SSC-236

A METHOD FOR DIGITIZING, PREPARING AND USING LIBRARY TAPES OF SHIP STRESS AND ENVIRONMENT DATA

SHIP STRUCTURE COMMITTEE

1973

SHIP STRUCTURE COMMITTEE

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The collection of full scale hull stress, ship motion and environmental data on ships at sea has been a significant part of the Ship Structure Committee program for several years. Yet, collection of data is only the first step in the long process of improving understanding of the loads experienced by a ship's hull. Results of the at-sea measurements must be reduced to facilitate analysis and then analyzed in detail, and the Ship Structure Committee has been active in these areas as well.

This report describes a method which has been developed for converting the unprocessed full scale data into a form which can be analyzed on a conventional digital computer. Additional information on the computer program may be found in SSC-237, Computer Programs for the Digitizing and Using of Library Tapes of Ship Stress and Environment Data.

Comments on this report would be welcomed.

W. F. REA, III
Rear Admiral, U. S. Coast Guard
Chairman, Ship Structure Committee

SSC-236

Final Technical Report

on

Project SR-187, "Ship Response Data Study"

PART I

A METHOD FOR DIGITIZING, PREPARING AND USING LIBRARY TAPES OF SHIP STRESS AND ENVIRONMENT DATA

by

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ABSTRACT

A method of analogue signal processing used to produce digital library tapes of midship bending stress data is described in this report. Examples of retrieval of the data for subsequent analysis using digital computers are given. A means is described for a) translating midship bending stress data recorded on analogue magnetic tape to digital form; b) measuring certain statistical parameters of the data and summarizing and storing this information; c) providing on the same digital tape the log-book data concerning environmental and ship conditions at the time of original analogue data recording; and d) providing a means for selective retrieval of data for subsequent analysis. The programs used provide a means of accommodating the several ways in which the original data were recorded, and permit a consistent analysis of the data which were acquired over the ten-year duration of Ship Structure Committee Project SR-153, "Ship Response Statistics." The basic procedures and programs are readily adaptable to handle other analogue signal processing of varying formats, and are not necessarily restricted to handling midship bending stress data.

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SHIP STRUCTURE COMMITTEE

The SHIP STRUCTURE COMMITTEE is constituted to prosecute a research program to improve the hull structures of ships by an extension of knowledge pertaining to design, materials and methods of fabrication.

SHIP STRUCTURE SUBCOMMITTEE

The SHIP STRUCTURE SUBCOMMITTEE acts for the Ship Structure Committee on technical matters by providing technical coordination for the determination of goals and objectives of the program, and by evaluating and interpreting the results in terms of ship structural design, construction and operation.

I. INTRODUCTION

A. Background and Objective of Study

Midship bending stress data from four dry-cargo ships, accumulated during the period 1959 through early 1970 under Ship Structure Committee Project SR-153, "Ship Response Statistics" were recorded as analogue signals on frequency modulation (FM) magnetic tape. The data are contained on 163 reels of 10 1/2-inch diameter, 1-inch wide magnetic tape. Associated logbooks contain hand-entry data relative to pertinent ship, sea, and weather information. The data reduction accomplished prior to the initiation of the current project had been adequate for the individual analysis of each ship voyage, but, because of the form of the data, extensive analysis (particularly comparative analysis between ships or equivalent sea and weather conditions) became prohibitively difficult, thus limiting the usefulness and value of the data collected. Further, the method of data acquisition and handling had improved significantly since initiation of the data acquisition program, and there had not been a consistent processing of the analogue data--even to special procedures being required for individual tapes.

Subsequent to the initiation of the data collection program, better techniques became available for digital processing of data by high-speed computers, thus making the effort under the present project more practicable. The current project was intended to determine the feasibility of converting the existing analogue data (including logbook information) to digital form, to develop the programming required to process the data and to convert the accumulated midship bending stress data and associated information to digital form.

The feasibility phase of the study (Ref. 1) established the type of data and purpose for which the data would be required, determined the desired format of data, and established the constraints on the insertion, extraction, and application of the data. Consideration was given to the character of the raw material in hand and the computer capabilities available for processing and analyzing of data.

During the subsequent effort (Ref. 2), a basic computer program (plus preprocessor programs) was developed to incorporate the information derived during the feasibility study. After debugging and documenting the program, verification was accomplished using sample data from the SS WOLVERINE STATE.

The final effort required the processing of data from the four vessels SS HOOSIER STATE, SS WOLVERINE STATE, SS MORMACSCAN and SS CALIFORNIA BEAR. This effort resulted in the preparation of magnetic tapes that contained, in digital form, the recorded analogue signal of wave-induced and first-mode frequencies, the associated logbook information, and derived stress data for each 30-minute interval of data originally recorded. Summary tapes of the logbook information and derived stress data for each interval (deleting the digitized records) were prepared for more efficient utilization in any subsequent statistical analyses. Following preparation of these tapes, demonstration examples (of the type of parametric studies that could be made for statistical analysis) were run to indicate several possible uses of the data. These illustrative examples served to define the latent capability of the digitized materials and to illustrate the method of extraction of selected information from summary tapes. The examples selected were illustrative only and were not intended for use in studying any existing physical phenomena. This report contains the description of the processing of data and the illustrative examples.

B. Definitions

To minimize possible confusion in this report, certain definitions and nomenclature, as used herein, are given here for reference.

Interval--nominally a 30-minute segment of recorded analogue data for which there was a corresponding logbook entry. An interval normally consisted of a 1-minute zero segment, followed by a 1-minute calibration segment, followed by a 28-minute segment of data. An interval was recorded once every four hours, but the recording time was not necessarily coincident with the beginning of a deck watch.

Long Interval--Under certain conditions (when stress levels exceeded a preset level) the recording system turned on automatically before the next interval was scheduled, and recorded data continuously until the stress levels fell below the preset level. No zero or calibration signals preceded the long interval data, but the normal interval would override to record the zero and calibration every four hours. There were no logbook entries corresponding to long intervals other than the entry for each watch. Long intervals could be of any duration depending on when during a watch the preset levels were exceeded, but were never longer than the remaining 3 1/2 hours of the watch. Long intervals were identified in 30-minute segments by a letter A-G which follows the immediately preceding interval number.

Voyage--the passage of a vessel from one port to another during which significant open-sea data were recorded. Estuary, river or harbor travel or travel between intracontinental ports (e.g., northern Europe) were not voyages, and a round trip would be considered two voyages.

Pass--a single-channel of frequency modulation (FM) analogue data recorded once through the tape. Normally, only one channel of data and its corresponding compensation channel were recorded during a voyage. Since the FM analogue tape had a 14-channel capability, upon completion of recording one pass, the ship's crew was able to switch the data and compensation to different recording channels and thus make more efficient use of the FM tape. Depending on many factors, a complete voyage could be recorded as several passes on one or more tapes.

Burst--a group of exponentially-decaying stress variations at the frequency of first-mode vibration, superimposed on the wave-induced bending stress variations. A burst of first-mode stress variations was usually excited by a slam. Maximum peak-to-trough amplitude of a burst normally occurred within one or two cycles of the beginning of the burst, and was rarely more than about 10% of the peak-to-trough wave-induced bending stress variation. Bursts were classified by their maximum amplitudes.

Full Bridge--All vessels were instrumented with an active stress gage and temperature-compensating gage (half-bridge) on both port and starboard sides. These four elements were wired into a four-arm Wheatstone bridge (full-bridge). The output signal was calibrated to represent the average midship vertical longitudinal bending stress. Horizontal longitudinal stress variations were eliminated by the configuration of the active gages in the bridge.

Half Bridge--On the SS WOLVERINE STATE only, a number of voyages were made with the two half-bridges on each side recorded separately on two separate tape channels. In the half-bridge configuration, stress contributions from horizontal bending were not eliminated. However, by recombining (adding) the two signals during data reduction, horizontal effects were again eliminated. In the event of failure of a transducer or amplifier on one side, the data from the remaining side were reported, but identified as "half-bridge".

Logbook Data--the information recorded by the watch officer during each watch relative to sea, weather, and vessel conditions. The format of these data changed during the program, and certain data were not consistently reported. There normally was an appropriate logbook entry for each interval of recorded data, and correlation was made by comparison of times between the recording instrumentation time meter and the logbook time recording.

Zero Signal--the automatic recording system initiated the recording of each interval by imposing a 1-minute period in which the excitation to the gages was interrupted. The purpose of the zero period was to provide a means of detecting any drift in the DC amplifiers.

Calibration Signal--immediately following the zero signal, there occurred a 1-minute period during which a calibration resistor was shunted every three seconds across one arm of the stress-gage bridge, which resulted in the superposition of ten cycles of offset on the stress signal. The magnitude of the calibration resistor was selected to produce the equivalent of a 10,000 psi stress, and thus provided a calibration for each interval.

Peak-To-Trough--the normal cyclic stress variation associated with the longitudinal bending of a vessel was determined from the maximum value of a positive stress (peak) and the next maximum negative stress (trough).

Mean Value Stress--determined as the average stress during an interval. The excursion in mean value stress for each interval in a pass was determined relative to the mean value stress in the first interval of that pass.

Ship Calibration Factor--determined from comparison of stresses measured during a dockside loading with the corresponding stresses calculated theoretically. This enabled the determination of the effects of unfairness in plating and other factors that may have yielded slight variations in measured stress from that stress determined theoretically using the gage location and calculated ship stiffness.

Whipping--the transient dynamic response of the vessel, occurring at the first-mode frequency as a result of impact loads (such as from a slam), and not to be confused with steady-state dynamic loads such as in springing.

C. Scope of This Report

This study resulted in two reports, 25 digitized data tapes, two summary tapes and computer printouts of the demonstration examples. This report summarizes the results of the study and provides documentation supporting the results. Reference 3 contains the necessary documentation on each of the computer, pre-processor, edit, and post-processor programs used to prepare and digitize the data, correct and edit data, and read and extract information for statistical study. As shown in Table I, the digitized data are contained on 3 magnetic tapes for the SS HOOSIER STATE, 15 tapes for the SS WOLVERINE STATE, 4 tapes for the SS MORMACSCAN and 3 tapes for the SS CALIFORNIA BEAR. In addition, included are two summary tapes. One tape contains summarized data from all four vessels when instrumented in a "full-bridge" midship bending stress gage configuration and the other tape contains summarized data from both port and starboard midship bending stress gage configurations (the "half-bridge" configuration available only on certain of the SS WOLVERINE STATE voyages). A copy of the computer printouts that resulted from the demonstration examples is available from the Ship Structure Committee, as are the digital tapes.

TABLE I - DIGITAL LIBRARY TAPES

Digital Tape No.	Ship	Full or Half Bridge	No. of Voyages	No. of Intervals	No. of Analogue Tapes
HOOS 01	SS HOOSIER STATE	Full	12	574	7
HOOS 02	" "	"	11	471	6
HOOS 03	" "	"	10	540	5
WOLV 01	SS WOLVERINE STATE	Full	11	540	13 1/2
WOLV 02	" "	"	10	576	11 1/2
WOLV 03	" "	"	11	601	15 1/2
WOLV 04	" "	"	12	575	13
WOLV 05	" "	"	6	377	5 1/2
WOLV 10	" "	Half	10	611	3
WOLV 11	" "	"	8	398	4
WOLV 12	" "	"	5	572	2
WOLV 13	" "	"	6	597	2
WOLV 14	" "	"	10	617	6
WOLV 15	" "	"	9	604	8
WOLV 16	" "	"	7	547	7
WOLV 17	" "	"	8	597	7
WOLV 18	" "	"	10	603	8 1/2
WOLV 19	" "	"	5	404	7 1/2
SCAN 01	SS MORMACSCAN	Full	9	563	4 1/2
SCAN 02	" "	"	11	561	6 1/2
SCAN 03	" "	"	6	370	3 1/2
SCAN 04	" "	"	6	368	3 1/2
BEAR 01	SS CALIFORNIA BEAR	Full	8	590	4 1/2
BEAR 02	" "	"	10	572	5 1/2
BEAR 03	" "	"	6	392	3
TOTAL 25			217	13,220	163

D. Nature of Data

The data under consideration were obtained from stress gages mounted on the sheer-strake plating approximately amidships on four dry-cargo vessels: SS HOOSIER STATE, SS WOLVERINE STATE, SS MORMACSCAN, and SS CALIFORNIA BEAR. A general description of the vessels and of the data is contained in Table II. Further details of instrumentation and ship characteristics can be found in previous Ship Structure Committee reports listed in References 4-9.

The primary objective of Project SR-153 was to obtain wave-induced midship bending moment stress data on a number of vessels operating for significant periods on various trade routes. The stress data were recorded as analogue signals on magnetic tape. The information was recorded using frequency modulation (FM) techniques at a tape speed of 0.3 inch per second. Since the system was essentially unmanned, a mechanical programmer was used to obtain a half-hour sample of data each four hours except when certain preset levels of stress were exceeded, in which case the instrument recorded continuously. A typical analogue record is shown in Figure 1, which shows the system zero, followed by the square wave calibration, which is followed by the actual record. The system bandpass characteristic was from 0 Hz to approximately 50 Hz, such that wave-induced information and the lower modes of ship vibratory data were recorded. In addition, higher frequency, nonperiodic data such as spikes (below the 50 Hz bandpass cut off) induced by slamming or noise were recorded. The recording system thus obtained higher frequency data beyond the primary scope required under the data acquisition contract (Project SR-153). The objective of the current study was to digitize and process

TABLE II
VESSEL AND ANALOGUE DATA IDENTIFICATION

VESSEL	TYPE	L x B x D (FEET)	PRIMARY ROUTES	APPROX. SHIP-YEARS OF DATA
SS HOOSIER STATE	General Cargo, C4-S-B5 (Machinery Aft)	520 x 71 x 54	North Atlantic	2.5
SS WOLVERINE STATE	General Cargo, C4-S-B5 (Machinery Aft)	520 x 71 x 54	North Atlantic and Pacific	5.5
SS MORMACSCAN	General Cargo, Type 1624	483 x 68 x 41	North Atlantic and East Coast of So. America	3.5
SS CALIFORNIA BEAR	General Cargo, C4-S-1A Standard Mariner	563 x 76 x 44	Pacific	2.5

NOTES:

STRESS GAGES: All gages located on side shell just below main deck, approximately amidships.

RECORDING MEDIUM: 1-inch wide magnetic tape, mylar-base, 1.0 mil thick.

DATA RECORDED: Individual or average (of Port and Starboard) midship longitudinal vertical bending moment stress.

RECORDING METHOD, SPEED AND RESPONSE: Frequency modulation recording at 270 Hz center frequency, tape speed of 0.3 ips; data frequency response flat from DC to 50 Hz.

TYPICAL DATA CHARACTERISTICS: Wave-induced data < 0.2 Hz; first mode (free-free) vertical natural frequency of vessel < 1.5 Hz; second mode of stiffest vessel ~ 5.0 Hz.

PROGRAMMING: Data recorded for 1/2 hour out of every 4 hours except that when stresses exceeding preset levels were reached the recording interval was automatically increased for anywhere from an additional 15 minutes up to the full remaining 3 1/2 hours.

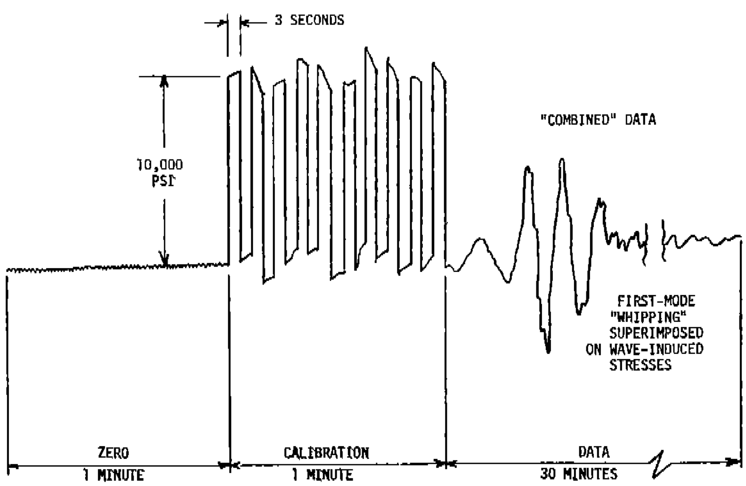


FIGURE I - TYPICAL INTERVAL DATA SAMPLE

only wave-induced bending stresses and first mode "whipping" data; hence, filtering of the higher frequency analogue data that was recorded eliminated data not to be included in the current study.

Weather and other environmental data, including a qualitative assessment of the sea state, were available in logbooks maintained by the watch officer on each vessel and were correlated with the analogue tape data by means of time readings.

II. PROCESSING TECHNIQUE

A. General

The processing technique was determined by consideration of the following:

1. Reduction in the volume of tapes without sacrifice of information, accuracy or ability to utilize or evaluate data.

2. Efficiency of extracting previously determined summary information and of access to "raw" data.

3. Ability to reproduce analogue data (at wave-induced and first-mode frequencies) and to develop spectral data at wave frequencies.

4. Use of nonspecial computational equipment for automatic processing of data.

5. Maximum utilization of existing editing, collating and analysis of analogue data from all vessels.

6. Standardization of presentation of data from all vessels, from each interval and from each voyage.

As a consequence of the above considerations, the data were processed in the following format:

1. Each digitized tape contained more than one (complete) voyage, but voyages from only one vessel.

2. Intervals were defined as analogue signals recorded for a period of 30 minutes continuous real time. Recorded data for longer continuous periods (the "long intervals") were identified in 30-minute segments each of which was processed as an interval. Twenty minutes (real time) of each interval was digitized and analyzed.

3. Each interval of data included Identification Data, Logbook Data, Interval Summary Data and Digitized Analogue Signal (See Table III and narrative under "Digital Data Processing" for description of material in each of these classifications).

4. Each voyage was summarized following the recording of the digitized intervals which comprise that voyage. This summary included both Identification Data and Voyage Summary Data. (See Table IV and narrative under "Digital Data Processing" for description of material included in each of these classifications).

The general flow of data resulted in preparing the logbook information separately and subsequently merging with the digitized analogue signals. Processing of the information was done on-line and the results were merged interval-by-interval and voyage-by-voyage until a tape was completed. Further editing, as required, and compacting of tape was done prior to the preparation of the summary tapes. This is shown schematically in Figure 2, and is described in more detail in subsequent sections of this report. Programming details and operating instructions are given in Reference 3.

TABLE III

DATA INCLUDED FOR EACH INTERVAL

INTERVAL IDENTIFICATION AND LOGBOOK DATA:

FM ANALOG TAPE REFERENCE
LOGBOOK INDEX NUMBER
INTERVAL NUMBER
DATE
TIME (GREENWICH MEAN)
LATITUDE PREVIOUS NOON
LONGITUDE PREVIOUS NOON
COURSE (DEGREES)
SPEED (AVG. PAST 4 HRS. IN KNOTS)
ENGINE RPM
BEAUFORT SEA STATE
RELATIVE WIND DIRECTION (DEGREES PORT OR STBD.)
RELATIVE WIND VELOCITY (KNOTS)
TRUE WIND VELOCITY (KNOTS)
RELATIVE WAVE DIRECTION (DEGREES PORT OR STBD.)
WAVE HEIGHT (FEET)
WAVE PERIOD (SECONDS)
WAVE LENGTH (FEET)
RELATIVE SWELL DIRECTION (DEGREES PORT OR STBD.)
SWELL HEIGHT (FEET)
SWELL LENGTH (FEET)
BAROMETER READING (IN. HG OR MILLIBARS)
SEA TEMPERATURE (DEG. F)
AIR TEMPERATURE (DEG. F)
WEATHER CODE
COMMENT CODE (SLAMMING, HEAVY GOING, ETC.)

INTERVAL SUMMARY:

NUMBER OF WAVE-INDUCED PEAK-TO-TROUGHS
NUMBER OF BURSTS OF FIRST-MODE
WAVE-INDUCED RMS STRESS
MAXIMUM WAVE-INDUCED PEAK-TO-TROUGH STRESS
MAXIMUM FIRST-CYCLE FIRST-MODE PEAK-TO-TROUGH STRESS
MEAN VALUE STRESS (RELATIVE TO FIRST INTERVAL IN PASS)
TABULATION OF ALL WAVE-INDUCED PEAK-TO-TROUGH STRESSES

DIGITAL RECORD OF INTERVAL

DIGITIZED ANALOG DATA FOR INTERVAL USING SAMPLING RATE OF 10 PER SECOND (12,000 DATA POINTS)

TABLE IV

DATA INCLUDED FOR EACH VOYAGE

VOYAGE IDENTIFICATION:

SHIP NAME
OWNER'S VOYAGE NUMBER
DATE VOYAGE START
DATE VOYAGE END
ROUTE (FROM/TO)
ROUTE CODE
FM TAPE REFERENCES
SHIP CALIBRATION FACTOR
LOCATION OF ACTIVE GAGES (PORT/STBD)
LOCATION OF ACTIVE GAGES (FORE/AFT POSITION)
DRAFT - FWD
DRAFT - MID
DRAFT - AFT

VOYAGE SUMMARY:

NUMBER OF WAVE-INDUCED (W.I.) PEAK-TO-TROUGHS
NUMBER OF BURSTS OF FIRST MODE
MAXIMUM WAVE-INDUCED RMS STRESS
MAXIMUM WAVE-INDUCED PEAK-TO-TROUGH STRESS
MAXIMUM FIRST-CYCLE FIRST-MODE PEAK-TO-TROUGH STRESS
MAXIMUM EXCURSION OF MEAN VALUE

Three computer systems were utilized in the processing of the data. An IBM 1130 system was used to prepare paper tapes for inputting the logbook information, a DEC PDP-8/I was used for processing and preparing of the data tapes, and an IBM 360 system was used for editing and compacting the digitized tapes and for performing the demonstration examples.

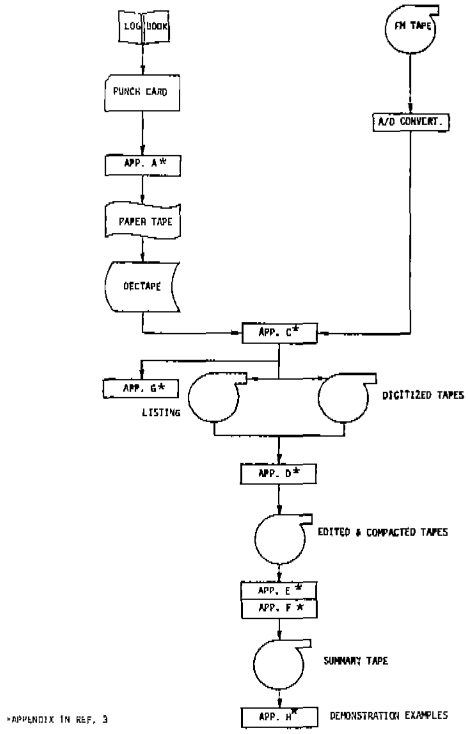


FIGURE 2 - SCHEMATIC OF DATA FLOW

B. Logbook Data Processing

Initially, the logbook information and analogue tape records were correlated and edited. Editing consisted of determining the number, sequence and acceptability of the analogue signals, including identification of long intervals. Each interval of data to be analyzed was correlated with a corresponding logbook entry. The logbook data were punched on computer cards, and the punched data were verified and edited by listing on an IBM 1130 computer-printer. The data then became output on punched paper tape in ASCII (American Standard Code for Information Interchange) format to be consistent with the PDP 8/I teletype paper-tape reader. The intermediate step of using punched cards provided simpler and quicker punching, verification and/or correction of the punched data than would have been possible by going directly to punched paper tape through the teletype. In addition, the preparation of logbook data through the use of other existing equipment permitted the uninterrupted use of the PDP-8/I and its equipment for the analogue data processing.

The logbook preprocessor program was used to prepare the paper tapes. Since the data in the hand-entry logbooks were recorded by a crew member of each particular vessel during each voyage, the amount of data recorded, the manner of recording, and the correctness of observations necessitated considerable editing and discretion during the preparation of the logbooks for punching. The preprocessor program was written to accept the four major formats in which the data were recorded and to convert (before punching the paper tape) to a single format whose output is that shown on Tables III and IV.

The details of the program and its operation which accomplished the editing and punching of the paper tapes is given in Appendix A of Reference 3, along with a generalized flow chart. A typical printout of a logbook tape is shown in Table V, and consists of a Header, Interval Identifications, and Voyage Identifications.

TABLE V - LOGBOOK TAPE PRINTOUT

```
HEADER INFORMATION
LIBRARY TAPE NUMBER N039 SHIP STRUCTURE COMMITTEE      N00024-69-C-5161

                424610 0 0138 0 0 0149 0 0 0149 0 0 02107L2108L2110L2
111L2123L2124L3145D4109L4110D4132L4136D

INTERVAL IDENTIFICATION
192W1-1     01023 12-12-62210039-37 N067-03 W08117.0080306070P3130101P04
03030            30.2046026PTCDY

192W1-1     01124 12-13-62010039-37 N067-03 W08216.0081305056P2118102P04
05045037P   045030.1750032PTCDY
 ROLLING AND PITCHING EASY
192W1-1     01225 12-13-62050039-37 N067-03 W08216.0081706067P2625102P06
05045            30.1062033CLDY
 ROLLING AND PITCHING EASY
192W1-1     01326 12-13-62090039-37 N067-03 W08216.0081607073P3030102P06
09040            30.0466033OCAST
 ROLLING AND PITCHING EASY
192W1-1     01427 12-13-62130039-37 N067-03 W08216.5081006072P3130102P06
09060062P   050030.0154036MTCDY
 ROLL MOD PITCH EASY
192W1-1     01528 12-13-62170039-37 N067-03 W08216.6080806072P3130102P06
09050            29.9756038CLDY
 ROLL MOD PITCH EASY

192W2-1     00606 12-21-62070049-39 N006-54 W   19.0079405158S3317045P04
05040            29.7848047CLEAR
 ROLLING EASY
192W2-1     00707 12-21-62110049-39 N006-54 W03918.0079207126S3528084P06
07060084P   030029.8248046CLDY
 ROLLING AND PITCHING
192W2-1     00808 12-21-62150049-39 N006-54 W04014.6079307116S3935075P08
08070075P   040029.9043046OCAST
 ROLLING AND PITCHING
192W2-1     00909 12-21-62190049-39 N006-54 W04515.0078604000S2914000S04
05050090P   040030.0644040PTCDY
 ROLL AND PITCH MOD TO HEAVY
192W2-1     01010 12-21-62230049-39 N006-54 W   16.2078804033S2716070S04
05040045P   030030.2242030PTCDY
 ROLLING EASY
WOLVERINE STATE 19212-12-6212-21-62PHILADELPHIA TO BREMERHAVEN GER 01-05

VOYAGE IDENTIFICATION
```

The punched-paper-tape logbook data were loaded in "blocks" (128 characters/block) on the PDP-8/I computer through the teletype and then were converted to EBCDIC (Extended Binary Coded Decimal Interchange Code), consistent with the required magnetic tape format. After conversion in the PDP-8/I, the data were stored on DECtape for merging during the data processing phase.

The magnetic tape label (Header) utilized the first three blocks on the paper tape for operating instructions for the processor program to control the data processing phase. Included in this information were the number of voyages to be written on each magnetic tape, the number of original FM analogue tape passes for each voyage, the number of intervals in each pass of data, the interval numbers which were not to be digitized, those intervals which were long intervals and intervals where halts were needed in the processing.

Each logbook interval consisted of two blocks on the DECtape, which contain the Interval Logbook Data. Four DECtape blocks were left blank after each logbook interval. These were utilized by the data acquisition program for storage of Interval Summary data (i.e., wave-induced peak-to-troughs, RMS stress, maximum peak-to-trough first mode, etc., as shown on Table III).

The last two blocks of paper tape contained the Voyage Logbook Data and were handled in the same manner as the Interval Logbook Data. Again, four DECtape blocks were left blank after each voyage identification for storage of Voyage Summary data (see Table IV).

