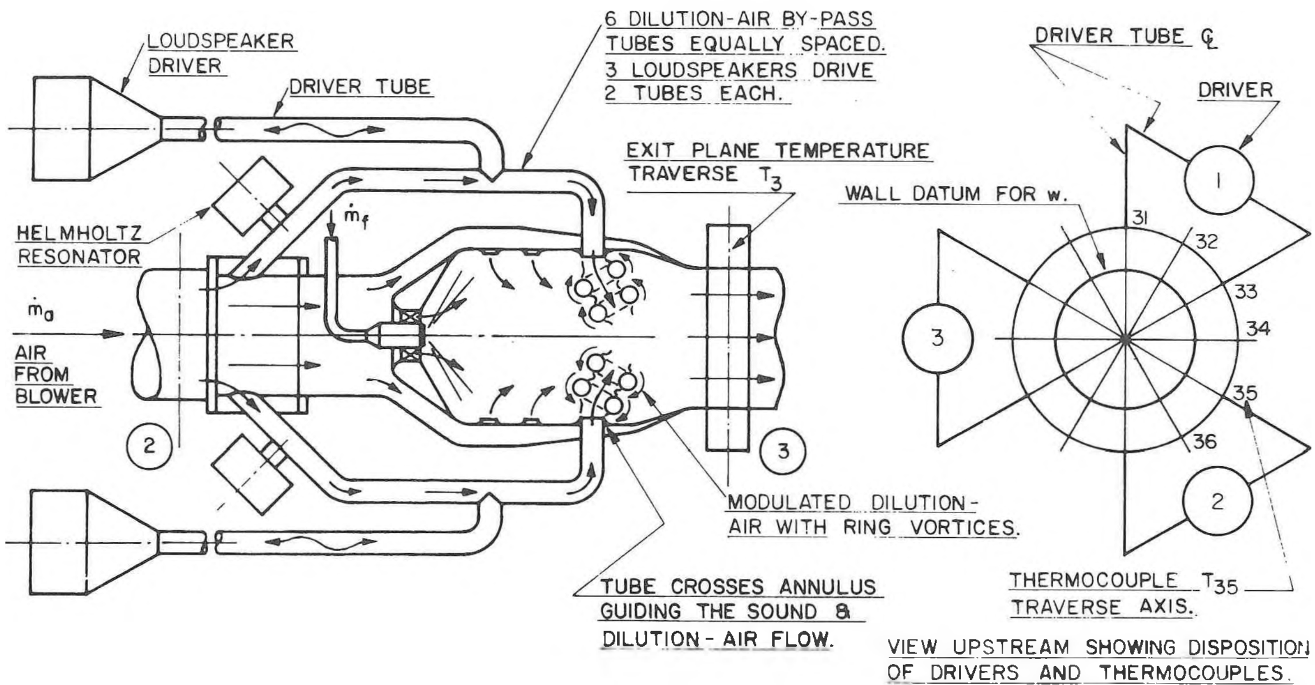


Fig. 7 Schema of Final Apparatus for Acoustic Control of Dilution Mixing Processes.

Typical dimensionless temperature distribution data for the 'with-drive' condition at 220 Hz is also shown in Figs. 8 to 11. Two driver patterns were explored as well as several driver powers, Table I. Little more than a cursory glance at the data is necessary to realise that acoustic modulation has been successful in changing the exit plane temperature pattern (also confirmed by the data not shown). This has been accomplished for an acceptable temperature pattern in contrast to that of the primitive combustor for the initial concept tests. There was no significant change in the exit plane mean temperature T_{3m}, as would be expected for mixing process effects only. Fig. 8, for uniform driving, shows an evening out of the temperature distribution, but the hot spot remains (at the 3 o'clock position looking upstream), although reduced in size. By only driving No. 3 loudspeaker at the 9 o'clock position it was found that this temperature peak could be trimmed, although more driver power was required for the higher mass flow rate, Figs. 9 and 10. The trimming of the temperature peak together with the increase in temperature of the region closest to the driven ports (at 9 o'clock) suggests that the modulated dilution-air jets have greater penetration properties. Test 13, at low air mass flow rate, confirmed this by a strong reduction in the hot spot temperature and a strong increase near the wall at the 9 o'clock position. The data also showed that the effectiveness of the modulation increased with increase in driver power.

