SSC-304
(SL-7-26)

SL-7 EXTREME STRESS DATA COLLECTION AND REDUCTION

SHIP STRUCTURE COMMITTEE

1981

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An Interagency Advisory Committee
Dedicated to Improving the Structure of Ships

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SR-1245

1981

This report is one of a group of Ship Structure Committee Reports which describe 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, classification 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 reponse, 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 installation of the long-term stress recorders and the method involved in selecting and converting the raw stress data to histograms. The reduction of a seven-year collection of these data are presented.

Clyde T. Lusk, Jr.
Rear Admiral, U.S. Coast Guard
Chairman, Ship Structure Committee

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16. Abstract

This report covers the installation of extreme stress gauges on eight SL-7 Vessels. Data collected over a seven-year period is presented.

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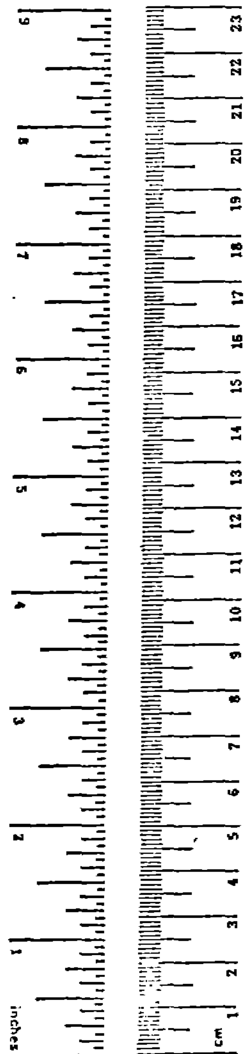
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

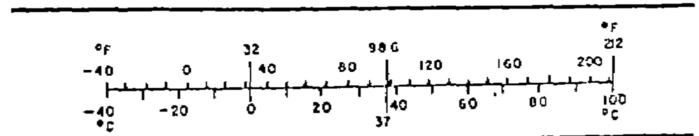
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
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)		
°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

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
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		
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)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
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)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



METRIC CONVERSION FACTORS

CONTENTS

I. BACKGROUND

This seven-year data collection program has been conducted in three phases. The first three years of the program were conducted under Department of the Navy Contract N00024-73-C-514D, Serial No. SF35422306 Task 2022, SR215. The next two years were conducted under Coast Guard Contract DOT-CG-61712A. Report SSC-286(SL-7-25) covering the first five years was published by the Ship Structure Committee in 1979. The final two years of data collection was also sponsored by the Ship Structure Committee, Contract No. DOT-CG-844331-A, Project SR-1245-SL-7 "Extreme Stress Data Collection and Reduction." The present report collates data from the final two years with data previously reported, to provide a comprehensive summary of all the data.

Nine N.C.R.E. mechanical strain-gauge recorders were installed on the eight SL-7 high-speed containerships operated by Sea-Land Service, Inc. These vessels operated on both transatlantic and transpacific routes.

II. FUNCTIONAL DESCRIPTION

The purpose of this program was to obtain as much midship bending stress data from the SL-7's in the simplest and most direct manner possible. To meet this requirement, N.C.R.E. (Naval Construction Research Establishment) maximum-reading strain-gauge recorders and clock units (Figures 1 and 2) were obtained from Elcomatic Limited of Glasgow, Scotland. The units were installed at approximately midships in the starboard longitudinal box girder (tunnel) of all eight SL-7s (see Appendix A for installation details).

The N.C.R.E. strain gauge consists of contact points 10 inches apart and a mechanical linkage which provides a magnification of approximately 100:1 at the stylus. The stylus moves against a pressure-sensitive recording paper causing both positive and negative deflections to be indicated by a scratch mark (Figure 3). The paper is indexed about 0.1 inch every four hours. Once every sixth interval (i.e., every 24 hours) the index is 0.4 inches wide. Each vertical marking has a length which represents the <u>maximum</u> peak to <u>maximum</u> trough stress which has occurred during the four-hour period during which the stylus was at one place on the paper. For accurate data interpretation, it is important to remember the following characteristics of this system:

1. The record indicates the combined wave-induced and first-(or higher) mode vibratory stresses; there is no way to separate the various effects.

2. The maximum peak, and maximum trough stresses indicated on the record may not have occurred as part of the same cycle; i.e., they may have occurred at different times during the four hour record interval (Figure 4).

3. Slow "static" changes in the average stress caused by thermal effects, ballast changes, etc., will contribute to the total length of the scratch line. Appendix D of this report provides further information on these slow changes.

N.C.R.E. -maximum reading STRAIN GAUGE RECORDER

The analysis of wave-induced stresses imposed on the steel hull of a surface vessel involves the use of data relating to maximum bending moments applied to the hull girder. In the course of such analysis, scientific staff of the Naval Construction Research Establishment, Dunfermline, Scotland, adopted a method of recording maximum strain variations during specified time intervals by means of a maximum-reading strain gauge incorporating a strip chart.

Prototype quantities of the NCRE designed recorder were produced within the Establishment, subsequently evaluated and used as highly successful data acquisition instruments in the arduous environments experienced by Royal Navy warships at sea. To meet a demand for further models, it was decided by NCRE to permit a strain instrumentation company to manufacture the device commercially. Elcomatic Limited of Glasgow was chosen, and the NCRE recorder now is available as a standard Elcomatic product.