C. Analogue Signal Processing

The original data, as recorded on FM analogue tape, were conditioned to a form acceptable to the data processor. In addition, extraneous or erroneous signals were eliminated or minimized before processing. The FM analogue data were recorded from 0 to 50 Hz. However, since only wave-induced and first bending mode data were to be processed, it was determined during the feasibility study that the only frequency data of current interest was from 0 to 2 Hz which would include all wave-induced data and first-bending-mode data for the four vessels.

The signal conditioning for the processing of tapes is shown on the flow diagram, Figure 3. The ± 1-volt rms (full-scale) FM analogue signal (and the recorded compensation channel) passed through the respective discriminators to achieve electronic compensation. The square-wave generator, calibration control and zero control permitted checking of the signal to a consistent basis before conditioning it for processing by the PDP-8/I. The A/D converter of the PDP-8/I accepts analogue signals only between -10V and 0V, hence, signal conditioning was used to center the signal at -5V and amplify it to maximize the available range. The 2 Hz low-pass filter eliminated any recorded signal whose frequency was above that of current interest (i.e., wave-induced and first mode only).

The compensated, filtered, amplified and offset signal (called "combined" signal for convenience) was split into three parallel paths for easier processing; namely, the "combined", "wave-induced" and "first-mode" paths. These three signals were then used as input into the A/D converter and multiplexer.

The combined signal (which contained both wave-induced and first-mode signals) was applied directly to the multiplexer. The function of this signal was to provide the zero and calibration signals for control and scaling purposes. It was also the signal which was digitized and recorded.

The combined signal was also passed through a bandpass filter set to pass only wave-induced signals (0.01-0.2 Hz real time). Because bandpass filters characteristically do not pass a nonperiodic signal (such as the DC offset used to center the signal in the available range for the processor) it was necessary to restore the offset at the output of the filter. This wave-induced signal was applied to the multiplexer where it was digitized, and measurements of wave-induced peak-to-trough values, number of cycles, etc., were made.

The combined signal was also passed through a bandpass filter set to pass only the first-mode signal (0.2-2.0 Hz). Again, the offset had to be restored. This first-mode signal was applied to the multiplexer, and measurements of first-mode amplitudes and numbers of occurrences, etc., were made.

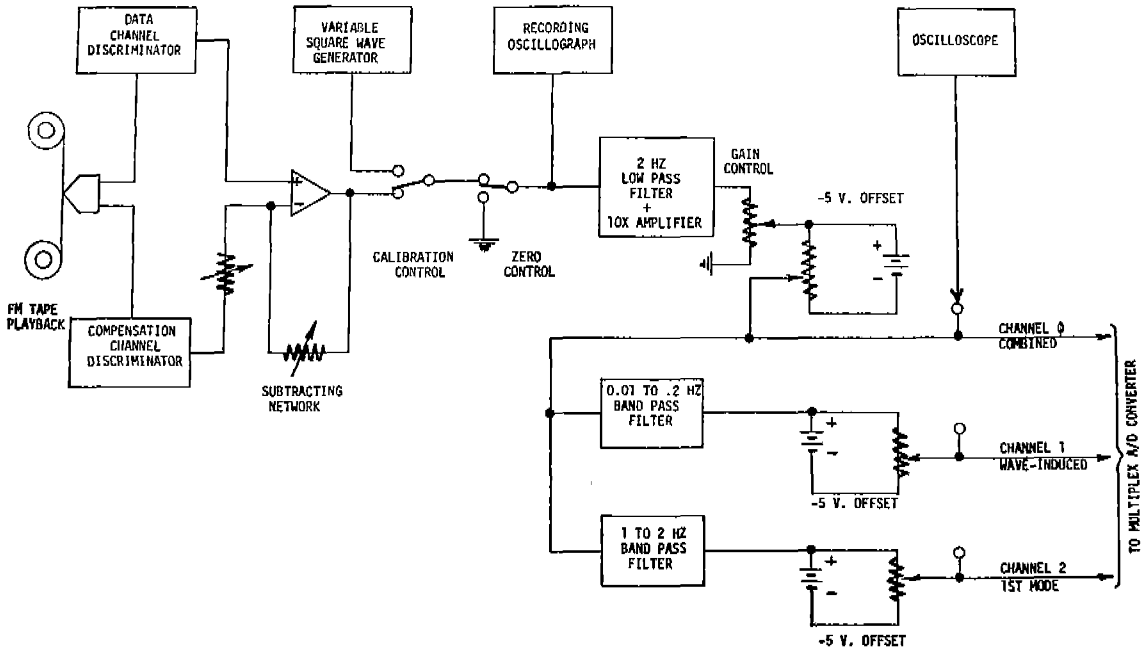


FIGURE 3 - SIGNAL CONDITIONING FOR PROCESSING ANALOGUE DATA TAPES

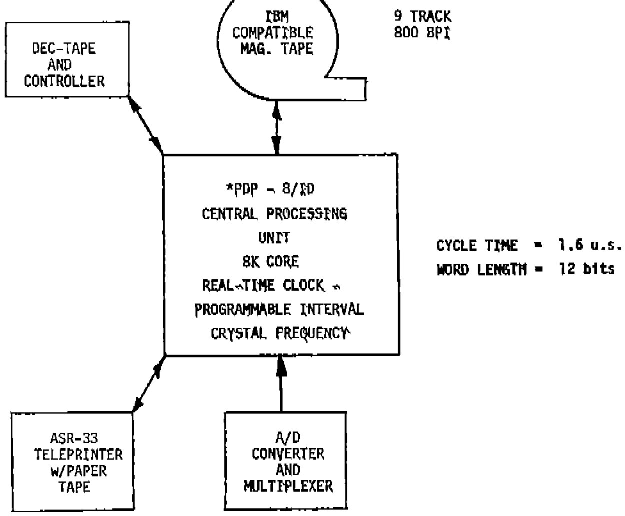
D. Digital Data Processing

The computer system used to perform a particular function is dependent on the hardware available and the software to make it work. Hardware consists of the equipment (i.e., central processor, input and output devices, and features such as clocks, auxiliary storage, etc.) needed to perform the job. Software is the method by which the computer hardware is told what to do, and consists of the programs which direct and control the method of operation.

The hardware utilized for the basic digital data processing was a Digital Equipment Corporation (DEC) PDP-8/I computer processor. The PDP-8/I and its peripheral equipment are shown schematically in Figure 4. The system consisted of the Central Processing Unit, 8192-word core memory, Analogue-to-Digital (A/D) Converter and Multiplexer, ASR-33 Teletype, Peripheral Equipment Corporation (PEC) IBM compatible magnetic tape unit, DECtape (auxiliary storage), Extended Arithmetic Element Hardware multiply and divide and Programmable Real-Time clock. Figure 5 shows the equipment used to process the data.

The Central Processor handled all arithmetic, logic, and system-control operations. It allowed the computer to store, retrieve, control and modify information and served as an interface between peripheral input/output equipment and core memory.

Core memory provided random-access storage for both instructions to be performed and information to be processed or distributed. The PDP-8/I, a single-address, fixed-word-length, parallel-transfer computer, used 12 bit, 2's complement arithmetic. Cycle time of the random-address magnetic core memory was 1.6μs. Standard features included indirect addressing and facilities for instruction skip and program interrupt as a function of the input/output device condition. It was the program interrupt facility in conjunction with the Real-Time clock that allowed the programming of a real-time data acquisition system.



*PROGRAMMED DATA PROCESSOR

FIGURE 4 - BASIC COMPUTER CONFIGURATION FOR PROCESSING DATA

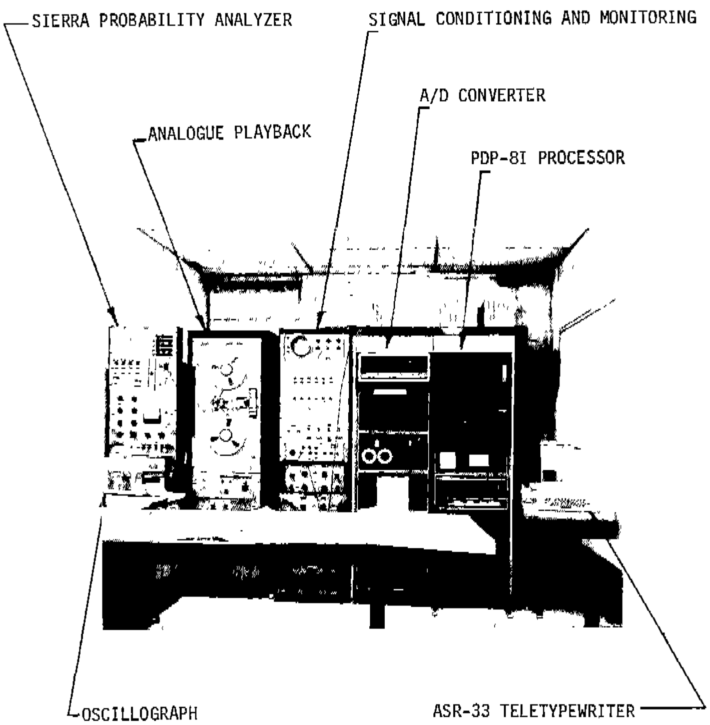


FIGURE 5 - DATA PROCESSING EQUIPMENT

The Analogue-to-Digital (A/D) Converter and Multiplexer allowed for fast multichannel scanning and conversion of analogue data from external signal sources. As configured, the system could multiplex up to 16 analogue signals concurrently and could convert the signals (0 to -10 volt range) to binary numbers. The A/D converter had a successive approximation converter that measured a 0 to -10 volt analogue input signal and provided a binary output indication of the input signal amplitude. Output was binary numbers from 6- to 12-bit accuracy with negative numbers represented in 2's complement notation.

The ASR-33 (Automatic Send-Receive) teletype was used to type in or print out information from the computer. The basic code was ASCII. Input was from either the perforated-paper-tape reader or keyboard. Output was either printed and/or punched on paper tape. The Teletype was an extremely slow device (approximately 10 characters/sec) and was used normally for program editing, assemblies and operator intervention during real-time operations.

The IBM Compatible Magnetic-Tape unit was an incremental-write, synchronous-read device. Tape format was 9-track, 800 bpi (bits/inch) consistent with industry-standard synchronous systems, allowing data acquired with this system to be utilized by another computer installation. The incremental writing allowed considerable flexibility in the acquisition of data, data reduction, and storage. Data was written one word at a time, eliminating the need for a buffer memory for storage of a block of data as would be required with synchronous-write units.

The DECtape served as an auxiliary magnetic-tape data-storage facility. Information was stored at fixed positions on the systems. This allowed for random-access read/write without disturbing other recorded information. The tape consisted of a series of data blocks (128 words/block) numbered from 1 to n. This allowed for the storage of 188,544 words in 1473 blocks which could be randomly accessed. Data were written/read in block format.

The Real-Time Clock provided a method of accurately measuring time intervals. The timing frequency was 10 KHz. The length of time to cause an interrupt was under program control. Using the interrupt facility and setting the clock allowed multiple processing. The clock was used to set the data sampling rate for running the program.

The Extended Arithmetic Element provided for hardware multiplication and division. This increased the speed a hundred fold by which multiplication and division could take place, and was extremely useful in a real-time environment.

To utilize the computer/processor and its peripheral equipment required instruction. This was where the software (computer program) came in.

The software requirements for the ship data processing consisted basically of two programs; the Logbook Pre-processor Program and the Data Conversion and Analysis Program. Other programs were used for special circumstances. All programs required during the performance of this contract are identified in Table VI and documented in Reference 3.

Once the data tapes were prepared, and the summary tapes created, data were available to perform the demonstration examples. The program PARM and its peripheral programs read the summary tapes and provided the listing of the required data (and punched cards). Use of commercially-available mechanical sorting equipment provided punched cards ready for computer plotting of the individual examples.

TABLE VI - LIST OF PROGRAMS AVAILABLE IN REF. 3

APPENDIX A - LOGBOOK PRE-PROCESSOR PROGRAM
APPENDIX B - LOGBOOK PAPER TAPE LOAD PROGRAM
APPENDIX C - DATA CONVERSION AND ANALYSIS PROGRAM
APPENDIX D - SUMMARY TAPE AND EDIT PROGRAM
APPENDIX E - FINAL SUMMARY TAPE PROGRAM
APPENDIX F - SUMMARY TAPE CORRECTION PROGRAM
APPENDIX G - SUMMARY TAPE LISTING PROGRAM
APPENDIX H - PARAMETRIC STUDIES PROGRAM
APPENDIX I - RELATIVE WIND DIRECTION CORRECTION SUBROUTINE

E. Computer Programs

A brief description of the function of each computer program follows. The details are given in Reference 3, along with operating instructions.

A listing of the computer program (Logbook Pre-processor) used to accomplish the editing and punching on paper tape of the logbook information is given in Appendix A of Reference 3 with a generalized flow chart. This program was used to prepare the paper tapes which provided operating instructions in the header and included such information as the number of voyages to be written on each magnetic tape, the number of original FM analogue tape passes for each voyage, the number of intervals in each pass of data, any interval numbers which would be digitized and other special instructions.

The paper tape output from the above program had to be read into the PDP processing computer and stored for use and subsequent merging with the digitized recorded data. Storage was on DECtape and the data could be input independently of the actual processing. In Appendix B of Reference 3 are given the details of the program which accomplishes the DECtape storage (Logbook Paper Tape Load program).

The main processing program, Data Conversion and Analysis program is given in detail in Appendix C of Reference 3. This program operated in a Real-Time environment through the Real-Time Programmable Clock. Programming was done in Assembler Language for DECtape, to take advantage of the shortened processing time, to work within the 8K word memory, and to utilize the single DECtape auxiliary storage unit. This permitted the processing to be done at a rate increase factor up to 25 over the recorded rate (0.3 inches/second for the FM analogue tape) without requiring starting and stopping of the analogue playback unit.

The three basic signals (i.e., the combined, wave-induced, and first-mode signals) which were fed to the A/D and multiplexer unit were digitized individually, although the data processing was done essentially simultaneously and continuously within the processor without the need to stop and start the analogue playback.

The practicality of processing and writing a complete digital data tape without errors, (which would have necessitated considerable rerunning of much already completed and correct data) early indicated the requirement for the capability to edit and compact partially filled data tapes onto one essentially filled data tape. The Summary Tape and Edit program (SUMT) was written to allow for the creation of a full digital data tape from as many as four partially filled data tapes. The editing capabilities included options to delete complete intervals and to recalculate the voyage summary data, correct selected items in the interval logbook data, and to provide for the addition of a reprint of the voyage-identification record at the beginning of each voyage. Two versions of this program (see Appendix D of Reference 3) were required because of the inconsistency in the manner in which the intervals were recorded in the logbooks. In Version I, the intervals to be corrected are identified only by index number (the majority of data were recorded this way). In Version II, to accommodate some of the earlier-recorded data, the intervals were identified by both the interval number and the logbook index number.

Two final summary tapes were created from the edited data tapes which resulted from the above edit, compact and correct routine. One summary tape contained only full-bridge data, and the second contained only half-bridge data. These summary tapes were created to minimize the computer processing time for the demonstration examples or any subsequent detailed analysis by eliminating all digitized signal records and by retaining only the voyage identification, logbook and summary records and the interval identification, logbook and summary records. In effect, by elimination of 12,000 pieces of raw data recorded for each interval, approximately 90 per cent of the information was eliminated, and considerable economy could be realized. Thus, the identification and processed data from a maximum of 150 voyages could be recorded on each summary tape. The details of the Final Summary Tape program (FSMT) are given in Appendix E of Reference 3.

An inconsistency in the Logbook Pre-processor program in the routine which determined relative wind direction resulted in some values of Relative Wind to be in error by 180° as punched on the paper tapes and which, therefore, were carried through to the final summary tapes. A subroutine RELWND was written to determine Relative Wind correctly and which could be applied to any of the programs. However, this correction was applied only to the final summary tapes through the Summary Tape Correction program (CRCT) which creates a correct Final Summary Tape.

In the course of the data processing, it became evident that a simple listing program which printed the magnetic tape information from the digital data tapes in a readable format would be very beneficial. This program (LIST--Appendix G of Reference 3) was not essential to the processing, but it was a considerable convenience during the processing of data, and, in particular, in the continual checking of processed data to assure that what was printed on the digital data tapes was correct. LIST contains an option to suppress the digitized data and print only the identification, logbook and summary data. This option was used to check and edit the digital data tapes before preparing the compacted data tapes (using SUMT).

The utilization of the data on the Final Summary Tapes required a program to read the tapes and perform comparisons or select certain data. The program PARM was written to permit the reading of the summary tape and to extract the required information as punched cards, printout or stored on magnetic tape for other processing. As noted earlier, punched card output was used and further processed with commercial mechanical card sorting equipment. This program is given in detail in Appendix H of Reference 3.

Certain program subroutines are essential to the processing of the data. To the extent possible, use was made of standard software provided by the computer manufacturer (IBM) or available through computer service bureaus, and modifications, where necessary, were incorporated. The subroutines included Relative Wind Direction (RELWND), Data Compression (ALIGN-EBCDIC), Conversion (BCNV), Shift (SHFT2V) and Masking (AND). With the exception of RELWND (described in Appendix I of Reference 3), the subroutines are described in the Appendices where used.

III. PROGRAM VERIFICATION AND TESTS

A. Data Processing

Data handling on magnetic tapes required verification that the intended data had been placed correctly on the digital tape and were retrievable on command. To assure that the original data were correctly transferred and processed, it was necessary to perform two independent checks; namely, 1) verify the primary portions of the program, and 2) verify the adequacy of the digitized record to reproduce the analogue signal.

Prior to the actual processing of data, the primary functions of the program were verified. These included:

1. Individual subroutine (e.g., read in data, perform calculations, write out data, etc.)

2. Interpretation of zero stress and calibration signals

3. Handling of wave-induced data

4. Handling of first-mode data

5. Handling of long intervals of data

Critical evaluation tests were performed on data taken from the SS WOLVERINE STATE data library. Since the SS WOLVERINE STATE was known to exhibit first-mode whipping and had experienced continuous recordings at times, three intervals were selected from voyage 263 W2-11. These corresponded to:

Interval	Logbook Index	
20	91	(Average data, slight first mode, two successive
21	92	(intervals
12	83	Long interval, substantial first mode

Initially, the FM analogue signals of these three intervals were re-recorded as if they were three consecutive intervals. The analogue signal was passed through the appropriate filters to yield three separate traces which corresponded to the three signals shown on Figure 3. Each of these traces was then fed into the A/D converter to verify that the programming could interpret properly the incoming data and perform the required operations. Upon satisfaction that each element of the program was correct, the re-recorded three-interval record was input to the A/D converter and the program checked in its entirety.

To assure that the program performed properly, the digitized magnetic tape was played back on an IBM 360/50 computer and a complete listing made of the tape, portions of which are reprinted as Table VII. (The 12,000 actual data points digitized for each interval are not reproduced in Table VII.) A typical Interval Identification and Interval Summary (for Interval No. 20) is shown at the top of the Table and at the bottom of the Table is displayed the Voyage Identification and Voyage Summary for the 4-interval "test" voyage. The digital playback printout of the identification and logbook data was checked against the original data which were input by punched tape.

TABLE VII - PRINTOUT OF DIGITAL RECORD OF TEST CASE

INTERVAL NO. 20 IDENTIFICATION AND SUMMARY

263 W2-11 09102C06/05/66215C
25815.581.505C48P19 1CCPC4C5015
008305029.7657C53MODERATE

146	2	1596	3045	1497	267				
553	1262	1548	706	1909	1447	681	1607	992	462
1346	597	1379	698	942	706	2448	2574	1346	1169
782	2835	2986	1068	1581	1447	1228	1360	883	1304
1329	849	1018	908	1531	1585	782	2566	2036	1489
1708	917	2692	1775	1522	799	2111	1994	513	1430
1489	774	2532	2053	1565	1768	1405	942	732	588
1977	1060	1245	1985	1447	2734	1127	841	3045	2196
1657	1438	1085	1615	1691	1396	1565	1152	1093	656
1203	858	1186	1447	1657	1674	1194	992	1152	1220
1236	2372	1893	1001	2016	1312	1304	1901	1295	1573
925	950	1102	1287	1430	1245	1270	1321	950	1009
723	841	1598	1384	1043	875	1228	1809	1413	1060
1539	1935	1287	1758	900	1665	2010	723	891	2541
976	1220	1455	572	1521	1615	2742	1565	1194	1405
1573	1169	1421	1851	1859	1556	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

VOYAGE IDENTIFICATION AND SUMMARY

WOLVERINE STATE 26406/01/6606/09/EUROP
E TO NO. AMER. EAST 05-01263 W2-1
1 1.06PORTMIDSH
IP

The playback data for one interval of the digitized record was output as punched cards which were in turn used to generate an x-y plot of amplitude as a function of time. This resulting curve was compared with an oscillograph record (to approximately the same scale) of the original filtered (0-2.0Hz) analogue signal. Comparisons of these curves for a representative portion of the record is shown in Figure 6. This comparison indicated the adequacy of the digitized record to reproduce the analogue signal. It should be noted that the digitized record reproduced the analogue signal so faithfully that some noise spikes and other erroneous sporadic signals which passed the 2 Hz low-pass filter were reproduced also. Certain of these signals were falsely identified as first-mode bursts in the subsequent demonstration examples. See further discussion in RESULTS section.

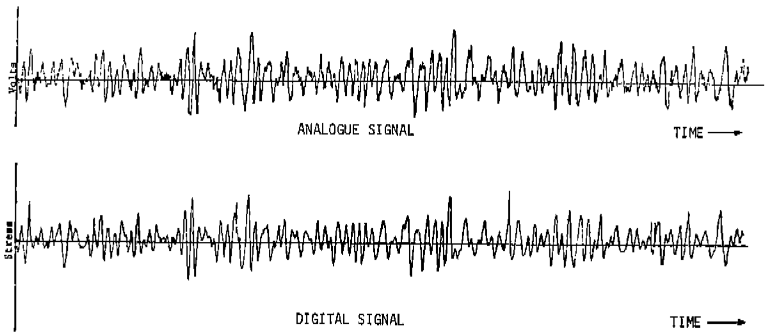


FIGURE 6 - COMPARISON OF DIGITAL RECORD WITH ORIGINAL ANALOGUE

The original (filtered) analogue signal of each of the three intervals was reanalyzed in accordance with the method used previously for data analysis (using the Sierra Probability Analyzer). This is described in some detail in Reference 5. The results of the probability analysis of the analogue record are compared in Table VIII with the similar information derived from the digital processor program. It is to be expected that the RMS values will be at variance

TABLE VIII - COMPARISON OF ANALOGUE AND DIGITIZED RESULTS

	(Digital) PDP-8/I Computer	(Analogue) Sierra Probability Analyzer
INTERVAL 20		
Number Cycles W.I.	146	437
Number Bursts First Mode	2	--*
RMS W.I. Stress, psi	1506	1150
Maximum Peak-to-Trough W.I. Stress, psi	3045	3100
Maximum Peak-to-Trough First Mode Stress, psi	1497	--
Mean Value Stress, psi	207	--
INTERVAL 21		
Number Cycles W.I.	191	433
Number Bursts First Mode	4	--
RMS W.I. Stress, psi	1088	910
Maximum Peak-to-Trough W.I. Stress, psi	2210	2100
Maximum Peak-to-Trough First Mode Stress, psi	945	--
Mean Value Stress, psi	1116	--
INTERVAL 12		
Number Cycles W.I.	174	362
Number Bursts First Mode	5	--
RMS W.I. Stress, psi	2593	2570
Maximum Peak-to-Trough W.I. Stress, psi	6135	5700
Maximum Peak-to-Trough First Mode Stress, psi	1563	---
Mean Value Stress, psi	-193	--
INTERVAL 12-A		
Number Cycles W.I.	176	--
Number Bursts First Mode	3	--
RMS W.I. Stress, psi	2452	--
Maximum Peak-to-Trough W.I. Stress, psi	5535	--
Maximum Peak-to-Trough First Mode Stress, psi	1459	--
Mean Value Stress, psi	-279	--

*NOTE: Dashes indicate that no data was obtained using the Probability Analyzer.

because the digital analysis is truly an RMS determination with each data point (peak-to-trough stress variation) being considered individually, whereas in the analogue determination, each data point falls into a histogram of 16 equal-stress-level bands, and the RMS is determined from the number of points in each band and the mid-band stress. The maximum peak-to-trough stresses compare quite well. The digital analysis is based on only peak-to-trough data, whereas the analogue analysis has twice the number of points due to utilizing both peak-to-trough and trough-to-peak data.

From the verification studies summarized above (and including that shown in Table VIII), sufficient confidence was obtained to proceed with the processing of the records into digital form.

During the processing of tapes, two types of checks were made. Validation of selected pieces of data was made from each interval, and a random sampling of other data was validated.

Subsequent to the processing program given in Reference 2, changes were incorporated which printed (on the ASR-33 teletype) selected information which could be compared readily with the previously determined data from the Sierra Probability Analysis. Included in this printout (one time per interval which occurred after each interval processing was completed and during the period where the program was searching for the start of the next interval) were the number, RMS and maximum stress values of wave-induced peak-to-trough stresses recorded during the interval, the number and maximum stress value of first-mode bursts recorded, and the mean value of stress for the interval (relative to the mean value of the first interval of the pass). A typical printout (a 5-pass, 4-voyage tape of SS WOLVERINE STATE data is given in Table IX. These printouts provided the basis for either rerunning the data or the selecting, editing and/or deletion of intervals when the data tapes were combined into the final compacted data tapes.

Correction of logbook data was accomplished either through the editing during preparation of the punched paper tapes or during the editing and compacting of the partially-filled data tapes.

B. Demonstration Examples

The addition of the demonstration examples to the effort provided the opportunity to demonstrate the capability of extracting selected information from the digitized data and to illustrate a variety of comparisons which could be made readily from the many ship years of data accumulated under project SR-153. Using the original data in analogue form would have made such comparisons prohibitively difficult.

All intervals were included in these studies (long intervals as well as the regular once-per-watch intervals) which tends to overemphasize certain conditions. However, for statistical studies it would only be required to determine data from the numbered intervals and not the number-lettered intervals (i.e., read data in Interval 16, but not in 16A). This can be accomplished quite readily within the PARM program by changing an input card (i.e., sort on numbered intervals only).

