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INTRODUCTION TO THE THEME:
A SUMMARY OF CURRENT PROBLEMS IN ARCTIC ACOUSTICS RESEARCH*

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A symposium on Acoustics Research in the Arctic was held on 4 and 5 January 1966 in Santa Barbara, California, jointly sponsored by the General Motors Corporation Defense Research Laboratory and the Office of Naval Research, Undersea Programs. The forty attendees represented ten United States government organizations, six university or industrial laboratories, and three Canadian units. Attendees were, in general, either researchers who have worked in the Arctic or sponsors of such work. The series of papers which follow this introduction were presented at the symposium and represent a review of the most current Arctic acoustics research.

This paper presents a broad view of current problems in the Arctic, both as enumerated in the discussion period, and from other information available to the author. Problems fall into five areas, each of which will be discussed:

1. Lack of stated requirements in the Arctic
2. Interference between projects
3. Power sources
4. Services
5. Funding

The Arctic ice provides an ideal platform for acoustics research, and even without strategic or tactical requirements in this area, there is sufficient justification for a continuing effort to advance the knowledge of acoustic propagation in the ocean. Only FLIP-like vehicles offer opportunities similar to those found in the Arctic for stable working platforms over deep water, and even these fairly costly vehicles cannot provide the degree of stability or permanence possible on an ice island. In addition, research in the Arctic is far removed from the background noise generated by ship traffic. Installations can be fairly inexpensive, and the work area available (for large arrays, for example) is relatively limitless. There are disadvantages too, such as the cold, long distances from supply bases, and the fact that instrumentation placed under the ice and frozen in is seldom recoverable. These disadvantages, however, are far outweighed by the conveniences made possible by this unique area for exploration, and it is no wonder that well qualified researchers are willing to endure the hardships of the environment to reap the benefits possible from acoustics research in the Arctic.

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*The Editors of the Journal are indebted to Cdr. Blaine Davidson for planning the theme, soliciting and editing the articles contributed, and for writing this Introduction to the Theme.
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A second fact of interest is the degree of coordination and cooperation evidenced in this work. Factors influencing this cooperation may include the small number of people engaged, the fact that much of the work is staged through the Arctic Research Laboratory in Point Barrow, Alaska, and, in general, the high qualifications of those doing the work. There is no formal coordinating activity although several informal groups do exist and these seem to provide a highly satisfactory coordinating function.

Approximately two years ago the Office of Naval Research initiated a study program to outline requirements for all phases of research in the Arctic. This study, when completed, could provide a basis for a more formal coordinating activity and should certainly point out program requirements in the nature of facilities and funding for the next several years. It could also help to provide some relief from the first of the five problem areas listed earlier in this paper, a lack of stated requirements for the United States in the Arctic.

The strategic value of missile carrying submarines operating under the Arctic ice is well known; the threat of enemy submarines in a similar role is also known. The necessity for an antisubmarine capability under the ice to combat this threat is a prime objective. Also suggested is a requirement for an under-ice surveillance system; a means of communicating with our own submarines when they are operating under the ice; and weapons capable of good performance in this area. These are subjects discussed in some of the following papers, but the missing element is a statement of specific operational requirements in regard to the Arctic. Other than those of an academic nature, what requirements does the Navy have toward which a research effort can be directed? Program directors believe that they are working toward meaningful applications of their research, but a statement of development objectives or operational requirements is needed to insure this. With these it would be possible, mostly from programs now in progress, to develop quickly a plan to meet the objectives.

During the past several years ice islands ARLIS II and T-3 were both available for research. With the passing of ARLIS II into the Greenland Straits and its abandonment in late 1965, only T-3 remains for semipermanent installations. This presents problems when conflicting experiments such as continuous subbottom profiling with high power sparker or boomer sources, and long term background noise studies or continuous surveillance, including transient detection, are scheduled simultaneously. This particular conflict exists today and must be resolved if both experiments are to be concluded satisfactorily. A second ice island for quiet camp operation can provide a solution, but this can be expensive and funding in this area is not plentiful. A new island would require on the order of $100,000 to set up and supply if all services were supplied by the Arctic Research Laboratory. If resupply, in the form of aircraft services, could be provided from other than ARL, however, say by the Air Force, then the annual cost of operations would be reduced to about $20,000. In other words, aside from the cost of equipment and personnel to conduct experiments on the ice, the major cost in providing an ice island for research is air supply. Recent surveys have discovered as many as six new islands in the Arctic and it is reasonably safe to assume that there are many others.

When considering the establishment of a new island, or even improving T-3 for acoustic research, the problem of greatest concern is the power source. T-3 is powered by a 40 kilowatt and two 19 killowatt diesel generators. These transmit a large amount of noise into the ice, thence through the water to hydrophones suspended below the ice, or directly to seismometers frozen into the ice. This is not conducive to the measurement of the low background environmental noise levels which normally exist in the Arctic. A partial solution has been provided by mounting one small generator on discarded truck tires. This generator can carry a reduced camp load during crucial measurement periods, but additional work toward sound isolation of the other generators is required. A more satisfactory solution, and one which must be considered if an island for quiet camp operation is to be established, would be the provision of a less noisy power source. This might take the form of a hydrazine fuel cell, a Stirling cycle engine, a gas turbine or other quiet source. The problem was discussed at the symposium and a recent study by GM/DRL for another application provided many interesting facts regarding the characteristics and operating costs of these exotic sources of power. A final selection would require more research and some testing. The fuel cells suggest many of the desired characteristics but unfortunately appear to be an order of magnitude more expensive to operate than the diesels, and Arctic researchers are not blessed with a "rich uncle."

