Department of Ocean Engineering

MASSACHUSETTS INSTITUTE OF TECHNOLOGY • CAMBRIDGE, MASS. 02139

13 August 1985

Mr. Charles Smith
Department of the Interior
Minerals Management Service
12203 Sunrise Valley Drive
Mail Stop 647
Reston, Virginia 22091

Subject: Quarterly Reports for the periods 1 October - 31 December 1984
1 January - 31 March 1985, 1 April - 30 June 1985.
Project Amount: $75,000
Effective Date: 1 October 1984 - 30 September 1985
J. Kim Vandiver, Principal Investigator
Massachusetts Institute of Technology

Dear Mr. Smith,

Enclosed are quarterly reports for the periods

1 October 1984 - 31 December 1984
1 January 1985 - 31 March 1985
1 April 1985 - 30 June 1985

The overall project has been one which has required the conduct and coordination of research on several topics simultaneously. The topics include:

a. The theory and application of non-linear and linear digital signal processing
b. Wave kinematics
c. Vortex-induced vibration

The objectives for the project included:

a. The development of techniques for computing auto-regressive, moving-average (ARMA) coefficients needed in generation of random wave time histories.

b. The development of convolution techniques for the computation of wave kinematics in random seas in both deep and shallow water cases.

c. The development of methods for predicting and modeling unsteady lift and drag forces generated on marine risers by vortex shedding.

For the period 1 October 1984 - 31 December 1984.

In this period the basic methods for computing the vertical and horizontal propagation of random wave kinematics in both deep and shallow water by convolution techniques was completed.

The principal investigator Professor J. Kim Vandiver made a research presentation at the MMS Information Transfer Meeting in New Orleans on November 27, 1984.

For the period 1 January 1985 - 31 March 1985.

The work accelerated and began progressing on several fronts in this period. A new graduate student, Nitan Joglekar, focussed his efforts on extending the linear convolution techniques to account for non-linear wave force effects due to large variations in the position of the water level on the structure of interest. A variety of numerical techniques were tested.

Cheng Yuan Liou, a Ph.D. candidate working specifically in the area of digital signal processing, worked on the problem of making accurate estimates of directional wave spectrum from measured data.

During this time substantial progress was made in the area of modelling and predicting the forces on marine risers due to vortex shedding. Two graduate students worked on this subject. One analyzed flow induced vibration data, while another studied methods for modelling non-linear relationships, such as those existing between lift and drag forces on risers excited by vortex shedding.

Professor Vandiver developed a new method of predicting vortex-induced vibration response of a marine riser in a sheared current. A manuscript was submitted for publication and was presented at the 1985 Offshore Technology Conference, and was submitted for later publication in the Journal of Energy Resources Technology. A copy of this paper is enclosed with this report and will be included in the final report. The title is "The Prediction of Lockin Vibration on Flexible Cylinders in a Sheared Flow".

For the period 1 April 1985 to 30 June 1985.

Work progressed in several directions. Cheng-Yuan Liou completed his Ph.D. thesis in the field of digital signal processing with applications to directional wave spectral

estimation. Some of the theoretical results are being prepared in a manuscript for publication. This paper will be available by the time of the final report.

In this period the wave kinematics work has emphasized the validation of the convolution techniques with experimental results. Wave propagation experiments were set up in the MIT Department of Ocean Engineering's ship model towing tank. Random waves were measured at two locations several wave lengths apart. Wave measurements made at the first wave staff were used as input to the convolution programs. The waves measured at a second point were then compared to the waves predicted at the second point by the numerical convolution. These tests are still in progress. The preliminary conclusions suggest that one of the most valuable uses of the convolution techniques being developed in this research will be in propagation of measured waves from a remote point of observation to the location of a real structure of interest. An engineer at Exxon is already using our methods to calculate wave kinematics on a real drilling ship and riser from remotely measured wave data. By the completion of this project the results will be available in the form of:

a. A master's thesis on wave kinematics simulation techniques using the convolution method.

b. A report (probably a Master's thesis) on the generation of wave time histories using ARMA models.

c. An OTC paper on the response prediction of marine risers in sheared flow.

d. A Ph.D. thesis and a journal manuscript on digital signal processing theory with application to the estimation of directional wave spectra.

I hope this letter has brought you satisfactorily up to date with our progress.

Sincerely,

J. Kim Vandiver

J. Kim Vandiver
Professor of
Ocean Engineering