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(SL-7-14)

ORIGINAL RADAR AND STANDARD TUCKER WAVEMETER SL-7 CONTAINERSHIP DATA REDUCTION AND CORRELATION SAMPLE

SHIP STRUCTURE COMMITTEE

1978

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Ship Structure Committee

An Interagency Advisory Committee
Dedicated to Improving the Structure of Ships

Address Correspondence to:
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U.S. Coast Guard Headquarters,(G-M/82)
Washington, D.C. 20590

SR-1221

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This report is one of a group of Ship Structure Committee Reports which describes the SL-7 Instrumentation Program. This program, a jointly funded undertaking of Sea-Land Service, Inc., the American Bureau of Shipping and the Ship Structure Committee, represents an excellent example of cooperation between private industry, regulatory authority and government. The goal of the program is to advance understanding of the performance of ships' hull structures and the effectiveness of the analytical and experimental methods used in their design. While the experiments and analyses of the program are keyed to the SL-7 Containership and a considerable body of the data developed relates specifically to that ship, the conclusions of the program will be completely general, and thus applicable to any surface ship structure.

The program includes measurement of hull stresses, accelerations and environmental and operating data on the S.S. Sea-Land McLean, development and installation of a microwave radar wavemeter for measuring the seaway encountered by the vessel, a wave tank model study and a theoretical hydrodynamic analysis which relate to the wave induced loads, a structural model study and a finite element structural analysis which relate to the structural response, and installation of long term stress recorders on each of the eight vessels of the class. In addition, work is underway to develop the initial correlations of the results of the several program elements.

Results of each of the program elements are being made available through the National Technical Information Service, each identified by an SL-7 number and an AD- number. A list of all SL-7 reports available to date is included in the back of this report.

This report documents the decisions and methods involved in selecting and converting the wavemeter raw data to useable form. A sampling of reduced wavemeter and other related data, i.e., mid-ship bending stresses, roll, pitch and acceleration from the original microwave radar and standard Tucker wavemeters is also presented.

Henry H. Bell
Rear Admiral, U. S. Coast Guard
Chairman, Ship Structure Committee

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TECHNICAL REPORT

on

Project SR-1221

"Correlation and Verification of

Wavemeter Data from the SL-7"

ORIGINAL RADAR AND STANDARD TUCKER WAVEMETER SL-7 CONTAINERSHIP DATA REDUCTION AND CORRELATION SAMPLE

by

J. F. Dalzell

Stevens Institute of Technology

under

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ABSTRACT

So that more precise correlations between full scale observations and analytical and model results could be carried out, one of the objectives of the instrumentation program for the SL-7 class container ships was the provision of instrumental measures of the wave environment. To this end, two wave meter systems were installed on the S.S. SEA-LAND McLEAN. Raw data was collected from both systems during the second (1973-1974) and third (1974-1975) winter data collecting seasons.

It was the purpose of the present work to reduce this raw data, to develop and implement such corrections as were found necessary and feasible, and to correlate and evaluate the final results from the two wave meters. In carrying out this work it was necessary to at least partly reduce several other channels of recorded data, so that, as a by-product, reduced results were also obtained for midship bending stresses, roll, pitch, and two components of acceleration on the ship's bridge.

As the work progressed it became evident that the volume of documentation required would grow beyond the usual dimensions of a single technical report. For this reason the analyses, the methods, the detailed results, discussions, and conclusions are contained in a series of ten related reports.

The present report is the first in the series, and involves the initial stages of the work. Specifically, this report documents the several decisions and methods thought necessary in conversion of the raw data from its original analog form to digital form, the sampling and calibration of data from the second (1973-1974) season, and a summary of initial results.

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NOTES

INTRODUCTION

In the analysis of the wave-induced ship hull strain data obtained by SSC in the 1960's it was necessary to infer the wave environment from estimated Beaufort wind speeds. An extraordinary amount of work was required to develop the inferential techniques. These techniques appear to suffice for valid prediction of long-term trends because a great deal of averaging is carried out. Unfortunately when verification of short-term statistical predictions is desired, the use of wind as a wave environment index appears to be less than satisfactory.

As a consequence it was one of the objectives of the SL-7 full-scale instrumentation program to provide a direct instrumental measure of the wave environment so that more precise correlations could be made between full-scale observations, and analytical and model results.

To this end the ship was fitted with a micro-wave radar relative wave meter and various motion sensing devices. A "Tucker Meter" pressure actuated wave height sensing system was also installed.

The purpose of the present project is to reduce and analyze the resulting wave meter data obtained on the SEA-LAND McLEAN in the second (1973-1974) and third (1974-1975) winter recording seasons.

The purpose of this report is to document the first phase of the project; that is, the selection of data, its digitization and calibration, and results of a first pass analysis. References 1 and 2 are the primary background references for this phase of the work, and a general familiarity with the measurement program, or with these references has been assumed.

INITIAL DATA TAPE SCREENING AND ANALOG MAGNETIC TAPE REPRODUCTION

The original recordings were made at 0.3 ips in low-band FM (270 Hz center frequency). Playback at Davidson Laboratory (D.L.) was not possible without modifications to existing machinery which requires intermediate band FM tapes. Because the D.L. digitization process requires starting and stopping the tape machinery, there would exist some danger of accident (tape stretch or breaks) and the consequent loss of some pieces of rather expensive data if original tapes were used.

For these reasons the most prudent course of action was to duplicate the original tapes in intermediate band FM. This is an operation in which starting and stopping of tape drives is generally limited to the leaders and trailers and represents minimal danger to the original data.

Duplicating analog tape carries with it the danger of introducing noise which would be expected to be mostly in the neighborhood of 60 Hz if present. Ideally the duplicating tape speed should be such that 60 Hz at duplicating speed is outside the bandwidth of interest in real time. The required bandwidth for the present project was estimated to be 1.5 Hz (real time). In order to get 60 Hz noise during duplication to appear as a frequency higher than about 1.5 Hz real time, the duplication speed needs to be no higher than 7-1/2 ips. Sixty Hz noise at a duplication speed of 60 ips corresponds to 0.3 Hz real time.

The costs of duplication go down sharply as duplicating tape speed increases. Accordingly, before any final choices were made as to what tapes to duplicate, how to do it, and how to handle digitization, some data fragments at least had to be in hand. For this purpose Teledyne Materials Research (TMR) produced a sample tape which is a partial duplicate in intermediate band FM of Data Tape 123 from the 73/74 season. The duplicating tape speed was 60 ips. One of the channels duplicated was a multiplex channel which is essentially a step function. Upon playback at 7.5 ips at D.L., expanded oscillograph recordings were made and this channel examined for 7.5 Hz noise which is what 60 Hz pickup during the duplicating process should appear as. None was found and it was concluded that, with reasonable care, tape duplication could be carried out at the highest and most economical tape speed.

The initial screening of the second (1973-1974) data was done by TMR. Their results are reproduced as Table I. Prior to Voyage 28E (11/29-12/3/73) no radar data (or an insignificant amount) was available. The Tucker Meter was not operational until Voyage 32E (12/30/72). From Voyage 36W onward until loss of the radar during Voyage 37, Tape Recorder No. 1 was mal-functioning and it appeared prudent not to attempt recovery of wavemeter data from Recorder No. 2 during this period. Therefore it appeared best to concentrate upon tapes containing both radar and Tucker Meter data; that is, the odd numbered tapes from 139 through 177, Table I. This decision eliminated from consideration data from Voyages 28 and 29 East. The tapes thus qualified for consideration cover 9 voyage legs during the period 30 December 1973 to 3 March 1974, a total of 20 analog tapes were involved, and these were duplicated by TMR. All thirteen data channels were reproduced against possible future use, though only seven channels were required for the present work.

INITIAL ANALOG TAPE ANALYSIS

The digitization process to be described was started under the assumption that a gross examination of the contents and nature of the analog signals would be unnecessary. Some peculiar behavior of the radar range signal on the visual signal monitor and some indications of higher than anticipated voltage levels necessitated a stop to digitization and the production of "quick look" oscillograph recordings for the channels of interest on all 20 magnetic tapes. The so-called "quick look" record is produced by playing the tape at high speed into an oscillograph

TABLE I

RESULTS OF INITIAL DATA TAPE SCREENING

By Teledyne Materials Research for
SEA-LAND McLEAN, 1973-1974 Winter Recording Season

Voyage	Dates	Recorder No. 1 Tape Numbers	No. Intervals Recorded Radar	Tucker
28E	11/29 - 12/3/73	121, 123	52, 48	
28W	12/6 - 12/10/73	125, 127	52, 52	
29E	12/11 - 12/15/73	129, 131	52, 48	
32E	12/30/73 - 1/4/74	139, 141	64, 60	64, 60
32W	1/8 - 1/14/74	143, 145, 147	64, 72, 32	64, 72, 32
33E	1/17 - 1/21/74	149, 151	64, 52	64, 52
33W	1/23 - 1/27/74	153, 155	64, 52	64, 52
34E	1/29 - 2/2	157, 159	52, 52	52, 52
34W	2/5 - 2/9	161, 163	48, 48	48, 48
35E	2/12 - 2/17	165, 167	48, 48	52, 56
35W	2/20 - 2/25	169, 171, 173	56, 46, 36	56, 56, 36
36E	2/27 - 3/3	175, 177	48, 28	48, 28
36W	3/7 - 3/12	179	Recorder problems	
37E&W	3/14 - 3/25		Time-shared, recorder problems	
38E	3/26 - 3/31		Time-shared, recorder problems	

running at low speed. The result is a compression of 30 minutes of real time recording into about 2-1/2 inches of oscillograph tape. The resulting time history is so compressed that only exceptionally large individual fluctuations are visible. However, from such records a quick assessment of oscillatory signal level and gross zero stability is possible, as well as an accounting of recording intervals.

By roughly correlating the interval summary in Reference 2 with the quick look records it appeared that under heavy weather conditions and some combinations of moderate weather and high ship speed, the radar apparently lost lock; with the result that large (physically impossible) changes in the mean radar range signal were visible on a compressed time scale. When this problem appeared the radar signal might typically oscillate about some mean for a few minutes real time, and then jump to a new mean up to the equivalent of 25 feet full scale away from the original. The new mean might persist for the remainder of the 1/2 hour recording interval or the signal might jump two or three more times to new and different means. When this occurred, absolutely no indication of such radical motions was visible in the roll, pitch or acceleration channels. There was in addition a tendency for the radical changes in radar mean to persist for some time after the heaviest weather. When any radical change was observed during a tape, the mean value of the radar signal was usually different at the end of a tape than at the beginning. In the longest tape corresponding to relatively heavy weather the radar mean appeared suspect in as many as 40 out of 72 half-hour recording intervals. Finally there were a few instances of no radar signal at all, or obvious dropouts during an interval.

The other tape tracks examined included longitudinal vertical bending stress, roll, pitch, vertical and horizontal deck house accelerations, and the Tucker meter. Qualitatively, no problems were apparent with these channels -- apart from a higher than expected calibration signal level on the accelerations, and a half dozen recording intervals (out of more than a thousand) where extraneous influences such as main power supply fluctuations could be suspected.

The peculiar behavior of the radar was discussed with the designers. It appears that the signal from the radar as installed during the 73/74 season is not the range in the ordinary sense of the meaning of radar range. It is the difference in range from some nominal initial range condition. The radar has automatic features which insure initial signal acquisition -- and re-acquisition in case of temporary return signal loss. It appeared likely that the symptoms observed on the quick look records might typically result from loss of signal in a trough (or crest) and re-acquisition in a crest (or trough) since the original range reference is lost when re-acquisition takes place.

Conceptually, the correction of the radar range for ship angular orientation is a straight-forward vector operation. The above considerations showed that the length of the radar range vector could not be established solely from the instrumental data. The only reasonable option appeared to be to assume that: a) the sample mean of the radar data in each interval corresponds to the position of the nominal still water zero speed waterline of the ship; b) to correct the instrumental data to this mean; and c) to add to the corrected data the distance from radar antenna to still water as computed from the ship's departure drafts. If the sample mean is really reasonably close to the still water waterline this procedure might result in total range errors of $2 \rightarrow 4$ feet out of 75, since the corrections are of a cosine nature the final results should not be too far off the mark.

THE INTERVAL SAMPLING SCHEME

In the 20 tape analog magnetic tape data set covering voyages 32E through 36E there are a total of 1064 half-hour recording intervals. As noted in detail in Reference 2, Recorder No. 1 in which the present data was obtained, was also the control recorder. Recorder No. 1 was run every time a new set of signals was patched into Recorder No. 2, so that

Recorder No. 1 was operating for the first two hours out of every four hour watch. The observational data entered in the TMR log was up-dated only for each watch, rather than for each interval actually recorded on Recorder No. 1. The magnitudes of longitudinal vertical bending stress presented in Reference 2 appear quite consistent within each watch. These considerations suggested that a reasonable interval sampling procedure would be to take one interval from each watch. The entire available data set corresponds to 266 watches; or just over forty-four 24 hour days.

The peculiarities of the radar signal re-inforced this sampling idea. The relatively large scale data reduction process envisioned more or less precluded the idea of spending time sorting out radar intervals which are badly chopped up (by a mechanism not fully understood) just for the challenge of it. However, it appeared for the most part that even in heavy weather one radar signal interval out of the four available in each watch was free of gross mis-behavior during the recording interval -- apart possibly from an apparently constant mean value during the interval which might be too high or too low.

Accordingly, the best interval sampling policy appeared to be to take the best looking interval from each watch in accordance with the analysis of quick-look records. This general approach was applied to all 20 tapes and the result was a list of about 215 intervals which satisfied the following:

a) Regardless of any lack of satisfaction of later criteria, the interval was the first interval of a voyage leg in which all data channels appeared to be functioning. (The main purpose in digitizing intervals of this type regardless of the generally very low level oscillatory signals involved was to obtain calibration signals as little as possible distorted by the actual signal.) It was intended that most intervals of this type would eventually be discarded.

b) The level of oscillatory signal on longitudinal moment was appreciable and the ship was well out to sea.

c) All data channels appeared to be functioning normally and free of gross analog magnetic tape saturation problems.

d) The interval was one for which a log book summary and analysis appears in Reference 2.

e) The radar signal appeared to have constant mean level during the interval, no obvious signal drop-out, and in marginal cases was at least the best looking of the four intervals available for the watch.

Considering the beginning-of-voyage intervals slated for discard, this sampling scheme involved 206 or 207 watches, or about 78% of those available. A few additional discards from this list were anticipated from mistakes in evaluating quick look data or from blunders during the digitization. It was assumed that the sampling scheme would result in a final sample of between 72 and 78% of the watches available. About half the discards would be from start and end of voyage leg, the other half a combination of perceived malfunctions of the various signals and various mistakes. The main advantage of the scheme is that it involves about an 85% coverage of the available observed conditions for which the responses were appreciable and the ship was in unprotected waters. The main disadvantage is that if the final analysis indicated a poor selection of interval had been made within a particularly interesting watch, it would be uneconomical to back up and digitize another interval.

DIGITIZATION ANALYSIS

Bandwidth

Digitization involves sequential sampling of analog signals at a constant time interval, Δt. The size of this interval controls the bandwidth of the analysis and the size of the resulting time series.

In the present study the interest is in the "rigid body" motions; the movement of the ship as a whole. Wave components which are smaller than the beam of the ship cannot be expected to excite the ship except possibly in vibration. The SL-7 has a 105 foot beam and it is very conservative to assume that little or no motions response should be observed at frequencies which correspond to waves shorter than 50 feet.

The radar is 70 or 80 feet above mean water and has a specified beam width of 3.2^{o}. On this basis the range is at best the average over about a 5 foot diameter circle at the water surface. A range resolution of about 1 foot is specified. A 20 ft by 2 ft wave is nearly breaking, so that it is extremely unlikely that any meaningful radar response at all can be expected at frequencies corresponding to 20 foot and shorter waves. In fact the lack of resolution and the smearing effect of spatial averaging would be expected to introduce significant error up to 40 or 50 foot wave lengths.

In the analyses of Tucker meter outputs from small Weather ships at zero speed, the data for component wave lengths shorter than the ship is considered suspect. Spectral analyses are not usually carried out for frequencies in excess of that corresponding to a 50 foot wave length because the pressure fluctuations induced at the below-surface taps become too weak for shorter waves and the magnitude of the signal becomes comparable with the resolution of the recording apparatus. Given that the SL-7 is nearly an order of magnitude larger than the weatherships it also seems quite conservative to assume that no significant Tucker meter signal will correspond to waves shorter than 40 or 50 feet.

The basic requirement for digitization is to determine the bandwidth of the analysis. All data are observed in the encounter frequency domain. The lower end of the analysis bandwidth is D.C. A conservative estimate of the upper end was made by transforming wave length into encounter frequency under the assumptions of full ship speed and head seas. (For lower speeds and other headings the frequencies decrease.) This transformation is shown in Figure 1. The result is that encounter frequencies corresponding to 40 or 50 foot long waves should be less than 1.4 - 1.7 Hz. Accordingly the required bandwidth of the analysis is D.C. to approximately 1.5 Hz. So long as this bandwidth is maintained throughout the analysis of the various intervals, the resolvable motion and wave components will be available. The typical frequencies of significance in the results of the first season's operations and in the sample tape 123 were seen to be well within the D.C. to 1.5 Hz range.

Analog Playback Considerations

It happens that the normal D.L. analog tape speed is 7-1/2 ips. This is the same tape speed used at TMR for playback and results in a ratio of 25 between playback time and real time. Another fairly normal procedure at D.L. is to interpose low pass filters between the signal out of tape and the A/D Multiplexer. There are available a sufficient number of matched 6 pole Butterworth filters of 40 Hz cutoff. Using the speed up ratio of 25, these filters correspond to 1.6 Hz filters in real time. The amplitude response is plotted in Figure 1.

The normal D.L. procedures fitted the present requirements fairly well. Using the 40 Hz filters in playback, frequency components corresponding to wavelengths greater than 70 feet are negligibly influenced by the filter. At the estimated inherent lower limit of wave length resolution the attenuation is only about 20%. Higher frequencies are rapidly attenuated, which is desirable, as response components above 2 Hz real time are expected to be extraneous noise insofar as motions and wave meters are concerned. The first longitudinal bending frequency would be resolved however. In the process of playback, use of these filters also has the advantage that a 60 Hz pickup or noise introduced by the playback tape recorder is attenuated about 90% before the A/D converter sees it.

Sampling Interval

The normal A/D Multiplex system in use at D.L. allows multichannel digitization at time intervals, Δt, which are integer multiples of 0.002 sec. Accordingly, taking account of the factor of 25 speedup, the available sampling intervals correspond to 0.05, 0.10, 0.15, 0.20..., seconds real time. The corresponding Nyquist frequencies are 10, 5, 3.333, 2.5..., Hz (real time). The existing TMR reduction program uses Δt = 0.1 sec for stress analysis. According to Figure 1 this is more than adequate for motions data. According to the previous discussion about filtering, a time interval of 0.15 sec should be quite adequate for the motions. Owing to the filtering, the corresponding Nyquist frequency of 3.333 Hz is sufficiently high so as to avoid aliasing (Fig. 1).

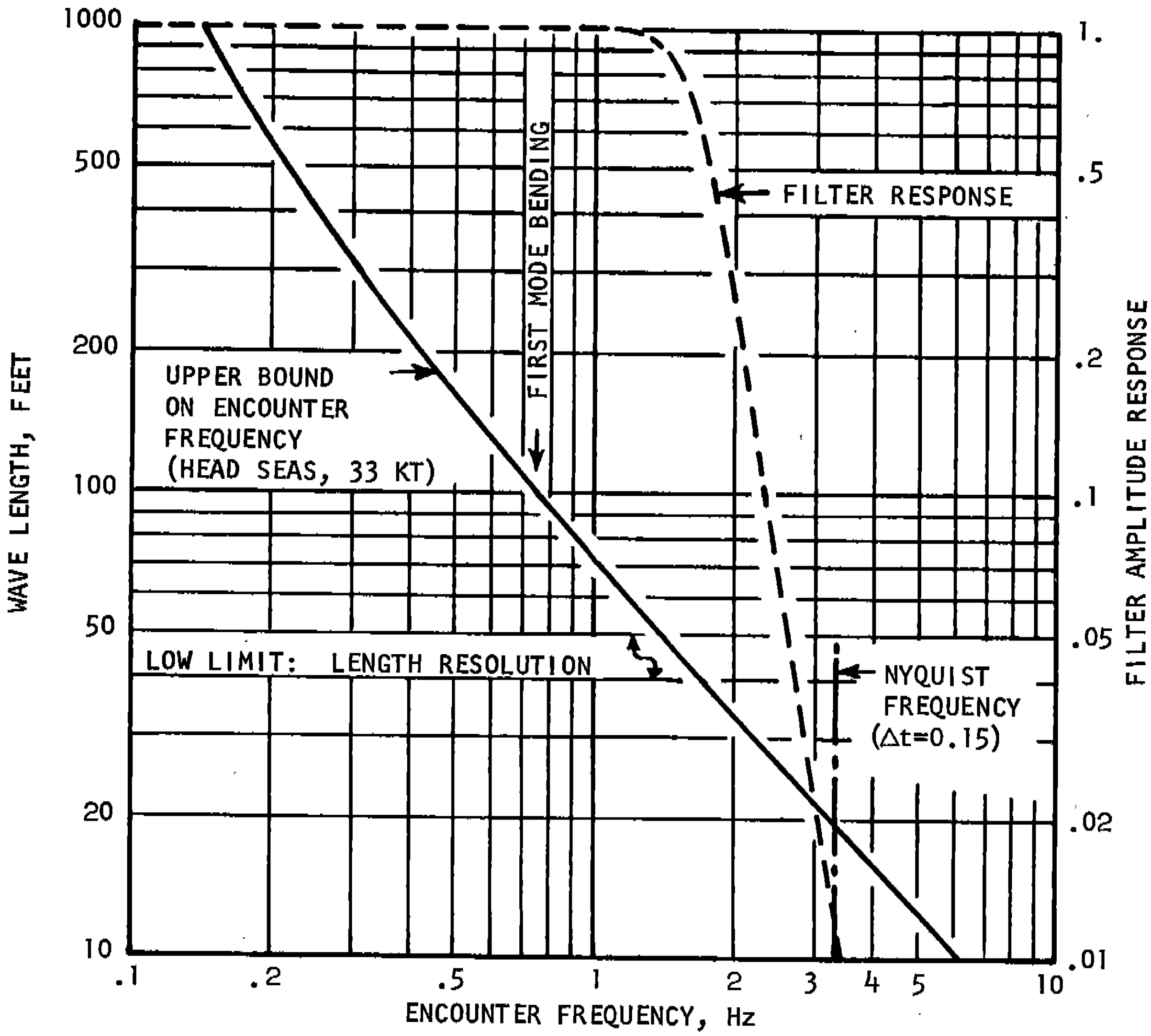

FIGURE 1 DIGITIZATION ANALYSIS

The main advantage in choosing $\Delta t = 0.15$ rather than 0.10 is in the 34% reduction of the size of the required digital data storage. The disadvantage is that typical wave components of 0.5 Hz, say are defined by 13 instead of 20 points.