The subject of air services, for resupply of the ice-islands was mentioned earlier. Present resupply is provided by ARL's one operating DC-3 and several light planes. A second DC-3 is disabled on T-3 but may be recoverable in the near future. In addition, charter services are available from Wien Alaska Airlines, but this is an expensive proposition. Occasionally services from the Air National Guard in Alaska, on training missions, can be obtained but these are irregular and cannot be included for long range planning. Air services can be provided if sufficient funding is found, but a different services requirement cannot be so easily provided, even with copious funding. This involves submarine target services for testing underwater detection and communications equipment.

The DIMUS array installed in Colby Bay off T-3 provides the only equipment today capable of detection and tracking under ice submarine targets. In addition, a facility is provided for communications over a limited range with underwater telephone equipment and a transducer suspended below the ice. The capabilities of this array have been calculated from theoretical considerations and data obtained from shots, but no performance against actual targets has been measured. A submarine cruise by either friendly or potential enemy targets would be of great benefit to this project in proving its capabilities and permitting extrapolition of surveillance capabilities of a series of such installations. It is estimated that a series of circular DIMUS arrays could be installed in the Arctic and the associated processing equipment provided for about $250,000 each, capable of providing cross bearings, and thus fixes, on any target in the area. Compare this with the cost of installations in the SOSUS network and again the advantage of working in the Arctic is clear. Again, however, the need for this capability must be considered. Even this cost is too high if there is no requirement for the information which can be provided.

Finally there is the ever present problem of funding. Here again requirements are a factor. With a proper statement of requirements and a restatement of some of the factors presented herein, a program justification can be presented to make the most hard hearted budgeteer come across with the needed bucks. Without the statement of requirements, the well worn shoestrings on which the current programs have been operating over the past several years will just have to be stretched again until they break. All of this points again and again to the necessity for a clear statement of United States requirements in the Arctic, a starting point for the development of a meaningful program.

The Arctic Acoustics Research Symposium was most successful from the viewpoint of those who sponsored it. Participation was enthusiastic and on a high scientific level. A list of attendees is included as an appendix to this paper and the program is represented by the papers which follow. The Office of Naval Research is grateful to all those who took part in the symposium and particularly to the General Motors Corporation/Defense Research Laboratory for providing such excellent facilities and acting as co-host. Also a vote of thanks goes to the authors for their very interesting presentation and the professional manner in which they were prepared and presented.

Appendix

ATTENDANCE LIST
ARCTIC ACOUSTICS RESEARCH SYMPOSIUM

Allen, Thomas F.	Bureau of Ships
Barash, Robert M.	Naval Ordnance Laboratory
Baker, Terry M.	GM Defense Research Laboratory
Barnett, Tim P.	Naval Oceanographic Office
Beal, M. Allan	Navy Electronics Laboratory
Birch, William B.	Naval Underwater Ordnance Station
Boosman, Jaap W.	Staff Oceanographer of the Navy
Britton, Max E.	Office of Naval Research
Browning, David G.	Navy Underwater Sound Laboratory

Brumbach, Rex P.	GM Defense Research Laboratory
Buck, Beaumont M.	GM Defense Research Laboratory
Davidson, J. Blaine	Office of Naval Research
Elbert, Theodore F.	GM Defense Research Laboratory
Fothergill, Neil O.	Defense Research Board Headquarters, Canada
Ganton, John H.	Pacific Naval Laboratory
Goldstein, Norman E.	Stanford Research Institute
Greene, Charles R., Jr.	GM Defense Research Laboratory
Hughes, T. E.	GM Defense Research Laboratory
Hunkins, Kenneth L.	Lamont Geological Observatory
Johnson, Don M.	GM Defense Research Laboratory
Kleinerman, Meinhard M.	Naval Ordnance Laboratory
Leedham, Clive	GM Defense Research Laboratory
Lyon, Waldo K.	Navy Electronics Laboratory
Mellen, Robert H.	AVCO Corporation
Miller, James R.	Naval Ordnance Laboratory
Milne, Allen R.	Pacific Naval Laboratory
Momsen, Charles B., Jr.	GM Defense Research Laboratory
Ostenso, Ned A.	University of Wisconsin
Parker, R. Joseph	Naval Ordnance Laboratory
Potter, David S.	GM Defense Research Laboratory
Poulter, Thomas C.	Stanford Research Institute
Pounder, Elton R.	McGill University
Pryce, Aubrey W.	Office of Naval Research
Rodolakis, Anthony S.	Naval Ordnance Laboratory
Russell, C. R.	GM Defense Research Laboratory
Schefer, Murray H.	Bureau of Naval Weapons
Schevill, William E.	Woods Hole Oceanographic Institution
Schroeder, Jacob	Naval Ordnance Laboratory
Springer, Richard M.	Headquarters, U. S. Air Force
Tickner, A. J.	Naval Ordnance Test Station Pasadena
Warner, Jacob L.	Office of Naval Research