TABLE IX - DATA PROCESSING PRINTOUT (SS WOLVERINE STATE)

DECTAPE ON 4? TOTAL NO. OF VOYAGES=

04
START OF VOYAGE 1 (WS 192)

INTERVAL NO.	NO. PEAK TO TROUGHS W.I.	NO. PEAK TO TROUGHS 1ST MODE	RMS W.I.	MAX PEAK TO TROUGHS W.I.	MAX PEAK TO TROUGHS 1ST MODE	MEAN VALUE
23	198		315	674		
24	136		631	1290		1864
25	132		616	1305		1807
26	125		788	1764		1735
27	114		1047	1879		1979
28	129		1219	3026		1706
29	103		1305	2782		1764
30	81		1706	3428		1965
31	79		1781	3069		1965
32	112		1620	4044		1965
33	65		1836	3643		1922
34	124		1219	2653		244
35	163		1198	2208		1391
36	146		1606	3786		1778
37	161		1491	3069		1993
38	187		2051	4174		1635
39	165		1879	4245		803
40	130		2160	4690		946
41	89		2108	3858		1348
42	89		2280	5708		1276
43	77		2323	5349		1420
44	90		1807	3758		1348
45	88		2022	5493		1237
46	93		1821	3614		760
47	99		1520	3557		1305
48	73		1979	3600		1434
49	79		1606	3700		1262
50	93		1606	3973		1176
51	77		2806	5551		975
52	80		1821	3313		1090
53	78		1663	4274		1147
54	68		1821	3385		1104
55	73		1463	2624		1004
56	75		1549	3069		918
57	85		1284	2667		588
58	77		1425	2811		487
59	73		1534	2911		745
60	70		1477	2940		674
61	90		946	2094		674
62	70		1204	2266		860
63	77		1147	2452		803
64	76		989	2180		846
65	79		889	1692		1118
66	71		1047	1979		1161
67	66		975	2223		1161
68	67		1118	2208		1176

END OF PASS

TABLE IX-2

MOUNT NEW DECTAPE? N

INTERVAL NO.	NO. PEAK TO TROUGHS W.I.	NO. PEAK TO TROUGHS 1ST MODE	RMS W.I.	MAX PEAK TO TROUGHS W.I.	MAX PEAK TO TROUGHS 1ST MODE	MEAN VALUE
01	66		1063	1979		
02	69		801	1783		278
03	63		507	817		605
04	56		785	1308		736
05	56		523	932		1030
06	104		294	670		1063
07	185		1308	3304		867
08	175		1390	2584		785
09	113		736	1717		1096
10	58		899	1783		1374

END OF PASS 2

**END OF VOYAGE 1

*

TABLE IX-3

MOUNT NEW DECTAPE? N

START OF VOYAGE 2 (WS 216)

INTERVAL NO.	NO. PEAK TO TROUGHS W.I.	NO. PEAK TO TROUGHS 1ST MODE	RMS W.I.	MAX PEAK TO TROUGHS W.I.	MAX PEAK TO TROUGHS 1ST MODE	
01	151		3170	6325		
02	157		2323	5371		-
03	159	1	2539	5709	1939	-
04	153		1646	3909		-
05	159		1785	3709		-
06	127		2016	4801		-
06A	119		2216	4971		-
06B	125		2293	4324		-
07	112		2708	6571		-
07A	118	1	2385	5986	2031	-
07B	120	1	2493	5048	1692	-
08	123		2200	4894		-
09	123		2339	5171		-
10	116		2108	3940		-
11	153	1	2354	5340	2616	-
12	139	1	1906	4093	3016	-
13	153		1769	3447		-
14	142		1616	3278		-
15	156		1692	4386		-
16	135		1539	4348		-
17	131		1462	3847		-
18	125		1462	3232		-
18A	167	9	2693	6325	4940	
18B	153	4	2831	6679	3047	
19	157		2447	5063		
20	154		1769	3816		
21	164		1308	2677		-
22	128		1138	2216		-
23	104		1031	2077		-
24	85		1046	2431		-
25	75		1231	2293		-
26	129		1215	3108		-
27	78		1616	3278		-
28	82		1662	4340		-
29	73		1662	3493		-
30	58		1277	2570		-
31	56		1077	2354		-
32	54		1046	1923		-

END OF PASS 1

**END OF VOYAGE 2

TABLE IX-4

MOUNT NEW DECTAPE? N

START OF VOYAGE 3 (WS-229)

INTERVAL NO.	NO. PEAK TO TROUGHS W.I.	NO. PEAK TO TROUGHS 1ST MODE	RMS W.I.	MAX PEAK TO TROUGHS W.I.	MAX PEAK TO TROUGHS 1ST MODE	MEAN VALUE
01	161		442	961		
02	149		518	1075		- 253
03	157		455	999		63
04	156		404	948		1214
05	150		531	3086		1100
06	145		569	1315		948
07	129		430	885		- 152
08	145		543	1087		- 595
09	127		430	809		- 76
10	116		480	986		948
11	104		493	1037		771
12	96		594	1302		518
13	121		569	1239		- 759
14	119		430	872		- 1506
15	96		581	1075		- 1076
16	114		505	1037		619
17	105		480	1075		657
18	81		569	1252		771
19	111		442	1062		- 772
20	109		417	847		1442
21	77		935	1707		- 1012
22	77		923	1671		276
23	72		1429	2833		341
24	65		1517	4224		177
25	64		1151	2770		- 140
26	81		1075	2403		- 519
27	72		1226	2554		50
28	72		1214	2782		366
29	88		796	1796		493
30	65		973	2023		126
31	70		910	1871		- 924
32	67		822	1479		- 1076
33	77		784	1682		- 557
34	83		822	1998		126
35	67		1011	1884		202
36	67		708	1226		- 51
37	69		708	1479		- 1164
38	70		594	1252		- 532
39	72		594	1163		37
40	89		581	1151		177
41	67		594	1037		50
42	70		505	1037		- 241
43	66		467	923		- 1379
44	54		328	556		- 1050
46	48		189	341		392
47	36		177	215		442
48	45		164	177		- 380
49	63		227	328		- 2062
50	47		265	404		- 1607

END OF PASS 1

**END OF VOYAGE 3

TABLE IX-5

MOUNT NEW DECTAPE? N

START OF VOYAGE 4 (WS 230)

INTERVAL NO.	NO. PEAK TO TROUGHS W.I.	NO. PEAK TO TROUGHS 1ST MODE	RMS W.I.	MAX PEAK TO TROUGHS W.I.	MAX PEAK TO TROUGHS 1ST MODE	MEAN VALUE
01	186		165	330		
02	184		203	406		1131
03	200		457	978		1067
04	189		940	2656		775
05	180		1334	2809		- 382
06	176		1449	3571		- 267
07	190		1321	3050		533
08	183		1614	3711		889
08A	182		1792	4054		915
10	195		1169	2974		533
11	127		775	1817		- 954
12	134		635	1690		- 1399
13	208		788	2008		457
14	196		864	1766		660
15	183		1004	2237		546
16	179		864	1728		457
17	191		886	1919		- 763
18	162		749	1817		- 636
19	189		635	1360		- 280
20	184		699	1499		521
21	174		610	1283		254
22	178		317	699		305
23	174		279	483		- 1094
24	163		241	559		- 1564
25	184		279	571		- 979
26	171		343	737		50
27	205		724	1436		- 89
28	183		877	1804		- 255
29	153		711	1461		- 178
30	106		1830	3635		165
30A	121		2173	4410	2173	508
31	103		1970	3876		699
32	97		1220	1224		597
33	102		889	1830		686
35	89		419	851		- 229
36	94		381	826		- 1907
37	96		279	571		- 1920
38	90		483	953		- 267
39	85		1182	2440		317
40	78		3037	6202		279
41	70		2148	4906		279
42	68		2707	5236		- 217
43	66		2567	5020		- 369
44	65		1118	1982		- 140
45	56		1639	3241		673
46	57		1334	3152		571
47	61		635	1512		- 64
48	50		432	838		- 1310
49	49		381	737		- 1577

END OF PASS 1

**END OF VOYAGE 4

** END OF JOB **

To illustrate the manner in which comparisons can be made, a series of twenty-one examples were made. These are summarized in Table X. Examples 1-8 were intended to illustrate a possible correlation between slamming and the ship or sea conditions which are responsible. Examples 9-15 were intended to illustrate any correlation between the wind direction and the wave-induced stress, and Example 16 was intended to illustrate correlation between observed conditions. Example 17 was intended to identify sea conditions encountered on eastbound North Atlantic runs during the winter months. In that some of the SS WOLVERINE STATE permitted it, (half-bridges recorded separately) the horizontal longitudinal midship bending stress could be determined as well as the vertical longitudinal midship bending stress. Examples 18-21 were intended to retrieve these data to illustrate this possibility.

TABLE X - DEMONSTRATION EXAMPLES

	A		B		C	D	E	F	Identification,		Plot				
Example No.	Primary Sort On	Values Of	Secondary Sort On	Values of	Print (1)	Print (2)	Print (3)	Print (4)	Print (5)	Print (6)	X	Y	No. Points	Summary Tape	See Fig. No.
1	Max. 1st Mode Peak-to-Tro.	22.0 ksi			Max. W.I. Peak-to-Tro.				Tape Ref. No.	Interval No.	A	C	859	Full Bridge	7
2	"	"			Rel. Wave Direction	Rel. Swell Direction			"	"	A	C	843	" "	8
3	"	"			Beaufort Sea State				"	"	C	A	857	" "	9
4	"	"			True Wind Speed				"	"	A	C	652	" "	10
5	"	"			RMS-W.I.				"	"	A	C	859	" "	11
6	"	"			Draft-FWD				"	"	A	C	239	" "	12
7	"	"			Eng. RPM	Eng. RPM Next Int.	Ship Speed	Ship Speed Next Int.	"	"	A	E-F	290	" "	13
8	"	"			Comments				"	"				" "	-
9	Beaufort Sea State	≥4	Rel. Wind Dir.	0≤n≤15°	RMS-W.I.				"	"	A	C	1099	" "	14
10	"	"	"	15°<n≤45°	"				"	"	A	C	1864	" "	15
11	"	"	"	45°<n≤75°	"				"	"	A	C	1021	" "	16
12	"	"	"	75°<n<105°	"				"	"	A	C	393	" "	17
13	"	"	"	105°<n≤135°	"				"	"	A	C	13[illegible]	" "	18
14	"	"	"	135°<n≤165°	"				"	"	A	C	80	" "	19
15	"	"	"	165°<n≤180°	"				"	"	A	C	60	" "	20
16	Beaufort Sea State	≥4			Wave Height				"	"	A	C	4528	" "	21
17	Routing Code	01-05 Only	Date Voyage Start	Oct-Mar	Beaufort Sea State	True Wind Speed			"	"	C	D	1121	" "	22
18	Gage Location	PORT			Rel. Wave Direction	RMS-W.I.			"	"	C	D	1236/1675	Half Bridge	23
19	"	STBD			" "	"			"	"	C	D	868/1521	" "	24
20	"	PORT			Rel. Swell Direction	"			"	"	C	D	862/1356	" "	25
21	"	STBD			"	"			"	"	C	D	678/1296	" "	26

IV. RESULTS

The initial objective of this study has been realized through the processing of all applicable data from the four vessels. The results are evident primarily as the digitized magnetic tape. However, in satisfaction of the requirement that the data be in retrievable form for subsequent evaluation, a series of demonstration examples proved that the required data were actually on the data tapes and in a form suitable for subsequent acquisition of selected information for further study. The results of these illustrative examples were intended only to demonstrate several possible ways in which data can be retrieved and to illustrate possible presentation formats. The scope of the present contract does not include interpretation or utilization of the data from the demonstration examples, nor was there any intent to use these examples to study any particular physical phenomena. The results of the twenty-one examples are given in subsequent paragraphs, but conclusions are drawn only relative to the satisfactory retrieval of data, and not to interpretation or meaning of the result themselves.

The results are presented in two ways; namely, a complete printout of pertinent data, and plots of data (where applicable) for each example. Because of the extensive amount of printout, a complete printout of all examples is not incorporated in this report. Rather a typical printout (for Example 1 as identified on Table X) is shown as Table XI. (Copies of other printouts are available from the Ship Structure Committee.) Included are the identification of ship/voyage/interval of each data point, and the maximum values of first-mode and of wave-induced peak-to-trough stress. These stresses are plotted in Figure 7 as abscissa and ordinate. Figures 8-26 present the results of the remaining examples.

As a consequence of reviewing the results of the demonstration examples, it was obvious that further study would be required to verify the validity of certain of the first-mode data (e.g., Figures 7-13 display several data points at very high apparent first-mode stress levels). Initial investigation indicated that these signals result from spurious transients which have considerable energy in the first-mode frequency filter bandpass. Comparison of a few of the original analogue signals with the corresponding filtered digital signals clearly indicate that noise transients (obviously of significantly differing shape and duration than the first-mode bursts of interest) are faithfully reproduced on the digitized record. The criteria used to determine the first-mode bursts did not discriminate between actual first-mode bursts and the spurious transients and thus listed both. These, in turn, being on the data tapes and summary tapes, were retrieved in the examples. Experience with the first three tape-recorder installations on these vessels indicated that the design of the tape tension arms, the horizontal tape-reel axes, and unsuitable mounting combined to create transients on the data tapes as a result of impact on the vessel or the transport system (for further discussion see Ref. 10). This problem applies only to first-mode data from the SS HOOSIER STATE, the SS MORMACSCAN, the SS CALIFORNIA BEAR, and early data from the SS WOLVERINE STATE. No reservations need be entertained about data other than the first mode.

The results reported herein are based on the information presently contained on the data tapes and the final summary tapes, and no attempt has been made to delete or suppress any information at this time. Each data point has been plotted with an "X" symbol, and in many cases of identical values, overprinting has resulted. No attempt has been made to produce "dot" plots which would show the number of overprints; however, these data are available on the printouts. The number of actual data points plotted on the several figures is included in Table X.

The required data retrieved from the Final Summary tapes were sorted, in most cases, in ascending or descending order of one of the variables before printing or

TABLE XI - PRINTOUT OF EXAMPLE NO. 1

FULL BRIDGE DATA ONLY

CODE 1. MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MAX W.I. P-TO-T

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	MAX 1ST MODE PEAK-TO-TROUGH
183H1-1	01920	800	2000
30MMS1-3	01613D	2350	2000
141H1-5	01601C	2650	2000
31MMS1-5	00606B	3150	2000
139H1-5	02402	3200	2000
175H1-1	00849	3250	2000
139H1-5	02402A	3600	2000
25MMS1-3	02125D	4150	2000
30MMS1-1	02929	4300	2000
175H1-1	01152	4600	2000
30MMS1-3	01109A	5250	2000
163H1-5	06806C	5350	2000
25CB1-4	00606A	5750	2000
217W2-1	00407C	5900	2000
217W2-1	00609A	5900	2000
217W2-1	00508B	6350	2000
161H1-3	04018	6400	2000
163H1-5	06402	6500	2000
211W1-1	01816E	6600	2000
170W2-1	03938	6650	2000
237W1-7	06402F	6700	2000
25CB1-4	00202	7000	2000
175H1-1	02122A	7150	2000
163H1-5	06503D	7350	2000
175H1-3	03118B	7550	2000
31MMS1-1	02824A	8700	2000
25CB1-4	00404A	8800	2000
183H1-1	01516	900	2050
183H1-1	00405	1350	2050
145H1-1	03668	2250	2050
165H1-3	00212	2400	2050
161H1-1	01262	2750	2050
25MMS1-1	03229C	2800	2050
32CB1-3	00201	3150	2050
25MMS1-3	02327B	3600	2050
163H1-1	05449	3800	2050
31MMS1-1	01714E	3800	2050
38MMS1-4	03251	4200	2050
29CB1-3	02724B	4650	2050
32CB1-3	01009E	4800	2050
165H1-3	01727	4850	2050
237W1-10	07508	5000	2050
32CB1-3	01009	5100	2050
217W2-1	00407	5150	2050
217W3-1	01406	5150	2050
25CB1-3	00411	5350	2050
151H1-5	04537E	5650	2050
198W2-1	01818	5650	2050
177H1-1	01549	5800	2050
25MMS1-7	00202A	5850	2050

TABLE XI-2

FULL BRIDGE DATA ONLY

CODE 1. MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MAX W.I. P-TO-T

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	MAX 1ST MODE PEAK-TO-TROUGH
215W1-1	00807A	6000	2050
31MMS1-3	04126C	6050	2050
155H1-1	00765	6400	2050
33CB1-7	03940A	6850	2050
217W4-1	05739	7000	2050
25CB1-7	02003C	7400	2050
174W4-1	00909	8500	2050
34CB1-4	04003B	9250	2050
34CB1-4	03902A	9950	2050
205W1-1	00103	450	2100
141H1-5	03419	950	2100
159H1-1	03731	2200	2100
163H1-5	08321	2200	2100
30MMS1-3	01311C	3500	2100
237W1-10	09125	4000	2100
34CB1-4	04811B	4200	2100
141H1-3	01240A	4250	2100
175H1-1	01255	4650	2100
145H1-1	01043	4750	2100
147H1-5	09010	5250	2100
35CB1-12	03205	5450	2100
178W2-1	03863	5700	2100
151H1-5	04436	5850	2100
29CB1-3	04442A	6050	2100
174W4-1	00505A	6200	2100
170W2-1	01514	6200	2100
237W1-7	06604C	6400	2100
178W2-1	04469A	6500	2100
175H1-3	03017	6650	2100
32CB1-11	05701A	7100	2100
237W1-4	05927E	7300	2100
170W2-1	02726	7700	2100
34CB1-7	06009F	9250	2100
174W2-1	05553	9850	2100
33CB1-8	01004	3600	2150
141H1-3	01543C	3900	2150
31MMS1-1	01111A	3900	2150
32CB1-3	00807D	4350	2150
229W1-4	08230A	4400	2150
143H1-5	01631	4400	2150
25MMS1-3	02529B	4600	2150
151H1-3	00101A	4900	2150
163H1-5	06402A	5000	2150
177H1-1	01348	5100	2150
32CB1-3	01009C	5100	2150
25MMS1-7	00707C	5400	2150
211W1-1	02119	5500	2150
188W2-1	02851E	5600	2150
25CB1-7	03620A	5750	2150
151H1-5	04335A	6150	2150

TABLE XI-3

FULL BRIDGE DATA ONLY

CODE 1. MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MAX W.I. P-TO

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	MAX 1ST MODE PEAK-TO-TROUG
151H1-3	00505A	6500	2150
151H1-3	00303	7050	2150
217W5-1	06102D	7700	2150
29CB1-3	04644A	7850	2150
29CB1-4	05206	8350	2150
174W3-1	04848A	9050	2150
34CB1-7	06110C	10350	2150
183H1-3	04125	1150	2200
183H1-1	00607	1250	2200
163H1-5	04220	1850	2200
139H1-5	02503E	2150	2200
31MMS1-1	01513C	2500	2200
37MMS1-4	03234	3600	2200
163H1-1	05954A	3600	2200
139H1-3	01514	3650	2200
175H1-3	02108	4700	2200
174W4-1	01515	4850	2200
175H1-1	02122D	4950	2200
188W2-1	02344	5500	2200
32CB1-7	04001A	5500	2200
237W1-10	09224	5900	2200
211W1-1	02018D	6150	2200
217W2-1	00508D	6600	2200
34CB1-7	05504D	6750	2200
174W3-1	04545B	6800	2200
217W2-1	00407D	7250	2200
29CB1-4	05408B	7550	2200
237W1-7	06301	7700	2200
34CB1-7	05201F	8800	2200
34CB1-7	06009C	9350	2200
174W2-1	05250	9550	2200
34CB1-7	06110F	9550	2200
25MMS1-5	01514E	10350	2200
139H1-5	04010	2150	2250
26CB1-3	05048	2400	2250
139H1-5	03808C	2900	2250
24MMS1-5	06967	3050	2250
139H1-5	02301B	3100	2250
163H1-1	05651D	3350	2250
183H1-3	02204	3800	2250
25MMS1-3	02428E	3850	2250
175H1-3	02108A	4100	2250
141H1-3	01139C	4450	2250
25MMS1-3	02423B	5350	2250
163H1-5	07008	5600	2250
217W4-1	03920	6050	2250
217W2-1	00811D	6650	2250
217W4-1	03314	6850	2250
151H1-5	04335C	7050	2250
174W2-1	00807A	7250	2250

TABLE XI-4

FULL BRIDGE DATA ONLY

CODE 1. MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MAX W.I. P-TO-T

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	MAX 1ST MODE PEAK-TO-TROUGH
174W3-1	04646A	7400	2250
175H1-3	03017C	7450	2250
163H1-5	06604	7700	2250
174W2-1	05654B	7850	2250
29CB1-3	04644	7950	2250
34CB1-4	04104A	8050	2250
151H1-5	01808	1550	2300
139H1-5	02705A	1800	2300
165H1-3	03040	2250	2300
139H1-3	01617	3700	2300
175H1-1	02728E	4000	2300
32CB1-3	00908E	4450	2300
147H1-5	08403	4450	2300
25MMS1-3	024280	4500	2300
155H1-1	00361	4750	2300
32CB1-3	01110D	4900	2300
190W3-1	01616	5650	2300
25MMS1-7	00606D	5650	2300
145H1-1	03870	6100	2300
151H1-3	004040	6950	2300
237W1-7	063010	7900	2300
34CB1-8	06301C	7950	2300
163H1-5	06503A	8000	2300
197W2-1	03723	8500	2300
25CB1-4	00404B	8550	2300
161H1-1	01615	1500	2350
139H1-5	02705B	1550	2350
175H1-3	03926	2450	2350
31MMS1-1	01513B	2750	2350
175H1-3	04028	2950	2350
141H1-5	03116	2950	2350
139H1-5	02402D	3100	2350
163H1-5	07311	3100	2350
139H1-5	02402B	3250	2350
161H1-1	01666	3300	2350
151H1-5	04234C	3700	2350
25MMS1-7	00707A	4000	2350
151H1-5	01202A	4000	2350
25MMS1-5	00303	4100	2350
147H1-5	08707	4850	2350
175H1-3	03320A	5150	2350
29CB1-3	02724D	5250	2350
34CB1-4	05013A	6200	2350
31MMS1-3	04126A	6400	2350
34CB1-7	059080	6800	2350
174W3-1	04545	6900	2350
197W2-1	03420	7650	2350
149H1-1	01940A	8400	2350
211W1-1	01715D	8950	2350
174W4-1	00101C	9250	2350

TABLE XI-5

FULL BRIDGE DATA ONLY

CODE 1. MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MAX W.I. P-TO-T

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	MAX 1ST MODE PEAK-TO-TROUGH
29CB1-4	05004A	9700	2350
34CB1-7	05302E	9750	2350
183H1-3	04024	950	2400
139H1-5	02503D	2100	2400
163H1-5	07614	2200	2400
151H1-5	04133A	3250	2400
31MMS1-5	00202	3750	2400
38MMS1-4	03857	3750	2400
31MMS1-5	00606D	3850	2400
38MMS1-4	03251B	3950	2400
32CB1-3	00807B	3950	2400
163H1-5	06907	4800	2400
29MMS1-3	01314D	5000	2400
172W2-1	02223	5100	2400
145H1-3	04905	5150	2400
35CB1-12	03104D	5250	2400
155H1-3	00801	5400	2400
217W3-1	01305B	5450	2400
170W2-1	00908	5450	2400
188W2-1	02952	5600	2400
163H1-5	06705	6150	2400
33CB1-8	03927	6200	2400
217W3-1	01103E	6900	2400
231W1-4	02039	7090	2400
172W2-1	05960	7950	2400
25CB1-4	00303F	8050	2400
175H1-1	02122B	8500	2400
29CB1-4	05105	9600	2400
183H1-1	00809	1450	2450
151H1-5	02717	2150	2450
32MMS1-3	04446A	3050	2450
30MMS1-1	00237A	3500	2450
141H1-3	01341E	3650	2450
165H1-3	02131	4100	2450
139H1-3	01718D	4200	2450
31MMS1-5	00606C	4300	2450
161H1-1	00555	4300	2450
163H1-5	07008A	4950	245C
149H1-1	01940	5300	2450
174W4-1	00404B	6000	245C
29CB1-4	05610E	6700	2450
151H1-3	00404A	6950	2450
151H1-3	00505D	7800	2450
174W3-1	04646C	9900	2450
163H1-5	08523	2600	2500
139H1-3	01718A	3850	2500
32CB1-3	01110B	4100	2500
231W1-1	02938	4400	2500
141H1-3	01341B	4600	2500
175H1-3	02714A	4750	2500

TABLE XI-6

FULL BRIDGE DATA ONLY

CODE 1. MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MAX W.I. P-TO-T

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	MAX 1ST MODE PEAK-TO-TROUGH
32CB1-3	00605E	4900	2500
25MMS1-7	00404C	5200	2500
190W3-1	03131	5450	2500
217W4-1	02608	5600	2500
197W3-1	00101	5700	2500
29CB1-3	02825A	5950	2500
34CB1-7	05908A	6050	2500
25MMS1-7	00404	6050	2500
34CB1-7	05706A	6050	2500
35CB1-12	03104C	6100	2500
29CB1-7	03245A	6400	2500
237W1-7	06402C	7450	2500
139H1-5	02301C	2800	2550
163H1-5	07412	2900	2550
25MMS1-3	02327C	3400	2550
163H1-5	07109A	3650	2550
25MMS1-3	01216A	3950	2550
29CB1-3	02623B	4100	2550
28CB1-3	00910D	4400	2550
161H1-1	04852	4600	2550
32CB1-3	01009D	4650	2550
25MMS1-3	02529D	5200	2550
31MMS1-5	00303C	5400	2550
33CB1-8	03826A	5500	2550
198W2-1	00909	5600	2550
29CB1-3	04442B	6200	2550
175H1-3	03118A	7050	2550
29CB1-3	04442C	7200	2550
29CB1-3	01108	7450	2550
35CB1-7	04113E	8200	2550
174W2-1	05351	8300	2550
34CB1-4	03902E	8650	2550
29CB1-4	05004	9600	2550
139H1-5	03909E	2400	2600
141H1-5	02207	2950	2600
147H1-3	07063	3000	2600
30MMS1-3	01311B	3550	2600
25MMS1-1	03229	4350	2600
37MMS1-4	03539	4650	2600
33CB1-7	00363B	5000	2600
151H1-5	04638	5050	2600
215W1-1	01211	5350	2600
211W1-1	02018F	5700	2600
237W1-10	07204A	6150	2600
163H1-5	06503	6900	2600
211W1-1	01311B	7250	2600
29CB1-4	05509A	8350	2600
34CB1-4	05013F	8500	2600
34CB1-4	03902	12600	2600
139H1-5	02503	2600	2650

TABLE XI-7

FULL BRIDGE DATA ONLY

CODE 1. MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MAX W.I. P-TO-T

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	MAX 1ST MODE PEAK-TO-TROUGH
161H1-1	01868	2900	2650
165H1-3	01323	3550	2650
161H1-1	01767	3700	2650
29MMS1-3	01516A	4000	2650
163H1-1	06055	4000	2650
25MMS1-3	02226A	4000	2650
165H1-3	01424	4150	2650
163H1-1	05954B	4450	2650
29CB1-3	02623A	4550	2650
29MMS1-3	01415A	5050	2650
33CB1-7	00262	5200	2650
28CB1-3	00910A	5750	2650
237W1-4	05927	5950	2650
35CB1-12	03104E	6000	2650
34CB1-7	05908B	6650	2650
170W2-1	03736	6700	2650
35CB1-7	04214E	6750	2650
159H1-1	01552	7100	2650
25CB1-4	00404D	8500	2650
174W4-1	00202D	8700	2650
237W1-7	06503A	10150	2650
163H1-5	08624B	2300	2700
139H1-5	02503C	2400	2700
141H1-5	01601A	2700	2700
139H1-5	03909	2900	2700
31MMS1-5	00101	3750	2700
32CB1-3	00908B	3850	2700
165H1-3	03343	4500	2700
31MMS1-5	00505C	5300	2700
163H1-5	06301A	5500	2700
163H1-5	06301B	5650	2700
34CB1-7	05706C	6200	2700
29CB1-4	05509B	6450	2700
34CB1-8	06301E	6750	2700
29CB1-4	05711C	7150	2700
34CB1-7	05504C	7200	2700
34CB1-7	05908C	7500	2700
143H1-3	01429C	7900	2700
35CB1-7	04214	8050	2700
139H1-5	02604C	2050	2750
163H1-5	08725	2600	2750
161H1-1	02171	2800	2750
32CB1-3	00807C	3750	2750
217W4-1	03718	5050	2750
217W3-1	01204F	5400	2750
32CB1-3	00605C	5650	2750
188W2-1	02851B	5700	2750
174W1-1	01215C	8550	2750
217W1-1	00706C	10900	2750
174W4-1	00101	12550	2750