THE DIGITIZING PROCESS

Generally, the philosophy of the TMR single channel digitization scheme seemed best to follow. In that scheme 20 minutes of each interval are digitized and analyzed. The first two minutes of each 30 minute recording interval provide zero and calibrations, the digitized data are essentially 20 minutes worth of the remaining 28. For a 20 minute sample the choice of $\Delta t = 0.15$ sec corresponds to 8000 points per channel per interval. Considering the potential use of the FFT algorithm it appeared useful to specify that at least 8192 points (2^{13}) per channel make up the final sample (20.5 minute samples instead of 20 minutes).

In order to minimize alterations in the existing D.L. digitizing system it was decided to start digitizing as near as possible after the start of the first minute (full scale) of electrical zero, and stop only when the remainder of the zero, the calibration signals and at least 8192 points/channel of sample had been obtained. A minor modification to the D.L. system was made so that after digitization was started it would stop itself after exactly 9015 scans of the channels had been obtained. (A "scan" is equivalent to the digitization of all "N" channels specified at the highest rate possible. In the present case the digitization rate during a scan was nearly two orders of magnitude faster than the basic scan-to-scan rate.) The total scan specification of 9015 was for later convenience. Some previously established conventions on the packing and subsequent handling of the multiplexed data in the general case made it simple to throw away (if desired) the first 805 scans containing the zeros and calibrations. This would leave 8210 scans of sample, a few more than the minimum number specified.

The digitization start was to be manually controlled. Operator reaction times were such that the digitizing actually started about half way through the electrical zero in the vast majority of intervals. Using the cited values of Δt and numbers of scans, and assuming the first scan of the actual sample to be the 806^{th}, the approximate timing of the digitized portions of the original 30 minute interval were as follows:

Start Digitized Electrical Zero:	.5 ±.2 min. after analog interval start
Start Digitized Calibration	1.0 ±.2 min. after analog interval start
End Digitized Calibration	2.0 ±.2 min. after analog interval start
Start Digitized Sample	2.5 ±.2 min. after analog interval start
End Digitized Sample	23.0 ±.2 min. after analog interval start

The digitizing process itself was somewhat cumbersome. The size of the resulting digital files, the minimum running time of the analog tapes (roughly 20 hours), and the necessity to schedule the use of the D.L. PDP-8e computer system meant that the actual digitization work was conducted in several sessions. The aspect of the work most prone to systematic error was the analog signal processing. Prior to the start of the work a voice annotated test tape was made up. The first part of this tape contained known step voltages placed in turn on each of the 7 tape tracks to be digitized. The second part of the tape contained several runs where sinusoidal voltages of constant amplitude and various frequencies were placed on all tape tracks.

As described, the analog setup for each digitizing session consisted of interposing a 40 Hz lowpass filter for each channel between the computer A/D converter and the Ampex FR1800L tape recorder used for playback. A two channel oscilloscope was used for visual monitoring of two of the filtered outputs. Before commencing work in a session three system checks were performed. The first was to check the system voltage calibration for each channel by using the computer in an "on-line" mode to digitize and analyze voltages applied simultaneously to all filter inputs (tape recorder disconnected). This operation was to insure that the D.C. gain and offset of the filters was nominal. The next operation involved connecting the tape recorder, and using the computer to digitize and analyze the first part of the test tape. The result of this operation was essentially a verification by the computer that no blunders had been made in analog wiring or in instructing the computer as to which seven of its 32 input channels to consider.

The last checking operation was to use the computer in a third on-line analysis mode to digitize and analyze the second part of the test tape. In this case a peak-to-peak analysis of the sinusoidal signals on all 7 channels was made for various frequencies. The results verified that the filter frequency response for each channel was nominal and had not changed from session to session.

Most of the activity during actual digitizing involved keeping track of which tape intervals to digitize in accordance with the list resulting from the sampling scheme. Since the tapes contain no annotation of any kind, it was necessary to keep a running account of tape footage corresponding to the actual end of each digitized sample or what would have been the end had the interval been digitized. Fortunately, the TMR programmer was quite reliable in providing constant lengths of tape for each recording interval. When an interval was to be digitized the tape was started prior to the electrical zero portion, and the computer was manually started as soon as the visually monitored signals quieted and returned to the nominal zero position. After the digitization of the interval was finished the tape was stopped, a unique run number was furnished the computer, and the digitized run was stored with its identification and the appropriate computer setup documentation in a file on one of the PDP-8e disk packs. At this stage the data obtained for each interval for the 7 channels consisted of 63105 12 bit computer words in order digitized; that is, an array in which the data for channel J occupies the (Jth), (J+7)th, (J+14)th, etc. positions in the array.

The files resulting from each digitizing session were loaded into DEC tapes (a form of digital magnetic tape peculiar to Digital Equipment Corporation Computer systems). These were ultimately transported to the Stevens Institute PDP-10 Computer Facility where the tapes were read, the files were converted from PDP-8e standard format to a format readable by the PDP-10 and finally the files were written on 9 track digital magnetic tape. At this stage the 63000 integers defining the interval remained in the original order but were packed 3 12 bit numbers to each 36 bit PDP-10 word, and the entire array was organized into blocks conforming to the existing standards for the D.L. digitization system.

ASSEMBLY OF OTHER PARAMETERS

The raw digitization files contained little more information than the original magnetic tape. Quite a number of other pieces of information were needed for analysis and for correlation.

All the readily available information about the general circumstances associated with each tape and interval is contained in the Appendix of Reference 2. This Appendix is a tabulation from the TMR logbooks of time, ships position, speed, draft, visual observations of weather and wave conditions, general comments, and the results of the TMR analysis of midship vertical bending stress. All of the data summarized by TMR for the particular intervals which had been digitized was key punched, reformatted slightly and stored on digital tape so as to be accessible by the Stevens PDP-10 system. In the present case, one item in the TMR summary (estimated wave length) had never been filled in, and was therefore omitted.

Table II contains a track description for Tapes 139 through 173, and the values and senses of the TMR calibration signals. The corresponding track description for Tapes 175 and 177 is the same except that the forward deckhouse accelerometer package (Tracks 6,7) was omitted and a like pair of accelerometers located in the radar pedestal were substituted. The values of calibration signals and their senses were established in conferences with both TMR and NRL, the designers of the radar.

It was decided to digitize longitudinal vertical bending stress (Track I) as a control channel and for possible use in a later phase of the program. In addition to the radar output, roll, pitch and the outputs of the accelerometer package nearest the radar were digitized (Tracks 3, 4,5,6,7). The seventh track digitized was the Tucker Meter.

The values of the calibration signals are used directly in the calibration of the data. Two sign inversions were necessary. Positive roll starboard side down, positive pitch bow up, and positive vertical acceleration in a sense opposite to the gravity signal from the accelerometer all suit a coordinate system in which the x axis is positive forward, the y axis is positive to star board and the z axis is positive downward. In this coordinate system positive transverse acceleration is

TABLE II

ANALOG MAGNETIC TAPE TRACK DESCRIPTION, TAPES 139 THROUGH 173

Track	Item	Calibration Signal Value and Sense
1	Longitudinal Vertical Bending	8214 psi (Tension)
2	Midships Torsional Shear	
3	Radar	46 ft. (Range decreasing)
4	Roll	10^{o} (Starboard side down)
5	Pitch	10^{o} (Bow up)
6	Forward Deckhouse Acceleration, Vertical	2 g (Opposite sense to gravity component of accelerometer output)
7	Forward Deckhouse Acceleration, Transverse	1 g (In same sense as gravity component of accelerometer signal for steady heel, starboard side down)
8	Forward Acceleration, Vertical	
9	Forward Acceleration, Transverse	
10	Operating Parameters (Multiplexed)	
11	Longitudinal Horizontal Bending	
12	Tucker Meter	10 ft. (Sense not documented)
13	Shear Forward, Starboard	
14	Shorted Input	

an acceleration to starboard so that the sign of the calibration signal was reversed for Track 7, the transverse accelerometer. In a preliminary development of the corrections to radar range, the range itself was considered positive, so that the sign of the radar calibration signal needed to be reversed also.

For the radar range corrections the relative position of accelerometer package and radar antenna need to be established. From the positions of the transducers given in Reference 2, ship's plans and radar pedestal drawings, the radar antenna was found to be 13.8 feet aft, 46.5 feet to starboard, and 2.25 feet below the forward deckhouse accelerometer package. These values hold for voyages 32 through 35 (Tapes 139-173). In voyage 36E the corresponding values are zero because of the shift in location of accelerometer package to the radar.

According to the radar log the radar was aimed relative to ship coordinates at an azimuth of 90° and depression from horizontal of 74°; that is, the radar was oriented in a plane normal to the ship centerline, pointing down and slightly to starboard.

The nominal distance of the radar above the departure waterline was established with recorded departure drafts furnished by the owners. The vertical position of radar antenna above baseline was computed from plans to be 106.5 feet, its longitudinal position 123 feet aft of FP. The departure drafts and the result of the computation of initial vertical position of the radar are given in Table III.

TABLE III

Voyage	Departure Drafts (feet and inches) Fwd.	Aft	Vertical Position or Radar above WL (feet)
32E	33-8	34-4	72.7
32W	31-4	32-4	75.0
33E	32-9	35-3	73.4
33W	34-9	35-9	71.6
34E	34-0	34-2	72.5
34W	31-8	32-10	74.7
35E	31-8	34-8	74.4
35W	33-2	34-6	73.2
36E	35-0	35-5	71.4

FIRST ANALYSIS OF DIGITIZED RESULTS

Content

The first analysis of the digitized results had the objectives of completing the calibration, developing a few simple indices of the content of the sample, and a general check on the results of the digitizing process. As noted in a previous section, the first 805 scans of each digitized interval were to contain electrical zero and the TMR step calibrations, and an 8200 scan sample followed.

The first step in analysis of the first 805 scans was to establish for each data channel the scan numbers corresponding to the mid-point of the 10 square wave signals produced by the TMR programmer. This was accomplished by a simple time correlation procedure which used the known nominal durations of the square waves, and the magnitude and sense of the swing. Once the position of the square waves was established, the nominal end of the electrical zero could be established and the digitized data could be averaged in the applicable groups of scans to produce an average representing electrical zero, averages representing the value of the cal step, and averages of the signal in between the cal step. To avoid the transient response of the data filters only the middle half of each step was averaged. Because the TMR reduction procedure includes the computation of the mean of the first 4 minutes of data after the calibration this was also incorporated, the average extending as far as necessary past the 805^{th} scan of the interval.

Four numbers were also extracted from the actual sample for each channel of each interval. These numbers were; 1) the largest digitized number in the sample time series; 2) the smallest; 3) the sample mean, and 4) the sample rms.

The results of these operations were listed for visual inspection.

Values of the Calibration Steps

All the calibration square waves are supposed to be imposed at the same time. In the vast majority of cases the calibration algorighm indicated cal steps at the same times and of constant magnitude for radar, pitch, and the two accelerations, but often significantly different times and erratic magnitudes for vertical bending stress, roll and the Tucker meter. Consultation of the quick look oscillograph records and some expanded records showed that the programmer switches were not always functioning for the Tucker, the magnitude of swing for roll was marginally too small, and the signal level on longitudinal bending stress was often too high relative to the cal step for the present simple algorithm. A re-run of the calibration was made in which the position of the cal steps on all channels was determined by the position detected for the transverse acceleration channel. The result was cal step magnitudes of reasonable constancy and these were used for the final calibrations.

Before indicating the calibration results for the various channels the various sensitivities of the elements of the digitization process should be noted. The nominal voltage sensitivity of the reproduce electronics in the analog tape recorder is 1.414 volts output for a 40% of center-frequency frequency deviation on the FM tape. The D.C. gain of the filters is unity ± .5%. The computer was set to resolve 2-1/2 volts input into 1024 parts. The net sensitivity from magnetic tape output through filter and computer A/D was nearly nominal, ranging from 410 to 412 cu/volt* depending on the channel. In round numbers, 411 cu indicated by the computer corresponded to 1 volt out of the tape recorder or a 28.2% frequency deviation on the tape.

The calibration steps are superimposed upon the signal for the longitudinal bending stress channel. As described in the TMR reports, the average of the 10 cal steps and the average of the nine pieces of signal between the cal steps is computed. The indicated cal step for each interval is the average of the cal steps minus the average of the intermediate pieces of signal. These average indicated steps were computed and listed for all the digitized intervals. Because the signal is mixed up with the calibration step in this channel, the typical interval to interval scatter in what should be a constant is often 15%. However the average result at beginning and end of voyages correlated within about ± 1% over the entire two month period of the data set. It was concluded best not to believe the indicated fluctuations and a final cal step of + 418 cu was used for all tapes all voyages. This corresponds to a positive 1.02 volt step or a 28.8% deviation, both figures nearly exactly the values set up by TMR.

In the radar calibrations the 10 square waves are imposed with reference to electrical zero and the signal is suppressed while the step is imposed. The indicated cal step is thus the average of the 10 individual steps minus electrical zero. This calibration was exceptionally steady from interval to interval and tape to tape, the typical variation being less than 1/2%. In this case the cal step was again taken as constant over all voyages, all tapes and equal to + 568 cu. This is equivalent to + 1.38 volts or a 39% deviation, and is 38% too high relative to the values which were supposed to have been setup.

The cal steps applied to the roll and pitch tracks were similar to that for the radar. The signal is suppressed while the steps are on, and the reference for the signal is electrical zero. Again the indicated average cal step is the average of the 10 individual steps minus electrical zero. In the first five tapes (Voyages 32E and W) the indicated cal steps were quite steady from interval to interval, the variation being typically less than 1%. The magnitudes determined for roll was 222 cu (.54 volts, 15% deviation) and for pitch was 450 cu (1.09 volts, 31% deviation). These results are very close to the values expected on

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*The abbreviation "cu" stands for computer units; that is, roughly 1/411 volts into the A/D.

the basis of TMR setup records. For the remaining 15 tapes (Voyage 33E onward) considerable interval to interval fluctuations were noted even though the values of the individual steps applied within each interval were quite constant. The ratio of the roll and pitch calibration steps was constant however. It turned out that both transducers and the calibration signal circuit were fed from the same power supply and troubles with drooping voltage from this power supply were experienced during the period of time in question. The best course of action was therefore to believe the cal steps derived from the digitization of each interval from Voyage 33E onward. The values ranged from nominal to 70% of nominal, and this variation was confirmed by the analog quick look records.

The cal steps applied to the acceleration channels were effectively superimposed on the mean signal level, though the signal was suppressed. Accordingly, the average cal step was derived by averaging the 10 individual steps from each interval and subtracting from this result the mean of the first 4 minutes of signal which was felt to be a slightly better estimator of the mean signal level during the calibration than the short pieces of signal between cal steps. The stability of these results from interval to interval was very good. The cal step for transverse acceleration appeared to be + 550 cu ± 1% for all tapes (+ 1.34 volts, 38% deviation). The step for vertical acceleration scattered less than 1% within any voyage leg but was set at slightly different levels for each voyage leg, these varying from + 1135 cu to + 1153 cu (2.78 to 2.81 volts, approximately a 79% deviation).

The step for the transverse acceleration is about 34% higher than the level expected, and that for the vertical acceleration is 280% of the level expected. The mean of the vertical acceleration was supposed to be biased negatively (to simulate gravity) approximately 0.5 volts (-14% deviation). On the tapes in hand it was biased negatively approximately 1.3 volts (-35% deviation) and thus the positive 2.8 volt swing just about stays inside the nominal tape deviation rating.

The average Tucker meter cal step was computed in the same way as for the accelerations. During Voyage 32E and W (Tapes 139-147) the calibration for the Tucker meter was missing in most intervals. Those solid calibrations present indicated a cal step of + 400 cu (0.97 volts, 27% deviation). This is in agreement with nominal values used in original setup. During Voyage 33E the cal step suddenly dropped 30% from nominal 3/4 of the way through the voyage. During Voyage 33W and 34E the step was nominal with interval-to-interval fluctuations of 1 or 2%. During Voyage 34W the step was consistently 6% below nominal with ± 2% variations. Finally in the last three voyage legs (35E to 36E) the cal step was 60% of nominal with only ± 1% fluctuations. Most of these variations appear to be matters of periodic gain readjustment prior to the start of a voyage leg, though this could not be confirmed. It was decided to use the individual cal steps computed for Voyage 33 East onward and the estimated value quoted above for Voyages 32E and 32W.

All of the final decisions were incorporated in a computer accessible file so that the correct cal step value could be associated with each channel of each interval.

The unsolved problem of the calibration exercise is why the cal levels on the radar, the accelerations, and on the Tucker meter during 3 voyage legs, are not as expected. One duplicate magnetic tape was returned to Teledyne for verification that it and the master tape were really the same. The conclusion from that exercise was that the duplicate analog tapes are really duplicates. In four of the seven channels (including three with higher than expected gain) the gain stability appears exceptionally good, considering that the original calibration signals have had the opportunity of being degraded by three separate recording/playback operations involving four separate tape recorders and probably at least as many separate pieces of analog hardware.

Zero Stability and Saturation

Enough data from the first pass analysis was available to check if the digitization had been started correctly during the electrical zero for each interval. The indications were that it had been in all but 3 intervals. These were discarded as far as subsequent analysis was concerned.

In principle, the average value for the digitized electrical zero for each interval is the reference level for that interval, irrespective of its deviation from zero volts input measured at the computer A/D interface. However, the magnitude of the offset of the tape electrical zero is an indicator of bias or zero stability of the entire system, including original signals and tape deck, and that of all the subsequent analog processing equipment. An examination of the digitized electrical zeros disclosed no large systematic variations with analog tape or with voyage, except in the cases where the programmer switch for the Tucker meter was known not to be operating properly. The general zero stability of the whole process is perhaps best judged by the zero stability for the roll and pitch channels. Electrical zero in these channels corresponds to a center tap on the potentiometric transducers rather than to the open circuited tape deck input utilized to create a zero on some other channels. In the case of roll and pitch the average offset throughout the data set for roll was about 70 mv with what appeared to be random fluctuations of ± 35 mv. The corresponding numbers for pitch are 100 mv and ± 35 mv. The typical mean electrical offset on other channels was not far different. A mean offset of 70 to 100 mv represents 5 to 7% of nominal full scale for the playback recorder. Absolute tape speed errors in the four recorders in the process could conceivably add up to this offset magnitude, to say nothing of small offsets in other analog components of the system. The fluctuations in offset of the pitch and roll channels amount to ± 2-1/2% of nominal full scale of the playback recorder. This, too could have been injected by the sum of absolute tape speed errors of original and final playback recorders. Overall, the apparent electrical offsets of the original electrical zero appear at least as small as could have been expected.

The final check on the validity of the digitized intervals was for saturation. As far as the digital part of the process is concerned all signals levels within ± 2-1/2 volts were resolved, signals outside this range appear digitized as the maximum possible number (± 1023 cu). The filters interposed between tape deck and computer have a ± 10 volt linear range. The tape machine used in playback has a nominal minimum linear reproduce electronics output range of ± 1.414 volts. In the present case the reproduce electronics are acceptably linear to ± 1.75 volts (50% signal deviation). Their output deviates progressively more from linearity as output voltage increases beyond 1.75 volts to some figure above 2 volts where the FM demodulator goes mad and produces wild fluctuations of output signal.

Saturation is thus controlled by the analog tape playback machine. In the present case a digitized number corresponding to less than 1.75 volts was considered unsaturated. Results between 1.75 and 2.0 or 2.1 volts were considered questionable. Digitized results of 1023 cu or -1023 cu were almost certainly a result of over saturation of the tape.

The extremes of the digitized samples were viewed with these criteria. In one or two instances there appeared to be excessive tape saturation and these intervals were disregarded in subsequent analysis. After these discards and the others noted previously the data set had contracted from around 215 to 198 intervals. Of these, there are 24 intervals where some question exists. Table IV summarizes the results of the examination of the data for saturation. There were 174 intervals in the set where the extremes in the sample lay in the ± 1.75 volt range.

The radar channel was somewhat prone to saturation, since when the oscillatory component of range was large, the mean sometimes shifted sufficiently away from zero that the largest oscillatory fluctuations then saturated the tape. Remaining in the data set are a total of seven intervals where the magnitude of extreme output voltage from the radar channel was between 1.75 and 2.1 V. The fact that one isolated extreme is in the non-linear range of tape reproduce electronics does not necessarily mean that the interval is useless, and the seven intervals were retained on this basis.

The vertical acceleration channel was somewhat more prone to saturation than the radar channel, there being 20 instances in Table IV where the magnitude of the extreme output voltage from the vertical acceleration channel was between 1.75 and 2.1 V. These intervals were retained on the same basis as in the case of the questionable radar intervals. The problem with the vertical acceleration channel is the excessive bias noted in the calibration analysis. The gain for the oscillatory components is not excessive. However a bias of -1.3 volts means that when significant oscillatory accelerations occur, the extremes will almost certainly exceed the nominal minimum linear range and occasionally the practical linear range.