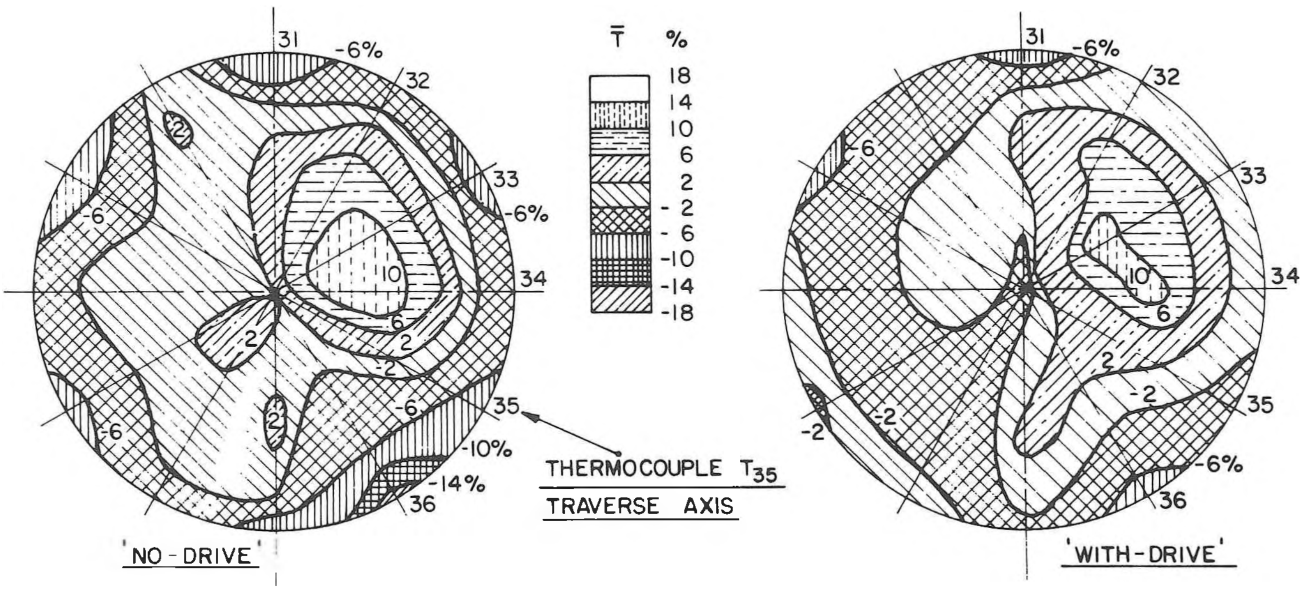


Fig. 8 Exit Plane Dimensionless Temperature Maps. Test Number 10. Views Looking Upstream. See Table Number I for Test Conditions.

The sensor of a hot film anemometer (Thermal Systems Inc.) was inserted radially through one of the by-pass tubes to a point inside the flame tube about one diameter downstream of the dilution-air port. Because of destruction of the sensor, measurements could only be made in cold air flows, but showed that over the test air mass flow rate range the modulated dilution-air jet flow pulsated with toroidal vortices superimposed on the flow. Figs. 9 and 10 show an evening out of the temperature pattern in the L.H. half sector suggesting better mixing effectiveness. The velocity profiles of Fig. 6 suggest that the effective mixing diameter of the dilution jet is about doubled by the toroidal vortex, thereby affecting a sector from about the 7 o'clock to 11 o'clock positions (for two ports). This coincides with the zone of improved mixing shown by Figs. 9 and 10 and is therefore probably due to vortex action.

Clearly from the evidence presented significant changes in the exit plane temperature distribution of a 'good' combustor are possible by acoustic control of the dilution mixing processes. Also the driver power required for significant effects is negligible when compared with the energy conversion rate of the combustor of 50 to 100 kW over the test range. Other combustor