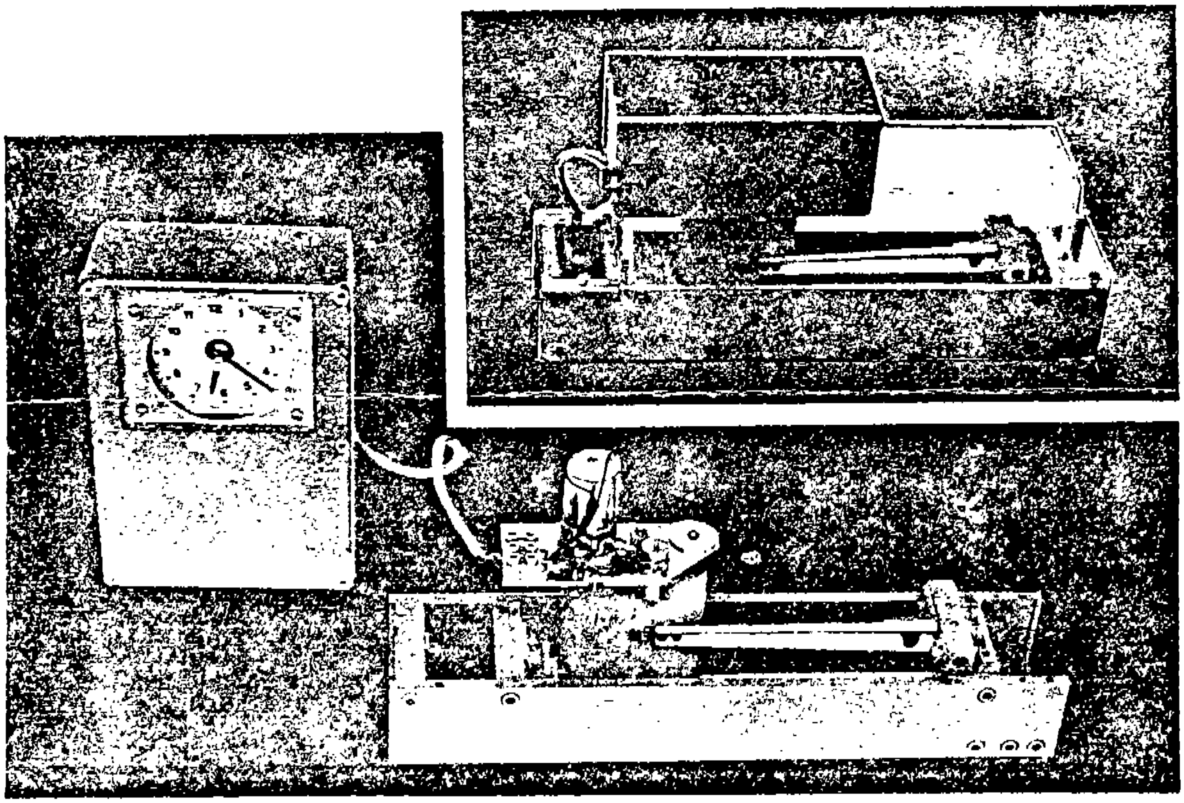
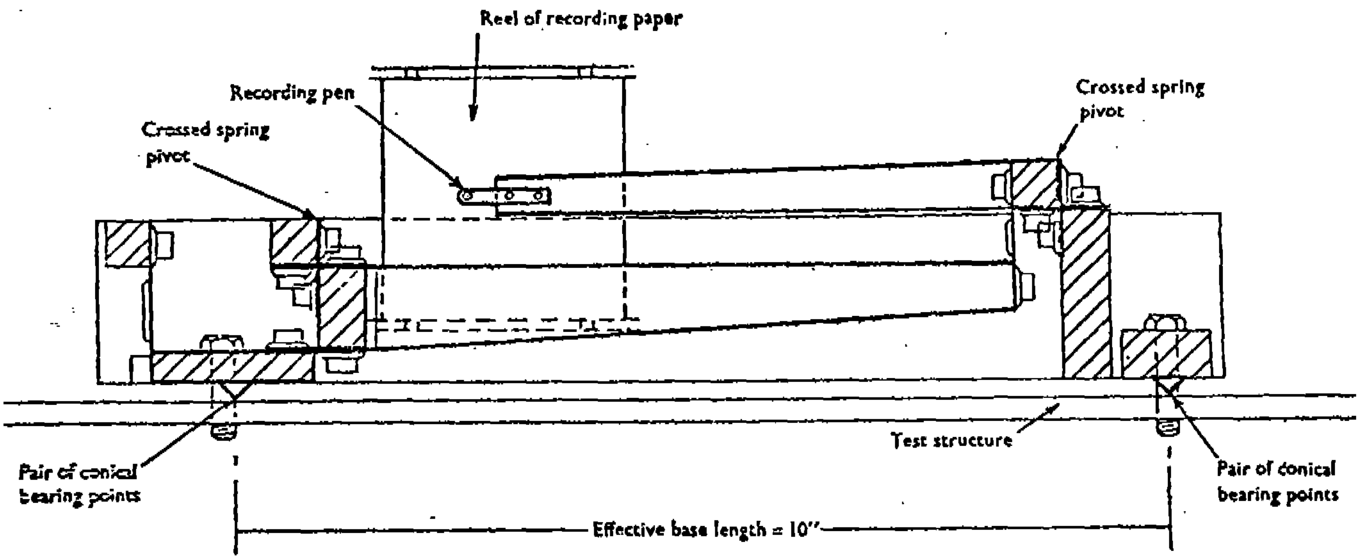