Two instances involving longitudinal bending stress are noted in Table IV. One is merely a questionable isolated extreme and the other is almost certainly a case of over saturation.

As implied by Table IV, no obvious saturation problems were noted for channels not mentioned.

TABLE IV

SUMMARY OF EXAMINATION FOR SATURATION
OF DIGITIZED INTERVALS

Voyage	Tape	Interval	Channels with Saturated Extremes (Magnitude in Volts)
32E	139,141	ALL	None
32W	143	58	Radar (1.8)
↓	143	60	Vertical Acceleration (1.8)
	145	1	Radar (2.0), Vertical Acceleration (1.8)
	145	9	Vertical Acceleration (2.1)
	145	13	Vertical Acceleration (1.9)
	145	21	Radar (2.0)
	145	25	Radar (1.9), Vertical Acceleration (1.9)
	145	29	Vertical Acceleration (1.9)
	145	37	Radar (1.9), Vertical Acceleration (1.9)
	145	61	Vertical Acceleration (1.8)
	147	ALL	None
33E	149,151	ALL	None
33W	153	15	Vertical Acceleration (1.8)
↓	153	61	Vertical Acceleration (2.0)
	155	ALL	None
34E	157,159	ALL	None
34W	161	17	Radar (2.1), Vertical Acceleration (1.9)
↓	163	5	Vertical Acceleration (1.9)
	163	9	Vertical Acceleration (1.9)
	163	33	Vertical Acceleration (1.9)
35E	165	37	Vertical Acceleration (1.8)
↓	165	42	Vertical Acceleration (1.8)
	167	ALL	None
35W	169	ALL	None
↓	171	5	Vertical Acceleration (1.8)
	171	13	Radar (1.9), Vertical Acceleration (1.9)
	171	21	Vertical Acceleration (2.0), Longitudinal Stress (1.9)
	171	43	Vertical Acceleration (1.9)
	171	56	Vertical Acceleration (1.9)
	173	ALL	None
36E	175	45	Longitudinal Stress (over saturated)
↓	177	ALL	None

An additional check on the validity of the data was made by forming the ratio of the range of sample extremes (largest - smallest) to the computed rms. If the statistics of the maxima of the processes involved follow the Rayleigh distribution (as dictated by custom and conventional wisdom) this ratio should lie between 5 and 8 in 90% of all samples of 100 or 200 maxima. Excluding the over saturated stress (tape 175 Table IV) in the 198 intervals finally qualified this ratio ranged from 4.5 to about 11, depending on channel. Table V summarizes for each channel the percentage of intervals in which the ratio of range to rms lay outside the 5 to 8 acceptance range. The results look fairly consistent with the statistical assumptions. Failure of this test did not correlate with the instances of questionable extremes in Table IV.

TABLE V

SUMMARY OF INCIDENCE OF FAILURE OF RANGE/RMS TEST

Channel	Percent of Intervals in which ratio of range to rms was outside range between 5 and 8
Longitudinal Vertical Bending Stress	15%
Radar	10%
Roll	5-1/2%
Pitch	14%
Vertical Acceleration	6%
Transverse Acceleration	6%
Tucker Meter	9%

SUMMARY OF DIGITIZED INTERVALS

TMR Log-book Data

The last stage of the sampling and digitization phase of the project was to gather together the various parameters and scale up some pertinent results from the digitization. The product of this operation was the nine tables appended; these are intended to serve as a listing of which intervals of those digitized were to be considered in subsequent analyses, as well as a summary of the surrounding circumstances and of the raw digitized signal magnitudes. Each table pertains to one of the nine voyage legs, and is divided into four parts (a through d).

Parts a and b of each table contain the log-book data extracted from Reference 2. With the exception of the first column of each page, the meaning of each entry is that established by TMR. The first column is the run number assigned to each interval during the digitization at D.L. This number is retained for identification in subsequent parts of the table.

Comparison of TMR and Raw D.L. Results for Longitudinal Stress

Part c of each table is a comparison of results from the present digitization with that at TMR. Five columns are stress results obtained at TMR, copied from Reference 2. Stresses are presented in thousands of pounds per square inch. The columns marked 6 through 8 are from the present digitization. The probable resolution of the analog tape recorder is ± 1% of full scale. This, according to the values of cal steps established previously, corresponds roughly to ±0.1 kpsi so that the two decimal places shown for stresses are optimistic.

Though it was not within the objectives of the present work to produce anything having to do with recorded midship bending stress, it was felt prudent to digitize this channel and make rudimentary comparisons with the results obtained by TMR. The main reason for this decision was to increase the credibility of the data processing methods described in this report. If the present results and those of TMR, Reference 2, were to diverge by unreasonably large margins, systematic errors in the present process would be suspected to exist in the data channels of primary interest as well as the midship bending stress channel.

Unfortunately the quantities compared in part c of the tables are in a strict sense, different things. This comes about because the two data reduction procedures are different and because the portions of the data interval actually analyzed was slightly different. Figure 2 illustrates some of the differences. The top sketch represents the combined vibratory and wave induced stress actually recorded. In the present analysis the largest and smallest combined stress were extracted. Subtraction of the two yields "range of recorded extremes" as noted in the figure, and recorded in column 6 of the tables. This number is comparable in principle to that produced by a mechanical scratch gage. The largest and smallest instantaneous stress are not necessarily associated except that they were observed in the same 20.5 minute sample. The second item obtained in the present analysis was the process rms, which is the square root of the mean squared deviation from the sample mean for the entire time history analyzed. The numbers produced by the TMR analysis were derived after two filtering operations separated "wave induced stress" and "vibratory stress." Sketches of the result of this operation upon the raw stresses are indicated in Figure 2. The TMR analysis produced only one number from the vibratory part of the stress, "the maximum first mode stress." As noted in Figure 2 this is just the largest double amplitude of vibration in the record. (It should be noted also that the TMR analysis recorded zero vibratory stress if the maximum vibration double amplitude was less than 0.4 to 0.6 kpsi.) With respect to the "wave induced stress" the basic TMR analysis is a "peak to trough" analysis; that is, a series of numbers representing the swing in stress (double amplitude) from each positive maximum to the succeeding negative

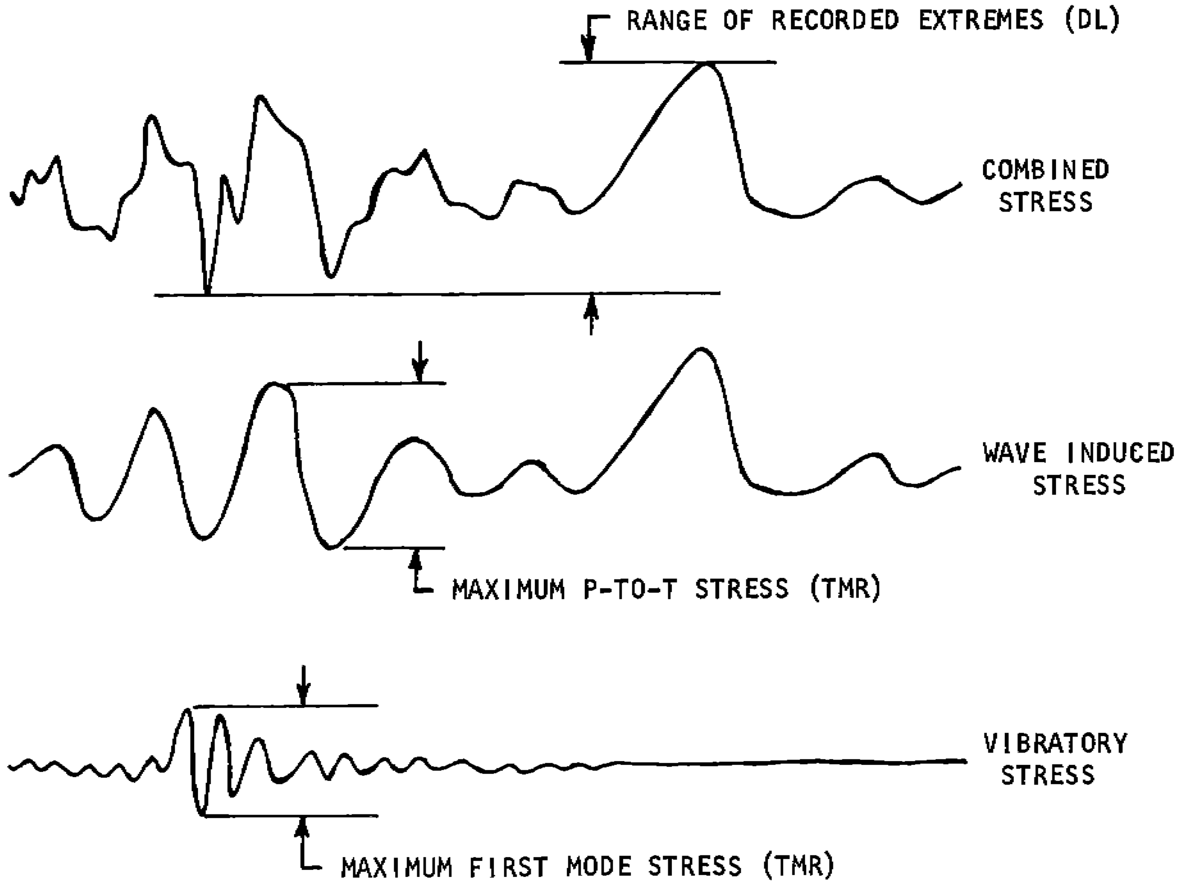

FIGURE 2 SKETCH ILLUSTRATING MAXIMUM STRESS PARAMETERS

minimum (the zero crossing convention is employed). A computation of the root mean square of this series of double amplitudes yields the number given in column 4 of the part c tables. Finally, the largest wave induced double amplitude is extracted and this number appears in column 3 of the table.

Now considering a comparison of the present "range of recorded extremes" with the TMR results it should first be noted that the "range of recorded extremes" could be exactly equal to the maximum peak-trough wave induced moment or practically equal to the sum of maximum wave induced and maximum vibratory double amplitudes. Given the non-ideal characteristics of real data (the sketches in Figure 2 are fairly realistic) the above is most unlikely. Thus, as far as correlations with the TMR results are concerned, the present range of recorded extremes would be expected to be larger than the maximum peak to trough bending stress found by TMR; and quite possibly smaller than the sum of the TMR maximum peak to trough bending stress and the TMR maximum first mode stress. At the right of the table the ratios of the corresponding columns are formed. The ratio of range to maximum peak to trough (6/3) averaged over all 198 intervals is 1.34, a reasonable result. The corresponding average ratio of range to sum of maximum bending and maximum burst (6/3+5) is 1.12, higher than was initially thought. If intervals in which the maximum burst stress is shown as zero are eliminated, this average is 1.04. It may be noted that tape over saturation (Table XIVc, Run 1945) produces quite unrealistic looking ratios. The TMR analysis may well not have included whatever produced the saturation in the present analysis.

Column 7 in the "c" part of the tables is $2\sqrt{2}$ times the scaled up stress process rms. This estimate should compare with the value given by TMR for "rms P to T stress," according to the Rayleigh assumption in common use. How well these latter two estimates compare is indicated by the ratio of column 7 to 4 shown at the right of the table. The mean value of this ratio is 1.18 over all 198 intervals. Since the D.L. digitization produces an rms which includes the effect of longitudinal first mode vibration and the TMR results should not be inclusive of vibration, this appeared to be a reasonable result. Casual examination of the ratio of column 7 to 4 indicates that the estimates are often closer together when the signal magnitude is large. However no further quantitative correlations were attempted.

Column 8 of part "c" of the tables is the scaled difference of the sample mean of the interval noted, from the sample mean of the first interval digitized in each voyage leg. This quantity should reflect the effects of ballast changes during the voyage. Direct correlation with results produced by TMR was not possible within the scope of information available for this project.

Given the present state of knowledge about how the extremes of vibratory and wave induced stress ought to combine, and the extent to which the Rayleigh assumption is generally valid for wave induced stress, there seemed about as much change of the expectations being wrong as the various analyses. In any event, the comparisons of the two different sets of results implied that no gross systematic problems were present in the present data reduction scheme.

Magnitude of Radar, Motion and Tucker Meter Signals

Part d of the tables involves scaled up indices of the magnitude of radar, roll, pitch, vertical and transverse acceleration, and Tucker meter signals. The first index in each case is 4.0 x the rms. This is a conventional approach to the significant double amplitude (or the average of the 1/3 highest double amplitudes).

The second and third indices are the positive and negative extremes for each channel. The extremes observed for roll and pitch were corrected for electrical zero on tape before scaling. The extremes for all other items were corrected to the sample mean before scaling. As a consequence, shifts in the mean of the radar are washed out, and the one "g" bias in vertical acceleration disappears. The extreme values shown are reasonably symmetrical, and, as was pointed out in a previous section, bear a believable relationship to the rms value.

All of the scaled up values in the part d tables appear physically possible. The magnitude of pitch seems quite reasonable. That for vertical acceleration is high, but the effects of vibration are included. Roll magnitudes seem high in general, and since the transverse acceleration magnitudes include a substantial gravity component due to roll angle, the magnitude of this channel follows that of roll. In general the magnitude of the radar signal appears proportionally about as much higher than the visually observed wave and swell height as the Tucker meter signal appears lower. It should be emphasized that neither radar or Tucker signals have been corrected for anything. The radar channel in particular appears to be significantly affected by roll.

The resolution of each channel on the basis of ± 1% of nominal full scale of the tape recorder is approximately as follows:

Radar	± 0.5 ft
Roll	± 0.25 degree
Pitch	± 0.12 degree
Accelerations	± 0.01 g
Tucker Meter	± 0.2 ft

Thus the majority of the data in the part "d" tables appears to be substantially above the noise level.

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2. Wheaton, J.W. and Boentgen, R.R., "Second Season Results from Ship Response Instrumentation Aboard the SL-7 Containership S.S. SEA-LAND McLEAN in North Atlantic Service," SL-7-9, 1976, AD-A034162.

TABLE VI (a)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 32 EAST

D.L. RUN NO.	TMR TAPE NO.	TMR INDX NO.	TMR INTV NO.	DATE	TIME (GMT)	LATITUDE	LONGITUDE	COURSE	SPEED KT.	PROP RPM	DRAFT FT.	SEA/AIR TEMP
113	139	4	13	12-30-73	2400	40-38 N	68-17 W	079	33.0	133.8	30.00	43/50
117	139	5	17	12-31-73	0400	40-38 N	68-17 W	079	32.7	132.4	30.05	44/50
121	139	6	21	12-31-73	0800	40-38 N	68-17 W	079	32.7	132.4	30.11	48/48
133	139	9	33	12-31-73	2000	42-49 N	52-42 W	078	32.6	132.2	30.28	45/55
137	139	10	37	12-31-73	2400	42-49 N	52-42 W	078	21.1	85.7	30.28	42/42
141	139	11	41	01-01-74	0400	42-49 N	52-42 W	078	21.0	85.1	30.24	46/46
145	139	12	45	01-01-74	0800	42-49 N	52-42 W	078	21.4	86.7	30.20	60/49
149	139	13	49	01-01-74	1200	42-49 N	52-42 W	078	21.3	86.3	30.20	47/48
153	139	14	53	01-01-74	1400	44-39 N	40-31 W	078	21.1	85.5	30.22	47/50
157	139	15	57	01-01-74	1600	44-39 N	40-31 W	090	21.0	85.1	30.01	58/52
161	139	16	61	01-01-74	2000	44-39 N	40-31 W	090	21.9	88.7	30.00	46/50
201	141	17	1	01-01-74	2400	44-39 N	40-31 W	090	20.8	84.5	29.89	52/50
205	141	18	5	01-02-74	0400	44-39 N	40-31 W	090	21.0	85.3	29.81	56/50
209	141	19	9	01-02-74	0800	44-39 N	40-31 W	075	21.4	87.0	29.85	56/52
213	141	20	13	01-02-74	1200	45-00 N	29-29 W	075	22.5	91.2	29.85	55/54
217	141	21	17	01-02-74	1600	45-00 N	29-29 W	090	24.1	97.6	29.63	56/56
221	141	22	21	01-02-74	2000	45-00 N	29-29 W	085	27.2	110.4	29.66	55/51
225	141	23	25	01-02-74	2400	45-00 N	29-29 W	085	27.1	109.9	29.53	55/52
229	141	24	29	01-03-74	0400	45-00 N	29-29 W	070	27.7	112.2	29.45	56/50
233	141	25	33	01-03-74	0800	45-00 N	29-29 W	070	27.7	112.4	29.50	54/50
237	141	26	37	01-03-74	1200	47-10 N	15-26 W	070	27.7	112.3	29.36	55/58
241	141	27	41	01-03-74	1600	47-10 N	15-26 W	070	27.7	112.3	29.33	56/54
245	141	28	45	01-03-74	2000	47-10 N	15-26 W	074	27.7	112.3	29.46	53/
249	141	29	49	01-03-74	2400	47-10 N	15-26 W	075	27.5	111.7	29.39	54/52

TABLE VI (b)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 32 EAST

D.L. RUN NO.	SEA STATE	<REL WIND> DIR/SPEED /(KT)	REL WAVE DIR	WAVE HT. FT.	REL SWELL DIR	<-SWELL-> HT FT.	LENGTH FT.	VISUAL WEATHER /TMR LOG-BOOK COMMENTS
113	7	169P/30	169P	5	169P	5	300	CLEAR /
117	7	169P/30	169P	6	169P	5	300	CLEAR /
121	6	169P/22	169P	5	169P	5	300	PTLY CLDY /
133	5	125P/20	168P	5	168P	5	300	CLDY /
137	4	168P/20	168P	5	168P	5	250	OCAST /
141	5	168P/20	168P	8	168P	8	250	OCAST /
145	5	123P/20	168P	10	168P	10	200	OCAST /
149	7	123P/28	123P	15	123P	12	200	OCAST /
153	7	123P/30	168P	18	168P	15	200	OCAST /
157	8	157P/35	157P	20	157P	15	200	CLDY /HEAVY ROLLS
161	8	135P/35	135P	20	135P	15	200	CLDY /
201	9	157P/40	157P	20	157P	15	200	CLDY /
205	8	157P/40	157P	12	135P	12	300	PT CLDY /
209	7	120P/40	120P	10	120P	12	300	PT CLDY /
213	9	120P/45	120P	12	120P	15	300	PT CLDY /
217	9	146P/50	157P	15	157P	15	300	CLDY /
221	8	141P/30	141P	12	141P	15	300	CLDY /ROLLING AND PITCHING
225	8	130P/45	130P	12.	130P	10	400	PT CLDY /RAIN SQUALLS
229	8	92P/45	115P	12	115P	10	500	CLDY /ROLLING MOD TO HEAVY
233	5	115P/35	115P	8	115P	10	500	CLDY /
237	6	115P/30	115P	10	115P	8	500	PT CLDY /
241	7	155S/30	155S	10	160P	10	500	PT CLDY /
245	6	151S/25	151S	10	151S	8	400	CLDY /'
249	6	150S/25	165P	8	165P	8	300	PT CLDY /

TABLE VI(c)

COMPARISON OF TMR RESULTS FOR MIDSHIP VERTICAL BENDING STRESS WITH CORRESPONDING RAW DIGITIZATION RESULTS AT DAVIDSON LABORATORY

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 32 EAST

D.L. RUN NO.	TMR RESULTS: NO. WAVE INDUCED CYCLES (1)	NO. 1ST MODE BURSTS (2)	MAX P-TO-T STRESS KPSI (3)	RMS P-TO-T STRESS KPSI (4)	MAX 1ST MODE STRESS KPSI (5)	D.L. DIGITIZATION: RANGE OF RECORDED EXTREMES KPSI (6)	2.83X (SAMPLE RMS) KPSI (7)	REL MEAN STRESS KPSI (8)	COLUMN RATIOS: (7) / (4)	(6) / (3+5)	(6) / (3)
113	83	0	3.55	1.63	0.00	4.95	2.06	-0.65	1.27	1.39	1.39
117	66	0	4.23	1.71	0.00	4.85	2.11	-0.82	1.23	1.15	1.15
121	57	0	3.79	1.77	0.00	6.47	2.95	-0.92	1.67	1.70	1.70
133	91	0	3.99	1.74	0.00	4.66	1.89	-0.52	1.09	1.17	1.17
137	105	0	4.26	1.42	0.00	4.62	1.66	-0.96	1.17	1.08	1.08
141	81	0	3.04	1.38	0.00	5.54	1.49	-1.19	1.08	1.82	1.82
145	76	0	5.93	2.98	0.00	6.31	2.97	-1.19	1.00	1.06	1.06
149	65	0	8.50	4.14	0.00	12.50	5.08	-0.17	1.23	1.47	1.47
153	55	1	13.41	6.07	0.58	11.40	5.55	-0.10	0.91	0.81	0.85
157	58	1	14.80	7.18	0.57	15.70	7.02	0.04	0.98	1.02	1.06
161	55	1	12.48	5.96	0.63	13.56	6.40	-0.10	1.07	1.03	1.09
201	57	0	12.30	7.02	0.00	14.60	7.36	-0.12	1.05	1.19	1.19
205	60	1	10.40	5.75	0.69	11.46	5.94	0.11	1.03	1.03	1.10
209	68	17	10.69	5.10	1.64	14.56	6.24	-0.09	1.22	1.18	1.36
213	58	8	12.89	7.61	1.11	15.25	7.91	0.06	1.04	1.09	1.18
217	61	11	15.80	5.93	0.90	18.94	7.10	0.22	1.20	1.13	1.20
221	56	15	11.63	6.32	1.09	15.64	7.11	-0.41	1.12	1.23	1.34
225	44	0	11.43	6.20	0.00	16.19	7.03	-0.59	1.14	1.42	1.42
229	48	7	10.95	6.26	0.83	14.33	6.72	-0.55	1.07	1.22	1.31
233	43	2	10.39	5.26	0.60	10.91	5.31	-0.59	1.01	0.99	1.05
237	44	0	8.01	4.78	0.00	10.26	5.58	-0.41	1.17	1.28	1.28
241	46	0	9.04	4.47	0.00	9.51	4.84	-0.54	1.08	1.05	1.05
245	46	1	13.80	5.18	0.57	13.44	5.68	-0.68	1.10	0.94	0.97
249	62	3	6.98	3.39	0.74	8.78	4.14	-0.94	1.22	1.14	1.26