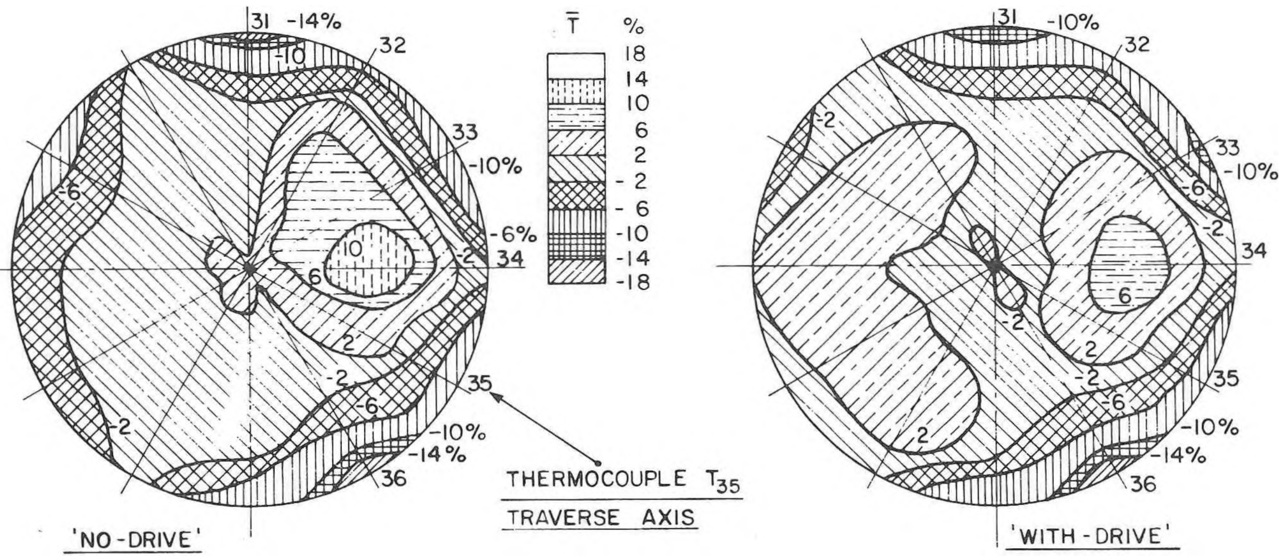


Fig. 9 Exit Plane Dimensionless Temperature Maps. Test Number 23. Views Looking Upstream.

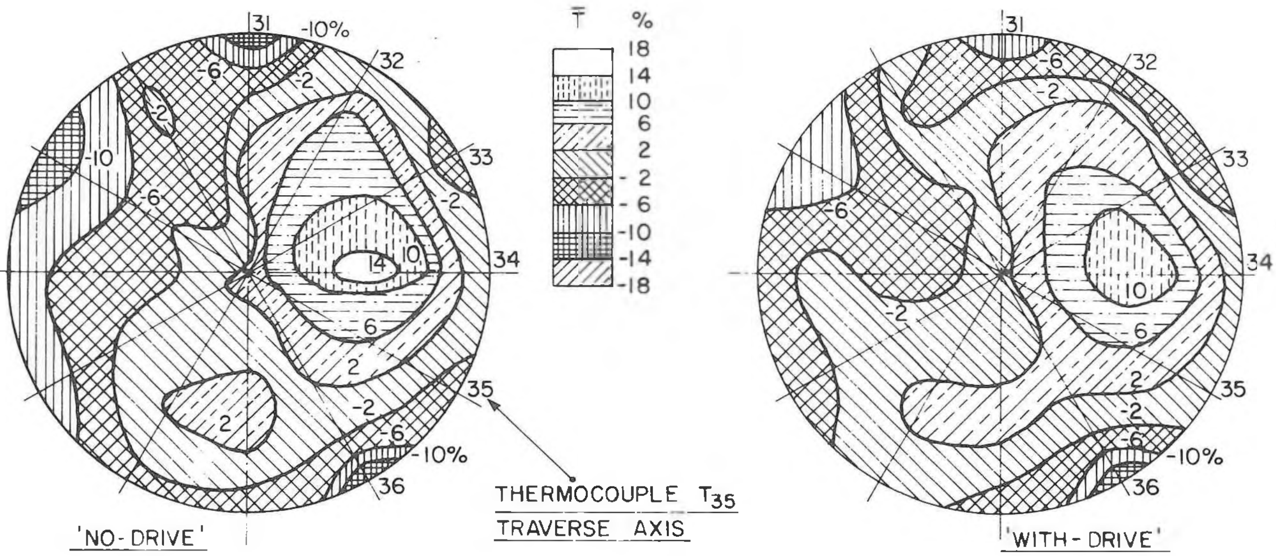


Fig. 10 Exit Plane Dimensionless Temperature Maps. Test Number 15. Views Looking Upstream.

performance parameters, such as pressure loss and overall combustion efficiency, were not significantly affected by the acoustic drive and in general no detrimental effects were observed.

Strouhal Number Range of The Tests and Future Work.

Care was taken to drive the system close to its resonant mode (as for the primitive combustor) thus trying to make the most effective use of the power to the drivers. However, recent literature research has shown that operation at a Strouhal number from 0.2 to 0.5 is likely to produce the best response from the dilution-air jets. In comparison for these tests, at low $\dot{m}_a$ $S_t = 0.2$, whilst at high $\dot{m}_a$ ('half-load') $S_t = 0.1$. Thus at 'half-load' the Strouhal number match was poor and at 'low load' it was barely adequate, suggesting that more effective driving might take place at frequencies higher than 220 Hz provided that the driver system could be tuned to have a compatible resonance mode. In contrast for the primitive combustor S_t ranged from 0.4 to 0.55, with $S_t = 0.5$ at resonance; a somewhat better match borne out by the observed temperature changes. Future experiments will be planned to better match the system resonance to the optimum Strouhal number.