TABLE XI-8

FULL BRIDGE DATA ONLY

CODE 1. MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MAX W.I. P-TO-T

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	MAX 1ST MODE PEAK-TO-TROUGH
139H1-5	02503F	2000	2800
139H1-5	02604D	2250	2800
175H1-3	04028A	3050	2800
139H1-5	03808B	3200	2800
24MMS1-5	03736	3200	2800
161H1-3	02806	3750	2800
31MMS1-5	00404A	4500	2800
32CB1-3	00908D	4600	2800
175H1-3	02714B	4750	2800
217W3-1	01305F	4900	2800
31MMS1-3	04227	4950	2800
31MMS1-5	00404E	4950	2800
165H1-3	03444	5000	2800
217W2-1	00306	5000	2800
33CB1-8	03725A	5150	2800
145H1-1	03062	5200	2800
141H1-3	01240B	5500	2800
30MMS1-1	02727D	5650	2800
147H1-1	01337	6000	2800
29CB1-4	05711B	6150	2800
29CB1-7	02134	6500	2800
34CB1-7	06009A	9250	2800
25CB1-4	00404C	9250	2800
139H1-5	03808	1500	2850
139H1-5	03909A	2500	2850
141H1-5	02510	2600	2850
183H1-3	03417	3000	2850
163H1-5	08927A	3300	2850
175H1-1	02728B	4400	2850
174W2-1	01009	4650	2850
165H1-3	03747	4650	2850
32CB1-3	01110C	4850	2850
163H1-1	06055B	5000	2850
31MMS1-5	00404	5150	2850
30MMS1-1	02828A	5300	2850
25MMS1-7	00707B	5350	2850
25CB1-7	03518B	5650	2850
29CB1-7	05901A	7350	2850
147H1-5	10121B	7350	2850
25CB1-7	01801B	7500	2850
29CB1-3	01209	8400	2850
29CB1-4	05105C	9450	2850
139H1-5	02503A	2550	2900
29MMS1-5	01313B	2600	2900
139H1-3	01920D	2950	2900
31MMS1-5	00606	3750	2900
165H1-3	01525	4500	2900
175H1-3	02815	4850	2900
35CB1-12	03306C	6000	2900
175H1-1	02122C	6900	2900

TABLE XI-9

FULL BRIDGE DATA ONL

CODE 1. MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MA

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	M PE
29CB1-4	05004D	7100	
178W2-1	04065	7150	
211W1-1	01412	7550	
34CB1-7	05403C	8500	
29CB1-4	05307	8950	
151H1-5	04234B	3150	
22MMS1-3	00505	3150	
147H1-1	02751	3600	
217W4-1	05337	4800	
31MMS1-5	00505D	4950	
149H1-1	03152	5100	
165H1-3	04355	5100	
161H1-3	04422	5550	
190W3-1	01515	6650	
25CB1-7	03518E	7750	
29CB1-3	02724C	8500	
29CB1-4	05004E	8750	
141H1-5	02308	3000	
30MMS1-1	02727C	3800	
215W1-1	01312	4100	
32CB1-3	01009B	5150	
198W2-1	02323	5450	
151H1-5	04537C	5550	
231W1-4	02443	5750	
231W1-4	02140	7600	
25CB1-4	00505A	8150	
188W2-1	02750B	8900	
29CB1-4	05105A	8950	
34CB1-7	06009B	9100	
34CB1-4	03801A	10150	
34CB1-4	03902D	11850	
163H1-5	08422A	2800	
155H1-3	00801A	4700	
31MMS1-5	00505	5050	
25MMS1-3	02428A	6000	
215W1-1	01918B	6700	
151H1-3	00608D	7300	
163H1-5	06604A	7300	
29CB1-7	03346	7450	
217W2-1	00609E	7500	
29CB1-4	04903	9650	
34CB1-7	05201D	9850	
141H1-5	03217	1800	
31MMS1-1	01513A	2600	
163H1-1	05651B	3350	
163H1-5	08826	3400	
165H1-3	00313	3450	
25MMS1-3	01216B	3550	
32CB1-3	01110E	3700	
175H1-1	02728D	3900	

TABLE XI-10

FULL BRIDGE DATA ONLY

CODE 1. MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MAX W.I. P-TO-T

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	MAX 1ST MODE PEAK-TO-TROUGH
31MMS1-5	00303A	3900	3100
217W2-1	00306D	4700	3100
172W2-1	02526	5000	3100
151H1-5	04537B	5050	3100
165H1-3	01727A	5250	3100
33CB1-8	03927A	5300	3100
34CB1-7	05605D	5550	3100
35CB1-12	03205E	560C	3100
35CB1-12	03306D	5850	310C
211W1-1	02018C	6350	3100
163H1-5	06402C	6700	3100
32CB1-4	03216E	6900	3100
165H1-3	04456	2300	3150
165H1-3	02434	2950	3150
139H1-5	02402C	3850	3150
165H1-3	00818	3950	3150
32CB1-3	00807A	4500	3150
197W2-1	03925	5850	3150
35CB1-12	03306	5900	3150
175H1-3	03017B	6600	3150
237W1-4	05320A	8400	3150
159H1-1	02966	1000	3200
139H1-5	03808A	2050	3200
163H1-5	07513	2150	3200
145H1-1	02355	2250	3200
25MMS1-3	01216C	3300	3200
30MMS1-3	02118	3500	3200
147H1-1	03458	3600	3200
235W1-4	02628	4000	3200
31MMS1-5	00606E	4450	3200
175H1-1	02728C	4650	3200
30MMS1-1	00237B	4700	3200
33CB1-7	00363A	5050	3200
33CB1-7	00363	5350	3200
203W1-1	03332	5750	3200
175H1-3	03219	6150	3200
30CB1-4	03903A	6200	3200
29CB1-4	05610A	6950	3200
217W1-1	00706B	7350	3200
25MMS1-5	01514D	8350	3200
197W2-1	03521	8400	3200
34CB1-4	04912B	8700	3200
170W2-1	01817	9050	3200
35CB1-7	04012E	9100	3200
163H1-5	08119	1650	3250
141H1-5	01601	2800	3250
139H1-5	03909B	2850	3250
163H1-5	07109B	3350	3250
31MMS1-1	01714A	3400	3250
141H1-3	01139	3600	3250

TABLE XI-11

FULL BRIDGE DATA ONLY

CODE 1. MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MAX W.I. P-TO-T

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	MAX 1ST MODE PEAK-TO-TROUGH
31MMS1-5	00606A	4500	3250
29CB1-7	00417	5450	3250
174W3-1	02829	5600	3250
211W1-1	01816F	6400	3250
29CB1-4	05105D	8800	3250
29CB1-4	04701D	9800	3250
34CB1-4	05114A	11350	3250
163H1-5	08624A	2050	3300
29MMS1-3	01415E	4650	3300
31MMS1-5	00202B	4750	3300
165H1-3	03545	5100	3300
151H1-5	04436A	5800	3300
34CB1-7	05403A	9000	3300
174W2-1	05250A	9200	3300
29CB1-4	04802E	9650	3300
139H1-5	02806	1300	3350
139H1-5	04010A	2050	3350
25MMS1-3	02125C	4800	3350
28CB1-3	00910C	5000	3350
151H1-5	04638B	5900	3350
29CB1-4	05307A	7100	3350
151H1-3	00303B	7750	3350
34CB1-7	05908E	9450	3350
151H1-5	03324	1700	3400
139H1-5	02705E	1750	3400
139H1-5	02604E	1800	3400
163H1-5	08624	2150	340C
29MMS1-5	01313E	2600	340C
38MMS1-4	03756A	3050	3400
29MMS1-3	00506D	3950	3400
32CB1-3	00706A	4650	3400
31MMS1-5	00505B	4750	3400
147H1-3	07770	5050	3400
34CB1-7	05504E	5250	3400
175H1-1	02223A	5350	3400
237W1-4	05118B	5500	3400
29MMS1-3	01314E	5750	3400
175H1-3	01704	5800	3400
35CB1-12	03205C	6050	3400
29CB1-4	05711A	6500	3400
25CB1-7	03518C	6800	3400
174W2-1	04947	8250	3400
34CB1-7	05201	9700	3400
151H1-5	02414	1600	3450
147H1-5	11233	1700	3450
151H1-1	02441A	3200	3450
30MMS1-3	01311A	4000	3450
163H1-5	08927	4050	3450
163H1-1	06055A	4700	3450
151H1-5	03930A	4800	3450

TABLE XI-12

FULL BRIDGE DATA ONLY

CODE 1. MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MAX W.I. P-TO-T

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	MAX 1ST MODE PEAK-TO-TROUGH
30MMS1-1	01246	5000	3450
207W2-1	01819	5550	3450
29MMS1-3	00809A	3150	3500
25MMS1-7	00606B	5150	3500
155H1-1	00664A	6700	3500
151H1-3	00303C	6750	3500
34CB1-7	05302B	8700	3500
34CB1-7	05302A	9250	3500
34CB1-7	05403	9900	3500
29CB1-4	04903D	11100	3500
139H1-5	02907	2050	3550
29MMS1-5	00101A	3900	3550
32CB1-3	01009F	4250	3550
141H1-5	03015	4600	3550
32CB1-3	01009A	5150	3550
151H1-5	04335B	5600	3550
163H1-5	06503B	8400	3550
217W1-1	00908A	9500	3550
235W1-10	01016	1500	3600
147H1-3	05002	3350	3600
175H1-3	03421A	4600	3600
32CB1-7	04102A	5450	3600
25CB1-7	01902C	5700	3600
29CB1-4	05408A	6650	3600
237W1-7	06503D	6900	3600
34CB1-7	05201C	7900	3600
25CB1-4	00202B	9250	3600
151H1-5	01606	1700	3650
29MMS1-3	00506B	3500	3650
31MMS1-5	00505A	4850	3650
172W2-1	02324	5200	3650
211W1-1	01311A	6850	3650
217W2-1	00508A	7150	3650
34CB1-4	03801	9950	3650
34CB1-4	03902C	10900	3650
139H1-5	02806E	2050	3700
139H1-5	02604A	2450	3700
163H1-5	08927B	4050	3700
155H1-3	00801B	4350	3700
163H1-5	06503C	7000	3700
217W2-1	00407A	7100	3700
34CB1-7	05201B	8000	3700
29CB1-4	05206B	11150	3700
29CB1-4	04903B	11500	3700
175H1-3	03825	1700	3750
141H1-5	02409	2950	3750
31MMS1-5	00303D	4850	3750
32CB1-3	00706C	4850	3750
29MMS1-3	01415B	5500	3750
31MMS1-5	00404C	5650	3750

TABLE XI-13

FULL BRIDGE DATA ONLY

CODE 1: MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MAX W.I. P-TO-T

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	MAX 1ST MODE PEAK-TO-TROUGH
217W3-1	01204E	6400	3750
237W1-4	05219	6750	3750
35CB1-7	04113F	9100	3750
29CB1-4	04802A	9750	3750
163H1-5	08826C	3150	3800
163H1-5	08826B	4450	3800
29CB1-4	05307B	7150	3800
29CB1-4	05105B	9950	3800
29MMS1-5	01313A	3450	3850
141H1-3	01341	4250	3850
175H1-1	02728A	4900	3850
35CB1-7	04214F	5100	3850
175H1-3	02815	5700	3850
35CB1-7	04214B	6200	3850
197W2-1	03319	7800	3850
29CB1-4	04903C	10000	3850
29CB1-4	05004B	10650	3850
151H1-1	04966	750	3900
197W2-1	04632	5400	3900
27CB1-4	02709A	5950	3900
34CB1-7	05302F	8000	3900
235W1-10	03545	1250	3950
141H1-5	01601F	1700	3950
141H1-5	01803C	2050	3950
163H1-5	07210	3550	3950
163H1-5	08725D	3900	3950
25MMS1-5	00906B	6050	3950
170W2-1	02322	8150	3950
34CB1-4	05013D	8900	3950
34CB1-4	03801B	12300	3950
27CB1-4	02608	5650	4000
175H1-3	01906	5800	4000
31MMS1-5	00303E	6350	4000
25CB1-7	02003B	6700	4000
29CB1-4	04802B	7400	4000
211W1-1	01412A	8500	4000
34CB1-4	04003A	10650	4000
32CB1-3	00908C	3900	4050
163H1-5	08725B	4000	4050
29MMS1-3	00708A	4100	4050
151H1-3	00910A	4350	4050
163H1-1	05348C	4500	4050
35CB1-7	04113D	6900	4050
29CB1-4	05509C	7450	4050
29CB1-3	04543B	7600	4050
29CB1-4	04701B	8350	4050
29CB1-4	04802D	9500	4050
29MMS1-5	01414B	2650	4100
159H1-1	01148	4350	4100
25MMS1-3	02125A	4450	4100

TABLE XI-14

FULL BRIDGE DATA ONLY

CODE 1. MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MAX W.I. P-TO-T

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	MAX 1ST MODE PEAK-TO-TROUGH
29MMS1-3	01516B	4500	4100
197W2-1	03824	5550	4100
29CB1-4	04701	8000	4100
32CB1-11	05701F	8500	4100
29CB1-4	04802	8750	4100
29MMS1-5	01414E	2800	4150
188W2-1	02447	5000	4150
175H1-3	03320B	5000	4150
149H1-1	02546A	6850	4150
217W2-1	00407E	7550	4150
145H1-1	03264	4200	4200
217W2-1	00609C	9350	4200
211W1-1	01715B	8700	4200
34CB1-7	06110A	11200	4200
151H1-5	03122	2550	4250
25MMS1-3	01115B	3150	4250
25MMS1-3	02226C	4200	4250
172W2-1	06667	5250	4250
27CB1-4	02709	6550	4250
151H1-5	04537A	6750	4250
141H1-5	01702F	1550	4300
139H1-5	02301E	2850	4300
29MMS1-3	00708D	3750	4300
145H1-1	03971B	4100	4300
217W2-1	00407B	4000	4300
175H1-3	03421	4700	4350
174W4-1	00404E	6650	4350
217W4-1	04526A	7500	4350
29CB1-4	04701A	9300	4350
29CB1-4	04802C	10300	4350
34CB1-7	06110B	12300	4350
235W1-10	02837	1550	4400
165H1-3	02939	1900	4400
141H1-5	01702E	1950	4400
235W1-10	01622	3300	4400
217W2-1	00306B	4050	4400
175H1-3	02714	4250	4400
31MMS1-5	00303	4400	4400
35CB1-12	03407A	7150	4400
29CB1-3	02926A	8650	4400
163H1-5	08422	3650	4450
31MMS1-5	00303B	5150	4450
186W3-1	01818	6450	4450
34CB1-7	05403B	8200	4450
172W2-1	06162A	8250	4450
183H1-3	03720	3200	4500
147H1-1	02549	4000	4500
25MMS1-7	00303D	5300	4500
151H1-5	04537	7300	4500
29CB1-7	03245B	8200	4500

TABLE XI-15

FULL BRIDGE DATA ONLY

CODE 1. MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MAX W.I. P-TO-T

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	MAX 1ST MODE PEAK-TO-TROUGH
163H1-5	08826E	3050	4550
29MMS1-3	01415C	4300	4550
30MMS1-1	02828B	6250	4550
34CB1-7	05201A	7750	4550
235W1-10	01521	2100	4600
151H1-1	01391	2350	4600
217W2-1	00306C	4300	4600
139H1-5	02705D	1500	4650
141H1-5	01906	2650	4650
31MMS1-5	00404B	4100	4650
147H1-3	08073	3000	4700
175H1-1	00950A	5050	4700
151H1-5	03526	1800	4750
35CB1-7	04214C	6850	4750
235W1-10	02228	2700	4800
139H1-5	02301D	2900	4800
235W1-4	02224	3500	4800
35CB1-12	03306E	6150	480C
34CB1-4	03902F	9900	4800
29CB1-4	04701E	10300	4800
217W2-1	00306E	5550	4850
174W2-1	05149A	8100	4850
34CB1-7	06110	10000	4850
31MMS1-1	03125D	10650	4850
29MMS1-5	01313C	3300	4900
25MMS1-3	01115A	3600	4900
163H1-1	01254	4300	4900
25MMS1-3	02125B	5300	4900
165H1-3	01020	3950	4950
215W1-1	01918A	4350	4950
25MMS1-7	00404A	4650	5000
163H1-5	06806A	5000	5000
141H1-5	01702B	2050	5050
151H1-5	04436C	5950	5050
235W1-10	02024	2800	5100
235W1-10	01824	3000	5100
32CB1-3	00605A	5050	5100
29CB1-3	04543C	8900	5100
139H1-5	02806A	2050	5150
235W1-10	02634	2250	5150
35CB1-7	04012A	3050	5150
175H1-3	03219A	6250	5150
29CB1-4	05206A	10600	5150
141H1-5	02611	2150	5200
235W1-10	02329	2200	5200
165H1-3	01828	4650	5200
31MMS1-5	00505E	5100	5200
35CB1-12	03407	6350	5200
139H1-5	02604B	2100	5250
174W2-1	00807B	6600	5250

TABLE XI-16

FULL BRIDGE DATA ONLY

CODE 1, MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MAX W.I. P-TO-T

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	MAX 1ST MODE PEAK-TO-TROUGH
151H1-3	00708	7100	5250
174W2-1	05654A	9400	5250
170W2-1	01918A	10300	5250
209W2-1	00102	5050	5300
235W1-10	01723	3700	5350
35CB1-12	03306F	7200	5350
29CB1-4	04701C	10150	5350
34CB1-4	03801C	14650	5350
141H1-5	01702	2100	5450
163H1-5	08826A	3150	5450
217W2-1	00306A	4800	5450
31MMS1-5	00404D	5900	5450
34CB1-7	05302C	10800	5450
141H1-5	01702A	1800	5500
139H1-5	02806F	2000	5500
33CB1-8	03826	5350	5500
235W1-10	00915	1850	5550
141H1-5	03318	1300	5600
170W2-1	02221	8500	5600
165H1-3	00616	3600	5650
163H1-5	08725C	4200	5650
35CB1-7	040128	4850	5650
29CB1-3	04543A	8700	5650
165H1-3	00919	3050	5700
217W4-1	04930A	5850	5700
182W2-1	04356	3950	5750
235W1-10	01925	2650	5800
25MMS1-7	00404D	5500	5800
235W1-10	02533	2500	5850
141H1-5	01601B	2900	5850
163H1-5	08725A	2900	5850
170W2-1	01716	6700	5850
155H1-3	01812	1000	5900
29CB1-4	04903A	8500	5900
151H1-5	04436D	4950	6000
237W1-4	05118A	5600	6000
165H1-3	04254	5900	6000
235W1-10	03140	1750	6050
141H1-3	00230	1150	6100
141H1-5	01702C	1750	6100
25MMS1-7	00505	5050	6100
147H1-5	08302	4150	6300
197W2-1	03218	5900	6300
139H1-5	02604	2150	6400
139H1-5	02705	1800	6500
139H1-5	02705C	2000	6500
139H1-5	03909C	2400	6500
139H1-5	02806D	2050	6550
163H1-5	08826D	3700	6550
174W1-1	00811A	9550	6550

TABLE XI-17

FULL BRIDGE DATA ONLY

CODE 1, MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MAX W.I. P-TO-T

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	MAX 1ST MODE PEAK-TO-TROUGH
139H1-5	02806C	2100	6600
237W1-4	05927A	6200	6400
139H1-5	02806B	2000	6650
151H1-5	011018	3900	6650
235W1-10	02127	2650	6700
235W1-10	02735	1800	6750
235W1-4	02426	4150	6800
175H1-1	01051	4350	6900
141H1-5	01803B	1850	6950
174W2-1	05351A	7600	6950
139H1-5	02604F	2400	7000
139H1-5	02503B	2350	7050
25MMS1-7	00707D	3750	7050
151H1-5	04031	2800	7100
217W4-1	02101A	7050	7100
217W1-1	00908B	12250	7100
235W1-10	02938	1300	7200
141H1-5	02106	2150	7300
235W1-10	02431	2500	7300
141H1-5	01803D	2150	7400
211W1-1	02018E	6650	7500
197W2-1	03622	10350	7550
35CB1-12	03306B	6500	7600
174W2-1	05553A	9700	7600
235W1-10	03241	1150	7650
198W2-1	02020	4050	7750
141H1-3	01543A	4550	7750
29CB1-3	04543	9350	7800
139H1-5	02301	2550	7900
237W1-7	06806B	5900	7900
141H1-5	01601E	2700	8000
31MMS1-3	04126	4800	8050
25MMS1-7	00606C	5550	8100
170W2-1	02019	8200	8200
151H1-5	03425	4200	8250
141H1-5	01702D	2250	9000
25MMS1-7	00606E	5450	9050
139H1-5	03808D	2650	9150
170W2-1	01615	7000	9200
141H1-5	01805E	2500	9450
174W4-1	00202C	9650	9500
141H1-5	01803A	2900	9950
235W1-10	01420	2300	10050
25MMS1-7	00707E	4050	10150
32CB1-3	00706	5500	10200
141H1-5	02914	2100	10250
141H1-5	01601D	2650	10500
25MMS1-7	00202	5600	11000
151H1-5	044369	5650	11150
141H1-5	02005	2550	11950

TABLE XI-18

FULL BRIDGE DATA ONLY

CODE 1, MAX 1ST MODE P-TO-T GREATER 2KSI VERSUS MAX W.I. P-TO-T

VOYAGE I.D.	INTERVAL NO.	MAX WAVE IND. PEAK-TO-TROUGH	MAX 1ST MODE PEAK-TO-TROUGH
32CB1-4	03418C	4900	11600
25MMS1-5	015149	9550	12450
141H1-5	01803	2550	12500
170W2-1	01110	6500	13600
235W1-10	01319	2700	13850
235W1-4	01010	3250	13850
175H1-1	00950	5500	15050
174W3-1	04545C	6850	22200
170W2-1	03837	10650	26850

NUMBER OF DATA POINTS = 859
NUMBER OF DATA POINTS = 859

plotting. This served two purposes; namely, 1) to illustrate a more useful format if further detailed analysis of similar data were anticipated; and 2) provide for more efficient plotting. In some instances (e.g., Examples 18-21) an additional item of data was acquired from the tapes which could be used for further detailed sorting. Typically, each Beaufort Sea State (BSS) value could yield a plot of data, or, as in the cases of Figures 23-26, selected values of BSS could be combined for plotting.

Example 8 does not lend itself readily to plotted presentation, therefore, only the printout has been presented in this report (see Table XII). For illustrative purposes, additional information which could help in evaluation of this type of study has been included in the printout.

Review of Figures 7-26 indicates that, in some instances, definite trends appear. In other instances, no substantial pattern emerges, possibly due to the apparent loss from overprinting data. For a particular detailed analysis, alternate forms of presentation would be worthy of further investigation.

Figures 7 and 8 exhibit clearly the effect of establishing a lower limit (i.e., delete data less than 2.0 Ksi of maximum first-mode stress). It is evident that elimination of the higher first-mode stresses which are attributable to the spurious transients, and replotting of the data, to an expanded scale would improve the visibility. Again, alternate presentation formats should be investigated when performing a detailed analysis.

In Figure 9 is indicated the result of data missing from the logbooks. Data handling within the computer has been prescribed to substitute a value of zero if a data field were left blank. Thus, the indicated high stresses at BSS of zero are in reality an indication of lack of logbook data. The apparent high stresses at BSS of one are attributed to the spurious transients in the first-mode data.

The results given in Figure 12, are indicative of relatively sparse data on draft recorded in the logbooks.

The effect of experiencing first-mode slamming, as evidenced by possible action by the ship captain to change speed, introduces an interesting set of data (Figure 13). While the preponderance of data indicates little, if any, change in speed from one 4-hour period to the next, there does appear to be an incidence of increased speed. Review of the logbooks in these instances indicates some anomalies. In many cases the ship was hove-to when it experienced slamming, but the weather improved sufficiently during the next four hours to permit getting underway.

Figures 14-20, taken collectively, show the obvious trend that beam seas are avoided in heavy weather. Further refinement of these data, as for example, determining the average RMS stress for each BSS might be of benefit in analysis of such data.

Figure 21, as in previous results, does not indicate clearly where the bulk of the data fall due to overprinting of data points. A total of 4,528 data points have been plotted and the tabulation in Table XIII shows the degree of overprinting. From these data, the average observed wave heights have been determined and plotted as filled circles on the figure. The average heights appear quite reasonable, even though certain of the logbook entries are questionable and tend to bias the average (e.g., 16 data points actually recorded as 35 to 40 feet--which are plotted as 38 ft.--result from the inclusion of long intervals). Again, it should be noted that for these examples, all intervals (whether regular or long) are included, and thus tend to skew the statistical sample toward the severe weather conditions.

TABLE XII - PRINTOUT OF EXAMPLE NO. 8

CODE 6. MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2KSI.LIST COMMENTS

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMMENTS
139H1-5	02402	2000	PITCH ROLL MODERAT
139H1-5	02402A	2000	PITCH ROLL MODERAT
183H1-1	01920	2000	
163H1-5	06402	2000	
163H1-5	06503D	2000	HOVE TO
163H1-5	06806C	2000	PITCHING HEAVILY
170W2-1	03938	2000	
217W2-1	00407C	2000	PITCHING HEAVY
217W2-1	005088	2000	PITCHING HEAVY
217W2-1	00609A	2000	
211W1-1	01816E	2000	
237W1-7	06402F	2000	ROLL AND PITCH
25CB1-4	00202	2000	SEAS OVER BOW
25CB1-4	00404A	2000	OCC SLAMMING
25CB1-4	00605A	2000	
30MMS1-1	02929	2000	PITCHING DEEPLY
31MMS1-1	02824A	2000	LABORING HOVE TO
25MMS1-3	02125D	2000	HEAVY PITCHING HEAD
30MMS1-3	01109A	2000	PITCHING MODERATELY
30MMS1-3	01613D	2000	VESSEL ROLLING EASY
31MMS1-5	00606B	2000	PITCHING DEEPLY
175H1-1	02122A	2000	ROLLING YAWING HEA
175H1-1	00849	2000	PITCH MOD ROLL EASY
175H1-1	01152	2000	PITCH HEAVY ROLL
175H1-3	03118B	2000	VESSEL HOVE TO
141H1-5	01601C	2000	SLAMMING
161H1-3	04018	2000	REDUCES SPEED AVOID
195H1-1	00765	2050	PITCHING HEAVILY
177H1-1	01549	2050	
151H1-5	04557E	2050	PITCH HEAVY ROLL EAS
183H1-1	00408	2050	
183H1-1	01516	2050	
163H1-1	05449	2050	ROLLING AND PITCHING
174W4-1	00909	2050	ROLLING PITCH MOD
217W2-1	00407	2050	PITCHING HEAVY
217W3-1	01406	2050	
217W4-1	05759	2050	PITCHING ROLLING HE
198W2-1	01818	2050	PITCH MOD
215W1-1	00607A	2050	
237W1-10	07508	2050	PITCH AND ROLL HEAVY
25CB1-3	00411	2050	
25CB1-7	02003C	2050	
34CB1-4	03902A	2050	
34CB1-4	04003B	2050	
29CB1-3	02724B	2050	
32CB1-3	00201	2050	
32CB1-3	01009	2050	
32CB1-3	01009E	2050	
33CB1-7	03940A	2050	
31MMS1-1	01714E	2050	ICING ON DECK HAT

TABLE XII-2

CODE 8. MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2KSI.LIST COMMENTS

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMMENTS
25MMS1-1	03229C	2050	HEAVY SEAS
25MMS1-3	023278	2050	HEAVY ROLLING MOD LA
25MMS1-7	00202A	2050	ROLLING PITCHING LAB
31MMS1-3	04128C	2050	
38MMS1-4	03251	2050	
145H1-1	03668	2050	PITCHING MODERATE TO
161H1-1	01262	2050	ROLLING PITCHING H
165H1-3	00212	2050	ROLL YAW MOD LY
165H1-3	01727	2050	ROLL PITCH YAW HEAVI
147H1-5	09010	2100	ROUGH
151H1-5	04436	2100	PITCH HEAVY ROLL MOD
159H1-1	03731	2100	ROLL YAW EASY
163H1-5	08321	2100	CLOUDY VESSEL ROLLIN
170W2-1	01514	2100	ROLLING MOD TO HEAV
170W2-1	02724	2100	ROLLING AND PITCH H
205W1-1	00103	2100	
174W2-1	05553	2100	ROLLING PITCH YAW H
174W4-1	00505A	2100	ROLLING PITCH MOD
178W2-1	03863	2100	RED SPEED TO PREVEN
178W2-1	04469A	2100	ROLL PITCH HEAVIL
237W1-4	05927E	2100	
237W1-7	06604C	2100	
237W1-10	09125	2100	
32CB1-11	05701A	2100	ROUGH SEAS
34CB1-4	048118	2100	
34CB1-7	08009F	2100	
35CB1-12	03205	2100	PITCHING HEAVY AT
29CB1-3	04442A	2100	PASSED THROUGH COL
30MMS1-3	01311C	2100	ROLLING PITCHING H
175H1-1	01253	2100	ROLL MOD. PITCH DEEP
175H1-3	03017	2100	ROLL MOD. PITCH DEEP
141H1-3	01240A	2100	PITCH ROLL MOD
141H1-5	03419	2100	RIDING EASILY
145H1-1	01043	2100	PITCH ROLL HEAVILY
143H1-3	01631	2150	PITCHING ROLL MOD
177H1-1	01348	2150	
151H1-3	00101A	2150	PITCHING MODERATELY
151H1-3	00303	2150	ROLL AND PITCHING HE
151H1-3	00505A	2150	PITCH ROLL HEAVILY
151H1-5	04335A	2150	
163H1-5	06402A	2150	
174W3-1	04848A	2150	ROLL PITCH YAW HEAV
217W5-1	06102D	2150	PITCH ROLL HEAVY
185W2-1	02851E	2150	ROLL PITCH MOD TO H
229W1-4	08230A	2150	
211W1-1	02119	2150	
25CB1-7	03620A	2150	PITCHING HEAVY
34CB1-7	06110C	2150	
33CB1-8	01004	2150	
29CB1-3	04644A	2150	PITCHING HEAVILY