TABLE VI(d)

SUMMARY OF RAW DIGITIZATION RESULTS FOR RADAR RANGE ROLL, PITCH, DECK HOUSE ACCELERATIONS, AND TUCKER METER

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 32 EAST

D.L. RUN NO.	RADAR 4.0 (RMS) FT	RADAR RECORDED EXTREMES FT	FT	ROLL 4.0 (RMS) DEG	ROLL RECORDED EXTREMES DEG	DEG	PITCH 4.0 (RMS) DEG	PITCH RECORDED EXTREMES DEG	DEG	VERT ACCEL 4.0 (RMS) (G)	VERT ACCEL RECORDED EXTREMES (G)	(G)	LAT ACCEL 4.0 (RMS) (G)	LAT ACCEL RECORDED EXTREMES (G)	(G)	TUCKER 4.0 (RMS) FT	TUCKER RECORDED EXTREMES FT	FT
113	24.	24.	-17.	9.9	7.	-11.	0.4	-0.2	-1.1	0.08	0.1	-0.1	0.27	0.2	-0.2	3.	2.	-3.
117	21.	16.	-18.	8.6	6.	-5.	0.4	-0.2	-0.9	0.07	0.1	-0.1	0.19	0.1	-0.1	2.	2.	-2.
121	23.	18.	-16.	9.4	7.	-7.	0.4	-0.1	-0.8	0.07	0.1	-0.1	0.20	0.2	-0.1	2.	2.	-2.
133	17.	17.	-14.	6.2	5.	-5.	0.5	0.1	-0.9	0.10	0.1	-0.1	0.15	0.1	-0.1	3.	2.	-2.
137	16.	14.	-13.	5.2	3.	-5.	0.6	0.0	-0.9	0.11	0.1	-0.1	0.13	0.1	-0.1	2.	2.	-2.
141	16.	14.	-14.	6.6	4.	-6.	0.5	0.1	-0.8	0.10	0.1	-0.1	0.15	0.1	-0.1	2.	2.	-2.
145	20.	15.	-18.	13.6	12.	-12.	0.5	0.1	-0.8	0.09	0.1	-0.1	0.32	0.3	-0.3	4.	3.	-3.
149	28.	21.	-21.	21.7	17.	-15.	0.7	0.3	-0.9	0.10	0.1	-0.1	0.49	0.4	-0.4	5.	5.	-4.
153	30.	27.	-25.	21.3	16.	-14.	0.7	0.2	-0.8	0.08	0.1	-0.1	0.46	0.3	-0.3	5.	5.	-4.
157	33.	28.	-32.	24.7	18.	-18.	0.7	0.2	-0.9	0.12	0.1	-0.1	0.55	0.4	-0.4	7.	6.	-6.
161	32.	28.	-23.	22.2	17.	-17.	0.8	0.3	-0.9	0.11	0.1	-0.1	0.49	0.4	-0.4	7.	6.	-6.
201	35.	30.	-35.	23.1	21.	-16.	0.8	0.5	-0.9	0.11	0.1	-0.1	0.51	0.4	-0.5	8.	7.	-5.
205	33.	35.	-28.	26.4	18.	-18.	0.7	0.2	-0.9	0.12	0.1	-0.1	0.59	0.4	-0.4	9.	8.	-7.
209	29.	24.	-26.	25.0	23.	-14.	0.8	0.5	-0.9	0.18	0.2	-0.1	0.55	0.3	-0.5	9.	7.	-7.
213	32.	31.	-28.	26.8	23.	-16.	0.9	0.4	-0.9	0.17	0.2	-0.2	0.63	0.4	-0.5	10.	9.	-7.
217	30.	24.	-26.	20.3	20.	-12.	0.8	0.5	-1.0	0.17	0.2	-0.1	0.47	0.3	-0.4	9.	7.	-7.
221	33.	26.	-24.	24.1	21.	-13.	0.8	0.5	-1.0	0.16	0.2	-0.1	0.56	0.4	-0.5	8.	7.	-8.
225	31.	25.	-25.	17.0	17.	-11.	0.6	0.4	-0.9	0.11	0.1	-0.1	0.38	0.3	-0.4	6.	5.	-4.
229	26.	24.	-24.	21.4	14.	-12.	0.8	0.3	-1.0	0.12	0.1	-0.1	0.47	0.3	-0.3	7.	6.	-5.
233	24.	18.	-19.	16.1	13.	-12.	0.6	0.2	-0.8	0.10	0.1	-0.1	0.36	0.3	-0.3	6.	4.	-4.
237	23.	24.	-21.	17.4	15.	-12.	0.7	0.6	-0.9	0.10	0.1	-0.1	0.36	0.2	-0.3	5.	5.	-4.
241	25.	20.	-20.	16.6	10.	-14.	0.7	0.2	-0.9	0.11	0.1	-0.1	0.36	0.3	-0.3	5.	3.	-4.
245	26.	21.	-20.	15.0	9.	-16.	0.9	0.5	-1.0	0.11	0.1	-0.1	0.32	0.3	-0.3	5.	4.	-4.
249	31.	34.	-20.	16.1	8.	-19.	0.9	0.2	-1.6	0.11	0.1	-0.1	0.35	0.3	-0.3	4.	3.	-2.

TABLE VII(a)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 32 WEST

D.L. RUN NO.	TMR TAPE NO.	TMR INDX NO.	TMR INTV NO.	DATE	TIME (GMT)	LATITUDE	LONGITUDE	COURSE	SPEED KT.	PROP RPM	DRAFT FT.	SEA/AIR TEMP
309	143	3	9	01-08-74	1500	51-39 N	02-07 E	260	31.5	127.6	29.38	48/44
313	143	4	13	01-08-74	1710	51-39 N	02-07 E	260	31.5	127.6	29.38	48/44
337	143	9	36	01-09-74	1200	45-08 N	13-30 W	233	32.6	132.0	29.87	45/55
341	143	10	40	01-09-74	1600	45-08 N	13-30 W	233	32.7	132.4	29.80	55/58
345	143	11	44	01-09-74	2000	45-08 N	13-30 W	267	32.3	131.0	29.69	55/52
349	143	12	48	01-09-74	2400	45-08 N	13-30 W	266	31.8	129.0	29.40	54/54
357	143	15	58	01-10-74	1200	43-29 N	24-51 W	245	11.0	44.9	29.62	54/54
361	143	15	60	01-10-74	1200	43-29 N	24-51 W	245	11.0	44.9	29.62	54/54
401	145	17	1	01-10-74	2000	43-29 N	24-51 W	250	8.7	35.3	29.84	45/50
405	145	18	5	01-10-74	2400	43-29 N	24-51 W	250	10.9	44.3	29.63	55/48
409	145	19	9	01-11-74	0400	43-29 N	24-51 W	240	26.1	105.9	28.90	55/48
413	145	20	13	01-11-74	0800	43-29 N	24-51 W	240	11.0	44.9	29.46	57/52
421	145	22	21	01-11-74	1600	41-31 N	29-25 W	270	12.4	50.3	29.70	58/51
425	145	23	25	01-11-74	2000	41-31 N	29-25 W	270	16.2	65.7	29.88	56/44
429	145	24	29	01-11-74	2400	41-31 N	29-25 W	270	18.7	75.9	29.89	57/46
437	145	26	37	01-12-74	0800	41-31 N	29-25 W	271	28.4	115.1	29.63	58/52
441	145	27	41	01-12-74	1200	41-07 N	40-08 W	245	32.5	131.9	29.64	58/
450	145	29	50	01-12-74	1630	41-07 N	40-08 W	245	28.1	122.0	29.66	61/53
453	145	30	53	01-12-74	2000	41-07 N	40-08 W	269	32.5	131.8	29.71	59/49
461	145	32	61	01-13-74	0400	41-07 N	40-08 W	272	29.6	119.9	29.40	63/59
465	145	33	65	01-13-74	0800	41-07 N	40-08 W	272	32.6	132.1	29.64	50/50
507	147	36	7	01-13-74	2000	40-17 N	56-29 W	274	31.9	129.3	30.14	61/38
512	147	37	12	01-13-74	2400	40-17 N	56-29 W	272	28.5	115.5	30.30	65/35
513	147	38	13	01-14-74	0400	40-17 N	56-29 W	274	32.8	132.9	30.42	61/31

TABLE VII(b)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 32 WEST

D.L. RUN NO.	SEA STATE	<REL WIND> DIR/SPEED /(KT)	REL WAVE DIR	WAVE HT. FT.	REL SWELL DIR	<-SWELL-> HT FT.	LENGTH FT.	VISUAL WEATHER /TMR LOG-BOOK COMMENTS
309	10	35P/55	35P	10	35P	8	250	OCAST /
313	10	35P/55	35P	10	35P	10	400	OCAST /
337	9	14S/45	8P	15	8P	10	500	CLDY /
341	7	30P/40	30P	15	8P	10	500	CLDY /
345	8	64P/45	64P	10	64P	10	500	CLDY /
349	9	41P/50	41P	15	41P	10	500	OCAST /
359	9	2S/55	2S	30	25S	15	500	CLDY RAIN SQUALLS /
361	9	2S/55	2S	30	25S	15	500	CLDY RAIN SQUALLS /
401	9	20S/50	20S	25	20S	20	500	OCAST RAIN /
405	7	2P/55	2P	25	2P	20	500	OCAST /
409	12	37P/60	37P	35	37P	20	500	OCAST /
413	11	15P/60	15P	35	30S	20	500	OCAST RAIN /
421	11	45S/60	45S	30	45S	25	400	PT CLDY /
425	10	45S/60	45S	20	45S	25	400	OCAST /
429	10	45S/60	0	20	0	25	500	OCAST RAIN SQUALLS /
437	9	91P/50	91P	15	91P	20	400	OCAST /
441	10	2S/50	2S	25	2S	20	400	OCAST /
450	9	2S/45	2S	25	2S	20	400	OCAST /
453	9	44P/45	44P	15	44P	20	400	OCAST /IN AUTO OPERATION
461	7	47P/40	47P	15	2P	12	500	OCAST /
465	10	43S/50	43S	25	43S	20	500	OCAST /HEAVY RAIN SQUALLS
507	9	41S/45	41S	15	41S	20	400	OCAST /HEAVY HAIL
512	9	43S/45	43S	10	43S	20	400	RAIN SNOW /
513	4	41S/35	41S	4	41S	8	300	OCAST /

TABLE VII(c)

COMPARISON OF TMR RESULTS FOR MIDSHIP VERTICAL BENDING STRESS WITH CORRESPONDING RAW DIGITIZATION RESULTS AT DAVIDSON LABORATORY

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 32 WEST

	TMR RESULTS					D.L. DIGITIZATION			COLUMN RATIOS		
D.L. RUN NO.	NO. WAVE INDUCED CYCLES (1)	NO. 1ST MODE BURSTS (2)	MAX P-TO-T STRESS KPSI (3)	RMS P-TO-T STRESS KPSI (4)	MAX 1ST MODE STRESS KPSI (5)	RANGE OF RECORDED EXTREMES KPSI (6)	2.83X (SAMPLE RMS) KPSI (7)	REL MEAN STRESS KPSI (8)	(7) / (4)	(6) / (3+5)	(6) / (3)
309	153	9	3.55	1.76	1.29	6.56	2.11	-0.19	1.20	1.36	1.85
313	212	62	11.02	3.99	7.58	10.98	4.19	-0.10	1.05	0.59	1.00
337	186	34	6.73	2.99	2.66	9.45	3.28	-0.58	1.10	1.01	1.40
341	179	60	8.33	3.43	4.97	13.83	3.53	-0.33	1.03	1.04	1.66
345	199	62	9.83	4.22	3.19	12.79	4.70	-0.24	1.11	0.98	1.30
349	142	65	14.51	7.25	4.16	19.02	7.49	1.52	1.03	1.02	1.31
359	109	49	17.32	10.06	2.33	23.11	10.46	-0.18	1.04	1.18	1.33
361	113	50	19.98	9.46	2.75	21.83	9.56	-0.08	1.01	0.96	1.09
401	113	9	19.36	7.60	3.28	21.07	7.88	-0.23	1.04	0.93	1.09
405	117	6	15.97	6.74	2.31	19.51	6.57	-0.35	0.97	1.07	1.22
409	158	37	13.71	4.70	3.86	16.80	4.96	-1.71	1.05	0.96	1.23
413	135	27	19.15	7.25	3.70	21.18	7.10	-0.48	0.98	0.93	1.11
421	132	28	17.53	7.54	3.61	17.84	7.16	-0.13	0.95	0.84	1.02
425	140	29	16.43	6.77	4.75	21.44	6.60	-0.27	0.97	1.01	1.30
429	150	47	14.39	6.34	4.42	17.49	6.42	-0.96	1.01	0.93	1.22
437	173	43	15.35	5.35	8.98	22.11	5.69	-1.37	1.06	0.91	1.44
441	197	23	6.63	3.30	3.25	11.59	3.93	-1.00	1.19	1.17	1.75
450	183	29	11.34	5.37	4.07	15.90	6.07	-0.10	1.13	1.03	1.40
453	208	23	7.64	3.40	3.43	14.46	4.08	-0.62	1.20	1.31	1.89
461	179	31	12.17	5.03	5.38	17.84	5.25	0.57	1.04	1.02	1.47
465	199	11	7.68	3.55	3.05	11.12	4.09	-0.44	1.15	1.04	1.45
507	210	11	10.09	3.67	3.20	12.44	4.48	-0.36	1.22	0.94	1.23
512	198	23	8.34	4.10	5.35	14.40	4.39	0.34	1.07	1.05	1.73
513	230	6	6.10	2.92	1.84	10.40	3.74	-0.10	1.28	1.31	1.70

TABLE VII(d)

SUMMARY OF RAW DIGITIZATION RESULTS FOR RADAR RANGE ROLL, PITCH, DECK HOUSE ACCELERATIONS, AND TUCKER METER

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 32 WEST

	RADAR			ROLL			PITCH			VERT ACCEL			LAT ACCEL			TUCKER		
D.L. RUN NO.	4.0 (RMS) FT	RECORDED EXTREMES FT	FT	4.0 (RMS) DEG	RECORDED EXTREMES DEG	DEG	4.0 (RMS) DEG	RECORDED EXTREMES DEG	DEG	4.0 (RMS) (G)	RECORDED EXTREMES (G)	(G)	4.0 (RMS) (G)	RECORDED EXTREMES (G)	(G)	4.0 (RMS) FT	RECORDED EXTREMES FT	FT
309	15.	13.	-13.	5.0	7.	-2.	0.6	0.2	-1.2	0.16	0.2	-0.1	0.15	0.2	-0.1	2.	2.	-2.
313	28.	28.	-39.	3.2	4.	-4.	1.3	0.5	-1.7	0.29	0.2	-0.2	0.11	0.2	-0.1	3.	3.	-3.
337	34.	28.	-23.	7.3	6.	-7.	1.7	0.9	-1.8	0.39	0.3	-0.3	0.21	0.2	-0.2	7.	5.	-6.
341	33.	32.	-41.	4.8	4.	-3.	1.8	1.2	-2.1	0.41	0.5	-0.4	0.15	0.1	-0.1	6.	5.	-5.
345	37.	29.	-34.	4.9	8.	-2.	2.1	1.2	-2.1	0.46	0.4	-0.3	0.16	0.1	-0.2	5.	4.	-5.
349	54.	41.	-38.	5.9	7.	-5.	2.2	2.0	-1.9	0.49	0.4	-0.4	0.19	0.2	-0.2	7.	5.	-6.
359	68.	59.	-48.	23.7	19.	-21.	1.9	2.0	-1.6	0.44	0.3	-0.4	0.64	0.6	-0.5	17.	11.	-11.
361	58.	45.	-50.	15.9	12.	-12.	2.0	2.0	-1.8	0.43	0.3	-0.4	0.43	0.3	-0.3	13.	10.	-11.
401	60.	69.	-50.	23.3	15.	-19.	1.7	1.9	-1.5	0.38	0.3	-0.4	0.62	0.5	-0.4	13.	9.	-10.
405	51.	50.	-35.	18.7	18.	-17.	1.7	1.6	-1.6	0.40	0.3	-0.3	0.50	0.5	-0.5	13.	9.	-10.
409	51.	56.	-48.	14.1	15.	-15.	2.4	2.3	-2.1	0.55	0.4	-0.6	0.39	0.4	-0.5	12.	11.	-11.
413	62.	45.	-53.	17.0	13.	-15.	2.0	2.1	-1.8	0.48	0.4	-0.5	0.47	0.4	-0.4	11.	8.	-8.
421	53.	41.	-51.	7.6	5.	-7.	1.9	1.9	-1.8	0.43	0.3	-0.4	0.21	0.2	-0.2	8.	6.	-6.
425	59.	54.	-54.	8.4	6.	-7.	2.2	2.2	-1.9	0.52	0.4	-0.5	0.23	0.3	-0.2	10.	11.	-8.
429	61.	47.	-57.	8.5	6.	-7.	2.6	2.3	-2.2	0.60	0.5	-0.5	0.25	0.2	-0.2	9.	7.	-7.
437	54.	51.	-54.	7.6	7.	-9.	2.6	2.4	-2.3	0.60	0.6	-0.5	0.22	0.3	-0.2	8.	6.	-8.
441	38.	32.	-48.	7.8	6.	-9.	2.0	1.1	-2.1	0.44	0.4	-0.3	0.22	0.2	-0.2	7.	5.	-6.
450	47.	35.	-52.	8.8	6.	-7.	2.4	1.5	-2.2	0.51	0.4	-0.4	0.22	0.2	-0.2	6.	4.	-5.
453	34.	32.	-42.	6.6	7.	-4.	1.8	1.3	-2.0	0.38	0.4	-0.3	0.18	0.2	-0.2	5.	4.	-4.
461	43.	35.	-42.	5.2	4.	-4.	2.3	1.7	-2.1	0.49	0.4	-0.4	0.15	0.2	-0.1	5.	3.	-5.
465	32.	25.	-28.	5.8	3.	-7.	1.8	1.1	-2.2	0.39	0.4	-0.3	0.15	0.1	-0.1	4.	3.	-4.
507	33.	24.	-42.	8.5	5.	-8.	1.6	0.9	-2.0	0.34	0.3	-0.3	0.21	0.2	-0.2	4.	3.	-3.
512	32.	27.	-28.	6.3	3.	-9.	1.9	0.9	-2.1	0.42	0.4	-0.3	0.17	0.1	-0.2	4.	3.	-4.
513	25.	23.	-19.	5.1	2.	-6.	1.1	0.5	-1.4	0.25	0.2	-0.2	0.14	0.1	-0.1	3.	2.	-3.