FIGURE 1

Gauge Action:

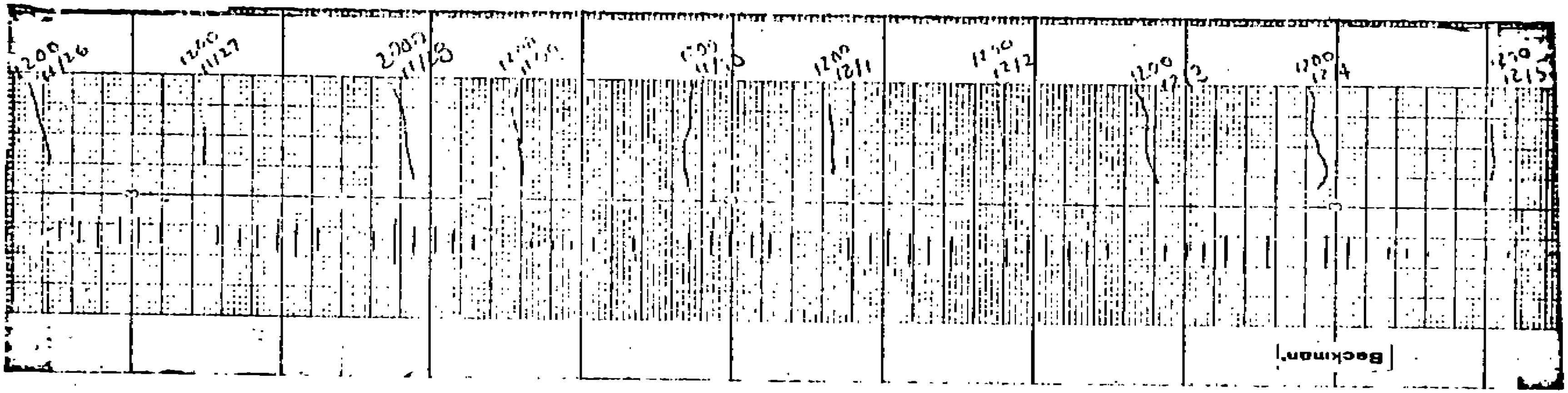
As shown in the sectional diagram below, the lever system is actuated by distortion of the structure under test and requires no external power supply. The instrument is bolted in position, bearing against the test surface on two sets of hardened conical studs. Any change in separation of bearing points is magnified by the lever system which drives the recording pen across the stationary reel of carbon-backed paper. Time related maximum strain records are obtained by forward movement of recording paper programmed by a precision battery-rewound clock and powered by a small motor also battery powered.

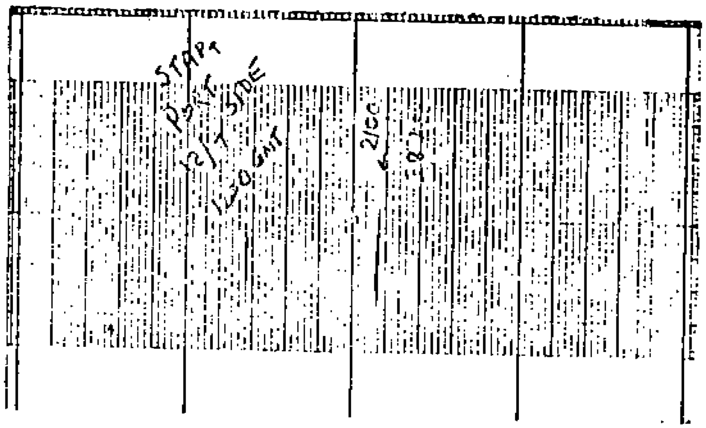


Details:

Prime function	Fully automatic recording of maximum strain.	**Linearity**	Substantially linear over strain range of 0.0025.
Duration of Continuous unattended operation	Three months depending on programme.	**Temperature effects**	Uniform temperature changes of gauge and steel test structure produce no discernible pen movement.
Magnification Factor	Nominally 100—subject to precise calibration by a dial gauge reading to 0.0001″.	**Vibration**	Tested by dynamic strains of double amplitude 0.0008 at frequencies 25 to 200 cycles per minute—no significant inaccuracy.
Resolution	A strain change of 0.001 will produce a 1″ pen deflection.	**Chart loading**	Cassette.