TABLE XII-3

CODE 8. MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2KSI.LIST COMMENTS

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMMENTS
29CB1-4	05206	2150	PITCHING HEAVILY RE
32CB1-3	00807D	2150	
32CB1-3	01009C	2150	
31MMS1-1	01111A	2150	
25MMS1-3	02529B	2150	PITCHING VERY HEAVY
25MMS1-7	00707C	2150	ROLLING PITCH HEAV
141H1-3	01543C	2150	OCC. POUND-MOD. PITC
185H1-3	04125	2200	
139H1-3	01516	2200	ITCHING ROLLING H
139H1-5	02503E	2200	PITCH ROLL MOD SOM
183H1-1	00607	2200	
163H1-1	05954A	2200	INCREASING WIND SW
163H1-5	08220	2200	CLOUDY VESSEL ROLLIN
174W2-1	05250	2200	ROLLING PITCH YAW H
174W3-1	04545B	2200	
174W4-1	01515	2200	ROLLING PITCHING EA
217W2-1	004070	2200	PITCHING HEAVY
217W2-1	005080	2200	PITCHING HEAVY
188W2-1	02346	2200	ROLL MOD TO HEAVY
211W1-1	02018D	2200	
237W1-7	06301	2200	
237W1-10	09226	2200	
34CB1-7	05201F	2200	
34CB1-7	05504D	2200	
34CB1-7	04009C	2200	
34CB1-7	06110F	2200	
29CB1-4	05408B	2200	PITCHING HEAVILY RE
32CB1-7	04001A	2200	
31MMS1-1	01513C	2200	ICING OVERALL
37MMS1-4	05296	2200	ROLLING PITCHING D
25MMS1-5	01514E	2200	MOUNTAINOUS SEAS S
175H1-1	02122D	2200	ROLLING YAWING HEA
175H1-3	02108	2200	PITCH MOD. TO HEAVY.
183H1-3	02204	2250	
139H1-5	023018	2250	PITCH ROLL MODERAT
139H1-5	03808C	2250	PITCH ROLL MOD.
139H1-5	04010	2250	PITCHING AND ROLLING
151H1-5	04335C	2250	
165H1-1	036510	2250	ROLLING PITCHING H
163H1-5	06604	2250	VESSEL ROLL PITCH
163H1-5	07008	2250	PITCH YAW MOD LY R
174W2-1	00807A	2250	PITCH HEAVY
174W2-1	056548	2250	ROLLING PITCH YAW H
174W3-1	04646A	2250	ROLL PITCH YAW HEAV
217W2-1	008110	2250	
217W4-1	03314	2250	
217W4-1	03920	2250	PITCHING HEAVY
26CB1-3	05048	2250	
34CB1-4	04104A	2250	
29CB1-3	04644	2250	PITCHING HEAVILY

TABLE XII-4

CODE 8. MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2KSI.LIST COMMENTS

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMMENTS
24MMS1-5	06967	2250	PITCH HEAVY
25MMS1-3	02428B	2250	HEAVY PITCHING
25MMS1-3	02428E	2250	HEAVY PITCHING
175H1-3	02108A	2250	PITCH MOD. TO HEAVY.
175H1-3	03017C	2250	ROLL MOD. PITCH DEEP
141H1-3	01139C	2250	ROLLING MODERATELY
165H1-3	03040	2300	ROLL MOD LY
155H1-1	00361	2300	PITCHING MODERATELY
139H1-3	01617	2300	
139H1-5	02705A	2300	PITCHING AND ROLLING
147H1-5	08403	2300	ROUGH
151H1-3	00404D	2300	ROLLING VIOLENTLY
151H1-5	01808	2300	PITCH ROLL EASY
165H1-5	06503A	2300	HOVE TO
197W2-1	03723	2300	ROLL PITCH MOD TO H
190W3-1	01616	2300	ROLL EASY PITCH MOD
237W1-7	06301B	2300	
25CB1-4	00404B	2300	OCC SLAMMING
34CB1-8	08301C	2300	
32CB1-3	00908E	2300	
32CB1-3	01110D	2300	
25MMS1-3	02428D	2300	HEAVY PITCHING
25MMS1-7	00606D	2300	ROLLING PITCHING H
175H1-1	02728E	2300	ROLLING MOD.
145H1-1	03870	2300	PITCHING ROLLING HEA
149H1-1	01940A	2350	ROUGH
139H1-5	02402B	2350	PITCH ROLL MODERAT
139H1-5	02402D	2350	PITCH ROLL MODERAT
139H1-5	02705B	2350	PITCHING AND ROLLING
147H1-5	08707	2350	ROUGH
151H1-5	01202A	2350	ROLL HEAVY
151H1-5	04234C	2350	ROLLING EASY PITCHIN
163H1-5	07311	2350	ROLLING 30/40 DEG
197W2-1	03420	2350	ROLL PITCH MOD TO H
174W3-1	04545	2350	
174W4-1	00101C	2350	ROLLING PITCH MOD
211W1-1	01715D	2350	
34CB1-4	05013A	2350	
34CB1-7	05302E	2350	
34CB1-7	05908D	2350	
29CB1-3	02724D	2350	
29CB1-4	05004A	2350	PITCHING HEAVILY RE
31MMS1-1	01513B	2350	ICING OVERALL
25MMS1-5	00303	2350	HEAVY PITCHING ROL
25MMS1-7	00707A	2350	ROLLING PITCH HEAV
31MMS1-3	04126A	2350	
161H1-1	01615	2350	ROLLING EASILY
175H1-3	03320A	2350	ROLL PITCH MOD
175H1-3	03926	2350	ROLLING PITCH MOD.
175H1-3	04028	2350	ROLLING PITCH MOD.

TABLE XII-5

CODE 8. MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2KSI.LIST COMMENTS

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMMENTS
141H1-5	03116	2350	ROLLING EASILY PITCH
161H1-1	01666	2350	MODERATE ROLLING
183H1-3	04024	2400	
155H1-3	00801	2400	
139H1-5	02503D	2400	PITCH ROLL MOD SOM
151H1-5	04133A	2400	ROLLING AND PITCHING
163H1-5	06705	2400	VES RUNNING BEFORE
163H1-5	06907	2400	VESSEL ROLLING
163H1-5	07614	2400	VESSEL ROLLING MOD L
170W2-1	00908	2400	
172W2-1	02223	2400	PITCHING AND ROLLIN
172W2-1	05960	2400	ROLLING EASY
217W3-1	01103E	2400	
217W3-1	01305B	2400	
231W1-4	02039	2400	
188W2-1	02952	2400	ROLL PITCH MOD TO HE
25CB1-4	00303F	2400	SEAS OVER BOW
33CB1-8	03927	2400	
35CB1-12	03104D	2400	
29CB1-4	05109	2400	PITCHING HEAVILY RE
32CB1-3	00807B	2400	
29MMS1-3	01514D	2400	ROLLING MOD.
31MMS1-5	00202	2400	VESSEL PITCHING DEEP
31MMS1-5	00606D	2400	PITCHING DEEPLY
38MMS1-4	03251B	2400	
38MMS1-4	03857	2400	
175H1-1	02122B	2400	ROLLING YAWING HEA
145H1-3	04905	2400	ROLLING PITCHING HEA
165H1-3	02131	2450	ROLL PITCH YAW HEAVI
149H1-1	01940	2450	ROUGH
139H1-3	01718D	2450	
151H1-3	00404A	2450	ROLLING VIOLENTLY
151H1-3	00505B	2450	PITCH ROLL HEAVILY
151H1-5	02717	2450	RIDING EASILY
183H1-1	00809	2450	
165H1-5	07008A	2450	PITCH YAW MOD LY R
174W3-1	04646C	2450	ROLL PITCH YAW HEAV
174W4-1	00404B	2450	ROLLING PITCH HEAVY
29CB1-4	05610E	2450	PITCHING MOD RED.
32MMS1-3	04446A	2450	ROLLING PITCHING E
30MMS1-1	00237A	2450	PITCHING MOD.
31MMS1-5	00606C	2450	PITCHING DEEPLY
141H1-3	01341E	2450	PITCH ROLL MOD OCC
161H1-1	00555	2450	
139H1-3	01718A	2500	
163H1-5	08523	2500	O CAST OCC L L RAIN
197W3-1	00101	2500	ROLL PITCH MOD
231W1-1	02938	2500	
217W4-1	02606	2500	ROLL AND PITCHING H
190W3-1	03131	2500	ROLLING PITCHING HE

TABLE XII-6

CODE 8. MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2KSI.LIST COMMENTS

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMMENTS
237W1-7	06402C	2500	ROLL AND PITCH
34CB1-7	05706A	2500	
34CB1-7	05908A	2500	
29CB1-7	03245A	2500	ROLLING HEAVY
35CB1-12	03104C	2500	
29CB1-3	02825A	2500	
32CB1-3	00605E	2500	
32CB1-3	01110B	2500	
25MMS1-7	00404	2500	ROLLING PITCHING H
25MMS1-7	00404C	2500	ROLLING PITCHING H
175H1-3	02714A	2500	PITCH MOD TO HEAVY R
141H1-3	01341B	2500	PITCH ROLL MOD OCC
139H1-5	02301C	2550	PITCH ROLL MODERAT
163H1-5	07109A	2550	PITCHING ROLLING H
163H1-5	07412	2550	ROLLING PITCHING H
174W2-1	05351	2550	ROLLING PITCH YAW H
198W2-1	00909	2550	
34CB1-4	03902E	2550	
33CB1-8	03826A	2550	
28CB1-3	00910D	2550	
29CB1-3	01108	2550	
29CB1-3	02623B	2550	
29CB1-3	04442B	2550	PASSED THROUGH COL
29CB1-3	04442C	2550	PASSED THROUGH COL
29CB1-4	05004	2550	PITCHING HEAVILY RE
32CB1-3	01009D	2550	
35CB1-7	04113E	2550	PITCH AND ROLLING
25MMS1-3	01216A	2550	PITCHING HEAVILY ROL
25MMS1-3	02327C	2550	HEAVY ROLLING MOD LA
25MMS1-3	02529D	2550	PITCHING VERY HEAVY
31MMS1-5	00303C	2550	LIGHT SLAMMING
175H1-3	03118A	2550	VESSEL HOVE TO
161H1-1	04852	2550	HEAVY ROLLING PITC
139H1-5	03909E	2600	PITCHING AND ROLLING
147H1-3	07063	2600	
151H1-5	04638	2600	
163H1-5	06503	2600	HOVE TO
215W1-1	01211	2600	ROLLING AND PITCHIN
211W1-1	01311B	2600	PITCHING HEAVY
211W1-1	02018F	2600	
237W1-10	07204A	2600	
34CB1-4	03902	2600	
34CB1-4	05013F	2600	
33CB1-7	00363B	2600	
29CB1-4	05509A	2600	PITCHING MOD RED.
25MMS1-1	03229	2600	HEAVY SEAS
37MMS1-4	03539	2600	PITCHING HEAVILY
30MMS1-3	01311B	2600	ROLLING PITCHING H
141H1-5	02207	2600	PITCH ROLL MOD
159H1-1	01552	2650	ROLLING PITCHING H

TABLE XII-7

CODE 8. MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2KSI.LIST COMMENTS

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMMENTS
139H1-5	02503	2650	PITCH ROLL MOD SOM
163H1-1	059549	2650	INCREASING WIND SW
163H1-1	06055	2650	RAIN ROLLING AND PIT
170W2-1	03736	2650	ROLLING PITCHING MO
174W4-1	00202D	2650	ROLLING PITCH HEAVY
237W1-4	05927	2650	
237W1-7	06503A	2650	
25CB1-4	00404D	2650	OCC SLAMMING
34CB1-7	05908B	2650	
33CB1-7	00262	2650	
35CB1-12	03104E	2650	
28CB1-3	00910A	2650	
29CB1-3	02623A	2650	
35CB1-7	04214E	2650	PITCH AND ROLLING
29HMS1-3	01415A	2650	N LY STORM
29HMS1-3	01516A	2650	
25HMS1-3	02226A	2650	VESSEL PITCHING LA
161H1-1	01767	2650	MODERATE ROLLING
161H1-1	01868	2650	MODERATE PITCHING
165H1-3	01323	2650	ROLL PITCH MOD LY
165H1-3	01424	2650	ROLL PITCH MOD LY
165H1-3	03343	2700	ROLL AND PITCH HEAVI
143H1-3	01429C	2700	PITCHING ROLL MOD
139H1-5	02503C	2700	PITCH ROLL MOD SOM
139H1-5	03909	2700	PITCHING AND ROLLING
163H1-5	06301A	2700	
163H1-5	06301B	2700	
163H1-5	08624B	2700	P CLOUDY ROLLING MOD
34CB1-7	05504C	2700	
34CB1-7	05708C	2700	
34CB1-7	05908C	2700	
34CB1-8	06301E	2700	
29CB1-4	05509B	2700	PITCHING MOD RED.
29CB1-4	05711C	2700	PITCHING MOD RED.
32CB1-3	00908B	2700	
35CB1-7	04214	2700	PITCH AND ROLLING
31MMS1-5	00101	2700	VESSEL PITCHING HEAV
31MMS1-5	00505C	2700	PITCHING DEEPLY
141H1-5	01601A	2700	SLAMMING
139H1-5	02604C	2750	PITCH ROLL MODERAT
163H1-5	08725	2750	ROLLING EASY
174W1-1	01215C	2750	ROLLING AND PITCHIN
174W4-1	00101	2750	ROLLING PITCH MOD
217W3-1	01204F	2750	
217W4-1	03718	2750	
217W1-1	00706C	2750	ROLLING AND YAWING
188W2-1	02851B	2750	ROLL PITCH MOD TO H
32CB1-3	00605C	2750	
32CB1-3	00807C	2750	
161H1-1	02171	2750	MODERATE PITCHING

TABLE XII-8

CODE 8. MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2KSI.LIST COMMENTS

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMMENTS
165H1-3	03444	2800	ROLL AND PITCH HEAVI
139H1-5	02503F	2800	PITCH ROLL MOD SOM
139H1-5	02604D	2800	PITCH ROLL MODERAT
139H1-5	03808B	2800	PITCH ROLL MOD.
217W2-1	00306	2800	
217W3-1	01305F	2800	
25CB1-4	00404C	2800	OCC SLAMMING
34CB1-7	06009A	2800	
29CB1-7	02134	2800	
33CB1-8	03725A	2800	
29CB1-4	05711B	2800	PITCHING MOD RED.
32CB1-3	00908D	2800	
30MMS1-1	02727D	2800	ROLLING PITCHING MOD
24MMS1-5	03736	2800	PITCHING MOD TO HEAV
31MMS1-3	04227	2800	CONFUSED SEAS SWEL
31MMS1-5	00404A	2800	PITCH. MOD.
31MMS1-5	00404E	2800	PITCH. MOD.
147H1-1	01337	2800	
175H1-3	02714B	2800	PITCH MOD TO HEAVY R
175H1-3	04028A	2800	ROLLING PITCH MOD.
141H1-3	01240B	2800	PITCH ROLL MOD
149H1-1	03062	2800	PITCH MOD ROLLING EA
161H1-3	02806	2800	PITCH ROLL MODERAT
165H1-3	03747	2850	ROLL AND PITCH HEAVE
183H1-3	03417	2850	
139H1-5	03808	2850	PITCH ROLL MOD.
139H1-5	03909A	2850	PITCHING AND ROLLING
147H1-5	10121B	2850	VERY ROUGH VESSEL IN
163H1-1	06055B	2850	RAIN ROLLING AND PIT
163H1-5	08927A	2850	FULL SEA SPEED
174W2-1	01009	2850	PITCH MOD
25CB1-7	01801B	2850	
25CB1-7	03516B	2850	PITCHING
29CB1-3	01209	2850	
29CB1-4	05105C	2850	PITCHING HEAVILY RE
29CB1-7	05901A	2850	PITCHING MOD RED.
32CB1-3	01110C	2850	
30MMS1-1	02828A	2850	ROLLING PITCHING MOD
25MMS1-7	00707B	2850	ROLLING PITCH HEAV
31MMS1-5	00404	2850	PITCH. MOD.
175H1-1	02728B	2850	ROLLING MOD.
141H1-5	02510	2850	PITCH ROLL HEAVILY
139H1-3	01920D	2900	PITCH ROLL MODERAT
139H1-5	02503A	2900	PITCH ROLL MOD SOM
178W2-1	04065	2900	ROLLING PITCHING MO
211W1-1	01412	2900	
34CB1-7	05403C	2900	
35CB1-12	03306C	2900	
29CB1-4	05004D	2900	PITCHING HEAVILY RE
29CB1-4	05307	2900	PITCHING HEAVILY RE

TABLE XII-9

CODE 8. MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2KSI.LIST COMMENTS

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMMENTS
29MMS1-5	01313B	2900	PITCHING DEEPLY
31MMS1-5	00606	2900	PITCHING DEEPLY
175H1-1	02122C	2900	ROLLING YAWING HEA
175H1-3	02815	2900	PITCHING HEAVY
165H1-3	01525	2900	ROLL PITCH YAW HEAVI
165H1-3	04355	2950	ROLL PITCH YAW HEAVI
149H1-1	03152	2950	MOD
151H1-5	04234B	2950	ROLLING EASY PITCHIN
217W4-1	05337	2950	
190W3-1	01515	2950	ROLL EASY PITCH MOD
25CB1-7	03518E	2950	PITCHING
29CB1-3	02724C	2950	
29CB1-4	05004E	2950	PITCHING HEAVILY RE
22MMS1-3	00505	2950	PITCHING MODERATELY
31MMS1-5	00505D	2950	PITCHING DEEPLY
147H1-1	02751	2950	ROUGH
161H1-3	04422	2950	SPEED REDUCED TO AVO
151H1-5	04537C	3000	PITCH HEAVY ROLL EAS
198W2-1	02323	3000	ROLL EASY
231W1-4	02140	3000	HEAVY POUNDING
231W1-4	02443	3000	
188W2-1	02750B	3000	ROLL PITCH MOD TO H
215W1-1	01312	3000	ROLLING AND PITCHIN
25CB1-4	00505A	3000	
34CB1-4	03801A	3000	
34CB1-4	03902D	3000	
34CB1-7	06009B	3000	
29CB1-4	05105A	3000	PITCHING HEAVILY RE
32CB1-3	01009B	3000	
30MMS1-1	02727C	3000	ROLLING PITCHING MOD
141H1-5	02308	3000	PITCH ROLL MOD
155H1-3	00801A	3050	
151H1-3	00606D	3050	HOVE TO STRONG NW GA
163H1-5	06604A	3050	VESSEL ROLL PITCH
163H1-5	08422A	3050	O CAST FOG PATCHES
217W2-1	00609E	3050	
215W1-1	01918B	3050	ROLL MOD
34CB1-7	05201D	3050	
29CB1-7	03346	3050	
29CB1-4	04903	3050	PITCHING HEAVILY
25MMS1-3	02428A	3050	HEAVY PITCHING
31MMS1-5	00505	3050	PITCHING DEEPLY
151H1-5	04537B	3100	PITCH HEAVY ROLL EAS
163H1-1	05651B	3100	ROLLING PITCHING H
163H1-5	06402C	3100	
163H1-5	08826	3100	RED SPD TO PREVENT P
172W2-1	02526	3100	ROLLING HEAVY
217W2-1	00306D	3100	
211W1-1	02018C	3100	
34CB1-7	05605D	3100	

TABLE XII-10

CODE 8, MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2KSI,LIST COMMENTS

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMMENTS
33CB1-8	03927A	3100	
35CB1-12	03205E	3100	PITCHING HEAVY AT
35CB1-12	033060	3100	
32CB1-3	01110E	3100	
32CB1-4	03216E	3100	
31MMS1-1	01513A	3100	ICING OVERALL
25MMS1-3	01216B	3100	PITCHING HEAVILY ROL
31MMS1-5	00303A	3100	LIGHT SLAMMING
175H1-1	02728D	3100	ROLLING MOD.
141H1-5	03217	3100	ROLLING EASILY PITCH
165H1-3	00313	3100	ROLL YAW MOD LY
165H1-3	01727A	3100	ROLL PITCH YAW HEAVI
165H1-3	02434	3150	ROLL PITCH YAW HEAVI
165H1-3	04456	3150	ROLL MOD PITCH HEAVY
139H1-5	02402C	3150	PITCH ROLL MODERAT
197W2-1	03925	3150	ROLLING PITCHING EA
237W1-4	05320A	3150	
35CB1-12	03306	3150	
32CB1-3	00807A	3150	
175H1-3	03017B	3150	ROLL MOD. PITCH DEEP
165H1-3	00818	3150	ROLL PITCH MOD LY
159H1-1	02966	3200	ROLLING EASY
139H1-5	03808A	3200	PITCH ROLL MOD.
163H1-5	07513	3200	VESSEL ROLLING MOD L
170W2-1	01817	3200	POUNDING RED SPEED
197W2-1	03521	3200	ROLL PITCH MOD TO H
203W1-1	03332	3200	PITCHING EASY
217W1-1	00706B	3200	ROLLING AND YAWING
235W1-4	02628	3200	
34CB1-4	04912B	3200	
33CB1-7	00363	3200	
33CB1-7	00363A	3200	
29CB1-4	05610A	3200	PITCHING MOD RED.
30CB1-4	03903A	3200	
35CB1-7	04012E	3200	PITCH MOD
25MMS1-3	01216C	3200	PITCHING HEAVILY ROL
25MMS1-5	01514D	3200	MOUNTAINOUS SEAS S
30MMS1-1	00237B	3200	PITCHING MOD.
30MMS1-3	02118	3200	PITCHING DEEPLY
31MMS1-5	00606E	3200	PITCHING DEEPLY
147H1-1	03458	3200	MODERATE
175H1-1	02728C	3200	ROLLING MOD.
175H1-3	03219	3200	
145H1-1	02355	3200	ROLLING YAWING PITCH
139H1-5	03909B	3250	PITCHING AND ROLLING
163H1-5	07109B	3250	PITCHING ROLLING H
163H1-5	08119	3250	CLOUDY VESSEL ROLLIN
174W3-1	02829	3250	PITCH EASY
211W1-1	01816F	3250	
34CB1-4	05114A	3250	

TABLE XII-11

CODE 8, MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2KSI,LIST COMMENTS

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMMENTS
29CB1-7	00417	3250	PITCHING HEAVILY
29CB1-4	047010	3250	PITCHING HEAVILY
29CB1-4	05105D	3250	PITCHING HEAVILY RE
31MMS1-1	01714A	3250	ICING ON DECK HAT
31MMS1-5	00606A	3250	PITCHING DEEPLY
141H1-3	01139	3250	ROLLING MODERATELY
141H1-5	01601	3250	SLAMMING
165H1-3	03545	3300	ROLL AND PITCH HEAVE
151H1-5	04436A	3300	PITCH HEAVY ROLL MOD
163H1-5	08624A	3300	P CLOUDY ROLLING MOD
174W2-1	05250A	3300	ROLLING PITCH YAW H
34CB1-7	05403A	3300	
29CB1-4	04802E	3300	PITCHING HEAVILY
29MMS1-3	01415E	3300	N LY STORM
31MMS1-5	00202B	3300	VESSEL PITCHING DEEP
139H1-5	02806	3350	STEADY
139H1-5	04010A	3350	PITCHING AND ROLLING
151H1-3	00303B	3350	ROLL AND PITCHING HE
151H1-5	04638B	3350	
34CB1-7	05908E	3350	
28CB1-3	00910C	3350	
29CB1-4	05307A	3350	PITCHING HEAVILY RE
25MMS1-3	02125C	3350	HEAVY PITCHING HEAD
139H1-5	02604E	3400	PITCH ROLL MODERAT
139H1-5	02705E	3400	PITCHING AND ROLLING
147H1-3	0777D	3400	ROUGH
151H1-5	03324	3400	PITCH ROLL EASY
163H1-5	08624	3400	P CLOUDY ROLLING MOD
174W2-1	04947	3400	
237W1-4	05118B	3400	
25CB1-7	03518C	3400	PITCHING
34CB1-7	05201	3400	
34CB1-7	05904E	3400	
35CB1-12	03209C	3400	PITCHING HEAVY AT
29CB1-4	05711A	3400	PITCHING MOD RED.
32CB1-3	00706A	3400	
29MMS1-3	00506D	3400	ROLLING PITCHING H
29MMS1-3	01314E	3400	ROLLING MOD.
29MMS1-5	01313E	3400	PITCHING DEEPLY
31MMS1-5	00505B	3400	PITCHING DEEPLY
36MMS1-4	03756A	3400	
175H1-1	02223A	3400	ROLLING YAWING HEA
175H1-3	01704	3400	PITCH HEAVY, ROLL MO
151H1-1	02441A	3450	ROLLING EASILY
147H1-5	11233	3450	MODERATE
151H1-5	02414	3450	RIDING EASILY
151H1-5	03930A	3450	PITCH MOD ROLL EASY
163H1-1	06055A	3450	RAIN ROLLING AND PIT
163H1-5	08927	3450	FULL SEA SPEED
207W2-1	01819	3450	PITCHING MOD

TABLE XII-12

CODE 8, MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2KSI,LIST COMMENTS

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMMENTS
30MMS1-1	01246	3450	PITCHING HEAVILY R
30MMS1-3	01311A	3450	ROLLING PITCHING M
155H1-1	00664A	3500	PITCHING HEAVILY
151H1-3	00303C	3500	ROLL AND PITCHING HE
34CB1-7	05302A	3500	
34CB1-7	05302B	3500	
34CB1-7	05403	3500	
29CB1-4	04903D	3500	PITCHING HEAVILY
29MMS1-3	00809A	3500	ROLLING PITCHING H
25MMS1-7	00606D	3500	ROLLING PITCHING H
139H1-5	02907	3550	PITCH ROLL MOD.
151H1-5	04335B	3550	
163H1-5	06503B	3550	HOVE TO
217W1-1	00908A	3550	ROLLING YAWING HEAV
32CB1-3	01009A	3550	
32CB1-3	01009F	3550	
29MMS1-5	00101A	3550	VESSEL ROLLING PIT
141H1-5	03015	3550	ROLLING EASILY PITCH
235W1-10	01016	3600	
237W1-7	06503D	3600	
29CB1-4	00202B	3600	SEAS OVER BOW
25CB1-7	01902C	3600	
34CB1-7	05201C	3600	
29CB1-4	05408A	3600	PITCHING HEAVILY RE
32CB1-7	04102A	3600	
147H1-3	05002	3600	MODERATE
175H1-3	03421A	3600	PITCHING MODERATELY
151H1-5	01606	3650	PITCH ROLL MOD.
172W2-1	02324	3650	PITCHING MOD
217W2-1	00508A	3650	PITCHING HEAVY
211W1-1	01311A	3650	PITCHING HEAVY
34CB1-4	03801	3650	
34CB1-4	03902C	3650	
29MMS1-3	00506B	3650	ROLLING PITCHING H
31MMS1-5	00505A	3650	PITCHING DEEPLY
155H1-3	00801B	3700	
139H1-5	02604A	3700	PITCH ROLL MODERAT
139H1-5	02806E	3700	STEADY
163H1-5	06503C	3700	MOVE TO
163H1-5	08927B	3700	FULL SEA SPEED
217W2-1	00407A	3700	PITCHING HEAVY
34CB1-7	05201B	3700	
29CB1-4	04903B	3700	PITCHING HEAVILY
29CB1-4	05206B	3700	PITCHING HEAVILY RE
217W3-1	01204E	3730	
237W1-4	05219	3750	
29CB1-4	04802A	3750	PITCHING HEAVILY
32CB1-3	00706C	3750	
35CB1-7	04113F	3750	PITCH AND ROLLING
29MMS1-3	01415B	3750	N LY STORM