TABLE VIII(a)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 33 EAST

D.L. RUN NO.	TMR TAPE NO.	TMR INDX NO.	TMR INTV NO.	DATE	TIME (GMT)	LATITUDE	LONGITUDE	COURSE	SPEED KT.	PROP RPM	DRAFT FT.	SEA/AIR TEMP
601	149	1	1	01-17-74	1600	40-20 N	70-19 W	090	32.2	130.4	30.04	48/35
605	149	2	5	01-17-74	2000	40-20 N	70-19 W	079	32.3	131.0	30.01	47/36
609	149	3	9	01-17-74	2400	40-20 N	70-19 W	079	32.1	130.0	30.05	48/24
613	149	4	13	01-18-74	0400	40-20 N	70-19 W	079	29.7	120.6	30.01	65/20
621	149	6	21	01-18-74	1200	40-20 N	70-19 W	078	32.5	131.9	29.96	60/29
625	149	7	25	01-18-74	1600	42-17 N	55-25 W	078	32.4	131.3	29.93	54/34
629	149	8	29	01-18-74	2000	42-17 N	55-25 W	078	32.3	131.0	29.80	48/34
633	149	9	33	01-18-74	2400	42-17 N	55-25 W	078	32.4	131.3	29.88	34/33
637	149	10	37	01-19-74	0400	42-17 N	55-25 W	077	32.5	131.6	29.80	48/33
641	149	11	41	01-19-74	0800	42-17 N	55-25 W	077	32.5	131.9	29.75	40/34
645	149	12	45	01-19-74	1100	42-17 N	55-25 W	077	32.2	130.7	29.63	54/45
649	149	13	49	01-19-74	1310	44-30 N	39-55 W	077	32.2	130.7	29.63	54/45
653	149	14	53	01-19-74	1530	44-30 N	39-55 W	078	32.4	131.5	29.67	55/47
657	149	15	57	01-19-74	1740	44-30 N	39-55 W	078	32.4	131.5	29.67	55/47
702	151	17	2	01-19-74	2000	44-30 N	39-55 W	070	32.5	131.7	29.81	65/48
705	151	18	5	01-19-74	2400	44-30 N	39-55 W	078	32.4	131.4	29.83	55/43
709	151	19	9	01-20-74	0400	44-30 N	39-55 W	078	32.5	131.6	29.88	53/49
713	151	20	13	01-20-74	0800	44-30 N	39-55 W	078	32.6	132.1	30.00	53/51
717	151	21	17	01-20-74	1200	46-57 N	23-30 W	079	32.4	131.3	30.00	53/58
721	151	22	21	01-20-74	1600	46-57 N	23-30 W	079	32.7	132.6	30.00	52/52
725	151	23	25	01-20-74	2000	46-57 N	23-30 W	077	32.7	132.5	30.07	52/52
729	151	24	29	01-20-74	2400	46-57 N	23-30 W	077	32.0	129.6	29.89	52/50
733	151	25	33	01-21-74	0400	46-57 N	23-30 W	077	32.3	131.1	29.95	53/54
737	151	26	37	01-21-74	0800	46-57 N	23-30 W	077	32.9	133.4	30.10	52/54

TABLE VIII(b)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 33 EAST

D.L. RUN NO.	SEA STATE	<REL WIND> DIR/SPEED /(KT)	REL WAVE DIR	WAVE HT. FT.	REL SWELL DIR	<-SWELL-> HT FT.	<-SWELL-> LENGTH FT.	VISUAL WEATHER /TMR LOG-BOOK COMMENTS
601	6	45P/25	90P	4	90P	10	400	PT CLDY /
605	7	79P/30	79P	8	79P	10	400	OCAST /SHIP RIDING EASILY
609	8	79P/35	79P	10	79P	12	400	OCAST /
613	8	79P/38	79P	10	79P	12	400	OCAST /
621	7	78P/30	78P	12	78P	12	400	CLDY /
625	8	100P/35	78P	20	78P	12	400	CLDY /
629	8	145P/35	145P	20	123P	12	500	CLDY /SHIPPING WATER OVER BOW
633	8	123P/35	123P	20	123P	12	500	CLDY /
637	9	122P/35	122P	20	122P	15	500	OCAST /
641	8	122P/35	122P	20	122P	15	500	CLDY /
645	9	167P/40	144P	20	144P	15	500	OCAST /
649	9	167P/40	144P	20	144P	15	500	OCAST /SAW 33 DEG ROLL
653	10	145P/45	145P	25	145P	15	600	PT CLDY /MANUAL OPERATION
657	10	145P/45	145P	20	145P	15	600	PT CLDY /
702	7	145P/35	145P	12	145P	12	600	PT CLDY /BACK IN AUTO OPERATION
705	6	145P/25	145P	8	145P	10	400	PT CLDY /
709	6	123P/25	123P	8	145P	10	400	CLDY /
713	5	168P/25	168P	4	168P	10	400	PT CLDY /
717	5	169P/20	169P	4	169P	8	300	PT CLDY /
721	4	124P/20	124P	4	169S	8	300	PT CLDY /
725	4	167P/20	167P	4	167P	6	300	PT CLDY /
729	6	77P/20	77P	6	77P	6	300	OCAST /
733	6	35S/20	35S	6	35S	4	300	OCAST /
737	5	58S/15	58S	6	58S	4	300	CLDY /

TABLE VIII(c)

COMPARISON OF TMR RESULTS FOR MIDSHIP VERTICAL BENDING STRESS WITH CORRESPONDING RAW DIGITIZATION RESULTS AT DAVIDSON LABORATORY

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 33 EAST

	TMR RESULTS					D.L. DIGITIZATION			COLUMN RATIOS		
D.L. RUN NO.	NO. WAVE INDUCED CYCLES (1)	NO. 1ST MODE BURSTS (2)	MAX P-TO-T STRESS KPSI (3)	RMS P-TO-T STRESS KPSI (4)	MAX 1ST MODE STRESS KPSI (5)	RANGE OF RECORDED EXTREMES KPSI (6)	2.83X (SAMPLE RMS) KPSI (7)	REL MEAN STRESS KPSI (8)	(7) / (4)	(6) / (3+5)	(6) / (3)
601	215	16	2.29	1.01	1.19	3.54	1.40	-0.00	1.38	1.02	1.55
605	156	36	3.75	2.00	1.52	6.09	2.29	0.11	1.14	1.16	1.63
609	96	36	6.73	3.40	2.61	7.88	3.38	0.10	0.99	0.84	1.17
613	97	51	7.83	3.41	2.29	10.41	4.26	0.04	1.25	1.03	1.33
621	73	38	9.69	4.50	1.57	12.09	5.75	-0.34	1.28	1.14	1.33
625	66	31	10.05	4.92	1.47	11.75	5.95	-0.56	1.21	1.02	1.17
629	58	17	10.33	4.77	1.36	12.22	5.58	-0.16	1.17	1.05	1.18
633	61	18	12.88	5.14	1.55	14.91	6.91	-0.24	1.34	1.03	1.16
637	52	19	13.83	6.78	1.12	16.92	7.81	-0.05	1.15	1.13	1.22
641	59	10	9.69	4.28	0.97	14.64	6.52	0.01	1.52	1.37	1.51
645	53	21	14.47	5.99	1.15	17.84	8.04	0.13	1.34	1.14	1.23
649	60	36	11.41	5.80	1.44	17.04	7.27	0.02	1.25	1.33	1.49
653	51	23	17.56	6.89	1.47	15.90	8.02	-0.27	1.16	0.84	0.91
657	47	18	13.01	7.06	1.41	16.35	7.60	0.10	1.08	1.13	1.26
702	74	0	9.02	3.84	0.00	15.11	6.28	-0.21	1.64	1.67	1.67
705	44	1	12.29	6.02	0.79	14.17	6.52	0.01	1.08	1.08	1.15
709	48	3	9.25	4.38	0.85	15.09	6.57	0.37	1.50	1.49	1.63
713	40	2	13.68	5.87	0.85	13.66	7.06	0.15	1.20	0.94	1.00
717	49	1	12.44	4.35	0.85	13.34	6.11	1.13	1.41	1.00	1.07
721	41	1	9.82	4.11	0.79	11.59	5.76	0.71	1.40	1.09	1.18
725	44	14	10.85	3.62	0.97	8.25	3.94	0.26	1.09	0.70	0.76
729	62	16	6.65	2.27	1.01	8.31	3.78	0.50	1.67	1.09	1.25
733	58	3	4.58	1.92	0.87	6.72	3.29	0.38	1.72	1.23	1.47
737	37	0	4.75	2.21	0.00	5.52	2.62	0.72	1.19	1.16	1.16

TABLE VIII(d)

SUMMARY OF RAW DIGITIZATION RESULTS FOR RADAR RANGE ROLL, PITCH, DECK HOUSE ACCELERATIONS, AND TUCKER METER

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 33 EAST

	RADAR			ROLL			PITCH			VERT ACCEL			LAT ACCEL			TUCKER		
D.L. RUN NO.	4.0 (RMS) FT	RECORDED EXTREMES FT	FT	4.0 (RMS) DEG	RECORDED EXTREMES DEG	DEG	4.0 (RMS) DEG	RECORDED EXTREMES DEG	DEG	4.0 (RMS) (G)	RECORDED EXTREMES (G)	(G)	4.0 (RMS) (G)	RECORDED EXTREMES (G)	(G)	4.0 (RMS) FT	RECORDED EXTREMES FT	FT
601	11.	9.	-9.	3.1	6.	0.	0.5	-0.0	-1.0	0.09	0.1	-0.1	0.09	0.1	-0.1	2.	2.	-2.
605	18.	14.	-21.	6.9	10.	-3.	0.9	0.4	-1.3	0.20	0.2	-0.2	0.18	0.2	-0.2	3.	3.	-3.
609	27.	26.	-22.	18.5	18.	-9.	0.7	0.2	-1.1	0.18	0.1	-0.1	0.44	0.3	-0.4	4.	4.	-3.
613	29.	27.	-28.	19.8	20.	-11.	1.3	1.1	-1.7	0.32	0.3	-0.3	0.45	0.4	-0.3	6.	8.	-6.
621	36.	33.	-28.	27.8	25.	-12.	1.1	0.8	-1.4	0.27	0.2	-0.2	0.63	0.4	-0.5	9.	9.	-7.
625	36.	29.	-36.	24.9	22.	-15.	1.0	0.3	-1.3	0.21	0.2	-0.2	0.55	0.5	-0.4	8.	8.	-6.
629	34.	29.	-23.	24.7	23.	-12.	0.8	0.4	-1.1	0.15	0.2	-0.1	0.55	0.4	-0.4	8.	9.	-6.
633	39.	39.	-29.	29.4	23.	-16.	1.0	0.7	-1.0	0.16	0.2	-0.1	0.68	0.5	-0.5	9.	8.	-7.
637	44.	46.	-33.	29.0	22.	-15.	1.1	0.7	-1.1	0.16	0.1	-0.1	0.63	0.4	-0.5	9.	10.	-7.
641	42.	44.	-34.	21.2	16.	-13.	1.0	0.6	-1.3	0.22	0.2	-0.2	0.46	0.3	-0.3	7.	6.	-6.
645	52.	49.	-32.	28.2	22.	-15.	1.0	0.5	-1.2	0.20	0.2	-0.2	0.61	0.4	-0.4	7.	7.	-5.
649	48.	42.	-40.	25.9	21.	-14.	1.0	0.4	-1.2	0.21	0.2	-0.2	0.60	0.4	-0.5	10.	9.	-8.
653	56.	45.	-41.	32.2	22.	-20.	1.0	0.5	-1.2	0.18	0.1	-0.2	0.68	0.5	-0.5	11.	9.	-8.
657	53.	49.	-42.	31.5	23.	-17.	1.0	0.3	-1.2	0.17	0.2	-0.1	0.71	0.5	-0.5	11.	10.	-7.
702	50.	53.	-42.	23.1	16.	-17.	1.1	0.5	-1.3	0.24	0.2	-0.2	0.48	0.4	-0.4	18.	10.	-10.
705	49.	34.	-46.	21.6	13.	-14.	1.1	0.6	-1.4	0.22	0.2	-0.2	0.45	0.3	-0.3	18.	10.	-9.
709	49.	43.	-36.	23.1	15.	-19.	0.9	0.3	-1.3	0.16	0.2	-0.2	0.46	0.4	-0.4	20.	10.	-10.
713	50.	50.	-33.	21.1	12.	-19.	0.8	0.2	-1.1	0.14	0.1	-0.1	0.44	0.4	-0.3	19.	11.	-10.
717	43.	34.	-29.	18.7	12.	-16.	0.8	0.3	-1.0	0.13	0.1	-0.1	0.41	0.3	-0.3	19.	10.	-10.
721	44.	38.	-29.	21.4	14.	-15.	0.7	0.2	-1.0	0.09	0.1	-0.1	0.43	0.3	-0.3	23.	11.	-11.
725	23.	17.	-19.	13.2	15.	-4.	0.7	0.3	-0.9	0.09	0.1	-0.1	0.28	0.2	-0.2	8.	6.	-4.
729	22.	17.	-16.	9.7	9.	-11.	0.6	0.2	-1.0	0.08	0.1	-0.1	0.21	0.2	-0.2	13.	10.	-10.
733	20.	22.	-15.	10.4	8.	-9.	0.7	0.1	-1.0	0.07	0.1	-0.1	0.21	0.2	-0.2	12.	10.	-8.
737	15.	14.	-14.	9.6	9.	-7.	0.6	0.1	-0.9	0.06	0.1	-0.0	0.20	0.1	-0.2	9.	6.	-7.

TABLE IX(a)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 33 WEST

D.L. RUN NO.	TMR TAPE NO.	TMR INDX NO.	TMR INTV NO.	DATE	TIME (GMT)	LATITUDE	LONGITUDE	COURSE	SPEED KT.	PROP RPM	DRAFT FT.	SEA/AIR TEMP
815	153	4	15	01-24-74	0400			245	32.3	131.0	30.10	50/47
817	153	5	17	01-24-74	0800			245	32.3	131.0	30.19	51/49
822	153	6	22	01-24-74	1200	47-33 N	11-56 W	247	32.2	130.6	30.20	52/50
825	153	7	25	01-24-74	1600	47-33 N	11-56 W	248	33.3	135.1	30.10	53/52
829	153	8	29	01-24-74	2000	47-33 N	11-56 W	246	32.4	131.4	30.15	52/50
833	153	9	33	01-24-74	2400	47-33 N	11-56 W	246	31.9	129.4	30.02	58/50
837	153	10	37	01-25-74	0400	47-33 N	11-56 W	246	32.1	130.3	29.90	53/50
841	153	11	41	01-25-74	0800	47-33 N	11-56 W	246	32.1	130.0	29.88	54/51
845	153	12	45	01-25-74	1200	42-51 N	28-27 W	265	31.8	129.0	29.81	56/55
849	153	13	49	01-25-74	1410	42-51 N	28-27 W	266	31.8	128.9	29.80	57/52
853	153	14	53	01-25-74	1620	42-51 N	28-27 W	266	31.8	128.9	29.80	57/52
861	153	16	61	01-25-74	2040	42-51 N	28-27 W	266	32.0	129.8	30.02	65/49
901	155	17	1	01-25-74	2400	42-51 N	28-27 W	266	31.2	126.7	30.03	57/48
905	155	18	5	01-26-74	0100	42-51 N	28-27 W	266	31.8	129.0	30.00	56/51
909	155	19	9	01-26-74	0800	42-51 N	28-27 W	266	32.6	132.0	30.05	61/49
913	155	20	13	01-26-74	1200	41-50 N	45-25 W	266	32.4	131.2	30.03	58/50
917	155	21	17	01-26-74	1600	41-50 N	45-25 W	266	32.3	130.9	30.11	44/39
921	155	22	21	01-26-74	2000	41-50 N	45-25 W	267	33.1	134.7	30.37	58/36
925	155	23	25	01-26-74	2400	41-50 N	45-25 W	267	32.4	131.2	30.45	63/44
929	155	24	29	01-27-74	0400	41-50 N	45-25 W	267	32.4	131.4	30.38	58/52
937	155	26	37	01-27-74	1200	40-45 N	62-42 W	266	32.2	130.4	30.00	59/58
941	155	27	41	01-27-74	1600	40-45 N	62-42 W	265	31.8	128.9	29.77	65/65
945	155	28	45	01-27-74	2000	40-45 N	62-42 W	266	32.1	130.0	29.81	43/60
949	155	29	49	01-27-74	2400	40-45 N	62-42 W	268	32.3	131.1	29.88	43/60

TABLE IX(b)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 33 WEST

D.L. RUN NO.	SEA STATE	<REL WIND> DIR/SPEED /(KT)	REL WAVE DIR	WAVE HT. FT.	REL SWELL DIR	<-SWELL-> HT FT.	<-SWELL-> LENGTH FT.	VISUAL WEATHER /TMR LOG-BOOK COMMENTS
815	4	2S/16	2S	2	2S	5	300	OCAST /PITCHING MODERATELY
817	4	25S/16	25S	1	25S	5	300	SCAT CLOUDS /GETTING GOOD VERT BEND
822	4	23S/20	23S	1	23S	4	250	SCAT CLOUDS /
825	5	12P/20	12P	2	22S	4	250	PT CLDY /PITCHING EASILY
829	4	10P/20	10P	2	10P	4	250	PT CLDY /
833	6	10P/25	24S	3	24S	4	250	PT CLDY /
837	6	1S/25	1S	5	1S	6	150	OCAST /PITCHING MODERATELY
841	7	21P/30	21P	5	21P	6	150	OCAST /
845	8	5S/35	5S	8	5S	6	150	PT CLDY /
849	9	4S/45	4S	8	4S	10	250	PT CLDY /MANUAL OPERATION HIGH WINDS
853	9	49S/45	49S	12	4S	10	250	PT CLDY /MORE VERT BENDING ACTION
861	9	26S/45	26S	12	26S	12	300	PT CLDY /SHIPPING WATER OVERDECKS
901	5	49S/20	4S	5	4S	10	300	PT CLDY /WIND DOWN TO 30 MPH
905	4	4S/15	4S	5	4S	8	250	OCAST /
909	3	26S/10	26S	1	26S	8	250	OCAST /
913	3	49S/10	4S	1	4S	8	250	OCAST /
917	6	49S/15	49S	2	49S	8	250	PT CLDY /
921	4	48S/15	48S	2	48S	6	300	CLDY /
925	4	48S/15	48S	2	48S	6	300	CLEAR /
929	3	48S/15	48S	1	48S	6	300	CLEAR /
937	8	41P/35	41P	6	41P	8	400	RAIN SQUALLS /
941	9	40P/40	40P	8	40P	8	400	OCAST /
945	8	41P/35	41P	5	41P	5	400	CLDY /
949	6	43P/25	43P	5	43P	5	400	CLDY /

TABLE IX(c).

COMPARISON OF TMR RESULTS FOR MIDSHIP VERTICAL BENDING STRESS WITH CORRESPONDING RAW DIGITIZATION RESULTS AT DAVIDSON LABORATORY

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 33 WEST

D.L. RUN NO.	IMR RESULTS: NO. WAVE INDUCED CYCLES (1)	NO. 1ST MODE BURSTS (2)	MAX P-TO-T STRESS KPSI (3)	RMS P-TO-T STRESS KPSI (4)	MAX 1ST MODE STRESS KPSI (5)	D.L. DIGITIZATION: RANGE OF RECORDED EXTREMES KPSI (6)	2.83X (SAMPLE RMS) KPSI (7)	REL MEAN STRESS KPSI (8)	COLUMN RATIOS: (7) / (4)	(6) / (3+5)	(6) / (3)
815	158	53	11.24	4.73	3.72	13.09	4.87	-0.37	1.03	0.87	1.16
817	175	40	8.57	4.04	2.56	11.04	4.00	-1.05	0.99	0.99	1.29
822	172	17	6.96	3.25	2.43	7.31	3.23	-1.04	0.99	0.78	1.05
825	180	7	5.97	2.76	1.28	7.53	2.89	-1.27	1.05	1.04	1.26
829	177	10	4.56	2.00	1.16	5.88	2.32	-1.30	1.16	1.03	1.29
833	204	38	4.97	2.23	2.17	6.86	2.63	-1.40	1.18	0.96	1.38
837	197	53	6.50	3.16	3.68	9.53	3.45	-1.35	1.09	0.94	1.47
841	205	66	9.50	3.84	5.04	15.31	4.10	-1.29	1.07	1.05	1.61
845	200	50	8.30	3.41	2.57	10.34	3.67	0.60	1.08	0.95	1.24
849	219	51	7.42	3.21	2.75	13.85	3.89	0.84	1.21	1.36	1.87
853	214	62	9.96	3.86	4.49	13.99	4.58	0.92	1.19	0.97	1.41
861	181	86	17.35	6.06	12.58	25.02	6.66	1.18	1.10	0.84	1.44
901	197	64	9.66	4.31	4.57	13.26	4.49	0.73	1.04	0.93	1.37
905	202	25	5.45	2.52	1.48	8.04	2.69	0.51	1.06	1.16	1.47
909	187	4	4.21	1.78	1.16	5.84	2.07	0.46	1.16	1.09	1.38
913	177	1	3.49	1.70	0.73	5.36	2.11	0.65	1.24	1.27	1.54
917	125	16	3.25	1.29	1.22	4.44	1.61	0.49	1.25	0.99	1.37
921	110	0	1.99	0.90	0.00	3.01	1.12	0.51	1.25	1.51	1.51
925	101	0	1.99	0.91	0.00	2.87	1.20	0.44	1.32	1.44	1.44
929	153	0	1.45	0.76	0.00	2.42	0.98	0.29	1.30	1.66	1.66
937	113	1	0.90	0.43	1.22	1.87	0.70	-1.13	1.64	0.88	2.07
941	240	38	4.37	1.59	1.47	6.43	2.21	-0.73	1.39	1.10	1.47
945	228	16	2.84	1.17	1.22	4.54	1.59	-0.38	1.36	1.12	1.60
949	212	37	4.73	2.19	1.85	6.66	2.66	-0.80	1.21	1.01	1.41

TABLE IX(d)

SUMMARY OF RAW DIGITIZATION RESULTS FOR RADAR RANGE ROLL, PITCH, DECK HOUSE ACCELERATIONS, AND TUCKER METER

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 33 WEST

D.L. RUN NO.	RADAR 4.0 (RMS) FT	RADAR RECORDED EXTREMES FT	RADAR RECORDED EXTREMES FT	ROLL 4.0 (RMS) DEG	ROLL RECORDED EXTREMES DEG	ROLL RECORDED EXTREMES DEG	PITCH 4.0 (RMS) DEG	PITCH RECORDED EXTREMES DEG	PITCH RECORDED EXTREMES DEG	VERT ACCEL 4.0 (RMS) (G)	VERT ACCEL RECORDED EXTREMES (G)	VERT ACCEL RECORDED EXTREMES (G)	LAT ACCEL 4.0 (RMS) (G)	LAT ACCEL RECORDED EXTREMES (G)	LAT ACCEL RECORDED EXTREMES (G)	TUCKER 4.0 (RMS) FT	TUCKER RECORDED EXTREMES FT	TUCKER RECORDED EXTREMES FT
815	46.	37.	-44.	6.8	4.	-7.	2.2	1.7	-2.1	0.49	0.4	-0.4	0.17	0.1	-0.1	9.	7.	-7.
817	34.	30.	-32.	4.5	3.	-5.	1.8	0.9	-1.9	0.40	0.3	-0.3	0.13	0.1	-0.1	6.	5.	-5.
822	29.	25.	-24.	4.6	2.	-5.	1.5	1.0	-1.9	0.34	0.3	-0.3	0.12	0.1	-0.1	5.	4.	-4.
825	26.	24.	-20.	4.8	2.	-6.	1.3	0.6	-1.9	0.30	0.2	-0.3	0.12	0.1	-0.1	5.	4.	-5.
829	22.	24.	-19.	5.3	3.	-5.	1.0	0.5	-1.8	0.24	0.2	-0.2	0.14	0.1	-0.1	5.	5.	-3.
833	22.	21.	-23.	4.3	3.	-4.	1.1	0.4	-1.6	0.23	0.2	-0.2	0.12	0.1	-0.1	4.	3.	-3.
837	29.	23.	-22.	3.7	3.	-3.	1.5	0.6	-1.9	0.34	0.3	-0.3	0.11	0.1	-0.1	4.	3.	-3.
841	36.	30.	-45.	4.0	3.	-5.	1.5	0.8	-2.1	0.34	0.4	-0.3	0.12	0.1	-0.1	5.	4.	-4.
845	27.	30.	-32.	2.9	3.	-2.	1.4	0.8	-1.7	0.30	0.3	-0.3	0.09	0.1	-0.1	3.	3.	-3.
849	27.	28.	-40.	2.9	3.	-3.	1.3	0.7	-1.8	0.26	0.3	-0.3	0.09	0.1	-0.1	4.	3.	-3.
853	33.	28.	-45.	3.7	2.	-4.	1.6	1.2	-2.1	0.35	0.4	-0.3	0.11	0.1	-0.1	4.	4.	-3.
861	60.	44.	-51.	5.4	3.	-9.	2.4	2.5	-2.1	0.59	0.6	-0.5	0.16	0.2	-0.2	7.	6.	-7.
901	35.	29.	-47.	4.7	2.	-6.	1.6	1.0	-1.7	0.40	0.3	-0.3	0.14	0.1	-0.1	5.	4.	-4.
905	24.	20.	-19.	4.4	2.	-6.	1.2	0.4	-1.9	0.27	0.2	-0.2	0.12	0.1	-0.1	4.	3.	-4.
909	19.	15.	-18.	5.3	1.	-7.	0.8	0.2	-1.4	0.19	0.2	-0.2	0.13	0.1	-0.1	4.	3.	-4.
913	23.	18.	-20.	10.1	5.	-12.	0.9	0.4	-1.3	0.19	0.2	-0.2	0.23	0.2	-0.2	4.	4.	-3.
917	20.	17.	-17.	9.1	3.	-12.	0.6	-0.0	-1.2	0.13	0.1	-0.1	0.20	0.2	-0.2	4.	4.	-3.
921	12.	10.	-11.	5.5	4.	-6.	0.6	-0.1	-1.0	0.06	0.1	-0.1	0.13	0.1	-0.1	2.	2.	-2.
925	13.	11.	-11.	5.9	2.	-7.	0.6	-0.1	-1.1	0.06	0.1	-0.1	0.13	0.1	-0.1	2.	1.	-2.
929	10.	8.	-9.	4.3	3.	-4.	0.7	0.1	-1.1	0.08	0.1	-0.1	0.10	0.1	-0.1	1.	1.	-1.
937	7.	6.	-7.	3.3	5.	1.	0.6	-0.2	-1.0	0.04	0.0	-0.0	0.08	0.1	-0.1	1.	1.	-1.
941	17.	13.	-14.	4.3	9.	2.	0.8	0.2	-1.1	0.14	0.1	-0.1	0.11	0.1	-0.1	2.	2.	-2.
945	13.	12.	-12.	4.9	7.	-2.	0.7	0.1	-1.0	0.11	0.1	-0.1	0.12	0.1	-0.1	2.	2.	-2.
949	19.	14.	-15.	5.7	8.	-4.	1.3	0.8	-1.4	0.28	0.3	-0.2	0.15	0.2	-0.1	3.	3.	-3.