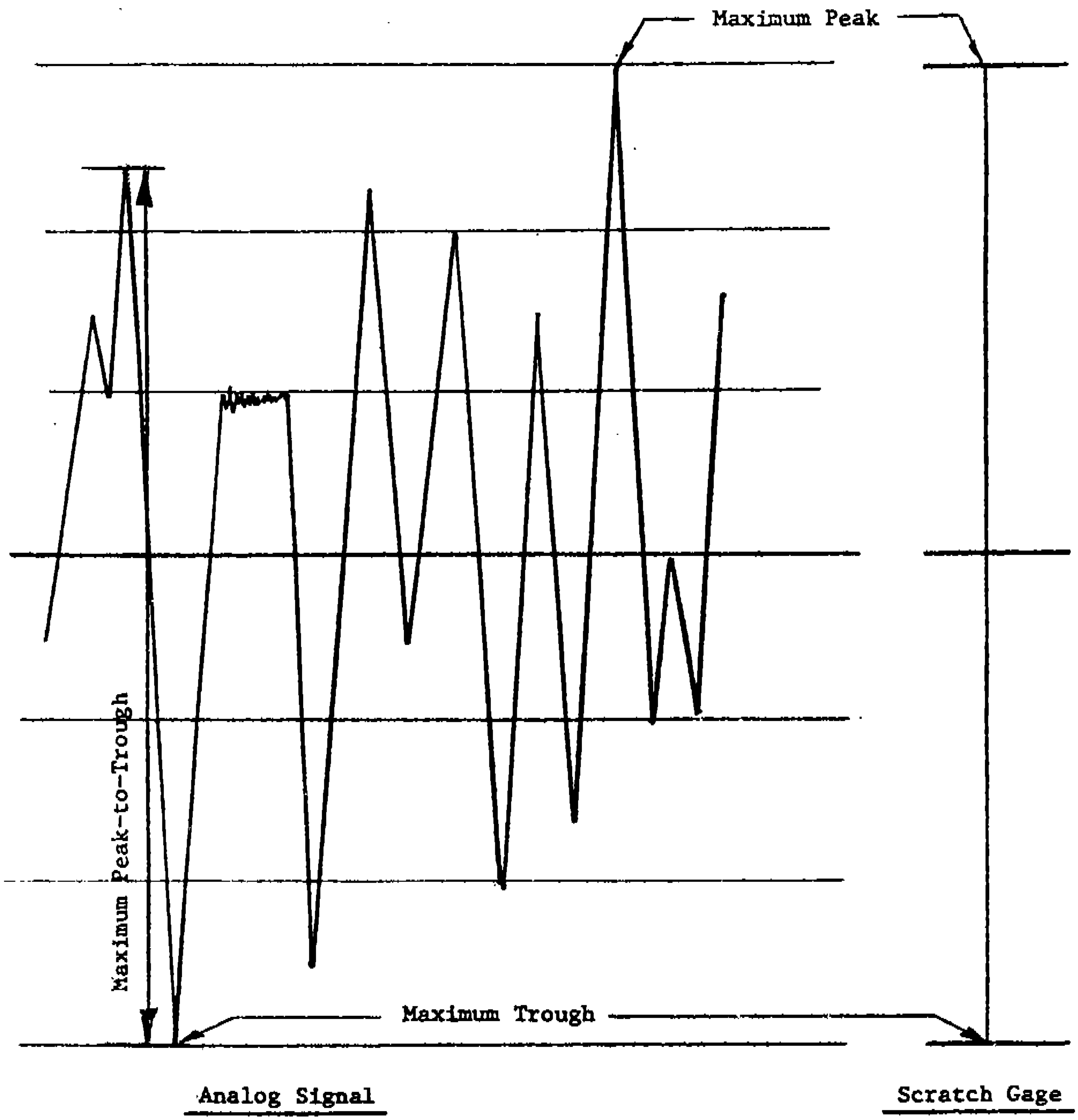
FIGURE 2





SEALAND McLEAN
VOYAGE #5
PORT SIDE

SAMPLE DATA TAPE
FIGURE 3



ILLUSTRATED EXAMPLE OF THE COMPARISON OF AN ANOLOG SIGNAL WITH THE SCRATCH GAGE

FIGURE 4

Prior to installations, each scratch gauge was calibrated utilizing a Bridgeport milling machine. The fixed collet and moveable table were used to generate strain. The table was moved in both tension and compression directions in increments of 0.001 inches, with a dial indicator used to measure the amount of displacement. A calibration table and plot for each instrument is provided in Appendix B of this report.

All of the scratch-gauge recorders and clock units have been removed from the vessels and returned to TES for storage. Each recorder was checked to insure that its calibration was still valid. No significant change in calibration was found.

III. VESSEL DEPLOYMENT AND EQUIPMENT HISTORY

The following section is a brief summary of each vessel's routing assignment from the time the scratch gauge(s) were installed until their removal. Included are comments concerning the operation of the equipment. The sequence is in the order in which the equipment was installed and placed in service.

The eight SL-7s have been utilized on either a transatlantic or transpacific route. Atlantic crossings involve some or all of the following ports: Port Elizabeth, N.J.; Portsmouth, VA; Bremerhaven, Germany; Rotterdam, Netherlands; and Algeciras, Spain. Those vessels assigned to Pacific duty followed a steady route that began in Seattle, Washington, with calls in turn at Long Beach, California; Oakland, California; Yokohama, Japan; Kobe, Japan; and Hong Kong.

For the first few years, the vessels operated at their designed speed of 33 knots. After the price of fuel quadrupled in the mid-seventies, the vessels' speed was reduced to 20-24 knots to conserve fuel and reduce operating costs.