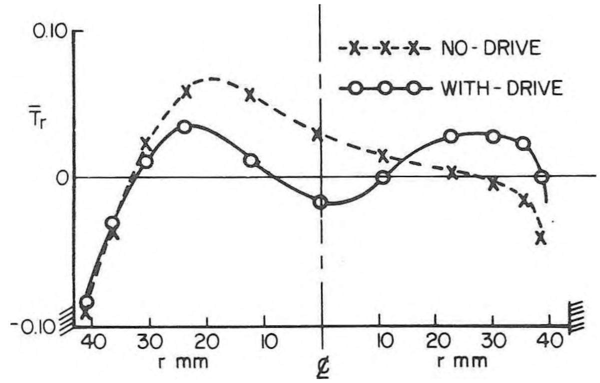


Fig. 11 Exit Plane Dimensionless 'Radial' Temperature Profiles. Test Number 23.

Development of the technique, for the dilution zone, up to 'full-load' operation has now taken place and a publication is forthcoming (18). Acoustic control of the primary zone mixing processes is perhaps of greater practical interest since improved combustion efficiency of this zone may result. Work to this end is now at an advanced stage. The current acoustic modulation system is clearly not very practical because of complexity and short running life. Research has therefore been initiated to produce a simpler and more reliable system, one that is entirely fluidic in nature for instance. Promising development to this end is taking place and a solution appears possible.

CONCLUSIONS

A technique has been developed to acoustically control the mixing processes of the dilution-air jets of a small combustor of normal design. The nature of the acoustically modulated jet flows up to 'half-load' conditions has been established as that of a pulsating jet flow with superimposed toroidal vortices. The technique can be used to selectively and progressiv- control the exit plane temperature distribution. In particular, for an already good temperature pattern, it is possible to trim the temperature profile. The changes in temperature pattern caused by the acoustic drive indicate that the modulated jets have greater penetration properties and that improved mixing may be due to vortex action. Successful flow modulation was achieved by minimal power requirements for the loudspeaker drivers. Other combustor performance parameters, such as pressure loss and overall combustion efficiency, were not significantly affected by the acoustic drive and in general no detrimental effects were observed. The study contributes to the design of combustors such that control may be exercised over the air jet mixing processes.

ACKNOWLEDGEMENT

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Tel.: (514) 735-3846

BVA Manufacturing Limited
Noise Control Products
2215 Midland Avenue
Scarborough, Ontario M1P 3E7
Tel.: (416) 291-7371

CA Engineering Services
P.O. Box 2520, DEPS
Dartmouth, Nova Scotia B2W 4A5

Eckel Industries of Canada Limited
Noise Control Products
Audiometric Rooms - Anechoic Chambers
Morrisburg, Ontario K0C 1X0
Tel.: (613) 543-2967

Electro Medical Instrument Company
Audiometric Rooms and Equipment
359 Davis Road
Oakville, Ontario L6J 5E8
Tel.: (416) 845-8900

Bruel & Kjaer Canada Limited
90 Leacock Road
Pointe Claire, Québec H9R 1H1

Higgot-Kane Industrial Noise Control Limited
1085 Bellamy Road North
Suite 214
Scarborough, Ontario M1H 3C7
Tel.: (416) 431-0641

Hooker Noise Control Inc.
360 Enford Road
Richmond Hill, Ontario L4C 3E8

Marshall Macklin Monaghan Ltd.
Consulting Engineers
275 Duncan Mill Road
Don Mills, Ontario M3B 2Y1
Tel.: (416) 449-2500

Nelson Industries Inc.
Corporate Research Department
P.O. Box 428
Stoughton, WI 53589
U.S.A.

SNC Inc.
Environment Division
Noise and Vibration Control
Contrôle du bruit et des vibrations
1, Complexe Desjardins
Montréal, Québec H5B 1C8
Tél.: (514) 282-9551

SPAARG Engineering Limited
Noise and Vibration Analysis
Windsor, Ontario N9B 1N9
Tel.: (519) 254-8527

Tacet Engineering Limited
Consultants in Vibration and Acoustical Design
111 Ava Road
Toronto, Ontario M6C 1W2
Tel.: (416) 782-0298

Valcoustics Canada Limited
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Willowdale, Ontario M2M 4C4

R.B. Johnston
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Oakville, Ontario L6J 5E8

E.H. Bolstad
P.O. Box 5768, Station "L"
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