TABLE X(a)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 34 EAST

D.L. RUN NO.	TMR TAPE NO.	TMR INDX NO.	TMR INTV NO.	DATE	TIME (GMT)	LATITUDE	LONGITUDE	COURSE	SPEED KT.	PROP RPM	DRAFT FT.	SEA/AIR TEMP
1009	157	3	9	01-29-74	2400			082	32.3	132.0	29.80	45/45
1013	157	4	13	01-30-74	0400			089	32.2	131.7	30.10	45/45
1017	157	5	17	01-30-74	0800			087	32.3	132.0	30.06	64/49
1021	157	6	21	01-30-74	1200	40-31 N	59-02 W	090	32.3	131.8	30.11	65/52
1026	157	7	26	01-30-74	1600	40-31 N	59-02 W	090	32.1	131.3	30.08	59/55
1029	157	8	29	01-30-74	2000	40-31 N	59-02 W	090	32.2	131.8	30.02	58/52
1033	157	9	33	01-30-74	2400	40-31 N	59-02 W	090	32.1	131.5	30.00	66/60
1037	157	10	37	01-31-74	0400	40-31 N	59-02 W	090	31.9	130.1	30.00	65/55
1041	157	11	41	01-31-74	0800	40-31 N	59-02 W	090	32.2	131.7	30.00	34/44
1045	157	12	45	01-31-74	1200	40-59 N	43-08 W	090	32.6	133.1	30.05	57/52
1049	157	13	49	01-31-74	1600	40-59 N	43-08 W	073	32.3	132.2	30.06	60/55
1101	159	14	1	01-31-74	2000	40-59 N	43-08 W	073	32.1	131.0	30.10	57/48
1105	159	15	5	01-31-74	2400	40-59 N	43-08 W	073	32.3	132.2	30.10	56/46
1109	159	16	9	02-01-74	0400	40-59 N	43-08 W	073	31.8	130.0	30.09	55/45
1113	159	17	13	02-01-74	0800	40-59 N	43-08 W	073	32.3	132.0	30.05	54/47
1117	159	18	17	02-01-74	1200	44-27 N	27-18 W	072	32.3	132.0	30.09	53/60
1122	159	19	22	02-01-74	1600	44-27 N	27-18 W	072	32.4	132.6	30.00	53/50
1125	159	20	25	02-01-74	2000	44-27 N	27-18 W	072	32.3	132.0	29.89	52/54
1129	159	21	29	02-01-74	2400	44-27 N	27-18 W	072	32.6	133.0	29.75	52/50
1134	159	22	34	02-02-74	0400	44-27 N	27-18 W	071	32.4	132.5	29.62	52/45
1137	159	23	37	02-02-74	0800	44-27 N	27-18 W	071	32.6	133.0	29.57	51/47
1141	159	24	41	02-02-74	1200	48-10 N	10-20 W	071	32.3	132.0	29.61	51/48
1145	159	25	45	02-02-74	1600	48-10 N	10-20 W	071	32.1	131.2	29.75	53/44
1149	159	26	49	02-02-74	2000	48-10 N	10-20 W	071	32.2	131.6	29.80	50/47

TABLE X(b)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 34 EAST

D.L. RUN NO.	SEA STATE	<REL WIND> DIR/SPEED /(KT)	REL WAVE DIR	WAVE HT. FT.	REL SWELL DIR	<-SWELL-> HT FT.	LENGTH FT.	VISUAL WEATHER /TMR LOG-BOOK COMMENTS
1009	2	172P/ 5	172P	1	172P	2	150	CLEAR /
1013	2	179P/ 5	179P	1	179P	3	150	CLEAR /
1017	2	19P/ 5	19P	1	177P	4	150	OCAST /
1021	2	0 / 5	0	2	180	4	150	OCAST /
1026	3	11S/ 8	11S	2	180	5	150	OCAST /
1029	3	11S/ 8	11S	2	180	5	150	OCAST /
1033	4	45S/12	45S	2	180	5	150	OCAST /
1037	4	22S/12	22S	2	180	5	150	OCAST /
1041	3	11S/10	11S	2	180	5	150	OCAST /
1045	2	11S/ 5	11S	3	180	8	150	PT CLDY /
1049	2	95P/ 5	95P	2	152S	8	150	PT CLDY /
1101	2	50P/ 5	50P	2	152S	8	150	PT CLDY /
1105	4	95P/12	95P	2	152S	8	150	PT CLDY /
1109	4	95P/15	95P	2	107S	8	150	PT CLDY /
1113	4	118P/15	118P	2	107S	8	150	PT CLDY /
1117	5	117P/20	117P	3	63S	8	150	PT CLDY /
1122	7	151P/30	151P	4	63S	8	150	PT CLDY /
1125	7	117P/30	117P	4	63S	6	150	PT CLDY /
1129	7	175S/30	175S	4	63S	6	150	PT CLDY /
1134	5	161P/20	161P	4	64S	8	150	OCAST /
1137	3	161P/10	161P	4	64S	8	150	OCAST /
1141	5	64S/20	64S	3	64S	6	150	OCAST /
1145	5	154S/20	154S	3	64S	8	150	OCAST /
1149	3	154S/10	154S	1	64S	1	300	PT CLDY /

TABLE X(c)

COMPARISON OF TMR RESULTS FOR MIDSHIP VERTICAL BENDING STRESS WITH CORRESPONDING RAW DIGITIZATION RESULTS AT DAVIDSON LABORATORY

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 34 EAST

D.L. RUN NO.	<----------TMR RESULTS: NO. WAVE INDUCED CYCLES (1)	NO. 1ST MODE BURSTS (2)	MAX P-TO-T STRESS KPSI (3)	RMS P-TO-T STRESS KPSI (4)	MAX 1ST MODE STRESS KPSI (5) ---------->	<----D.L. DIGITIZATION: RANGE OF RECORDED EXTREMES KPSI (6)	2.83X (SAMPLE RMS) KPSI (7)	REL MEAN STRESS KPSI (8) --->	<--COLUMN RATIOS: (7) / (4)	(6) / (3+5)	(6) / (3) -->
1009	109	0	2.79	1.15	0.00	3.18	1.40	-1.93	1.21	1.14	1.14
1013	86	0	3.74	1.54	0.00	4.21	1.85	-1.83	1.20	1.12	1.12
1017	95	0	3.74	1.61	0.00	5.33	2.27	-2.22	1.41	1.42	1.42
1021	109	0	2.15	1.12	0.00	4.26	1.69	1.53	1.51	1.99	1.99
1026	93	0	2.77	1.43	0.00	5.05	2.12	1.39	1.48	1.82	1.82
1029	108	0	3.40	1.47	0.00	4.95	1.96	1.40	1.33	1.46	1.46
1033	127	19	4.25	1.67	1.05	4.70	2.04	0.33	1.22	0.89	1.11
1037	128	13	3.73	1.86	0.97	5.44	2.24	0.68	1.21	1.16	1.46
1041	128	2	4.52	2.27	0.67	5.88	2.61	0.59	1.15	1.13	1.30
1045	142	21	7.44	3.53	1.91	8.90	3.78	0.74	1.07	0.95	1.20
1049	108	0	4.84	2.41	0.00	8.37	3.15	0.96	1.30	1.73	1.73
1101	108	8	7.71	2.75	1.14	7.72	3.28	0.91	1.19	0.87	1.00
1105	105	12	5.34	2.71	1.20	9.37	3.67	0.69	1.35	1.43	1.76
1109	106	15	6.36	2.92	1.42	8.80	3.92	0.87	1.34	1.13	1.38
1113	109	11	6.58	2.84	1.02	8.04	3.48	0.82	1.23	1.06	1.22
1117	93	10	8.77	2.77	1.58	8.31	3.32	1.50	1.20	0.80	0.95
1122	94	3	7.28	2.94	1.43	9.37	3.94	1.64	1.34	1.08	1.29
1125	69	1	6.41	3.26	0.75	9.83	4.00	1.78	1.23	1.37	1.53
1129	90	0	6.92	2.84	0.00	9.35	3.80	2.04	1.34	1.35	1.35
1134	79	4	8.04	3.38	0.89	7.64	3.85	1.73	1.14	0.86	0.95
1137	64	1	6.50	2.98	8.74	9.20	3.65	1.80	1.22	0.60	1.41
1141	48	0	6.92	3.54	0.00	7.88	4.30	1.90	1.22	1.14	1.14
1145	49	0	7.71	3.90	0.00	9.47	4.43	1.86	1.14	1.23	1.23
1149	24	0	4.32	2.86	0.00	5.46	3.39	1.89	1.19	1.27	1.27

TABLE X(d)

SUMMARY OF RAW DIGITIZATION RESULTS FOR RADAR RANGE ROLL, PITCH, DECK HOUSE ACCELERATIONS, AND TUCKER METER

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 34 EAST

D.L. RUN NO.	<--- RADAR: 4.0 (RMS) FT	RECORDED EXTREMES FT	FT --->	<--- ROLL: 4.0 (RMS) DEG	RECORDED EXTREMES DEG	DEG ---->	<--- PITCH: 4.0 (RMS) DEG	RECORDED EXTREMES DEG	DEG --->	<--VERT ACCEL: 4.0 (RMS) (G)	RECORDED EXTREMES (G)	(G) ->	<--LAT ACCEL: 4.0 (RMS) (G)	RECORDED EXTREMES (G)	(G) -->	<-- TUCKER: 4.0 (RMS) FT	RECORDED EXTREMES FT	FT -->
1009	14.	13.	-12.	5.9	5.	-4.	0.5	-0.0	-1.1	0.10	0.1	-0.1	0.14	0.1	-0.1	2.	2.	-2.
1013	21.	21.	-14.	9.9	5.	-12.	0.5	-0.1	-1.2	0.10	0.1	-0.1	0.22	0.2	-0.2	6.	7.	-3.
1017	21.	16.	-18.	9.1	5.	-10.	0.5	0.0	-1.2	0.10	0.1	-0.1	0.21	0.2	-0.2	4.	5.	-3.
1021	14.	16.	-12.	6.0	2.	-7.	0.4	-0.1	-1.0	0.08	0.1	-0.1	0.13	0.1	-0.1	3.	3.	-3.
1026	19.	24.	-18.	8.9	5.	-10.	0.5	0.1	-1.1	0.10	0.1	-0.1	0.19	0.2	-0.2	4.	4.	-3.
1029	18.	14.	-16.	8.2	4.	-9.	0.5	0.1	-1.2	0.12	0.1	-0.1	0.18	0.2	-0.2	4.	4.	-2.
1033	18.	16.	-12.	7.2	3.	-10.	0.7	0.1	-1.2	0.15	0.1	-0.1	0.16	0.2	-0.1	4.	4.	-3.
1037	21.	19.	-22.	9.1	6.	-10.	0.8	0.3	-1.4	0.19	0.2	-0.2	0.20	0.2	-0.2	4.	4.	-4.
1041	22.	18.	-17.	8.0	5.	-7.	1.0	0.5	-1.6	0.24	0.2	-0.2	0.18	0.1	-0.2	5.	4.	-4.
1045	30.	27.	-26.	9.4	8.	-9.	1.6	1.1	-1.9	0.39	0.3	-0.3	0.22	0.2	-0.2	6.	4.	-6.
1049	25.	21.	-19.	12.1	8.	-10.	1.1	0.6	-1.6	0.26	0.2	-0.2	0.27	0.2	-0.2	5.	5.	-4.
1101	25.	21.	-21.	12.9	9.	-12.	1.1	0.6	-1.6	0.26	0.2	-0.2	0.28	0.3	-0.2	6.	6.	-5.
1105	26.	22.	-22.	13.7	11.	-11.	1.1	0.6	-1.5	0.25	0.2	-0.2	0.30	0.3	-0.3	6.	7.	-5.
1109	26.	22.	-25.	13.8	11.	-10.	1.0	0.4	-1.4	0.23	0.2	-0.2	0.30	0.2	-0.2	6.	5.	-5.
1113	26.	21.	-20.	14.9	12.	-12.	1.1	0.4	-1.6	0.26	0.2	-0.2	0.33	0.3	-0.3	6.	8.	-5.
1117	27.	22.	-20.	16.0	13.	-13.	1.0	0.4	-1.5	0.24	0.2	-0.2	0.35	0.3	-0.3	9.	9.	-5.
1122	27.	20.	-26.	16.2	16.	-12.	0.9	0.5	-1.3	0.23	0.2	-0.2	0.34	0.2	-0.4	8.	7.	-6.
1125	29.	24.	-21.	17.9	15.	-14.	1.0	0.4	-1.6	0.24	0.2	-0.2	0.39	0.3	-0.4	8.	7.	-6.
1129	33.	30.	-23.	18.7	12.	-14.	1.0	0.8	-1.6	0.26	0.3	-0.2	0.41	0.3	-0.3	12.	10.	-7.
1134	30.	23.	-26.	19.8	17.	-17.	1.1	0.6	-1.7	0.26	0.2	-0.2	0.42	0.3	-0.4	14.	10.	-9.
1137	31.	35.	-22.	19.6	17.	-15.	0.8	0.4	-1.1	0.18	0.2	-0.2	0.43	0.3	-0.4	15.	11.	-10.
1141	30.	23.	-22.	21.3	18.	-15.	0.7	0.2	-1.2	0.14	0.1	-0.1	0.46	0.3	-0.4	17.	11.	-8.
1145	34.	34.	-20.	23.1	17.	-17.	0.8	0.2	-1.3	0.10	0.1	-0.1	0.51	0.4	-0.4	16.	11.	-11.
1149	24.	21.	-17.	13.1	8.	-11.	0.8	0.1	-1.1	0.04	0.0	-0.0	0.27	0.2	-0.2	10.	11.	-11.

TABLE XI (a)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 34 WEST

D.L. RUN NO.	TMR TAPE NO.	TMR INDX NO.	TMR INTV NO.	DATE	TIME (GMT)	LATITUDE	LONGITUDE	COURSE	SPEED KT.	PROP RPM	DRAFT FT.	SEA/AIR TEMP
1209	161	3	9	02-06-74	0400			308	32.3	132.0	28.82	43/40
1217	161	5	17	02-06-74	1200	58-27 N	08-51 W	267	31.9	130.0	29.09	46/42
1228	161	7	28	02-06-74	2000	58-27 N	08-51 W	246	30.8	127.0	29.74	47/41
1230	161	8	30	02-06-74	2400	58-27 N	08-51 W	246	31.3	128.0	29.83	47/45
1233	161	9	33	02-07-74	0400	58-27 N	08-51 W	246	31.6	129.0	29.65	47/46
1237	161	10	37	02-07-74	0800	58-27 N	08-51 W	242	31.6	129.0	29.34	47/48
1241	161	11	41	02-07-74	1200	54-00 N	30-00 W	241	31.6	129.2	29.15	44/50
1245	161	12	45	02-07-74	1600	54-00 N	30-00 W	238	31.7	129.5	29.04	42/44
1305	163	14	5	02-07-74	2400	54-00 N	30-00 W	243	31.3	128.0	28.93	45/42
1309	163	15	9	02-08-74	0400	54-00 N	30-00 W	243	31.4	128.5	28.97	54/44
1317	163	17	17	02-08-74	1200	48-09 N	47-18 W	243	31.4	128.5	29.22	34/31
1321	163	18	21	02-08-74	1600	48-09 N	47-18 W	245	31.8	130.0	29.14	28/27
1329	163	20	29	02-08-74	2400	48-09 N	47-18 W	245	31.3	128.0	29.62	28/24
1333	163	21	33	02-09-74	0400	48-09 N	47-18 W	240	31.4	128.5	29.60	33/26
1337	163	22	37	02-09-74	0800	48-09 N	47-18 W	246	31.8	130.0	29.42	34/28
1341	163	23	41	02-09-74	1200	42-32 N	63-16 W	245	32.1	131.0	29.52	37/33
1345	163	24	45	02-09-74	1600	42-32 N	63-16 W	245	32.1	131.0	29.62	39/34

TABLE XI (b)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 34 WEST

D.L. RUN NO.	SEA STATE	<REL WIND> DIR/SPEED /(KT)	REL WAVE DIR	WAVE HT. FT.	REL SWELL DIR	<-SWELL-> HT FT.	<-SWELL-> LENGTH FT.	VISUAL WEATHER /TMR LOG-BOOK COMMENTS
1209	4	83P/15	83P	1				PT CLDY /
1217	6	138S/25	138S	5	115S	8	150	OCAST /HEAVY ROLL
1228	8	136S/35	136S	5	136S	8	150	PT CLDY /HEAVY ROLL
1230	3	156P/10	156P	4	136S	6	150	PT CLDY /RIDING EASY
1233	5	100P/20	100P	2	114S	6	150	OCAST /
1237	6	118P/25	118P	2	118S	6	150	OCAST /
1241	3	106P/10	106P	3	119S	6	150	OCAST FOG RAIN /
1245	3	103P/10	103P	2	122S	6	200	OCAST /
1305	3	18P/10	18P	2	18P	6	200	PT CLDY /
1309	6	49S/25	49S	5	18P	8	150	HAIL RAIN SQUALLS /
1317	2	49S/ 5	49S	5	27S	8	150	CLEAR FOG SNOW /
1321	4	47S/15	47S	0	25S	15	200	OCAST SNOW /ICE FIELD ROLLING HIGH SWELL
1329	6	92S/25	92S	2	25S	5	150	OCAST /
1333	5	75S/20	75S	2	30S	5	150	OCAST /
1337	5	159S/20	159S	2	24S	5	150	OCAST SNOW /
1341	4	137S/15	137S	2	25S	3	200	OCAST SNOW /
1345	4	137S/15	137S	2	160S	2	300	PT CLDY /

TABLE XI (c)

COMPARISON OF TMR RESULTS FOR MIDSHIP VERTICAL BENDING STRESS WITH CORRESPONDING RAW DIGITIZATION RESULTS AT DAVIDSON LABORATORY

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 34 WEST

D.L. RUN NO.	TMR RESULTS: NO. WAVE INDUCED CYCLES (1)	NO. 1ST MODE BURSTS (2)	MAX P-TO-T STRESS KPSI (3)	RMS P-TO-T STRESS KPSI (4)	MAX 1ST MODE STRESS KPSI (5)	D.L. DIGITIZATION: RANGE OF RECORDED EXTREMES KPSI (6)	2.83X (SAMPLE RMS) KPSI (7)	REL MEAN STRESS KPSI (8)	COLUMN RATIOS: (7) / (4)	(6) / (3+5)	(6) / (3)
1209	177	0	1.32	0.55	0.00	1.83	0.73	3.53	1.35	1.38	1.38
1217	142	44	10.16	4.85	3.30	14.62	5.21	0.01	1.07	1.09	1.44
1228	140	23	11.02	5.29	1.53	15.15	5.95	0.28	1.13	1.21	1.37
1230	145	19	9.21	4.81	2.34	12.58	5.49	1.96	1.14	1.09	1.37
1233	125	5	8.66	3.64	1.02	11.69	4.73	1.55	1.30	1.21	1.35
1237	85	34	8.34	3.83	1.33	11.69	5.19	2.05	1.36	1.21	1.40
1241	91	5	6.72	3.01	1.17	8.76	4.16	0.28	1.38	1.11	1.30
1245	137	8	8.97	4.12	1.81	12.34	4.98	1.89	1.21	1.14	1.38
1305	157	60	14.77	5.80	4.03	17.51	6.15	-0.06	1.06	0.93	1.19
1309	154	57	14.43	5.68	5.62	18.31	5.99	0.02	1.06	0.91	1.27
1317	138	43	9.26	3.87	2.10	12.14	4.70	0.06	1.21	1.07	1.31
1321	117	0	8.34	3.00	0.00	8.49	3.53	-0.04	1.17	1.02	1.02
1329	198	45	8.31	3.47	1.77	9.39	3.68	0.18	1.06	0.93	1.13
1333	181	44	10.46	4.39	3.63	13.32	4.54	0.21	1.03	0.95	1.27
1337	197	2	5.41	2.36	0.92	6.66	2.66	0.18	1.12	1.05	1.23
1341	192	0	2.87	1.10	0.00	3.20	1.22	-0.04	1.11	1.12	1.12
1345	139	2	1.84	0.86	0.81	2.99	1.22	0.10	1.42	1.13	1.62

