Study of Instrumentation for Direct Torque Measurements

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Proposal to

Bureau of Ships

STUDY OF INSTRUMENTATION FOR DIRECT TORQUE MEASUREMENTS

Submitted By

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INTRODUCTION

Since no completely satisfactory means for measuring the torque applied to the rudder of naval vessels is available, the following proposal outlines a study aimed at developing a useable method. In the past attempts have been made to measure torque on the rudder stock of DLG 27 (Josephus Daniels). These results are suspect because of the high bending stresses which are present. The conventional method of measuring torque has been to record the pressure in the hydraulic rams which can then be converted to torque. If the efficiency of torque transmission were known the hydraulic pressure would give accurate information. However, the efficiency of torque transmission is not accurately known; thus the data derived from ram pressure is inaccurate.

STUDY PLAN

In order to find a solution to this dilemma, it is proposed to make a study of several possible ways of solving the problem, to recommend one method, and to suggest suitable instrumentation for making the measurements. Specifically the study would consider means for direct rudder troque measurement on the Western Gear Company's electro-hydraulic steering gear Model SHRE-9.25 or its Hyde Windlass counterpart. In all cases the goal is to measure torque applied to the rudder with an accuracy of 1%, to have instrumentation as simple as possible, to have at least six months useful life for the instruments, and to maintain present safety

and design standards for the steering system. The study would include at least the following steps.

1. The first step is to make a stress analysis of the rudder tiller in order to determine whether a torque determination is possible by measuring the stresses in the existing tiller. The use of the existing tiller is desirable from a number of viewpoints. If sufficiently accurate measurements can be made by strain gages or other transducer, this would be the most satisfactory means of meeting the above goals.

2. The second step is to consider redesigning the tiller to make it more suitable for making torque measurements. This chiefly means providing a location on the tiller with a fairly high stress range and where the stress will vary linearly with torque. As indicated above this design must not compromise the safety of the ship.

3. The third step is to consider inserting a long rod in the center of the bored stock. This rod would be fastened securely at the lower end. The chief advantage of this system is that it would have large angular deflections at the top of the stock which is accessible. The system also has several disadvantages, but by careful design it may be possible to eliminate these. It seems that this system is good enough to be worth considering. Torque transients and vibratory effects would have to be carefully considered.

4. A fourth step is the investigation of the problems of applying strain gages to the rudder stock. Since data has already been obtained, by this method, the study is essentially an investigation of the possible errors in the existing data. In particular consideration will be given to

the effects of high bending stresses on the accuracy of the torsional stress measurements.

December 11, 1963

Department of Naval Architecture and
Marine Engineering
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WEST, GEORGE L., JR.

Personal Data

Birthdate: January 26, 1923
Married, 5 children

Education

BSE 1949, University of Michigan
1953, Oak Ridge School of Reactor Technology (no degree given)

Teaching Experience

Appointed Assistant Professor of Naval Architecture and Marine Engineering, September 1956
Appointed Assistant Professor of Nuclear Engineering, September 1958
From September 1956 through the present responsible for the following courses: Naval Architecture 330, 331, 430, 473, 590, 630; Nuclear Engineering 400
Ann Arbor Extension Division Night School, Fall Semester 1957
Advisor for Nuclear Engineering 690 Spring and Summer of 1958
Appointed Associate Professor in Naval Architecture and Nuclear Engineering, July 1959
Appointed Professor of Naval Architecture and Nuclear Engineering, July 1963

Professional Experience

Seven years, Newport News Shipbuilding and Dry Dock Co.
One year in shipyard training program to obtain an overall picture of their operation.
One and one-half years at the Hydraulic Laboratory testing models of all types.
One year at Oak Ridge (see education)
Three and one-half years in charge of Reactor Technical Section - about 15 graduate engineers
Summer 1960 at New York Shipbuilding Corp. working on the N. S. Savannah
Co-technical Director of a project for the Federal Aviation Authority on problems of mooring navigational platforms in deep water, Summer 1962
Director of a conference on reliability for the Office of Naval Research, 1962-63.
Consultant to the U. S. Maritime Administration, General

Motors Research Laboratories, Great Lakes Engineering Works, Manitowac Shipbuilding Corp. and Norden Corp.
Summer 1964, Testing Program US Navy, Submarines

Scientific and Professional Societies

American Nuclear Society - Member
American Society of Mechanical Engineers - Member
Member of Power Division Executive Committee; Chairman, Power Division, 1963-64
Institution of Marine Engineers - Associate Member
Sigma Xi
Society of Naval Architects and Marine Engineers - Associate Member, Member Scholarship Committee
Tau Beta Pi
Listed in: American Men of Science and Who's Who in Engineering

Committees and Administrative Positions

Campus Coordinator for AID Brazil contract
Counseling and classification for Naval Architecture and Marine Engineering Department
Engineering College Computer Committee
Engineering College Mathematics Committee - 1962, 1963
Seven Doctoral Committees
North Campus Planning Committee, March 1958, 1959
Nuclear Engineering Committee from September 1956 to June 1958 College of Engineering
Program Advisor for Marine Engineering option in Department of Naval Architecture and Marine Engineering

Civic Organizations

Ann Arbor Exchange Club, January 1957 to March 1963
Parent Teachers Organization - City-wide Legislative Committee (Chairman, 1961)

Publications

1. Co-author Ship Motion Effects on Boiling Water Reactor Dynamics, ASME Paper 63-WA-244, November 1963
2. Co-author of "A Preliminary Report of an Investigation of the Effects of Ship Mition on Boiling Water Reactors," published in the Journal of the Joint Panel on Nuclear Marine Propulsion, October 1962

3. Co-author of Bibliography of Selected Literature of Low Maintenance Ship Propulsion Plants, Office of Research Administration, October 1961
4. Co-author of "Considerations for Prevention of Wear in Diesel Engines," French Technical Periodical, December 1958
5. "Introduction to Computers and Their Use in Marine Design and Operation," SNAME Great Lakes Section, 1957
6. Co-author of report to the Naval Research Laboratory entitled: "ABrief Investigation of Impact Forces on Ships," March 1952
7. "Test of Condenser Scoop Model for DD927 and 929," Report to the Naval Research Laboratory, May 1951
8. The Effect of Ship Motion on Marine Machinery, Journal De La Marine Marchande, Paris, April, 1965.
9. Marine Engineering Section of Mark's Mechanical Engineers Handbook, 7th Ed., McGraw Hill, in Publication

Four discussions of technical papers

BUDGET

Salaries and Wages (including staff benefits)	
Project Director, G. L. West, Jr.	NC
Assistant Professor (full time, 2 mos.)	2,200
Research Assistant (full time, 2 mos.)	1,000
Total Salaries and Wages	3,200
Indirect Costs @ 46% on personnel (Predetermined fixed)	1,470
Computer Costs (IBM 7090)	400
Report Costs	100
Total Estimated Cost	$ 5,170