TABLE XII-13

CODE 8, MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2KSI,LIST COMMENTS

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMMENTS
31MMS1-5	00303D	3750	LIGHT SLAMMING
31MMS1-5	00404C	3750	PITCH. MOD.
175H1-3	03625	3750	ROLLING MODERATELY
141H1-5	02409	3750	PITCH ROLL HEAVILY
163H1-5	08826B	3800	RED SPD TO PREVENT P
163H1-5	08826C	3800	RED SPD TO PREVENT P
29CB1-4	05105B	3800	PITCHING HEAVILY RE
29CB1-4	05307B	3800	PITCHING HEAVILY RE
197W2-1	03319	3850	ROLL PITCH MOD TO H
29CB1-4	04903C	3850	PITCHING HEAVILY
29CB1-4	05004B	3850	PITCHING HEAVILY RE
35CB1-7	04214B	3850	PITCH AND ROLLING
35CB1-7	04214F	3850	PITCH AND ROLLING
29MMS1-5	01313A	3850	PITCHING DEEPLY
175H1-1	02728A	3850	ROLLING MOD.
175H1-3	02815	3850	PITCHING HEAVY
141H1-3	01341	3850	PITCH ROLL MOD OCC
151H1-1	04966	3900	RIDING EASILY
197W2-1	04632	3900	PITCH MOD
34CB1-7	05302F	3900	
27CB1-4	02709A	3900	
163H1-5	07210	3950	ROLLING HEAVY LT RAI
163H1-5	08725D	3950	ROLLING EASY
170W2-1	02322	3950	ROLLING HEAVY
235W1-10	03545	3950	
34CB1-4	03801B	3950	
34CB1-4	05013D	3950	
25MMS1-5	00908B	3950	
141H1-5	01601F	3950	SLAMMING
141H1-5	01803C	3950	MOD PITCH ROLLING
211W1-1	01412A	4000	
25CB1-7	02003B	4000	
34CB1-4	04003A	4000	
27CB1-4	02606	4000	
29CB1-4	04802B	4000	PITCHING HEAVILY
31MMS1-5	00303E	4000	LIGHT SLAMMING
175H1-3	01906	4000	PITCHING HEAVILY
151H1-3	00910A	4050	
163H1-1	05348C	4050	ROLLING AND PITCHING
163H1-5	08725B	4050	ROLLING EASY
29CB1-3	04543B	4050	
29CB1-4	04701B	4050	PITCHING HEAVILY
29CB1-4	04802D	4050	PITCHING HEAVILY
29CB1-4	05509C	4050	PITCHING MOD RED.
32CB1-3	00908C	4050	
35CB1-7	04113D	4050	PITCH AND ROLLING
29MMS1-3	00708A	4050	PITCHING HEAVILY ROL
159H1-1	01145	4100	ROLLING PITCH YAWI
197W2-1	03824	4100	ROLL PITCH MOD
32CB1-11	05701F	4100	ROUGH SEAS

TABLE XII-14

CODE 8, MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2KSI,LIST COMMENTS

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMMENTS
29CB1-4	04701	4100	PITCHING HEAVILY
29CB1-4	04802	4100	PITCHING HEAVILY
29MMS1-3	01516B	4100	
29MMS1-5	01414B	4100	PITCHING MOD. TO HEA
25MMS1-3	02129A	4100	HEAVY PITCHING HEAD
149H1-1	02546A	4150	VERY ROUGH
217W2-1	00407E	4150	PITCHING HEAVY
188W2-1	02447	4150	ROLL MOD TO HEAVY
29MMS1-5	01414E	4150	PITCHING MOD. TO HEA
175H1-3	03320B	4150	ROLL PITCH MOD
217W2-1	00609C	4200	
211W1-1	01715B	4200	
34CB1-7	06110A	4200	
145H1-1	03264	4200	PITCH MOD ROLLING EA
151H1-5	03122	4250	PITCHING AND ROLLING
151H1-5	04537A	4250	PITCH HEAVY ROLL EAS
172W2-1	06667	4250	ROLLING PITCHING YA
27CB1-4	02709	4250	
25MMS1-3	01115B	4250	PITCHING HEAVILY
25MMS1-3	02226C	4250	VESSEL PITCHING LA
139H1-5	02301E	4300	PITCH ROLL MODERAT
217W2-1	00407B	4300	PITCHING HEAVY
29MMS1-3	00708D	4300	PITCHING HEAVILY ROL
141H1-5	01702F	4300	PITCHING ROLLING M
145H1-1	03971B	4300	
174W4-1	00404E	4350	ROLLING PITCH HEAVY
217W4-1	04526A	4350	VERY ROUGH SEAS
34CB1-7	06110B	4350	
29CB1-4	04701A	4350	PITCHING HEAVILY
29CB1-4	04802C	4350	PITCHING HEAVILY
175H1-3	03421	4350	PITCHING MODERATELY
165H1-3	02939	4400	ROLL EASY
217W2-1	00306B	4400	
235W1-10	01622	4400	
235W1-10	02837	4400	
35CB1-12	03407A	4400	
29CB1-3	02926A	4400	
31MMS1-5	00303	4400	LIGHT SLAMMING
175H1-3	02714	4400	PITCH MOD TO HEAVY R
141H1-5	01702E	4400	PITCHING ROLLING H
163H1-5	08422	4450	O CAST FOG PATCHES
172W2-1	06162A	4450	ROLLING VERY HEAVY
186W3-1	01818	4450	PITCH HEAVY ROLL MO
34CB1-7	05403S	4450	
31MMS1-5	00303B	4450	LIGHT SLAMMING
183H1-3	03720	4500	
151H1-5	04537	4500	PITCH HEAVY ROLL EAS
29CB1-7	03245B	4500	ROLLING HEAVY
25MMS1-7	00303D	4500	ROLLING HEAVILY
147H1-1	02549	4500	ROUGH

TABLE XII-15

CODE 8, MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMM
163H1-5	08826E	4550	RED SPD T
34CB1-7	05201A	4550	
30MMS1-1	02829B	4550	ROLLING P
29MMS1-3	01415C	4550	N LY STOR
151H1-1	01331	4600	YAWING
217W2-1	00306C	4600	
235W1-10	01521	4600	
139H1-5	02705D	4650	PITCHING
31MMS1-5	00404B	4650	PITCH. MO
141H1-5	01904	4650	PITCHING
147H1-3	08073	4700	MODERATE
175H1-1	00950A	4700	PITCH MOD
151H1-5	03526	4750	YAW EASY,
35CB1-7	04214C	4750	PITCH A
139H1-5	02301D	4800	PITCH R
235W1-10	02228	4800	ROLLING
235H1-4	02224	4800	
34CB1-4	03902F	4800	
35CB1-12	03306E	4800	
29CB1-4	04701E	4800	PITCHIN
174W2-1	05149A	4850	ROLLING
217W2-1	00306E	4850	
34CB1-7	06110	4850	
31MMS1-1	03125D	4850	HOVE TO
183H1-1	01254	4900	
29MMS1-5	01313C	4900	PITCHING
25MMS1-3	01115A	4900	PITCHING
25MMS1-3	02125B	4900	HEAVY PIT
215W1-1	01918A	4950	ROLL MOD
165H1-3	01020	4950	ROLL PI
163H1-5	06806A	5000	PITCHING
25MMS1-7	00404A	5000	ROLLING
151H1-5	04436C	5050	PITCH HEA
141H1-5	01702B	5050	PITCHING
235W1-10	01824	5100	
235W1-10	02026	5100	
29CB1-3	04543C	5100	
32CB1-3	00605A	5100	
139H1-5	02806A	5150	STEADY
235W1-10	02634	5150	
29CB1-4	05206A	5150	PITCHING
35CB1-7	04012A	5150	PITCH H
179H1-3	03219A	5150	
235W1-10	02329	5200	
35CB1-12	03407	5200	
31MMS1-5	00505E	5200	PITCHING
141H1-5	02611	5200	PITCHING
165H1-3	01828	5200	ROLL PITC
139H1-5	02604B	5250	PITCH R
151H1-3	00708	5250	HOVE TO M

TABLE XII-16

CODE 8: MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2KSI.LIST COMMENTS

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMMENTS
170W2-1	01918A	5250	POUNDING RED SPEED
174W2-1	00807B	5250	PITCH HEAVY
174W2-1	05654A	5250	ROLLING PITCH YAW H
209W2-1	00102	5300	ROLLING
235W1-10	01723	5350	
34CB1-4	03801C	5350	
35CB1-12	03306F	5350	
29CB1-4	04701C	5350	PITCHING HEAVILY
163H1-5	08826A	5450	RED SPD TO PREVENT P
217W2-1	00306A	5450	
34CB1-7	05302C	5450	
31MMS1-5	00404D	5450	PITCH. MOD.
141H1-5	01702	5450	PITCHING ROLLING H
139H1-5	02806F	5500	STEADY
33CB1-8	03826	5500	
141H1-5	01702A	5500	PITCHING ROLLING H
235W1-10	00915	5550	
170W2-1	02221	5600	ROLLING HEAVY
141H1-5	03318	5600	ROLLING EASILY NO PI
163H1-5	08725C	5650	ROLLING EASY
29CB1-3	04543A	5650	
35CB1-7	04012B	5650	PITCH MOD
165H1-3	00616	5650	ROLL PITCHING HEAV
217W4-1	04930A	5700	ROLL HEAVY
165H1-3	00919	5700	ROLL PITCH MOD LY
182W2-1	04356	5750	PITCHING EASY
235W1-10	01925	5800	ROLLING AND PITCHIN
25MMS1-7	00404D	5800	ROLLING PITCHING H
163H1-5	08725A	5850	ROLLING EASY
170W2-1	01716	5850	ROLLING MOD TO HEAV
235W1-10	02533	5850	
141H1-5	01601B	5850	SLAMMING
155H1-3	01812	5900	ROLL EASY
29CB1-4	04903A	5900	PITCHING HEAVILY
165H1-3	04254	6000	ROLL MOD LY PITCH HE
151H1-5	04436D	6000	PITCH HEAVY ROLL MOD
237W1-4	05118A	6000	
235W1-10	03140	6050	
25MMS1-7	00505	6100	ROLLING PITCHING H
141H1-3	00230	6100	STEADY
141H1-5	01702C	6100	PITCHING ROLLING H
147H1-5	08302	6300	ROUGH
197W2-1	03218	6300	
139H1-5	02604	6400	PITCH ROLL MODERAT
139H1-5	02705	6500	PITCHING AND ROLLING
139H1-5	02705C	6500	PITCHING AND ROLLING
139H1-5	03909C	6500	PITCHING AND ROLLING
139H1-5	02806D	6550	STEADY
163H1-5	08826D	6550	RED SPD TO PREVENT P
174W1-1	00811A	6550	ROLLING AND PITCHIN

TABLE XII-17

CODE 8. MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2KSI.LIST COMMENTS

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMMENTS
139H1-5	02806C	6600	STEADY
237W1-4	05927A	6600	
139H1-5	02806B	6650	STEADY
151H1-5	01101B	6650	
235W1-10	02127	6700	
235W1-10	02735	6750	
235W1-4	02426	6800	PITCHING MOD
175H1-1	01051	6900	PITCH HEAVILY
174W2-1	05551A	6950	ROLLING PITCH YAW H
141H1-5	01803B	6950	MOD PITCH ROLLING
139H1-5	02604F	7000	PITCH ROLL MODERAT
139H1-5	02505B	7050	PITCH ROLL MOD BOW
25MMS1-7	00707D	7050	ROLLING PITCH HEAV
151H1-5	04031	7100	ROLLING AND PITCHING
217W4-1	02101A	7100	PITCHING HEAVY
217W1-1	00908B	7100	ROLLING YAWING HEAV
235W1-10	02938	7200	
235W1-10	02431	7300	
141H1-5	02106	7300	MOD PITCHING ROLLI
141H1-5	01803D	7400	MOD PITCH ROLLING
211W1-1	02018E	7500	
197W2-1	03622	7550	ROLL PITCH MOD TO H
174W2-1	05553A	7600	ROLLING PITCH YAW H
35CB1-12	03306S	7600	
235W1-10	03241	7650	
198W2-1	02020	7750	PITCH MOD
141H1-5	01543A	7750	OCC. POUND-MOD. PITC
29CB1-3	04543	7800	
139H1-5	02301	7900	PITCH ROLL MODERAT
237W1-7	06806B	7900	
141H1-5	01601E	8000	SLAMMING
31MMS1-3	04126	8050	
25MMS1-7	00606C	8100	ROLLING PITCHING H
170W2-1	02019	8200	POUNDING RED SPEED
151H1-5	03425	8250	PITCH ROLL EASY
141H1-5	01702D	9000	PITCHING ROLLING H
25MMS1-7	00606E	9050	ROLLING PITCHING H
159H1-8	03808D	9150	PITCH ROLL MOD.
170W2-1	01615	9200	ROLLING MOD TO HEAV
141H1-5	01803E	9450	MOD PITCH ROLLING
174W4-1	00202C	9500	ROLLING PITCH HEAVY
141H1-5	01803A	9950	MOD PITCH ROLLING
235W1-10	01420	10050	
25MMS1-7	00707E	10150	ROLLING PITCH HEAV
32CB1-3	00706	10200	
141H1-5	02914	10250	ROLLING EASILY PITCH
141H1-5	01601D	10500	SLAMMING
25MMS1-7	00202	11000	ROLLING PITCHING LAB
151H1-5	04436B	11150	PITCH HEAVY ROLL MOD
141H1-5	02005	11550	PITCHING MOD. ROLL

TABLE XII-18

CODE 8. MAX 1ST MODE PEAK-TO-TROUGH GREATER THAN 2KSI.LIST COMMENTS

VOYAGE I.D.	INTERVAL NO.	MAX 1ST MODE PEAK-TO-TROUGH	COMMENTS
32CB1-4	03418C	11600	
25MMS1-5	01514B	12450	MOUNTAINOUS SEAS S
141H1-5	01803	12500	MOD PITCH ROLLING
170W2-1	01110	13600	ROLL PITCH MOD TO H
235W1-10	01319	13850	
235W1-4	01010	13850	
175H1-1	00950	15050	PITCH MOD ROLL EASY
174W3-1	04545C	22200	
170W2-1	03837	26850	ROLLING PITCHING MO

NUMBER OF DATA POINTS = 859

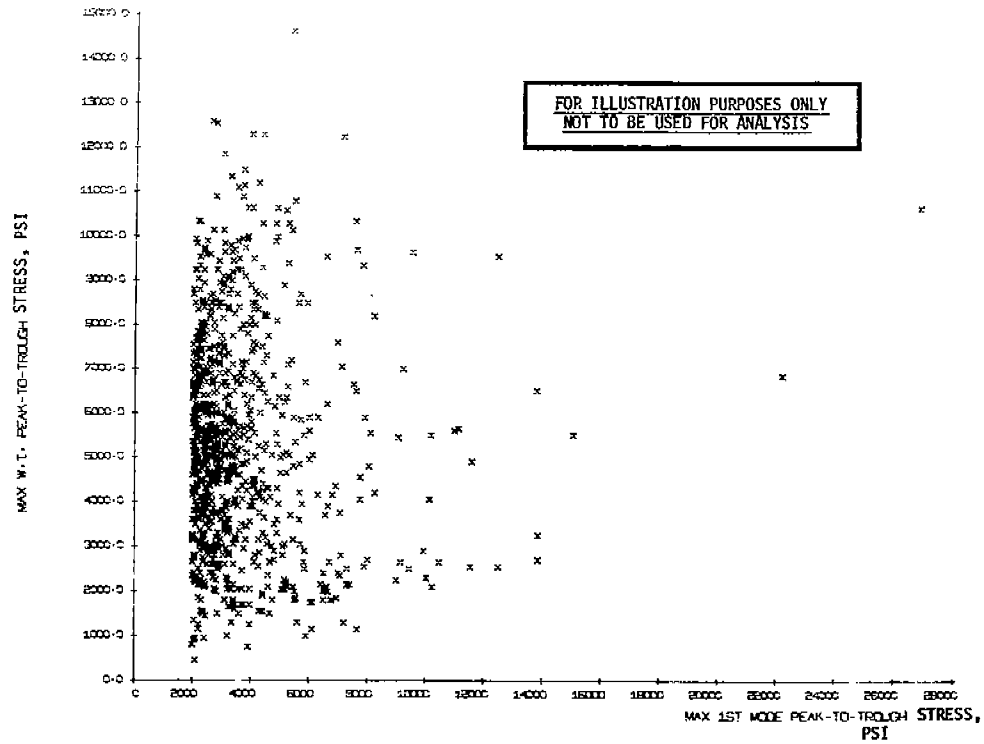


FIGURE 7 - RESULTS OF EXAMPLE NUMBER 1. Code 1, Max 1st Mode P-To-T Greater 2KSI Versus Max W.I. P-To-T

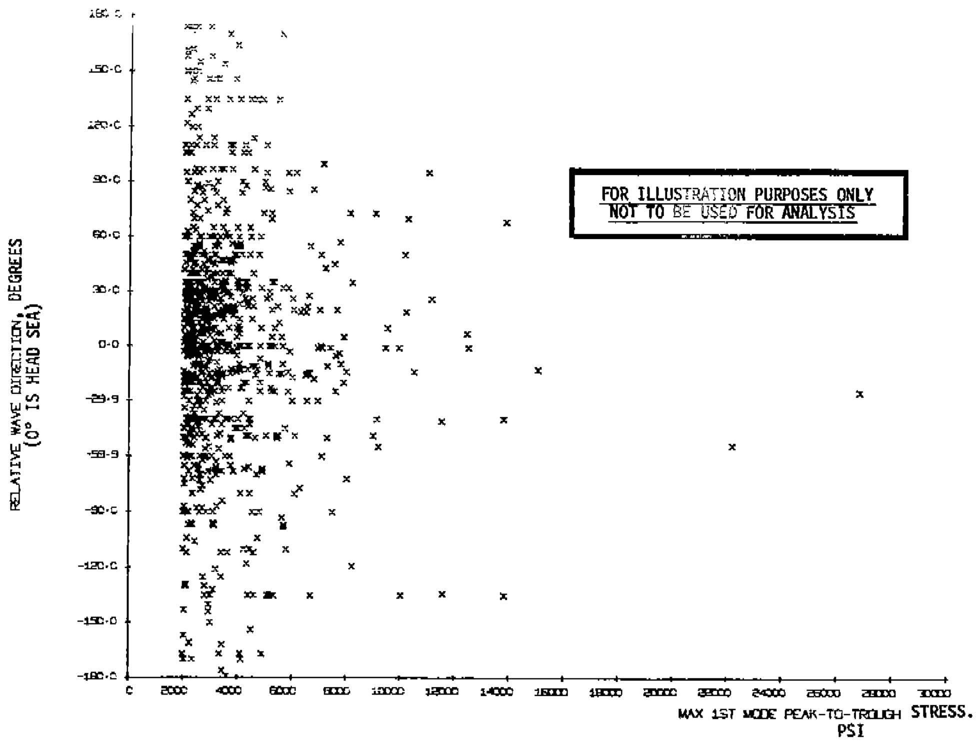


FIGURE 8 - RESULTS OF EXAMPLE NUMBER 2. Code 2, Max 1st Mode P-To-T Greater 2KSI Versus Relative Wave Direction

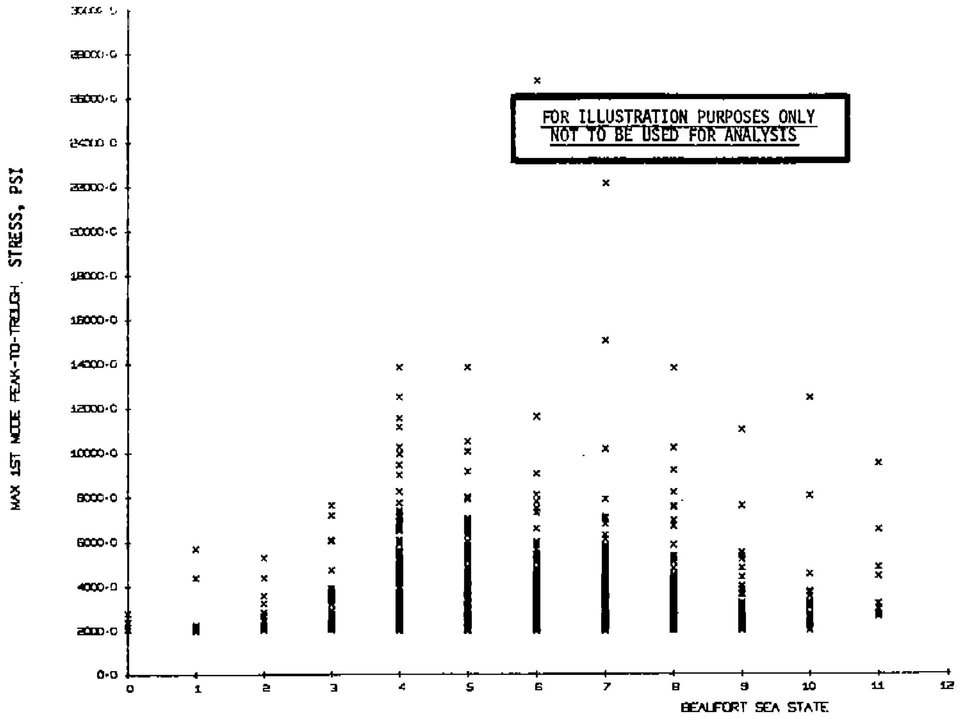


FIGURE 9 - RESULTS OF EXAMPLE NUMBER 3. Code 3, Beaufort Sea State Versus Max 1st Mode P-To-T Greater Than 2KSI

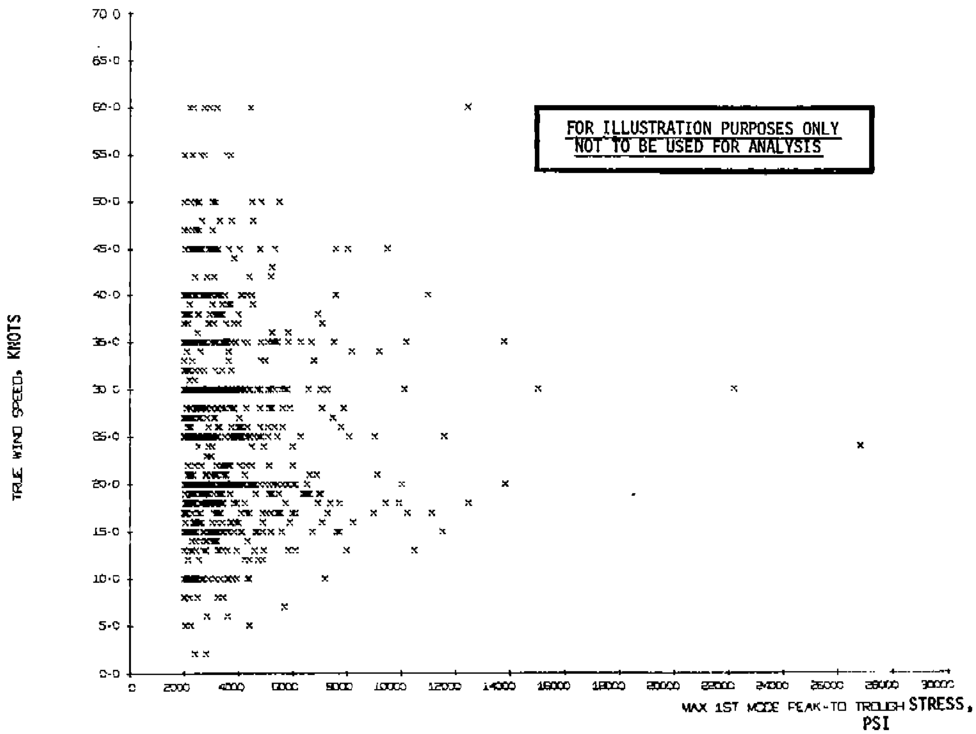


FIGURE 10 - RESULTS OF EXAMPLE NUMBER 4. Code 4, Max 1st Mode P-To-T Greater Than 2KSI Versus True Wind Speed

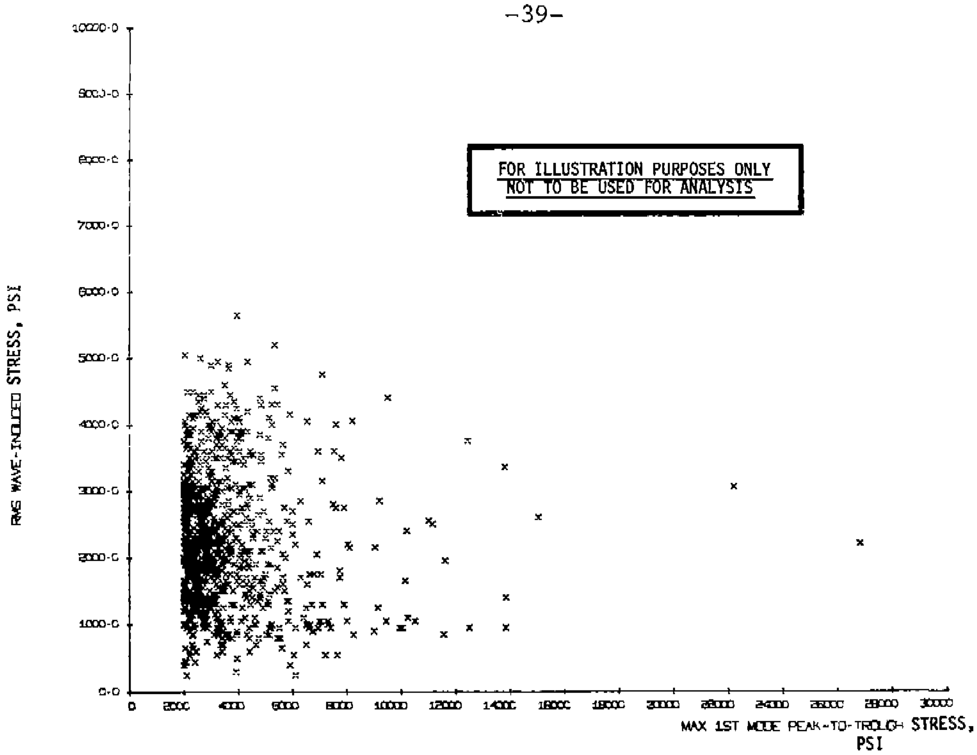


FIGURE 11 - RESULTS OF EXAMPLE NUMBER 5. Code 5, Max 1st Mode P-To-T Greater Than 2KSI Versus RMS Wave Induced