1. SEA-LAND MCLEAN

This vessel became the test bed of the eight SL-7s. The hull and numerous components were heavily instrumented to investigate bending and torsional hull response. The data were published by the Ship Structure Committee as part of its SL-7 library. Two scratch gauges were installed October 7, 1972 (Serial No. BS72E0001 in the port tunnel, and Serial No. 026 in the starboard tunnel). Teledyne engineers rode this vessel for the winter months of 1972 to 1975 and were able to monitor the scratch gauges daily during this period. The McLean sailed the Atlantic until May 1975, when she transferred to the Pacific after a dry-docking at Newport News, Virginia.

In order to ascertain if the calibration curve for an installed unit had changed with time, the McLean port tunnel gauge was removed on October 18, 1975 and replaced with the spare unit (Serial No. BS73E0001). The removed unit was returned to TES and recalibrated. See Appendix B for the results of this test.

Both instruments performed well up to the time of their removal on September 14, 1980. One clock unit failed in May 1978, and one roll of tape from the port gauge was lost due to loss of stylus pressure in April-May 1979.

2. SEA-LAND GALLOWAY

Gauge unit Serial No. BS73A007 was installed in the starboard tunnel on March 10, 1973. A problem with excessive moisture condensation in the tunnels during the winter months was solved by placing a plexiglass enclosure around each unit and using a 40-watt light bulb as a heat source. Both the Galloway and McLean were retrofitted with this arrangement, and it was included for all subsequent installations. The Galloway started in Atlantic service, transferred to the Pacific in September 1973, and then returned to the Atlantic in December 1975.

Data output from the Galloway has not been up to a par with the other vessels. Numerous nagging problems encountered over the years include clock failures, broken wires, improper stylus pressure, loose screws, and a constant crew change.

3. SEA-LAND COMMERCE

Scratch-gauge Serial No. BS73A002 was installed on May 8, 1973 prior to the ship sailing for Pacific duty. The Commerce has remained in the Pacific ever since. The data from this ship have been good. Early problems included a defective drive motor and clock failure. Periodic clock and switch problems occurred, but did not cause any major interruptions of data collection. The unit was removed from service September 10, 1980.

4. SEA-LAND EXCHANGE

Scratch-gauge Serial No. BS73A004 was installed on May 13, 1973. The vessel stayed in Atlantic service until November 1973, when she transferred to, and remained in, the Pacific. With the exception of clock problems in 1975, the data received from this vessel have been excellent. The credit for this must go to the Chief Engineer, who took a personal interest in this project and provided on-board care for the unit.

Removal was on April 12, 1980 during a regular service call. The entire recorder drive chain of gears had stripped. It was also anticipated at that time that the SL-7s would be out of service by mid-summer because of their expected sale to the U. S. Government.

5. SEA-LAND TRADE

Scratch-Gauge Serial No. BS73A008 was installed on May 22, 1973. The vessel transferred immediately to Pacific Service and remained there. This system performed well until May, 1976, when the dynamic response data did not seem to match data from other Pacific vessels. In September, 1977 the unit was removed and Serial No. BS72E001 (the original McLean port gauge) was installed. The quality of the data returned to normal. The problem was found to be caused by the misalignment of the mechanical multiplier arm. With this exception, this unit produced excellent data, and credit must go to the two Chief Engineers who provided the on-board care. The unit was removed from service on September 25, 1980.

6. SEA-LAND FINANCE

Scratch-Gauge Serial No. BS73A005 was installed October 3, 1973 prior to her departure for the Pacific, where she remained. A broken mounting stud was repaired in June 1974 and a clock replaced in October 1979. The unit was removed September 28, 1980. This unit has produced good data during its entire service.

7. SEA-LAND MARKET

Scratch-Gauge Serial No. BS73A003 was installed on November 5, 1973. This vessel has remained in Atlantic service during her operational life. Clock problems were encountered during the first year, and switch problems during 1979. With these two exceptions, the unit has been satisfactory. The unit was removed from service on November 13, 1980.

8. SEA-LAND RESOURCE

Scratch-Gauge Serial No. BS73A006 was installed on December 13, 1973. This ship was originally assigned to the Pacific, but returned to Atlantic service late in 1974. This unit was plagued with problems during its entire service. Stylus problems occurred in 1974-1975 and again in 1979. Clock failures occurred in 1976-1977-1979 and early 1980. In addition, a number of data tapes were lost in the mail. The unit was removed October 30, 1980.

SUMMARY

Most of the systems have performed well. The battery-operated clock is the major weak link. Periodic routine maintenance is required to keep these systems at top performance. On-board care was reduced to changing tapes and batteries. Usually, the Chief Engineer of each vessel undertook this responsibility. He also annotated the tapes with the date and time periodically. In general, the cooperation was excellent throughout the entire program.

IV. DATA PRESENTATION AND INTERPRETATION

As previously stated, the data have been collected on rolls of pressure-sensitive paper. Each roll represents approximately three months' time and usually, at least, 2 rolls of tape are collected during each six-month visit to the vessel. In order to protect the data and facilitate analysis, each data roll was subsequently mounted on 8 1/2 x 11" card stock with usually 3 strips of the roll mounted per sheet. This is approximately two weeks of real-time data.