TABLE XI (d)

SUMMARY OF RAW DIGITIZATION RESULTS FOR RADAR RANGE ROLL, PITCH, DECK HOUSE ACCELERATIONS, AND TUCKER METER

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 34 WEST

D.L. RUN NO.	RADAR 4.0 (RMS) FT	RADAR RECORDED EXTREMES FT	FT	ROLL 4.0 (RMS) DEG	ROLL RECORDED EXTREMES DEG	DEG	PITCH 4.0 (RMS) DEG	PITCH RECORDED EXTREMES DEG	DEG	VERT ACCEL 4.0 (RMS) (G)	VERT ACCEL RECORDED EXTREMES (G)	(G)	LAT ACCEL 4.0 (RMS) (G)	LAT ACCEL RECORDED EXTREMES (G)	(G)	TUCKER 4.0 (RMS) FT	TUCKER RECORDED EXTREMES FT	FT
1209	9.	7.	-9.	2.0	1.	-3.	0.6	-0.0	-0.9	0.09	0.1	-0.1	0.06	0.1	-0.0	2.	2.	-2.
1217	50.	59.	-52.	17.6	7.	-19.	1.8	1.2	-2.3	0.42	0.4	-0.4	0.39	0.4	-0.3	15.	10.	-10.
1228	56.	46.	-52.	18.0	10.	-16.	1.9	1.0	-2.1	0.43	0.3	-0.3	0.39	0.3	-0.3	19.	11.	-11.
1230	43.	32.	-46.	15.7	9.	-14.	1.6	0.9	-1.9	0.35	0.3	-0.3	0.34	0.3	-0.2	14.	11.	-8.
1233	36.	30.	-40.	14.5	8.	-15.	1.0	0.4	-1.7	0.23	0.2	-0.2	0.30	0.3	-0.2	15.	11.	-9.
1237	30.	25.	-23.	9.8	10.	-8.	0.9	0.3	-1.4	0.19	0.2	-0.2	0.22	0.2	-0.2	9.	8.	-5.
1241	25.	22.	-19.	8.9	5.	-8.	0.9	0.3	-1.4	0.18	0.1	-0.2	0.20	0.2	-0.2	8.	8.	-7.
1245	31.	26.	-25.	8.3	5.	-7.	1.3	0.5	-2.0	0.27	0.2	-0.3	0.18	0.1	-0.1	9.	7.	-6.
1305	44.	33.	-44.	8.0	5.	-7.	2.2	1.7	-2.4	0.50	0.4	-0.4	0.19	0.2	-0.2	9.	7.	-7.
1309	43.	40.	-43.	10.1	8.	-9.	2.1	1.7	-2.3	0.47	0.5	-0.4	0.23	0.2	-0.2	9.	9.	-8.
1317	40.	33.	-47.	16.2	9.	-16.	1.3	0.6	-1.9	0.30	0.3	-0.3	0.35	0.3	-0.3	14.	10.	-9.
1321	33.	31.	-20.	16.5	7.	-16.	0.7	0.0	-1.3	0.15	0.1	-0.1	0.36	0.3	-0.2	13.	11.	-7.
1329	25.	26.	-25.	4.0	-1.	-8.	1.2	0.5	-2.1	0.28	0.3	-0.2	0.11	0.1	-0.1	5.	4.	-3.
1333	35.	31.	-47.	4.6	2.	-6.	1.8	1.2	-2.2	0.41	0.4	-0.4	0.12	0.1	-0.1	4.	4.	-4.
1337	19.	15.	-16.	3.9	2.	-6.	1.0	0.4	-1.8	0.23	0.2	-0.2	0.09	0.1	-0.1	4.	3.	-4.
1341	11.	13.	-10.	2.8	-0.	-5.	0.7	-0.0	-1.3	0.12	0.1	-0.1	0.07	0.1	-0.1	3.	2.	-2.
1345	12.	15.	-11.	5.3	1.	-8.	0.6	-0.0	-1.1	0.07	0.1	-0.1	0.12	0.1	-0.1	6.	5.	-4.

TABLE XII(a)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 35 EAST

D.L. RUN NO.	TMR TAPE NO.	TMR INDX NO.	TMR INTV NO.	DATE	TIME (GMT)	LATITUDE	LONGITUDE	COURSE	SPEED KT.	PROP RPM	DRAFT FT.	SEA/AIR TEMP
1405	165	2	5	02-12-74	2000	40-25 N	71-01 W	079	32.4	132.5	30.00	43/34
1409	165	3	9	02-12-74	2400	40-25 N	71-01 W	079	32.3	132.0	30.00	43/36
1413	165	4	13	02-13-74	0400	40-25 N	71-01 W	079	32.4	132.4	30.00	46/34
1417	165	5	17	02-13-74	0800	40-25 N	71-01 W	079	32.3	132.3	30.04	51/36
1421	165	6	21	02-13-74	1200	42-35 N	55-02 W	079	32.1	131.0	30.10	44/35
1429	165	8	29	02-13-74	2000	42-35 N	55-02 W	079	32.3	132.0	30.18	47/35
1433	165	9	33	02-13-74	2400	42-35 N	55-02 W	079	32.4	132.4	30.24	34/35
1437	165	10	37	02-14-74	0400	42-35 N	55-02 W	079	32.3	132.0	30.22	57/36
1442	165	11	42	02-14-74	0800	42-35 N	55-02 W	079	32.3	132.0	30.22	57/35
1445	165	12	45	02-14-74	1200	45-05 N	38-25 W	079	32.1	131.4	30.20	54/45
1449	165	13	49	02-14-74	1600	45-05 N	38-25 W	079	32.3	132.0	30.18	54/47
1501	167	14	1	02-14-74	2000	45-05 N	38-25 W	079	32.1	131.2	30.11	43/48
1505	167	15	5	02-14-74	2400	45-05 N	38-25 W	079	32.2	131.5	30.10	52/47
1513	167	17	13	02-15-74	0800	45-05 N	38-25 W	077	31.9	130.5	29.92	52/48
1517	167	18	17	02-15-74	1200	47-09 N	21-59 W	076	31.9	130.5	29.80	52/54
1525	167	20	25	02-15-74	2400	47-09 N	21-59 W	080	17.2	70.0	29.70	50/50
1529	167	21	29	02-16-74	0400	47-09 N	21-59 W	075	17.3	72.0	29.69	52/50
1533	167	22	33	02-16-74	0800	47-09 N	21-59 W	075	17.3	72.0	29.70	52/49
1537	167	23	37	02-16-74	1200	48-36 N	11-29 W	075	16.5	65.0	29.76	51/53
1541	167	24	41	02-16-74	1600	48-36 N	11-29 W	075	19.7	82.0	29.74	50/49
1545	167	25	45	02-16-74	2000	48-36 N	11-29 W	075	26.2	107.0	29.73	50/49

TABLE XII(b)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 35 EAST

D.L. RUN NO.	SEA STATE	<REL WIND> DIR/SPEED /(KT)	REL WAVE DIR	WAVE HT. FT.	REL SWELL DIR	<-SWELL-> HT FT.	<-SWELL-> LENGTH FT.	VISUAL WEATHER /TMR LOG-BOOK COMMENTS
1405	5	124P/20	124P	2	124P	3	150	PT CLDY /
1409	5	124P/20	124P	3	79P	5	150	OCAST /
1413	5	124P/20	124P	3	79P	5	150	OCAST /
1417	5	124P/20	124P	3	124P	5	150	OCAST /
1421	5	124P/20	124P	3	124P	5	150	OCAST /
1429	6	135P/25	135P	4	90P	6	150	PT CLDY /
1433	4	169P/15	169P	6	124P	8	200	PT CLDY /
1437	5	169P/20	169P	6	124P	10	200	PT CLDY /HEAVY ROLL
1442	7	146P/30	146P	6	124P	10	200	PT CLDY /HEAVY ROLL
1445	8	124P/35	124P	5	124P	10	200	PT CLDY /HEAVY ROLL
1449	8	146P/35	146P	5	124P	8	200	PT CLDY /HEAVY ROLL
1501	9	124P/45	124P	6	124P	10	200	PT CLDY /HEAVY ROLL
1505	9	124P/45	124P	6	124P	10	200	PT CLDY /HEAVY ROLL
1513	9	111P/45	111P	10	122P	15	250	PT CLDY /HEAVY ROLL
1517	10	121P/55	121P	20	121P	25	300	PT CLDY /HEAVY ROLL
1525	10	125P/55	125P	20	80P	20	250	OCAST /
1529	9	120P/45	120P	20	75P	20	250	OCAST /
1533	9	97P/45	97P	20	75P	20	250	PT CLDY /
1537	9	97P/45	97P	20	75P	20	250	PT CLDY./HEAVY ROLL
1541	10	97P/55	97P	20	75P	20	300	PT CLDY /HEAVY ROLL
1545	9	97P/45	97P	4	75P	6	300	PT CLDY /

TABLE XII(c)

COMPARISON OF TMR RESULTS FOR MIDSHIP VERTICAL BENDING STRESS WITH CORRESPONDING RAW DIGITIZATION RESULTS AT DAVIDSON LABORATORY

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 35 EAST

	TMR RESULTS					D.L. DIGITIZATION			COLUMN RATIOS		
D.L. RUN NO.	NO. WAVE INDUCED CYCLES (1)	NO. 1ST MODE BURSTS (2)	MAX P-TO-T STRESS KPSI (3)	RMS P-TO-T STRESS KPSI (4)	MAX 1ST MODE STRESS KPSI (5)	RANGE OF RECORDED EXTREMES KPSI (6)	2.83X (SAMPLE RMS) KPSI (7)	REL MEAN STRESS KPSI (8)	(7) / (4)	(6) / (3+5)	(6) / (3)
1405	120	0	3.18	1.37	0.00	4.60	1.47	0.21	1.07	1.45	1.45
1409	84	9	4.70	2.63	0.86	7.09	2.97	-0.20	1.13	1.28	1.51
1413	99	4	6.99	2.12	0.79	8.06	3.44	-0.19	1.63	1.04	1.15
1417	126	10	6.85	2.72	1.16	8.45	4.12	0.22	1.51	1.05	1.23
1421	165	3	3.74	1.83	0.97	7.60	3.27	-0.15	1.79	1.61	2.03
1429	97	11	7.92	3.24	0.99	11.06	4.04	-0.03	1.25	1.24	1.40
1433	105	4	9.51	3.27	0.80	10.38	4.27	-0.09	1.31	1.01	1.09
1437	105	26	7.19	3.55	1.70	10.57	4.36	-0.45	1.23	1.19	1.47
1442	114	23	10.19	4.58	2.00	16.33	6.03	-0.20	1.32	1.34	1.60
1445	71	23	17.74	5.48	1.23	18.20	7.46	0.19	1.36	0.96	1.03
1449	63	23	13.62	5.49	1.14	14.25	6.75	-0.11	1.23	0.96	1.05
1501	62	9	11.51	4.73	1.22	18.12	6.72	-0.05	1.42	1.42	1.57
1505	74	31	15.15	5.00	1.34	17.37	6.65	0.44	1.33	1.05	1.15
1513	58	44	13.11	6.52	1.63	17.92	7.90	0.73	1.21	1.22	1.37
1517	59	42	18.22	6.73	2.21	20.04	8.42	0.97	1.25	0.98	1.10
1525	67	18	14.83	6.74	1.36	17.84	7.30	0.98	1.08	1.10	1.20
1529	76	17	12.13	5.74	1.10	13.05	5.79	1.16	1.01	0.99	1.08
1533	82	26	10.52	5.62	1.14	11.61	5.29	1.23	0.94	1.00	1.10
1537	58	33	15.26	7.08	1.41	17.25	7.46	0.84	1.05	1.04	1.13
1541	61	33	11.42	5.81	1.35	11.00	5.81	0.78	1.00	0.86	0.96
1545	44	23	7.76	4.37	1.39	9.88	4.85	-0.30	1.11	1.08	1.27

TABLE XII(d)

SUMMARY OF RAW DIGITIZATION RESULTS FOR RADAR RANGE ROLL, PITCH, DECK HOUSE ACCELERATIONS, AND TUCKER METER

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 35 EAST

	RADAR			ROLL			PITCH			VERT ACCEL			LAT ACCEL			TUCKER		
D.L. RUN NO.	4.0 (RMS) FT	RECORDED EXTREMES FT	FT	4.0 (RMS) DEG	RECORDED EXTREMES DEG	DEG	4.0 (RMS) DEG	RECORDED EXTREMES DEG	DEG	4.0 (RMS) (G)	RECORDED EXTREMES (G)	(G)	4.0 (RMS) (G)	RECORDED EXTREMES (G)	(G)	4.0 (RMS) FT	RECORDED EXTREMES FT	FT
1405	15.	14.	-14.	5.6	5.	-4.	0.6	-0.5	-1.7	0.11	0.1	-0.1	0.14	0.1	-0.1	2.	2.	-1.
1409	24.	21.	-18.	15.5	13.	-9.	0.8	0.2	-1.1	0.15	0.1	-0.1	0.36	0.2	-0.3	3.	4.	-3.
1413	25.	22.	-23.	12.4	11.	-10.	0.7	0.1	-1.1	0.12	0.1	-0.1	0.26	0.3	-0.2	3.	4.	-3.
1417	28.	21.	-22.	10.0	12.	-5.	1.0	0.5	-1.3	0.22	0.2	-0.2	0.21	0.2	-0.2	3.	3.	-2.
1421	22.	20.	-22.	7.2	8.	-6.	0.9	0.4	-1.5	0.16	0.2	-0.2	0.16	0.2	-0.2	2.	2.	-2.
1429	33.	30.	-30.	14.5	12.	-13.	1.0	0.4	-1.5	0.23	0.2	-0.2	0.33	0.3	-0.2	5.	5.	-4.
1433	36.	30.	-28.	17.9	13.	-12.	1.1	0.4	-1.8	0.25	0.2	-0.2	0.40	0.3	-0.3	9.	8.	-6.
1437	34.	29.	-37.	13.4	13.	-10.	1.5	1.0	-2.2	0.35	0.3	-0.3	0.31	0.3	-0.3	8.	7.	-6.
1442	45.	39.	-40.	23.8	23.	-14.	2.1	1.6	-2.3	0.44	0.4	-0.3	0.49	0.4	-0.5	12.	9.	-8.
1445	48.	35.	-43.	28.2	30.	-24.	1.7	1.0	-2.2	0.35	0.3	-0.3	0.59	0.6	-0.6	17.	15.	-9.
1449	42.	35.	-33.	28.1	25.	-14.	1.6	0.9	-2.1	0.33	0.3	-0.2	0.61	0.4	-0.5	13.	10.	-8.
1501	42.	50.	-29.	23.6	19.	-16.	1.3	0.9	-1.6	0.30	0.3	-0.3	0.53	0.4	-0.4	14.	14.	-11.
1505	44.	36.	-31.	25.3	26.	-18.	1.5	1.0	-1.9	0.35	0.3	-0.3	0.55	0.5	-0.5	16.	14.	-10.
1513	42.	32.	-33.	33.9	38.	-14.	1.6	1.4	-1.7	0.31	0.3	-0.3	0.68	0.4	-0.5	18.	16.	-10.
1517	43.	37.	-36.	31.6	27.	-17.	1.4	1.0	-1.5	0.31	0.3	-0.3	0.67	0.5	-0.5	16.	12.	-12.
1525	44.	44.	-44.	29.6	24.	-18.	1.0	0.4	-1.3	0.26	0.3	-0.2	0.66	0.5	-0.4	14.	16.	-8.
1529	42.	34.	-32.	22.0	22.	-13.	0.9	0.4	-1.2	0.26	0.3	-0.2	0.50	0.4	-0.4	9.	7.	-7.
1533	39.	32.	-42.	19.1	20.	-10.	0.9	0.3	-1.3	0.26	0.2	-0.2	0.45	0.4	-0.3	9.	8.	-7.
1537	40.	36.	-30.	29.1	26.	-14.	1.1	0.8	-1.5	0.30	0.3	-0.3	0.68	0.5	-0.5	12.	10.	-7.
1541	39.	39.	-28.	34.0	29.	-14.	1.0	0.4	-1.3	0.22	0.2	-0.2	0.72	0.5	-0.5	13.	13.	-7.
1545	28.	20.	-23.	23.1	20.	-12.	0.8	0.3	-1.3	0.11	0.1	-0.1	0.50	0.4	-0.3	8.	11.	-5.

TABLE XIII(a)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 35 WEST

D.L. RUN NO.	TMR TAPE NO.	TMR INDX NO.	TMR INTV NO.	DATE	TIME (GMT)	LATITUDE	LONGITUDE	COURSE	SPEED KT.	PROP RPM	DRAFT FT.	SEA/AIR TEMP
1617	169	5	17	02-20-74	2400	50-23 N	01-16 W	263	31.6	129.0	30.42	51/50
1621	169	6	21	02-21-74	0400	50-23 N	01-16 W	263	31.8	130.0	30.37	51/50
1625	169	7	25	02-21-74	0800	50-23 N	01-16 W	263	31.8	130.0	30.36	51/51
1629	169	8	29	02-21-74	1200	47-19 N	19-35 W	261	32.0	131.0	30.32	51/50
1633	169	9	33	02-21-74	1600	47-19 N	19-35 W	261	31.4	128.3	30.20	52/50
1641	169	11	41	02-21-74	2400	47-19 N	19-35 W	261	31.9	130.5	30.40	52/47
1645	169	12	45	02-22-74	0400	47-19 N	19-35 W	261	32.0	131.0	30.35	51/48
1649	169	13	49	02-22-74	0800	47-19 N	19-35 W	261	32.0	131.0	30.12	53/50
1653	169	14	53	02-22-74	1200	45-12 N	38-08 W	259	31.8	130.0	29.83	53/53
1705	171	16	5	02-22-74	1700	45-12 N	38-08 W	259	31.3	128.0	29.65	57/48
1710	171	17	10	02-22-74	2000	45-12 N	38-08 W	259	31.3	128.0	29.80	57/37
1713	171	18	13	02-22-74	2400	45-12 N	38-08 W	235	25.3	106.0	29.99	40/34
1717	171	19	17	02-23-74	0400	45-12 N	38-08 W	260	20.2	86.0	30.12	36/34
1721	171	20	21	02-23-74	0800	45-12 N	38-08 W	261	31.8	130.0	30.20	31/33
1725	171	21	25	02-23-74	1200	42-32 N	52-49 W	261	32.1	131.4	29.97	45/45
1729	171	22	29	02-23-74	1600	42-32 N	52-49 W	259	32.0	131.0	29.55	52/46
1743	171	25	43	02-24-74	0400	42-32 N	52-49 W	259	10.0	60.0	29.67	34/44
1747	171	26	47	02-24-74	0800	42-32 N	52-49 W		6.0	42.0	29.81	38/45
1749	171	27	49	02-24-74	1200	40-35 N	60-49 W	225		30.0	30.02	55/45
1756	171	28	56	02-24-74	1600	40-35 N	60-49 W	250	10.0	62.0	30.09	50/46
1801	173	29	1	02-24-74	1900	40-35 N	60-49 W	270	10.0	64.0	30.20	50/41
1809	173	31	9	02-24-74	2300	40-35 N	60-49 W	268	32.0	131.0	30.20	60/40
1813	173	32	13	02-25-74	0100	40-35 N	60-49 W	268	32.1	131.5	30.10	52/39
1817	173	33	17	02-25-74	0300	40-35 N	60-49 W	269	32.3	131.8	29.96	40/38

TABLE XIII(b)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 35 WEST

D.L. RUN NO.	SEA STATE	<REL WIND> DIR/SPEED /(KT)	REL WAVE DIR	WAVE HT. FT.	REL SWELL DIR	<-SWELL-> HT FT.	LENGTH FT.	VISUAL WEATHER /TMR LOG-BOOK COMMENTS
1617	1	7S/ 2	7S	1	7S	3	250	PT CLDY /
1621	3	7S/10	7S	1	7S	3	250	PT CLDY /
1625	3	38P/10	38P	1	38P	3	250	OCAST /
1629	5	36P/20	36P	2	36P	4	200	PT CLDY /
1633	5	47P/20	36P	3	36P	5	150	OCAST /
1641	2	99S/ 5	99S	3	9S	5	150	OCAST /
1645	2	171P/ 5	171P	3	9S	5	150	PT CLDY /
1649	5	103P/20	103P	3	36P	5	150	PT CLDY /
1653	7	79P/30	79P	6	79P	8	150	OCAST /
1705	9	33S/45	33S	5	79P	8	150	OCAST /
1710	8	22S/40	22S	5	22S	8	150	OCAST /RETURN TO AUTO RECORDING
1713	8	35S/40	35S	6	35S	8	150	OCAST /
1717	5	44S/20	55S	4	55S	6	200	PT CLDY /
1721	2	36P/ 5	36P	2	36P	4	200	PT CLDY /
1725	5	81P/20	81P	2	81P	4	200	PT CLDY /
1729	7	56P/30	56P	5	11S	7	150	OCAST /
1743	9	12S/45	12S	25	0	25	400	OCAST /HOVE TO 30 RPM
1747	10	0 /50	0	30	25S	30	400	PT CLDY /HOVE TO 30 RPM
1749	10	56S/50	56S	30	45S	30	400	PT CLDY /
1756	10	20S/50	20S	15	20S	15	200	PT CLDY /
1801	9	11S/45	11S	15	0	15	200	PT CLDY /
1809	2	34S/ 5	2S	6	2S	6	300	OCAST / .
1813	5	178P/20	178P	4	178P	4	300	OCAST /
1817	7	179P/30	179P	3	179P	3	300	OCAST /

