WAKE CHARACTERISTICS STUDIES
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Ocean and Atmospheric Science, Incorporated

Prepared for:
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Final Report

Wake Characteristics Studies

by

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Technical Report

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None

Advanced Research Projects Agency

The work effort under the contract is briefly summarized. Details are covered in the list of technical reports.

Three general areas related to nonacoustic detection were investigated:

1. Diffusion from the wake
2. Signal processing
3. Analysis of oceanographic experiments
<table>
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<tr>
<th>KEY WORDS</th>
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Sponsored by
Advanced Research Projects Agency
ARPA Order No. 1910

ARPA Order Number: 1910
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Principal Investigator and Phone Number:
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Scientific Officer: Director, Fluid Dynamics Program

Short Title of Work:
Wake Diffusion Modeling

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The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the Advanced Research Projects Agency or the U.S. Government.
This is the final report under Contract No. N00014-72-C-0127 for the Office of Naval Research, sponsored by Advanced Research Projects Agency (ARPA Order No. 1910), by Ocean & Atmospheric Science, Inc. The work effort is briefly summarized below. Details are covered in the attached list of technical reports. Three general areas related to nonacoustic detection were investigated:

1. Diffusion from the wake
2. Signal processing
3. Analysis of oceanographic experiments

The basic objective of the first task was to study the diffusion of a passive scalar in the turbulent wake of a self-propelled body, and out of that wake under the influence of the ocean turbulence. In order to accomplish this task, a number of detailed calculations were carried out. The late stages of the diffusion were modeled by calculating the diffusion from a well-mixed and essentially non-turbulent wake under the influence of the background ocean turbulence. In order for this study to be meaningful, it was necessary to examine the validity of various diffusion models and to examine the related data on diffusion coefficients. The existing knowledge of oceanographic diffusion processes and data on measured diffusion coefficients in the ocean (both near surface and at intermediate depths) were reviewed. Based on the existing diffusion data, related turbulence data for the oceans, and basic turbulence theory, it was possible
to obtain reliable estimates of the ocean diffusion coefficients at inter-
mediate depths, which are the region of interest. Finally, the diffusion 
in the early wake was modeled with a point source. Using this model, 
equations were derived which allowed the calculation of the concentra-
tion of the scalar through the stage of wake growth and subsequent 
collapse and deformation.

The second task was that of signal processing. Several theories 
have evolved about how the passage of a submerged object can alter the 
surface wave power spectra. The evaluation carried out under this con-
tract is of a system and signal processor which examines the consequent 
alterations in the directional wave power spectrum and uses the maximum 
likelihood ratio to decide if such passage has occurred.

The third task, oceanographic experiment analysis, was com-
bined of several subtasks. These included a critical review of available 
methods for measuring short surface gravity waves and capillary waves, 
an analysis of the potential for using the acoustic techniques to probe the 
fine structure of the thermocline, and a review of the state of knowledge 
of the thermal structure of the air-sea interface.

The detailed technical discussion of the results of this research 
is contained in the technical reports, Table I, prepared under this 
contract.
<table>
<thead>
<tr>
<th>OAS Report No.</th>
<th>Title and Author(s)</th>
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<tbody>
<tr>
<td>71-057</td>
<td>Equalization of the Thermistor Response B. Harris</td>
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<td>71-062</td>
<td>Preliminary Evaluation of an Active Sonar System for Measuring the Fine Structure of the Thermocline. B. Harris</td>
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<td>72-065</td>
<td>Some Comments on the Modeling of the Collapsing Wake. E. Y. T. Kuo and C. E. Grosch</td>
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<td>Preliminary Analysis of Using a Vertical Array Sonar System to Measure the Fine Structure of the Thermocline. B. Harris and R. M. Chervin</td>
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<td>72-073</td>
<td>Some Comments on the Modeling of the Turbulent Wake of a Self-Propelled Body in a Stratified Fluid. E. Y. T. Kuo and C. E. Grosch</td>
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<td>72-083</td>
<td>Signal Processing of Ocean Surface Effects (Secret) B. Harris and R. Gershman</td>
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<td>72-089</td>
<td>Bi-mode Hypothesis and Horizontal Oceanic Turbulent Diffusion I. Theoretical Predictions E. Y. T. Kuo</td>
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<td>72-092</td>
<td>Turbulent Diffusion in a Stratified Fluid with Application to the Ocean. C. E. Grosch</td>
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<td>A Simple Diffusion Model in a Collapsing Wake. E.Y.T. Kuo</td>
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<td>Thermal Structure of the Air-Sea Interface. C.E. Grosch, E.Y.T. Kuo and M. Bernstein</td>
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<td>Final Report: Wake Characteristics Studies. C.E. Grosch, B. Harris, E.Y.T. Kuo and R. Gershman</td>
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