The length of each data marking (scratch) has been measured to the nearest 0.02 inch and the results tabulated for each vessel over the seven data years of information collected. It is this data tabulation which supplies the basis for the histograms which are presented in the following pages. In order to present the data in a more useful form (i.e., psi of midships bending stress vs. number of occurrences) it was necessary to perform the following transformation:

Since the scratch gauge is substantially linear, its calibration curve is approximated by a straight line, and this by the equation

$$y = Mx + B$$

where

y = stylus deflection in inches
X = hull girder elongation in 10 inches
B = slope intercept
M = slope of the calibration curve around the point of interest

If we assume that the scratch gauge operates around the zero points; i.e., there is no constant stress and any offset due to loading is ignored, "B", the slope intercept, is zero.

Solving for X:

$$X = \frac{y}{M}$$

Stress (psi) = (E, Young's Modulus for Steel) (Elongation in 1 inch)

$$\sigma = (30 \times 10^6)\ \left(\frac{y}{M} \times 10^{-1}\right)$$

and

$$\sigma = (3 \times 10^6)\ \frac{y}{M}$$

or

$$\sigma \text{ psi} = \frac{(3 \times 10^6)\ (\text{length of scratch line in inches})}{(\text{slope of the best straight line approximation})}$$

The lengths of the scratch lines have been tabulated. The slope of the calibration curve for each vessel has been derived from the calibration plots of Appendix B and is tabulated in Table I. Since the majority of the data points lie between a gauge deflection of +0.4 inches to -0.4 inches, the slope of the line was calculated between these two values. The stress value for each data interval, therefore, can be calculated from:

psi = (length of scratch line in inches) x (scale factor)

The scale factors have been calculated for each gauge and are presented in Table II. Thus, all the information to prepare histograms of stress levels versus the number of occurrences has been developed.

TABLE I

SLOPES OF CALIBRATION CURVES

Scratch Gauge	Calibration Curve (Fig.)	Slope Value
McLEAN PORT		
Original	B-1	87
Recalibration	B-2	88
Spare (Replacement)	B-3	96
MCLEAN STBD	B-4	94
GALLOWAY	B-5	91
COMMERCE	B-6	88
EXCHANGE	B-7	91
TRADE (Original)	B-8	97
(Replacement)	B-2	88
FINANCE	B-9	99
MARKET	B-10	82
RESOURCE	B-11	86

TABLE II

DATA MULTIPLICATION SCALE FACTORS

SCRATCH GAUGE	SCALE FACTOR
McLEAN PORT	
Original	3.448×10^4
Spare (Replacement)	3.125×10^4
McLEAN STBD	3.191×10^4
GALLOWAY	3.297×10^4
COMMERCE	3.409×10^4
EXCHANGE	3.297×10^4
TRADE (Original)	3.093×10^4
(Replacement)	3.409×10^4
FINANCE	3.030×10^4
MARKET	3.659×10^4
RESOURCE	3.488×10^4

The histograms are arranged in the order of data years. One histogram is provided for each gauge for each year. (In data year five, 2 histograms are provided for the SEA-LAND TRADE as two gauges of different calibration factors were used).

Associated with each year are three additional plots. A summary plot of all Atlantic data, a summary plot of all Pacific data, and a final plot of all data collected within the year. Finally, three summary total histograms are included: A seven-year Atlantic summary, a seven-year Pacific summary, and a summary of all data collected during the seven-year period. Thus, a total of 88 histograms are presented (Figures 5 through 92, inclusive).

To facilitate data presentation, the data have been divided into "Data Years" as follows:

Data Year (1)

September 1972 to May 1, 1974

The first year has been broadened to include the early contractual period which started in September of 1972 rather than starting with May 1, 1973, primarily because only the MCLEAN and GALLOWAY had their installations in operation prior to the May 1, 1973 date. Data year seven has also been expanded to include the remaining months of 1980 prior to system removal.

Data Year (2)

May 1, 1974 - May 1, 1975

Data Year (3)

May 1, 1975 - May 1, 1976

Data Year (4)

May 1, 1976 - May 1, 1977

Data Year (5)

May 1, 1977 - May 1, 1978

Data Year (6)

May 1, 1978 - May 1, 1979

Data Year (7)

May 1, 1979 - Fall 1980

As part of this contract, it was desired to establish a correlation between the McLean scratch-gauge data and tape-recorded stress data from the longitudinal vertical bending stress transducers in operation during the first two winter seasons.