TABLE XIII(c)

COMPARISON OF TMR RESULTS FOR MIDSHIP VERTICAL BENDING STRESS WITH CORRESPONDING RAW DIGITIZATION RESULTS AT DAVIDSON LABORATORY

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 35 WEST

	TMR RESULTS					D.L. DIGITIZATION			COLUMN RATIOS		
D.L. RUN NO.	NO. WAVE INDUCED CYCLES (1)	NO. 1ST MODE BURSTS (2)	MAX P-TO-T STRESS KPSI (3)	RMS P-TO-T STRESS KPSI (4)	MAX 1ST MODE STRESS KPSI (5)	RANGE OF RECORDED EXTREMES KPSI (6)	2.83X (SAMPLE RMS) KPSI (7)	REL MEAN STRESS KPSI (8)	(7) / (4)	(6) / (3+5)	(6) / (3)
1617	171	8	7.61	3.50	1.10	7.05	3.16	-1.32	0.91	0.81	0.93
1621	179	1	6.39	2.86	0.70	6.54	2.76	-1.29	0.96	0.92	1.02
1625	173	0	4.44	2.22	0.00	5.29	2.20	-1.26	0.99	1.19	1.19
1629	177	23	7.14	2.97	1.19	8.08	3.14	-1.41	1.05	0.97	1.13
1633	183	37	8.16	3.56	2.00	9.71	3.55	-1.25	1.00	0.96	1.19
1641	189	25	11.25	4.01	2.10	11.83	3.71	-1.38	0.93	0.89	1.05
1645	199	8	7.27	3.24	1.59	8.35	3.22	-1.36	0.99	0.94	1.15
1649	194	13	4.46	2.16	1.16	5.09	2.14	-1.49	0.99	0.91	1.14
1653	190	37	5.59	2.50	3.39	8.17	2.83	-1.52	1.13	0.91	1.46
1705	166	59	12.51	5.21	4.53	15.74	5.47	-1.20	1.05	0.92	1.26
1710	165	71	7.72	4.00	4.21	10.55	4.17	-1.10	1.04	0.88	1.37
1713	160	69	15.99	6.61	4.11	16.68	6.71	-0.25	1.01	0.83	1.04
1717	147	45	13.06	5.61	3.18	14.56	5.72	0.01	1.02	0.90	1.12
1721	189	52	16.48	5.10	9.33	24.03	5.07	-1.23	0.99	0.93	1.46
1725	210	2	5.00	2.40	0.93	6.33	2.64	-1.49	1.10	1.07	1.27
1729	199	34	3.23	1.32	1.71	4.17	1.64	-1.64	1.24	0.84	1.29
1743	113	71	23.26	11.01	3.29	23.56	10.38	0.52	0.94	0.89	1.01
1747	107	42	27.76	10.07	2.95	26.12	9.38	0.68	0.93	0.85	0.94
1749	107	37	18.64	9.00	2.32	17.67	8.35	0.59	0.93	0.84	0.95
1756	147	73	20.10	8.19	5.13	21.62	7.95	0.37	0.97	0.86	1.08
1801	133	22	18.78	7.98	3.90	18.73	7.07	0.53	0.89	0.83	1.00
1809	200	25	7.94	3.82	7.15	9.77	4.23	-0.93	1.11	0.65	1.23
1813	221	0	4.21	2.02	0.00	6.13	2.57	-1.22	1.27	1.46	1.46
1817	184	0	3.30	1.33	0.00	4.07	1.49	-1.20	1.12	1.23	1.23

TABLE XIII(d)

SUMMARY OF RAW DIGITIZATION RESULTS FOR RADAR RANGE ROLL, PITCH, DECK HOUSE ACCELERATIONS, AND TUCKER METER

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 35 WEST

	RADAR			ROLL			PITCH			VERT ACCEL			LAT ACCEL			TUCKER		
D.L. RUN NO.	4.0 (RMS) FT	RECORDED EXTREMES FT	FT	4.0 (RMS) DEG	RECORDED EXTREMES DEG	DEG	4.0 (RMS) DEG	RECORDED EXTREMES DEG	DEG	4.0 (RMS) (G)	RECORDED EXTREMES (G)	(G)	4.0 (RMS) (G)	RECORDED EXTREMES (G)	(G)	4.0 (RMS) FT	RECORDED EXTREMES FT	FT
1617	27.	22.	-20.	3.1	2.	-3.	1.5	0.8	-2.0	0.33	0.3	-0.3	0.09	0.1	-0.1	3.	3.	-3.
1621	23.	21.	-19.	3.0	2.	-3.	1.3	0.5	-1.8	0.28	0.2	-0.2	0.09	0.1	-0.1	3.	3.	-2.
1625	18.	17.	-15.	2.7	2.	-2.	1.0	0.2	-1.5	0.22	0.2	-0.2	0.08	0.1	-0.1	2.	2.	-2.
1629	25.	21.	-20.	2.4	2.	-2.	1.4	0.8	-1.8	0.29	0.2	-0.3	0.07	0.1	-0.1	3.	2.	-3.
1633	26.	23.	-24.	2.2	3.	-1.	1.4	0.6	-1.8	0.30	0.2	-0.2	0.07	0.1	-0.1	3.	2.	-2.
1641	26.	24.	-40.	2.5	1.	-3.	1.4	1.0	-2.2	0.30	0.4	-0.3	0.07	0.1	-0.1	2.	2.	-2.
1645	24.	18.	-18.	3.2	1.	-4.	1.3	0.5	-1.9	0.27	0.2	-0.2	0.09	0.1	-0.1	3.	2.	-2.
1649	17.	15.	-13.	3.0	3.	-2.	0.9	0.3	-1.4	0.20	0.2	-0.2	0.09	0.1	-0.1	2.	2.	-2.
1653	19.	16.	-18.	5.7	7.	-3.	1.0	0.3	-1.3	0.21	0.2	-0.2	0.15	0.2	-0.1	3.	2.	-2.
1705	41.	30.	-44.	11.0	9.	-9.	2.2	1.7	-2.3	0.49	0.4	-0.4	0.26	0.2	-0.2	6.	5.	-5.
1710	34.	31.	-42.	5.8	4.	-6.	1.8	1.1	-2.0	0.37	0.3	-0.3	0.15	0.2	-0.1	4.	4.	-3.
1713	50.	34.	-51.	5.0	2.	-7.	2.4	1.5	-2.1	0.52	0.4	-0.4	0.13	0.1	-0.1	5.	4.	-4.
1717	51.	35.	-49.	4.6	1.	-14.	2.0	1.1	-2.0	0.45	0.3	-0.3	0.13	0.1	-0.1	5.	4.	-4.
1721	34.	34.	-46.	3.3	2.	-5.	1.9	2.0	-2.4	0.39	0.6	-0.5	0.10	0.1	-0.1	3.	3.	-3.
1725	16.	15.	-14.	2.6	2.	-3.	1.0	0.3	-1.3	0.19	0.2	-0.2	0.08	0.1	-0.1	2.	2.	-2.
1729	11.	9.	-11.	3.1	5.	-0.	0.8	0.3	-0.9	0.11	0.1	-0.1	0.09	0.1	-0.1	2.	2.	-2.
1743	52.	39.	-42.	9.3	11.	-12.	2.1	1.9	-2.1	0.45	0.3	-0.4	0.24	0.2	-0.3	7.	7.	-7.
1747	51.	39.	-43.	10.3	8.	-13.	1.6	1.4	-1.8	0.36	0.3	-0.3	0.26	0.3	-0.3	8.	8.	-8.
1749	49.	35.	-41.	11.1	5.	-12.	1.6	1.2	-1.6	0.36	0.3	-0.3	0.27	0.2	-0.2	9.	8.	-8.
1756	55.	44.	-49.	7.0	4.	-8.	2.3	1.7	-2.0	0.49	0.4	-0.4	0.18	0.2	-0.2	6.	5.	-6.
1801	53.	36.	-51.	5.5	2.	-6.	1.9	1.3	-1.8	0.43	0.4	-0.3	0.14	0.1	-0.2	5.	4.	-4.
1809	28.	23.	-25.	5.2	3.	-7.	1.7	0.8	-2.0	0.38	0.3	-0.3	0.14	0.1	-0.1	3.	3.	-3.
1813	16.	15.	-13.	3.8	1.	-6.	0.9	0.2	-1.4	0.17	0.1	-0.1	0.10	0.1	-0.1	2.	1.	-2.
1817	12.	11.	-12.	3.6	2.	-4.	0.8	0.2	-1.3	0.16	0.1	-0.1	0.10	0.1	-0.1	2.	1.	-1.

TABLE XIV(a)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 36 EAST

D.L. RUN NO.	TMR TAPE NO.	TMR INDX NO.	TMR INTV NO.	DATE	TIME (GMT)	LATITUDE	LONGITUDE	COURSE	SPEED KT.	PROP RPM	DRAFT FT.	SEA/AIR TEMP
1925	175	7	25	02-28-74	2000	41-36 N	58-10 W	079	32.3	131.0	30.31	47/37
1929	175	8	29	02-28-74	2400	41-36 N	58-10 W	078	32.1	130.0	30.30	43/35
1933	175	9	33	03-01-74	0400	41-36 N	58-10 W	078	32.4	131.3	30.30	42/34
1937	175	10	37	03-01-74	0800	41-36 N	58-10 W	078	31.9	129.5	30.26	37/35
1941	175	11	41	03-01-74	1200	41-36 N	58-10 W	078	32.1	130.0	30.24	60/36
1945	175	12	45	03-01-74	1600	44-05 N	42-20 W	078	32.2	130.6	30.27	57/46
1949	175	13	49	03-01-74	2000	44-05 N	42-20 W	078	32.3	130.8	30.25	58/47
1953	175	14	53	03-01-74	2400	44-05 N	42-20 W	077	32.3	131.0	30.29	57/48
1957	175	15	57	03-02-74	0400	44-05 N	42-20 W	077	32.4	131.3	30.34	53/48
1961	175	16	61	03-02-74	0800	44-05 N	42-20 W	077	32.2	130.5	30.33	54/47
2001	177	17	1	03-02-74	1200	44-05 N	42-20 W	077	32.1	130.0	30.34	52/48
2005	177	18	5	03-02-74	1600	46-36 N	25-47 W	078	32.4	131.3	30.40	52/50
2010	177	19	10	03-02-74	2000	46-36 N	25-47 W	077	32.4	131.2	30.36	52/50
2013	177	20	13	03-02-74	2400	46-36 N	25-47 W	078	32.2	131.0	30.39	51/48
2017	177	21	17	03-03-74	0400	46-36 N	25-47 W	078	32.5	131.6	30.38	51/48
2021	177	22	21	03-03-74	0800	46-36 N	25-47 W	077	32.4	131.4	30.33	51/47

TABLE XIV(b)

SUMMARY OF TMR LOG-BOOK DATA CORRESPONDING TO INTERVALS SELECTED FOR WAVE METER DATA REDUCTION

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 36 EAST

D.L. RUN NO.	SEA STATE	<REL WIND> DIR/SPEED /(KT)	REL WAVE DIR	WAVE HT. FT.	REL SWELL DIR	<-SWELL-> HT FT.	<-SWELL-> LENGTH FT.	VISUAL WEATHER /TMR LOG-BOOK COMMENTS
1925	4	56P/12	56P	2	56P	3	150	PT CLDY /
1929	3	56P/12	56P	2	55P	3	150	PT CLDY /
1933	4	33P/12	33P	3	33P	3	150	PT CLDY /
1937	5	55P/15	55P	3	55P	3	150	PT CLDY /
1941	5	33P/15	33P	3	33P	3	150	PT CLDY /
1945	5	33P/20	33P	3	33P	3	250	PT CLDY /
1949	4	55P/15	55P	3	33P	3	250	PT CLDY /
1953	2	54P/10	32P	2	32P	4	300	CLDY /
1957	2	54P/ 5	32P	2	32P	4	300	OCAST /
1961	2	/ 5		2		6	500	CLDY /LONG CONFUSED SWELL
2001	2	/ 5		2		6	500	PT CLDY /
2005	2	78P/ 5	78P	2	123P	6	500	PT CLDY /
2010	4	99P/10	99P	2	124P	6	300	CLDY /
2013	3	78P/10	78P	4	124P	6	300	CLDY /
2017	4	78P/10	78P	4	124P	6	125	CLDY /
2021	4	54P/15	54P	5	124P	6	125	PT CLDY /

TABLE XIV(c)

COMPARISON OF TMR RESULTS FOR MIDSHIP VERTICAL BENDING STRESS WITH CORRESPONDING RAW DIGITIZATION RESULTS AT DAVIDSON LABORATORY

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 36 EAST

D.L. RUN NO.	TMR RESULTS: NO. WAVE INDUCED CYCLES (1)	NO. 1ST MODE BURSTS (2)	MAX P-TO-T STRESS KPSI (3)	RMS P-TO-T STRESS KPSI (4)	MAX 1ST MODE STRESS KPSI (5)	D.L. DIGITIZATION: RANGE OF RECORDED EXTREMES KPSI (6)	2.83X (SAMPLE RMS) KPSI (7)	REL MEAN STRESS KPSI (8)	COLUMN RATIOS: (7) / (4)	(6) / (3+5)	(6) / (3)
1925	197	0	2.24	0.88	0.00	2.85	1.12	0.39	1.26	1.27	1.27
1929	187	0	2.29	0.94	0.00	3.05	1.17	0.19	1.25	1.33	1.33
1933	207	2	2.48	1.04	0.72	3.42	1.23	0.31	1.18	1.07	1.38
1937	197	50	3.46	1.74	2.15	5.64	2.10	0.23	1.21	1.01	1.63
1941	181	13	4.52	2.03	0.79	6.21	2.44	0.28	1.20	1.17	1.37
1945	149	6	3.49	1.50	3.40	22.95 **	2.21	0.50	1.47	3.33	6.58
1949	136	1	2.56	1.38	0.56	4.24	1.79	0.51	1.30	1.36	1.66
1953	121	0	3.29	1.45	0.00	4.44	1.80	0.44	1.24	1.35	1.35
1957	124	0	3.61	1.73	0.00	5.27	2.15	0.48	1.24	1.46	1.46
1961	113	7	4.08	2.00	0.83	5.84	2.43	0.60	1.21	1.19	1.43
2001	95	2	3.78	1.89	0.53	5.76	2.33	-0.14	1.24	1.33	1.52
2005	102	7	6.19	2.37	0.92	5.93	2.64	-0.24	1.11	0.83	0.96
2010	91	1	4.39	2.22	0.65	6.21	2.84	-0.78	1.28	1.23	1.42
2013	82	11	4.72	2.20	1.00	7.49	2.74	-0.58	1.25	1.31	1.59
2017	90	10	4.80	2.08	0.77	5.82	2.60	-0.71	1.25	1.05	1.21
2021	76	19	5.69	2.22	1.19	6.05	2.52	-0.61	1.13	0.88	1.06

** Magnetic Tape Saturation, probably extraneous

TABLE XIV(d)

SUMMARY OF RAW DIGITIZATION RESULTS FOR RADAR RANGE ROLL, PITCH, DECK HOUSE ACCELERATIONS, AND TUCKER METER

SEA LAND MC LEAN : 1973-1974 WINTER SEASON : VOYAGE 36 EAST

D.L. RUN NO.	RADAR: 4.0 (RMS) FT	RECORDED EXTREMES FT	FT	ROLL: 4.0 (RMS) DEG	RECORDED EXTREMES DEG	DEG	PITCH: 4.0 (RMS) DEG	RECORDED EXTREMES DEG	DEG	VERT ACCEL: 4.0 (RMS) (G)	RECORDED EXTREMES (G)	(G)	LAT ACCEL: 4.0 (RMS) (G)	RECORDED EXTREMES (G)	(G)	TUCKER: 4.0 (RMS) FT	RECORDED EXTREMES FT	FT
1925	10.	10.	-8.	2.1	3.	-1.	0.5	-0.2	-1.1	0.08	0.1	-0.1	0.06	0.1	-0.1	1.	1.	-1.
1929	10.	8.	-10.	2.3	3.	-1.	0.5	-0.3	-1.1	0.09	0.1	-0.1	0.07	0.1	-0.1	1.	1.	-1.
1933	11.	9.	-10.	2.3	3.	-1.	0.5	-0.1	-1.0	0.09	0.1	-0.1	0.07	0.1	-0.1	1.	1.	-1.
1937	16.	13.	-12.	3.4	5.	-1.	0.8	0.3	-1.3	0.18	0.2	-0.2	0.10	0.1	-0.1	2.	2.	-2.
1941	18.	20.	-18.	4.8	6.	-2.	1.0	0.6	-1.6	0.22	0.2	-0.2	0.13	0.1	-0.1	2.	2.	-2.
1945	14.	14.	-13.	5.0	5.	-4.	0.7	0.1	-1.1	0.15	0.1	-0.1	0.13	0.1	-0.1	2.	2.	-2.
1949	14.	12.	-12.	5.5	5.	-4.	0.8	0.7	-0.7	0.15	0.1	-0.1	0.14	0.1	-0.1	2.	2.	-2.
1953	16.	12.	-12.	9.0	6.	-6.	0.7	0.7	-0.6	0.13	0.1	-0.1	0.21	0.1	-0.2	2.	3.	-2.
1957	18.	14.	-14.	7.6	9.	-5.	0.9	0.9	-0.7	0.19	0.2	-0.2	0.19	0.2	-0.2	3.	3.	-2.
1961	20.	19.	-15.	9.4	9.	-7.	1.0	1.1	-0.8	0.20	0.2	-0.2	0.23	0.2	-0.2	3.	3.	-3.
2001	19.	18.	-13.	10.6	9.	-7.	0.7	0.7	-0.7	0.16	0.2	-0.1	0.25	0.2	-0.2	3.	3.	-2.
2005	22.	19.	-17.	12.3	10.	-10.	0.9	1.0	-0.9	0.20	0.2	-0.2	0.29	0.3	-0.2	4.	4.	-3.
2010	27.	25.	-21.	19.0	16.	-13.	0.8	0.7	-0.8	0.17	0.2	-0.1	0.43	0.3	-0.3	5.	7.	-4.
2013	24.	23.	-19.	17.5	15.	-12.	0.8	0.8	-0.6	0.14	0.1	-0.1	0.38	0.3	-0.3	5.	7.	-5.
2017	25.	20.	-19.	16.1	14.	-9.	0.8	0.9	-0.5	0.14	0.1	-0.1	0.37	0.3	-0.3	5.	5.	-3.
2021	24.	23.	-16.	14.7	14.	-9.	0.7	0.8	-0.4	0.12	0.1	-0.1	0.36	0.3	-0.3	5.	6.	-3.

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

LENGTH

Symbol	When You Know	Multiply by	To Find	Symbol
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km

AREA

Symbol	When You Know	Multiply by	To Find	Symbol
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha

MASS (weight)

Symbol	When You Know	Multiply by	To Find	Symbol
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t

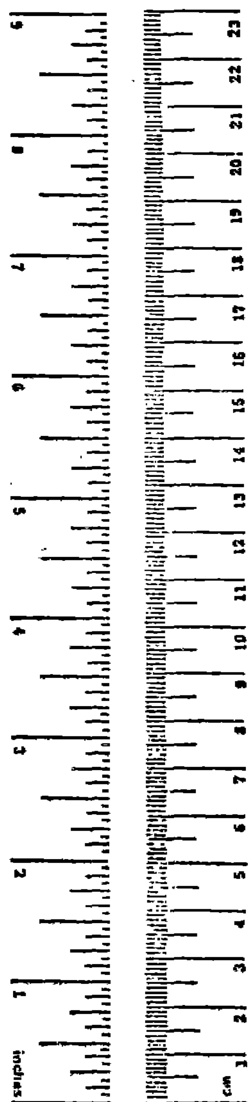
VOLUME

Symbol	When You Know	Multiply by	To Find	Symbol
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3

TEMPERATURE (exact)

Symbol	When You Know	Multiply by	To Find	Symbol
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

LENGTH

Symbol	When You Know	Multiply by	To Find	Symbol
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi

AREA

Symbol	When You Know	Multiply by	To Find	Symbol
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	

MASS (weight)

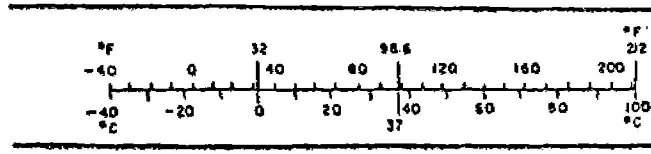
Symbol	When You Know	Multiply by	To Find	Symbol
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	

VOLUME

Symbol	When You Know	Multiply by	To Find	Symbol
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3

TEMPERATURE (exact)

Symbol	When You Know	Multiply by	To Find	Symbol
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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So that more precise correlations between full scale observations and analytical and model results could be carried out, one of the objectives of the instrumentation program for the SL-7 class container ships was the provision of instrumental measures of the wave environment. To this end, two wave meter systems were installed on the S.S. SEA-LAND McLEAN. Raw data was collected from both systems during the second (1973-1974) and third (1974-1975) winter data collecting seasons.

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It was the purpose of the present work to reduce this raw data, to develop and implement such corrections as were found necessary and feasible, and to correlate and evaluate the final results from the two wave meters. In carrying out this work it was necessary to at least partly reduce several other channels of recorded data, so that, as a by-product, reduced results were also obtained for midship bending stresses, roll, pitch, and two components of acceleration on the ship's bridge.

As the work progressed it became evident that the volume of documentation required would grow beyond the usual dimensions of a single technical report. For this reason the analyses, the methods, the detailed results, discussions, and conclusions are contained in a series of ten related reports.

The present report is the first in the series, and involves the initial stages of the work. Specifically, this report documents the several decisions and methods thought necessary in conversion of the raw data from its original analog form to digital form, the sampling and calibration of data from the second (1973-1974) season, and a summary of initial results.

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