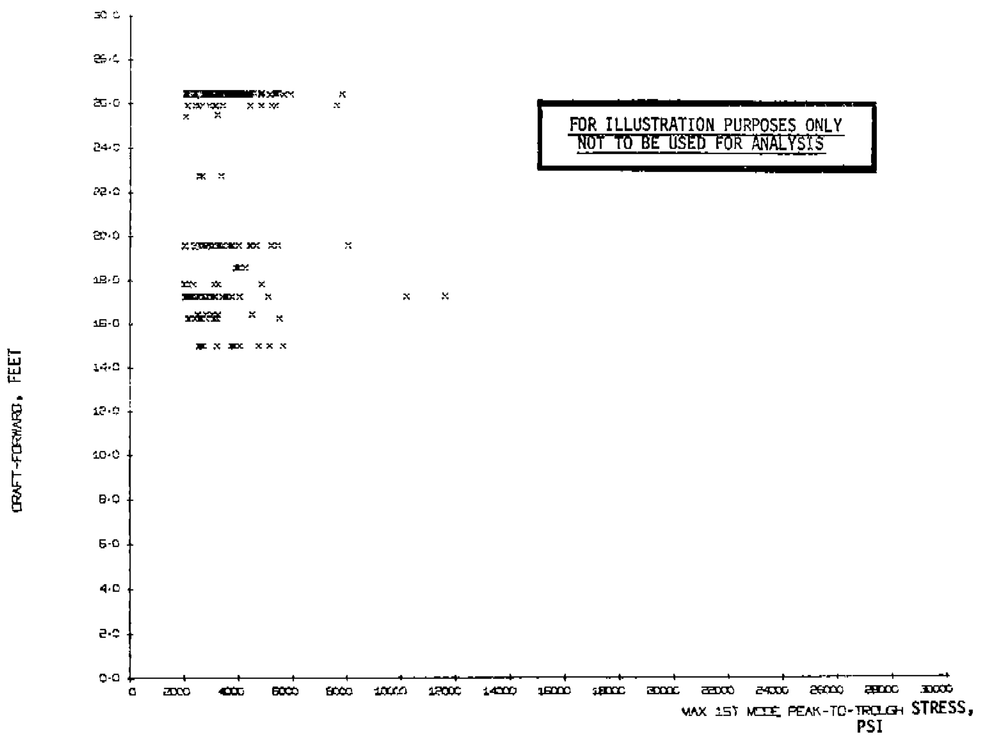


FIGURE 12 - RESULTS OF EXAMPLE NUMBER 6. Code 6, Max 1st Mode P-To-T Greater Than 2KSI Versus Draft Forward

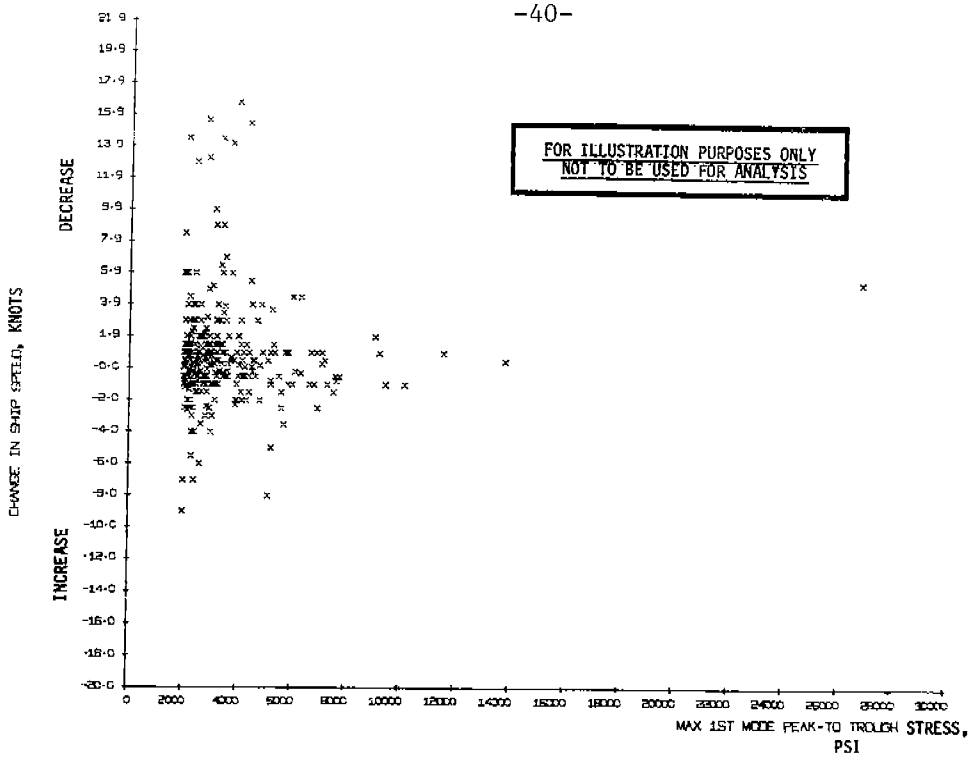


FIGURE 13 - RESULTS OF EXAMPLE NUMBER 7 - Code 7, Max 1st Mode P-To-T Greater 2KSI Versus Change in Ship Speed

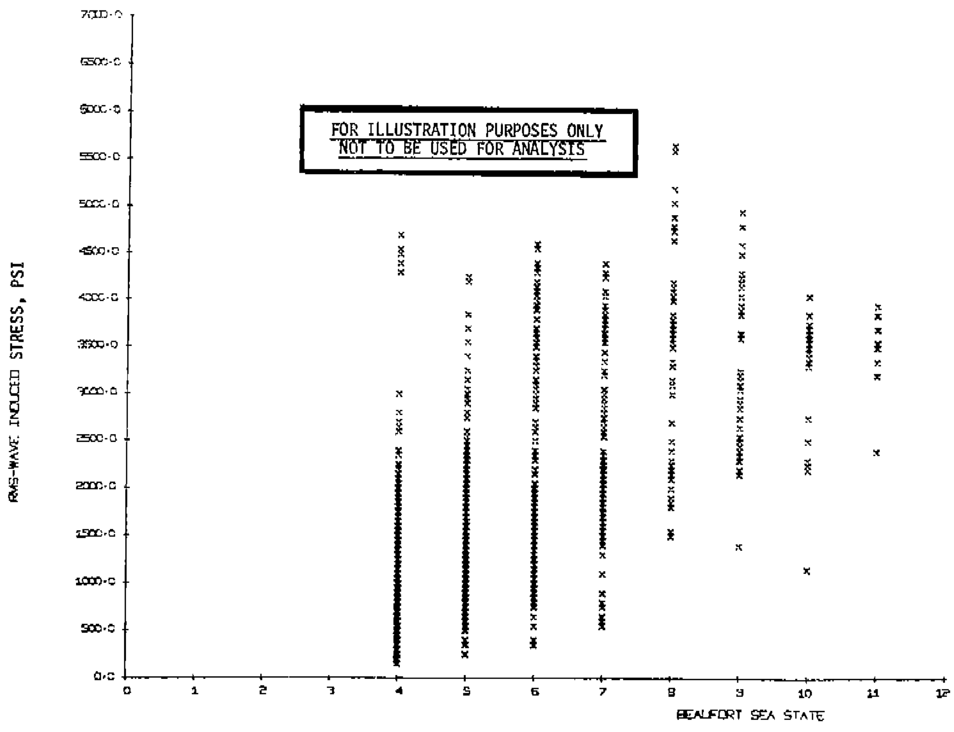


FIGURE 14 - RESULTS OF EXAMPLE NUMBER 9 - RMS WAVE-INDUCED STRESS VS. BSS FOR Relative Wind Direction Greater Than 0, Less Than Or Equal 15, (0^o IS HEAD SEA)

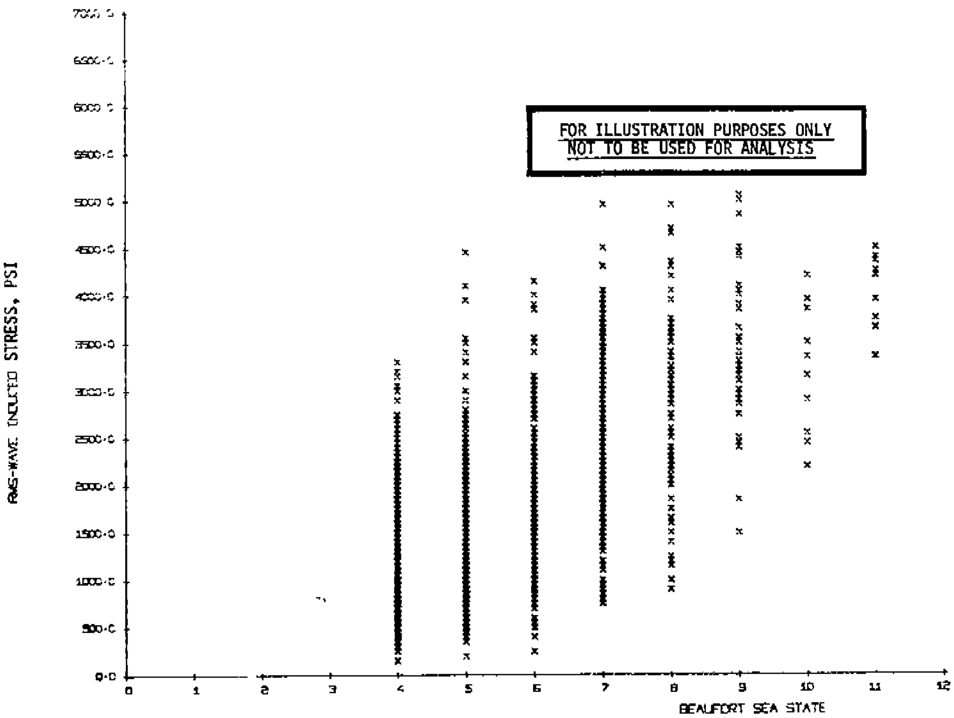


FIGURE 15 - RESULTS OF EXAMPLE NUMBER 10 - RMS WAVE-INDUCED STRESS VS. BSS FOR Relative Wind Direction Greater Than 15, Less Than Or Equal 45, (0° IS HEAD SEA)

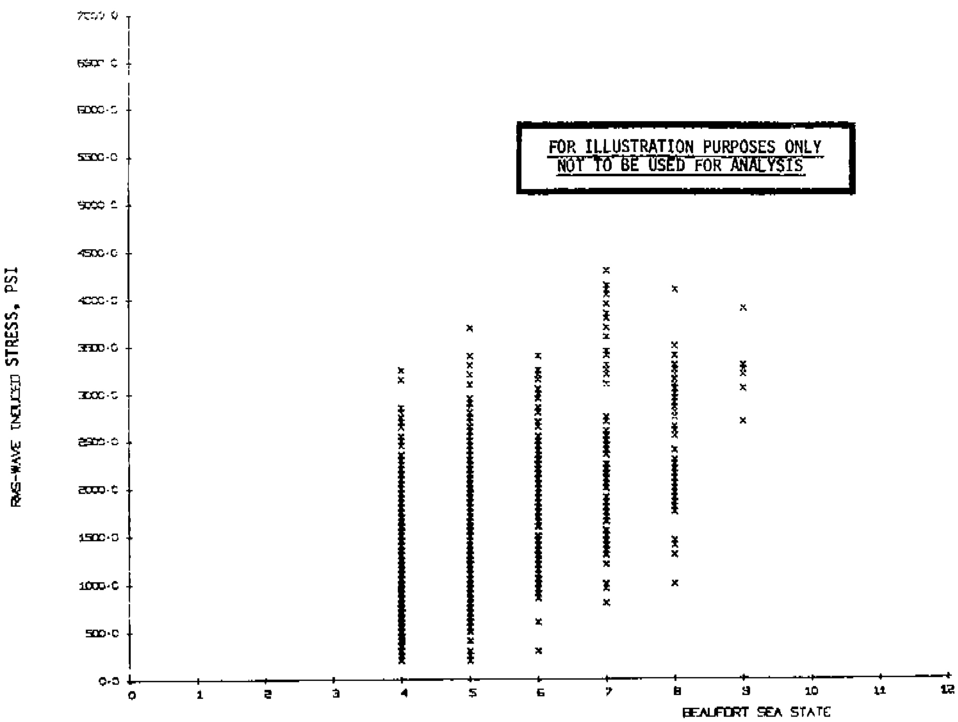


FIGURE 16 - RESULTS OF EXAMPLE NUMBER 11 - RMS WAVE-INDUCED STRESS VS. BSS FOR Relative Wind Direction Greater Than 45, Less Than Or Equal 75, (0° IS HEAD SEA)

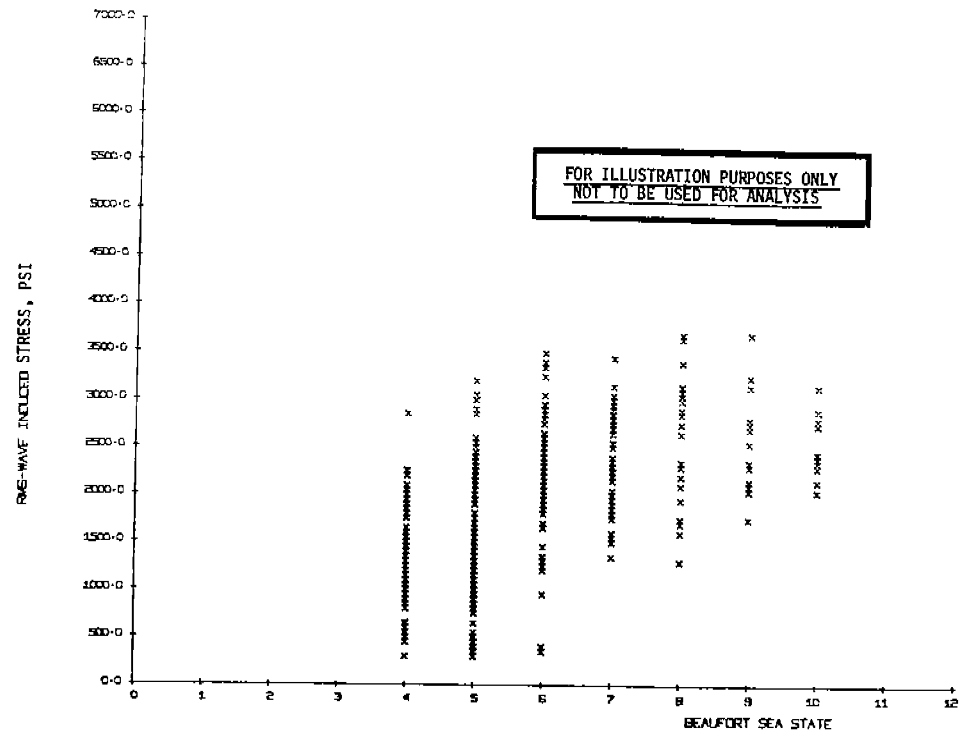


FIGURE 17 - RESULTS OF EXAMPLE NUMBER 12 - RMS WAVE-INDUCED STRESS VS. BSS FOR Relative Wind Direction Greater Than 75, Less Than Or Equal 105, BSS Greater 04 (0^o IS HEAD SEA)

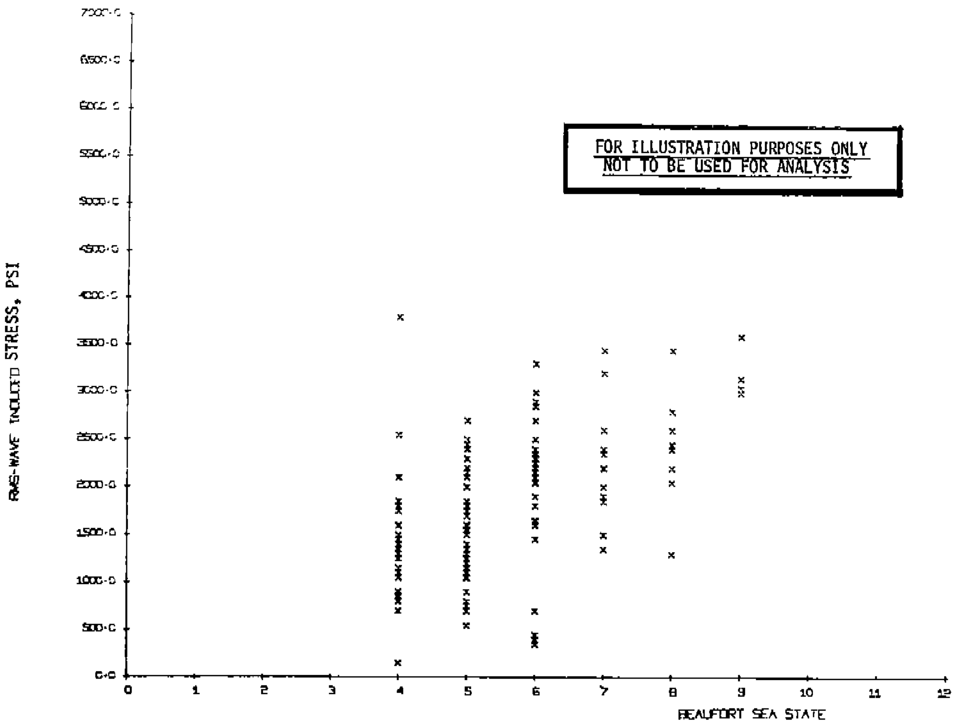


FIGURE 18 - RESULTS OF EXAMPLE NUMBER 13 - RMS WAVE-INDUCED STRESS VS. BSS FOR Relative Wind Direction Greater Than 105, Less Than Or Equal 135, (0^o IS HEAD SEA)

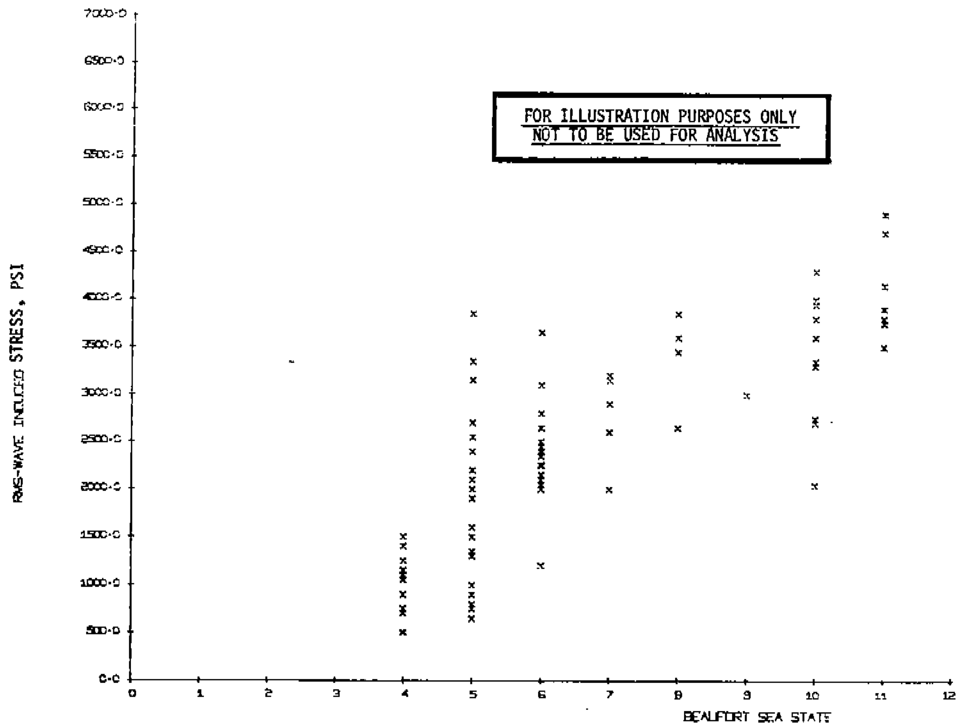


FIGURE 19 - RESULTS OF EXAMPLE NUMBER 14 - RMS WAVE-INDUCED STRESS VS. BSS FOR Relative Wind Direction Greater Than 135, Less Than Or Equal 165, (0° IS HEAD SEA)

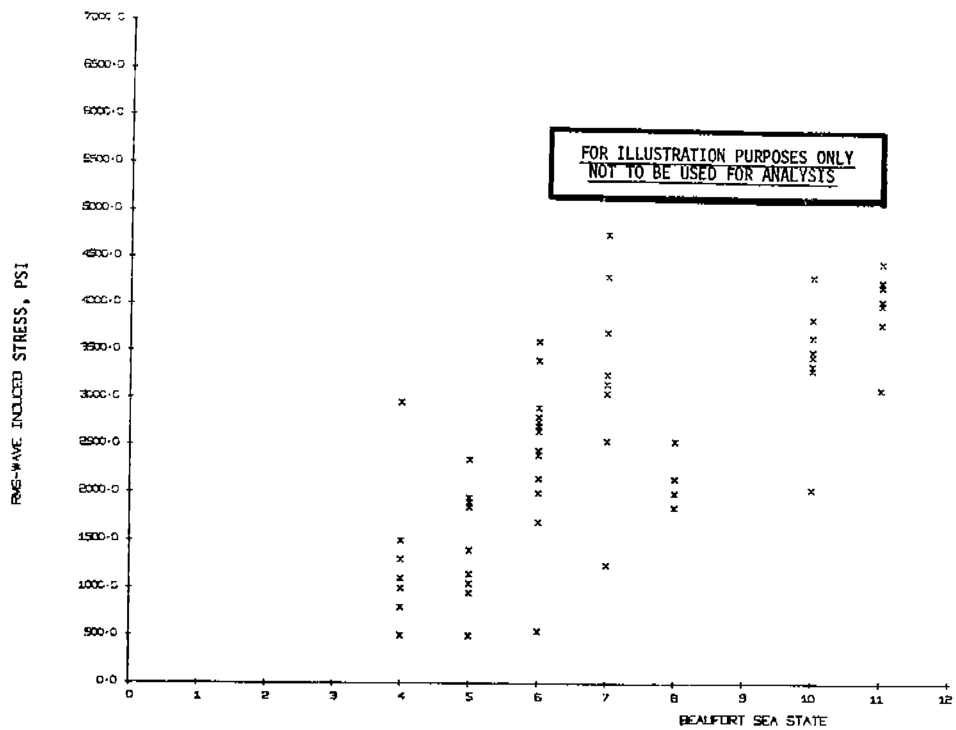


FIGURE 20 - RESULTS OF EXAMPLE NUMBER 15 - RMS WAVE-INDUCED STRESS VS. BSS FOR Relative Wind Direction Greater Than 165, Less Than Or Equal 180, (0° IS HEAD SEA)

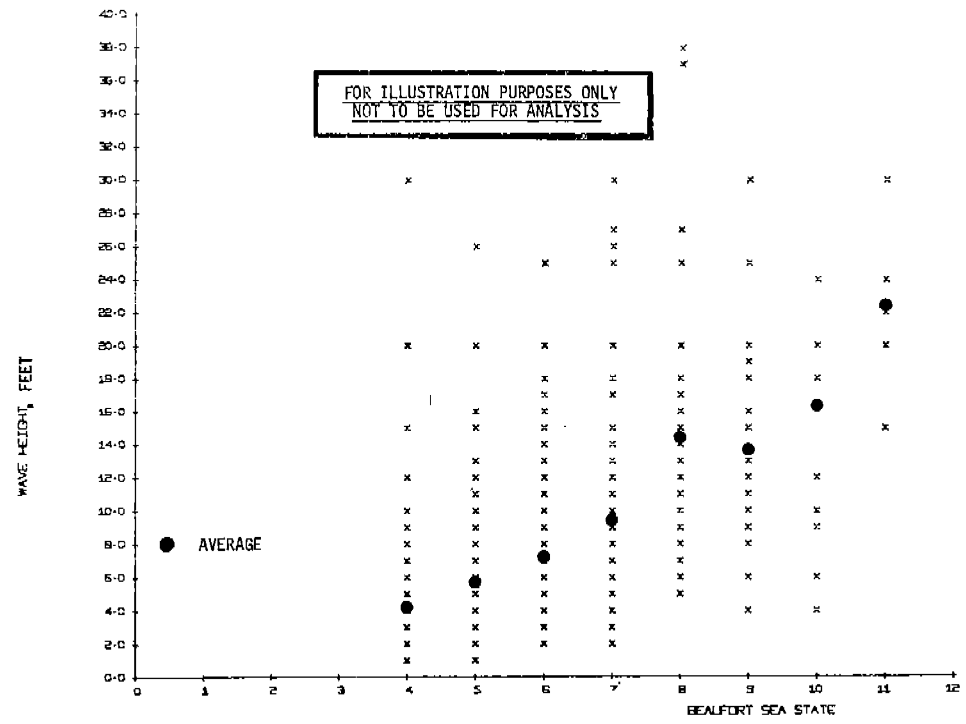


FIGURE 21 - RESULTS OF EXAMPLE NUMBER 16 - Code 16, Beaufort Sea State Vers. Wave Height, All Relative Wind Directions

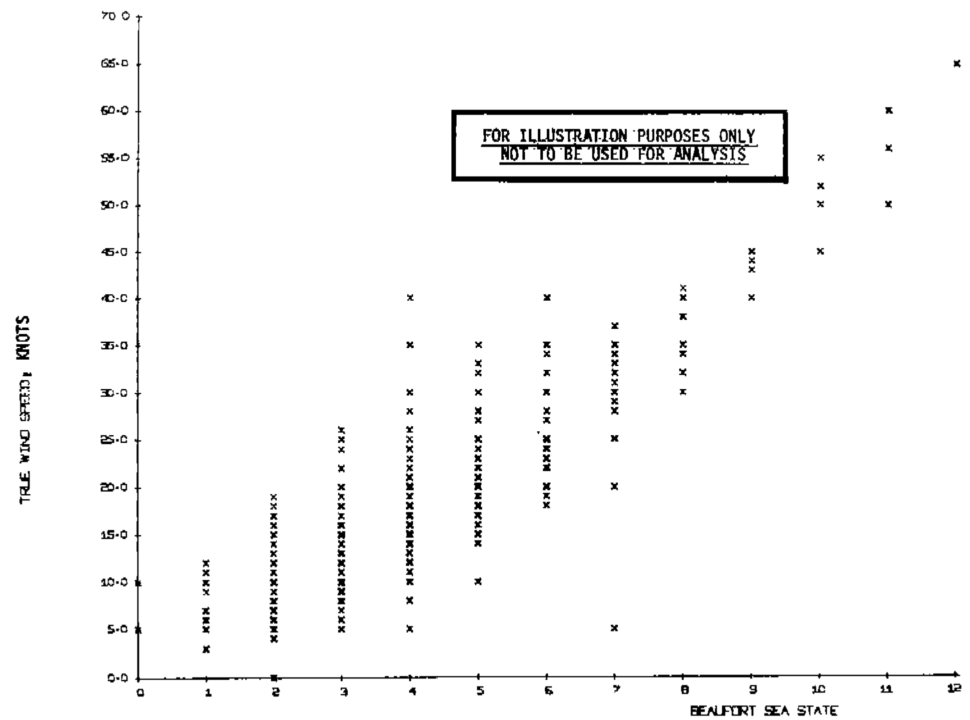


FIGURE 22 - RESULTS OF EXAMPLE NUMBER 17 - Code 17, Routing Code 01-05 Only, Date Voyage Starts, Oct to Mar Only

