Offshore Technology Conference
6-9 May 2002 • Houston, TX, U.S.A.

SPECIAL SESSION Abstract Form

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- Maximum 300 words
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Paper Title Direct Measurement of Large Strains in Synthetic Fiber Mooring Ropes Using Polymeric Optical Fibers

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Subject Categories: Indicate the subject categories that most directly apply to your abstract. Categories are listed on the last page of this form.
□ Primary 30103 – Mooring □ Secondary _____

Description of the Proposed Paper:
This paper will describe a new method under study at the Oak Ridge National Laboratory to monitor the performance of Synthetic Fiber Mooring Rope (SFMR) using polymeric optical fibers. Other than visual inspection and monitoring the load, there is currently not available any reliable method to assess the performance of SFMR during a long life time of service. The ultimate strain of polyester mooring rope, including the kinematic response due to the twisted and braided architecture of the rope and stretch in response to loads, is on the order of 15 percent**.** References suggest that the accumulative strain at failure of polyester rope is within a narrow range almost independent of load path or cyclic loading. If the accumulative strain in the rope could be measured, one would have a reliable structural health monitoring method for this critical primary structure. Glass optical fibers have been suggested for making strain measurements, but glass fibers are limited to ultimate strains of less than 3 percent. Any optical fiber method which uses glass must therefore be an indirect method subject to calibration and response inaccuracies. ORNL is investigating a technique to use highly elastic polymeric optical fibers which can potentially record tensile strains on the order 10 percent or more, making them attractive as sensors for monitoring the strain and performance of SFMR. ORNL's experience is being directed toward developing a reliable strain measurement system using large strain polymeric optical fiber sensors and an optical time-domain reflectometry (OTDR) instrumentation technique. The paper will describe the method, give test results demonstrating the capabilities of the polymeric optical fiber to perform large strain measurements using the OTDR system, and describe how the system will be integrated into the rope.

Application:
Synthetic Fiber Mooring Rope (SFMR) constructed from high performance polyester is an important emerging technology which promises to advance the economical production of oil and gas from deepwater reservoirs in the Gulf of Mexico (GOM) and elsewhere around the world. The availability of an in-service structural health monitoring system would provide greater confidence in the reliability of SFMR's for future GOM deployment.

Results, Observations, and Conclusions:
The paper will describe the basic principles on which the technique is based and provide data demonstrating the potential of the technique. The project is a 3 year development program initiated by the DOE in 2001 and includes participation by the oil industry and rope manufactures. The goal is to be able to directly measure axial strains of 10 percent at discrete short length segments along the length of the rope.

Significance of Subject Matter:
The Minerals Management Service (MMS) has not yet approved the use of SFMR for the GOM and has encouraged the industry to develop better understanding of the issues. Measurement of the state of strain in the rope including accumulated strain (creep) would provide a reliable benchmark with which to estimate the remaining life of the rope and allow the establishment of meaningful criteria for rope recertification or retirement. Such measurements would be particularly useful following hurricanes or other major disturbances.

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PAPER TITLE: Direct Measurement of Large Strains in Synthetic Fiber Mooring Ropes Using Polymeric Optical Fibers

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