(Text continues on Page 34)

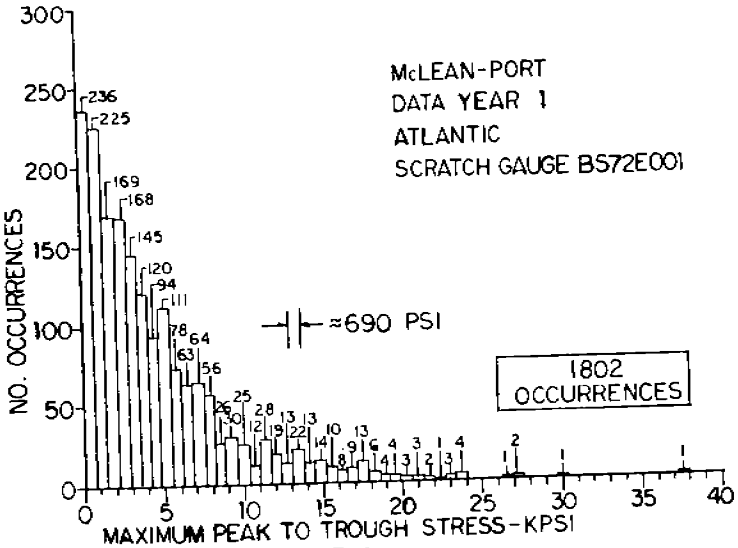


FIGURE 5

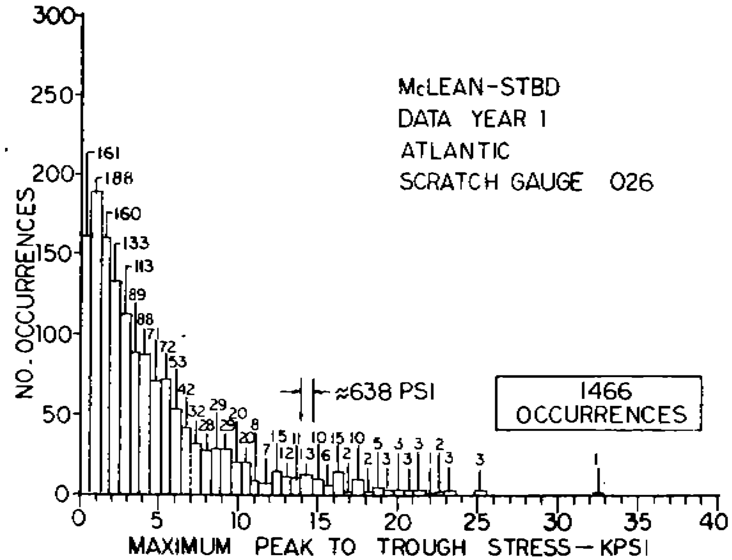


FIGURE 6

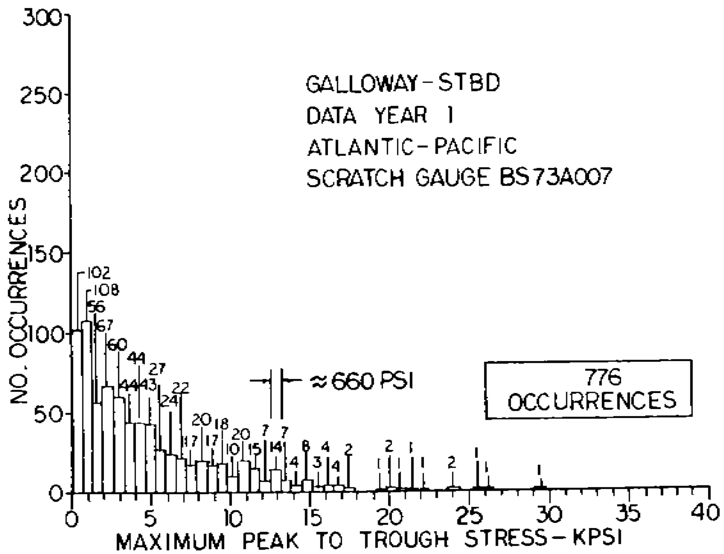


FIGURE 7

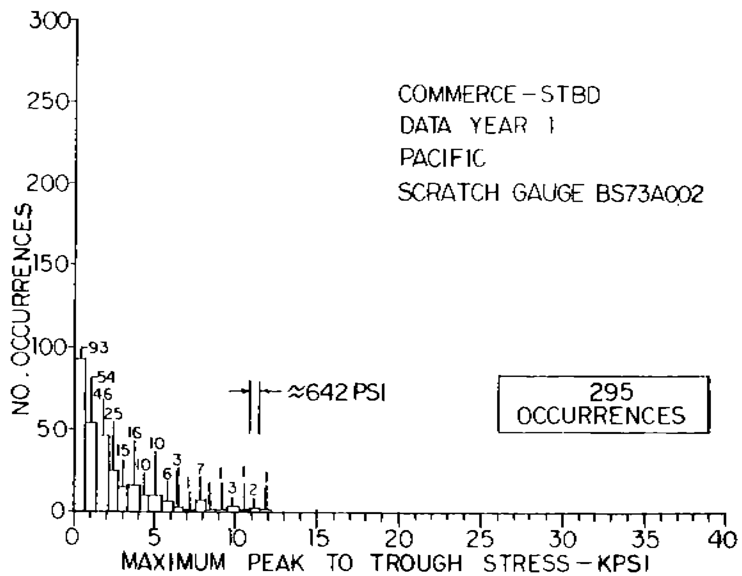
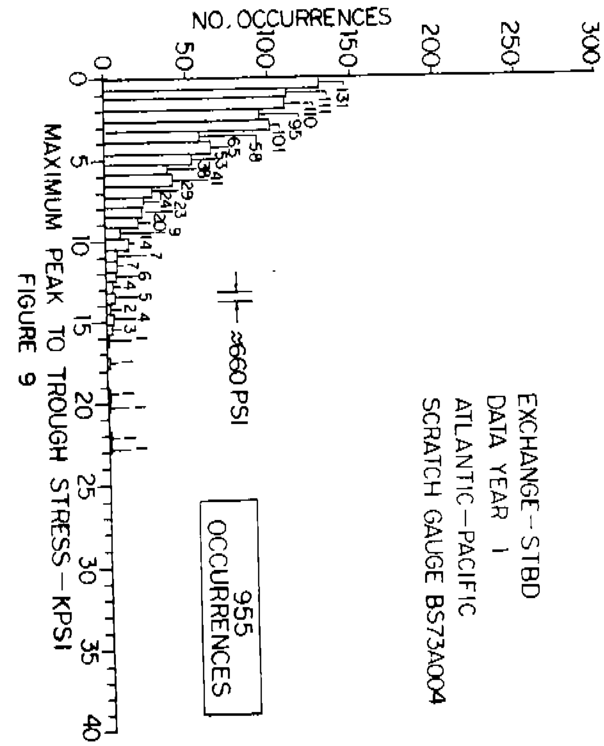