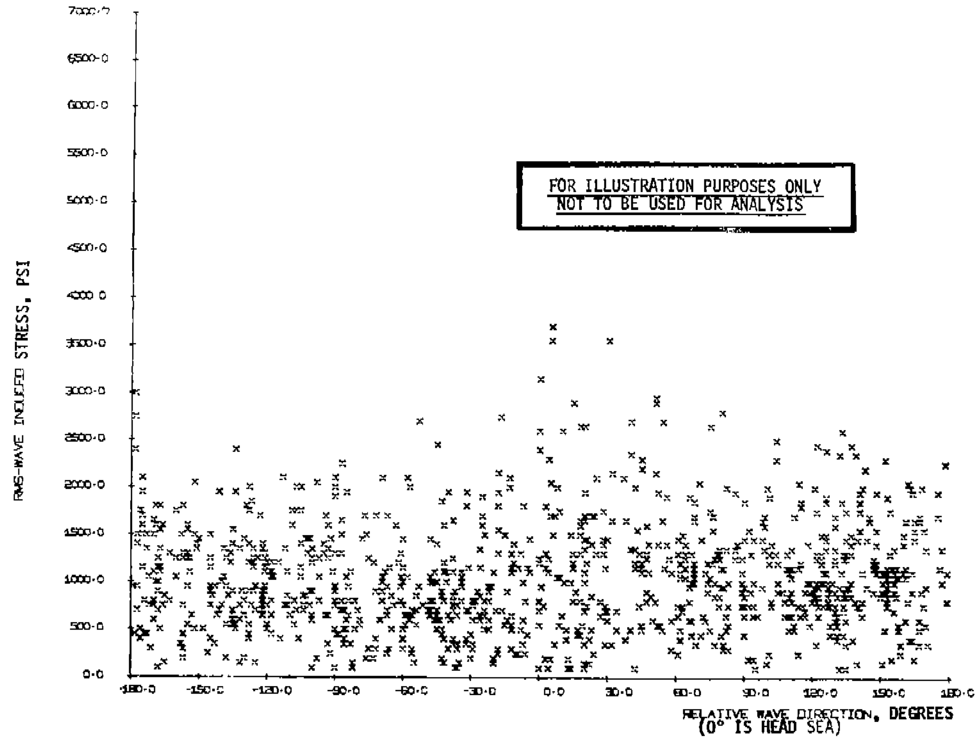


FIGURE 23a - RESULTS OF EXAMPLE NUMBER 18 (Beaufort Sea State 0-3) - Code No.18, Relative Wave Direction Versus RMS-Wave Induced (PORT GAGE)

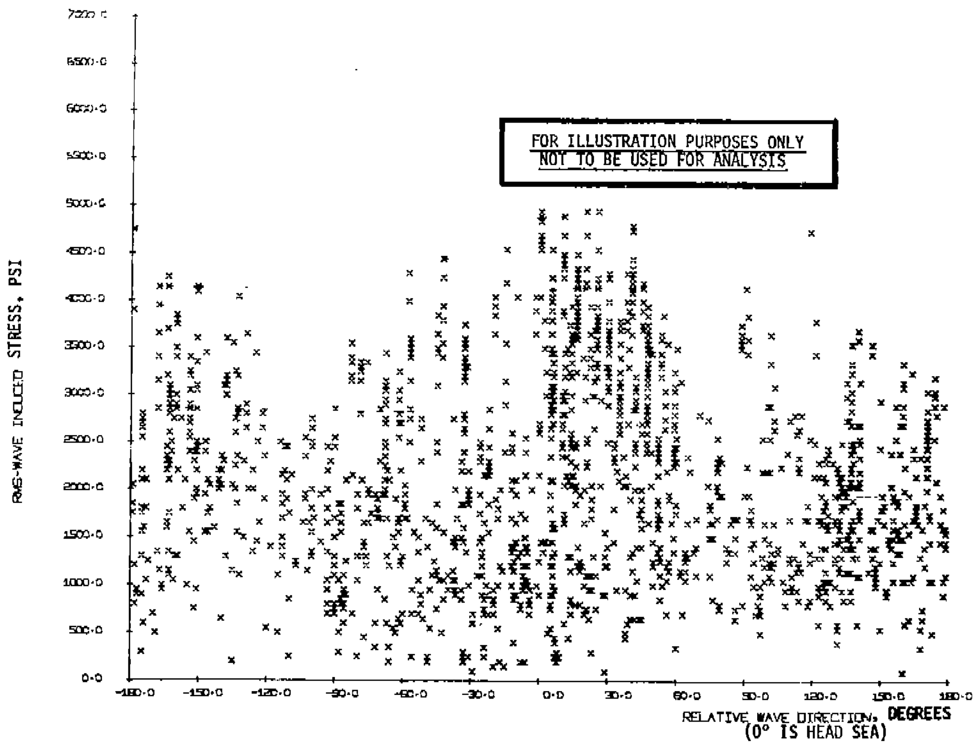


FIGURE 23b - RESULTS OF EXAMPLE NUMBER 18 (Beaufort Sea State 4-12) - Code No.18, Relative Wave Direction Versus RMS-Wave Induced (PORT GAGE)

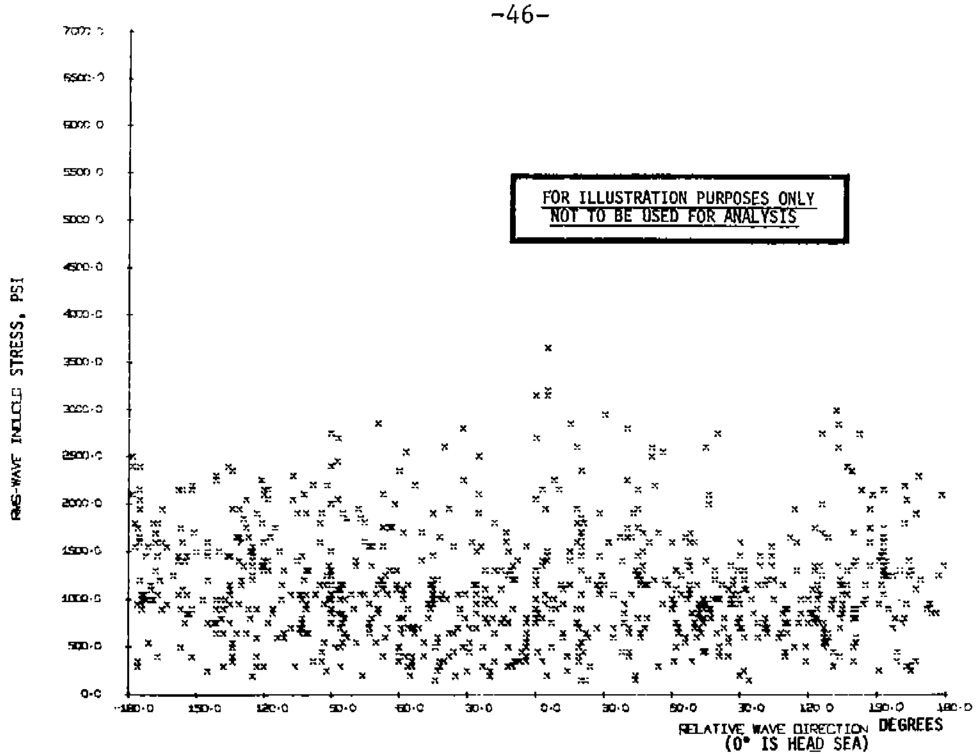


FIGURE 24a - RESULTS OF EXAMPLE NUMBER 19 (Beaufort Sea State 0-3) - Code No.19, Relative Wave Direction Versus RMS-Wave Induced (STBD. GAGE)

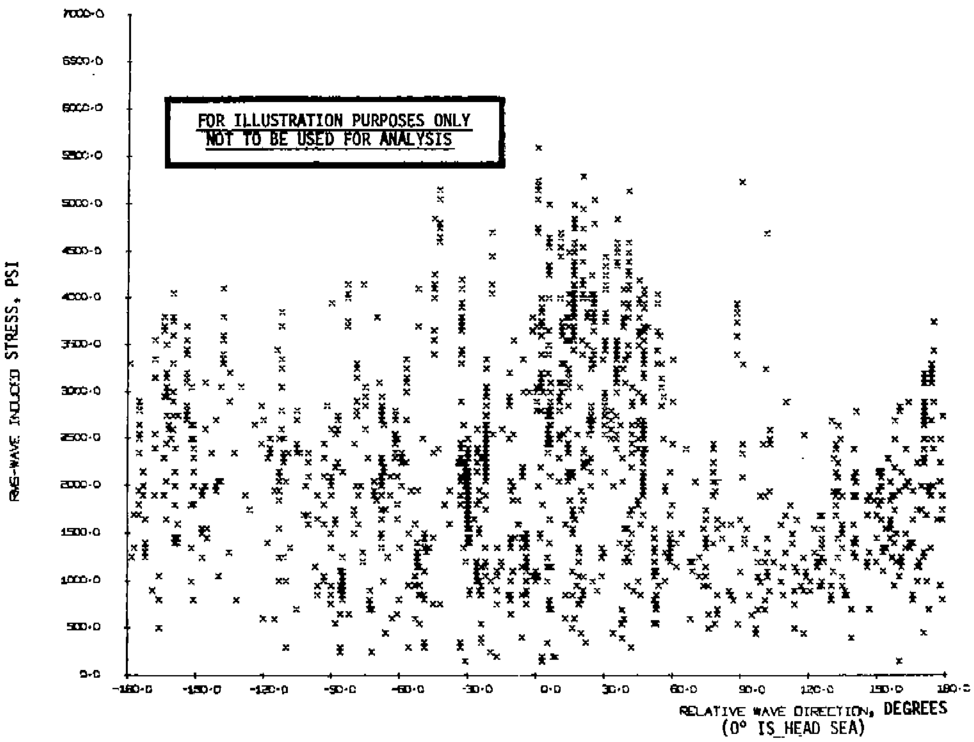


FIGURE 24b - RESULTS OF EXAMPLE NUMBER 19 (Beaufort Sea State 4-12) - Code No.19, Relative Wave Direction Versus RMS-Wave Induced (STBD GAGE)

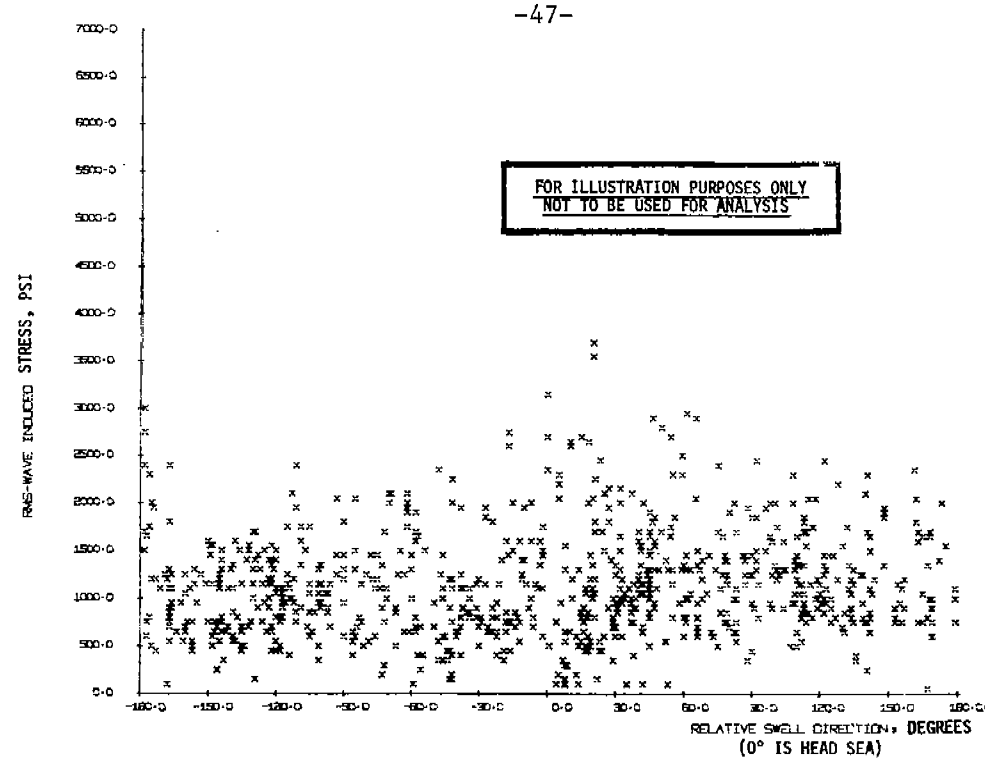


FIGURE 25a - RESULTS OF EXAMPLE NUMBER 20 (Beaufort Sea State 0-3) - Code No. 20, Relative Swell Direction Versus RMS-Wave Induced (PORT GAGE)

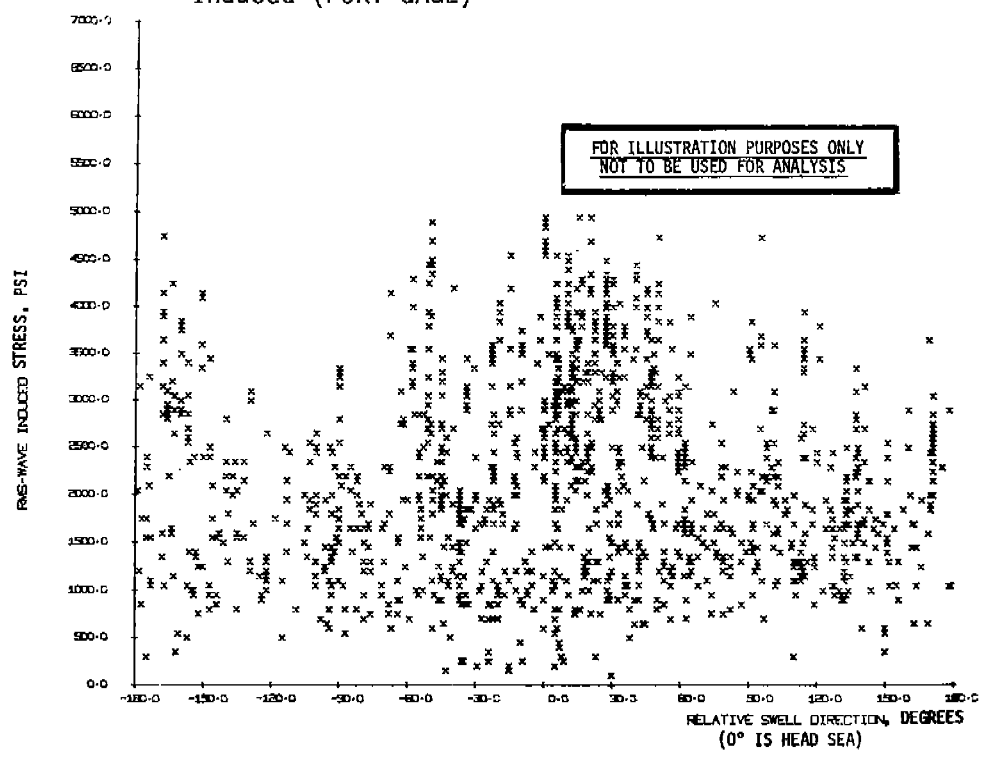


FIGURE 25b - RESULTS OF EXAMPLE NUMBER 20 (Beaufort Sea State 4-12) - Code No.20, Relative Swell Direction Versus RMS-Wave Induced (PORT GAGE)

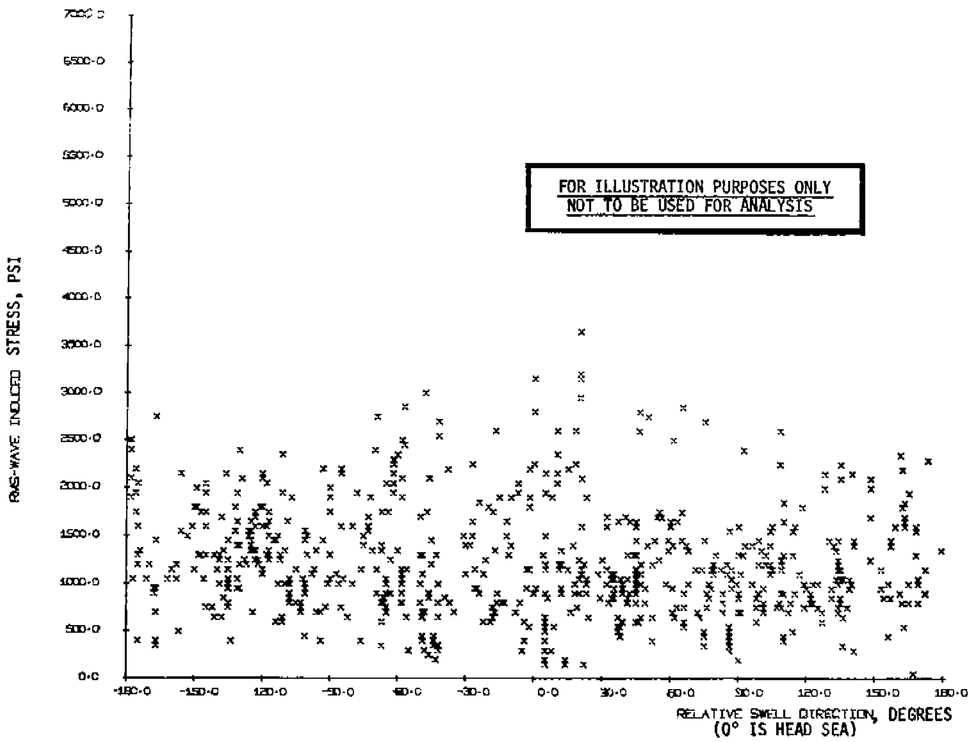


FIGURE 26a - RESULTS OF EXAMPLE NUMBER 21 (Beaufort Sea State 0-3) - Code No. 21, Relative Swell Direction Versus RMS-Wave Induced (STBD. GAGE)

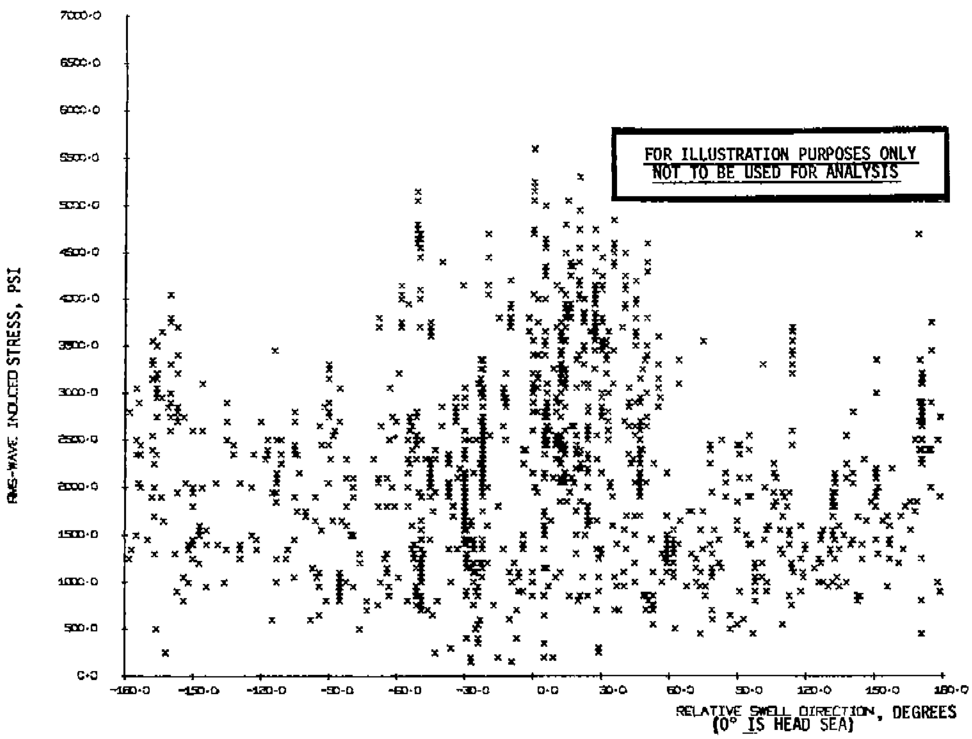


FIGURE 26b - RESULTS OF EXAMPLE NUMBER 21 (Beaufort Sea State 4-12) - Code No. 21, Relative Swell Direction Versus RMS-Wave Induced (STBD. GAGE)

TABLE XIII - MODIFIED PRINTOUT OF EXAMPLE NO.16

TABLE XIII-2

BEAUFORT SEA STATE= 4

WAVE HEIGHT =	NO. OF DATA POINTS=
1	39
2	239
3	392
4	355
5	199
6	371
7	25
8	28
9	1
10	6
12	1
15	2
20	1
30	1

BEAUFORT SEA STATE= 5

WAVE HEIGHT =	NO. OF DATA POINTS=
1	12
2	77
3	169
4	196
5	230
6	162
7	61
8	71
9	10
10	195
11	43
12	9
13	1
15	3
16	1
20	1
26	1

BEAUFORT SEA STATE= 6

WAVE HEIGHT =	NO. OF DATA POINTS=
2	29
3	58
4	34
5	81
6	146
7	73
8	69
9	29
10	61
11	4
12	16
13	2
14	2
15	6
16	34
17	2
18	1
20	7
25	3

BEAUFORT SEA STATE= 7

WAVE HEIGHT =	NO. OF DATA POINTS=
2	7
3	26
4	12
5	23
6	60
7	38
8	94
9	38
10	92
11	14
12	31
13	2
14	1
15	16
17	5
18	3
20	20
25	5
26	5
27	4
30	3

TABLE XIII-3

BEAUFORT SEA STATE= 8

WAVE HEIGHT = 5	NO. OF DATA POINTS= 8
WAVE HEIGHT = 6	NO. OF DATA POINTS= 15
WAVE HEIGHT = 7	NO. OF DATA POINTS= 4
WAVE HEIGHT = 8	NO. OF DATA POINTS= 29
WAVE HEIGHT = 9	NO. OF DATA POINTS= 9
WAVE HEIGHT = 10	NO. OF DATA POINTS= 47
WAVE HEIGHT = 11	NO. OF DATA POINTS= 1
WAVE HEIGHT = 12	NO. OF DATA POINTS= 45
WAVE HEIGHT = 13	NO. OF DATA POINTS= 4
WAVE HEIGHT = 14	NO. OF DATA POINTS= 16
WAVE HEIGHT = 15	NO. OF DATA POINTS= 26
WAVE HEIGHT = 16	NO. OF DATA POINTS= 6
WAVE HEIGHT = 17	NO. OF DATA POINTS= 2
WAVE HEIGHT = 18	NO. OF DATA POINTS= 11
WAVE HEIGHT = 20	NO. OF DATA POINTS= 26
WAVE HEIGHT = 25	NO. OF DATA POINTS= 2
WAVE HEIGHT = 27	NO. OF DATA POINTS= 7
WAVE HEIGHT = 37	NO. OF DATA POINTS= 1
WAVE HEIGHT = 38	NO. OF DATA POINTS= 16

BEAUFORT SEA STATE= 9

WAVE HEIGHT = 4	NO. OF DATA POINTS= 7
WAVE HEIGHT = 6	NO. OF DATA POINTS= 4
WAVE HEIGHT = 8	NO. OF DATA POINTS= 19
WAVE HEIGHT = 9	NO. OF DATA POINTS= 2
WAVE HEIGHT = 10	NO. OF DATA POINTS= 12
WAVE HEIGHT = 11	NO. OF DATA POINTS= 2
WAVE HEIGHT = 12	NO. OF DATA POINTS= 7
WAVE HEIGHT = 13	NO. OF DATA POINTS= 2
WAVE HEIGHT = 15	NO. OF DATA POINTS= 2
WAVE HEIGHT = 16	NO. OF DATA POINTS= 18
WAVE HEIGHT = 18	NO. OF DATA POINTS= 5
WAVE HEIGHT = 19	NO. OF DATA POINTS= 14
WAVE HEIGHT = 20	NO. OF DATA POINTS= 15
WAVE HEIGHT = 25	NO. OF DATA POINTS= 1
WAVE HEIGHT = 30	NO. OF DATA POINTS= 1

TABLE XIII-4

BEAUFORT SEA STATE= 10

WAVE HEIGHT = 4	NO. OF DATA POINTS= 5
WAVE HEIGHT = 6	NO. OF DATA POINTS= 2
WAVE HEIGHT = 9	NO. OF DATA POINTS= 2
WAVE HEIGHT = 10	NO. OF DATA POINTS= 7
WAVE HEIGHT = 12	NO. OF DATA POINTS= 1
WAVE HEIGHT = 18	NO. OF DATA POINTS= 8
WAVE HEIGHT = 20	NO. OF DATA POINTS= 18
WAVE HEIGHT = 24	NO. OF DATA POINTS= 8

BEAUFORT SEA STATE= 11

WAVE HEIGHT = 15	NO. OF DATA POINTS= 3
WAVE HEIGHT = 20	NO. OF DATA POINTS= 1
WAVE HEIGHT = 22	NO. OF DATA POINTS= 11
WAVE HEIGHT = 24	NO. OF DATA POINTS= 14

NUMBER OF DATA POINTS = 4528

In addition to the plots, as defined in Table X, the number of data points to be plotted in certain examples appears to be excessive to interpret results. Recognizing that each of the examples numbered 18-21 would contain half of the total intervals recorded on the half-bridge summary tape (approximately 2,775 data points per example), the Beaufort Sea State was read in addition to the required data. Thus, the total number of data points could be sorted further by B.S.S. Example 18 has been plotted for values of B.S.S. between zero and three in Figure 23a, and B.S.S. between four and twelve in Figure 23b. Similarly, Figures 24-26 break the total data into groupings by B.S.S. With the data on cards as output from the program, considerable further processing can be done quite readily with additional card sorting and/or other simple programming.

In any computer analysis system, the computer time and/or cost to perform the several tasks is very important. The approximate computer times for processing 100 intervals and output to a Final Summary Tape follow. The key punched logbook data were loaded onto perforated paper tape using a standard IBM 1130 computer with paper-tape punch. Approximately one hour of computer time is required to list, edit and prepare the paper tape (including verification printout). The paper tape was read into a PDP-8/I Computer and the data stored on DECtape using approximately 30 minutes of computer processor time. To digitize and process 100 intervals (originally recorded for approximately 32 minutes each at 0.3 inch/minute) at a speed-up factor of 25, requires approximately 2 1/4 hours of PDP-8/I computer time.

The preparation of a Final Summary Tape from several tapes is dependent on several factors. The generation of a tape equivalent to the full-bridge data tape (approximately 7700 intervals from 15 data tapes) required approximately 1 hour of IBM 360/65 computer time. It requires approximately 10 minutes to run a Final Summary Tape through the IBM 360/65 to retrieve the data from the PARM program. However, judicious use of the program permits several studies to be run with each pass of the tape through the computer. For example, the first eight of the demonstration examples were retrieved in one pass. Depending on the output specified, mechanical card sorting and preparation of computer plots are very dependent on equipment used and operator experience. Typically, plots equivalent to Figure 24b (using a Calcomp 565 plotter operating through an IBM 1130 computer) require approximately 1.4 hours of computer time. The simpler plots (and with fewer data points) require less time, but are not necessarily linear with the number of data points.

V. CONCLUDING REMARKS

The data from 13,220 intervals of midship bending stress and accompanying logbook information have been processed to digital form. The original data from 163 analogue tapes, covering 217 voyages of the SS HOOSIER STATE, SS WOLVERINE STATE, SS MORMACSCAN, and SS CALIFORNIA BEAR are now available on 25 digital tapes to permit easier access for further study.

In addition, two summary tapes (which retain only the logbook data and the derived data) have been prepared. These tapes were used to retrieve selected data to illustrate the manner of retrieval, to indicate possible formats for presentation of data, and to show the type of statistical information available from these data. Inasmuch as these demonstration examples were intended as illustrative of capabilities, no interpretive analysis was done of the data.

The computer programs which were written to process the data and perform the demonstration examples are documented in Reference 3.

The data available on the digital tapes have been edited, as required, to provide a single consistent basis for treatment of the original information (analogue tape and logbook). The analogue signals are faithfully reproduced by the digital record to permit reconstruction of the wave-induced and first-mode signals. So faithful is the reproduction that some spurious transients, attributed to noise and other factors, are also included in the reconstruction. On all of the full-bridge data, because of the hard-mounted, vertical tape-reel configuration of the tape-recording system, these spurious transients occur in the first-mode data (only) and further study and editing of these data should be undertaken before full confidence in the total first-mode data can be established.

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13. ABSTRACT

Midship bending stress and environmental data from four dry-cargo ships, accumulated during the period 1959 through early 1970 under Ship Structure Committee Project SR-153, "Ship Response Statistics," have been processed and written on digital magnetic tapes. During the processing, selected statistical information was derived which has been included on the digital tapes for each of the 13220 intervals recorded.

The original FM analog data were contained on 163 reels of magnetic tape. The entire collection is now stored on 25 reels of digital tape and pertinent reduced data from each interval are stored on two summary reels.

Processor programs were written to convert the original analog data and environmental information to the final digital format and to provide a capability to extract portions of the data for subsequent statistical analysis.

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