FIGURE 8



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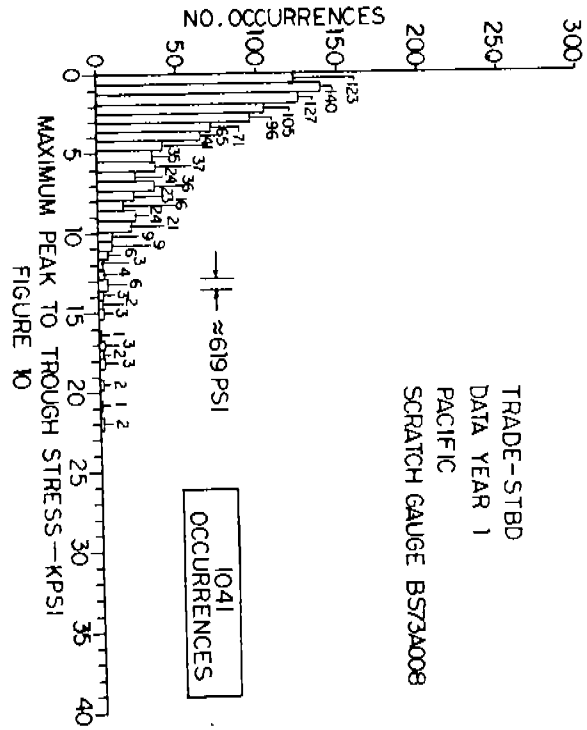

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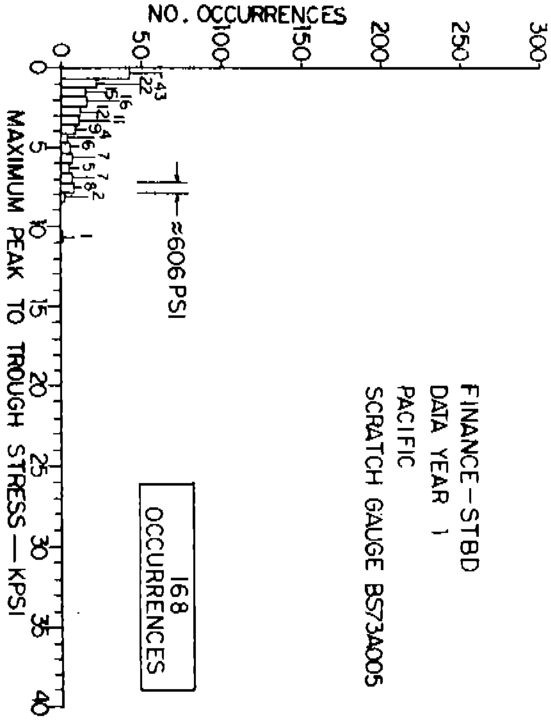

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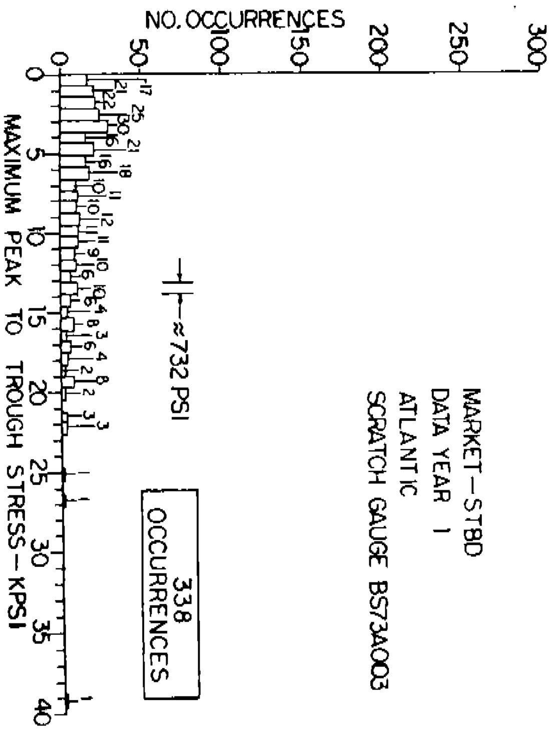

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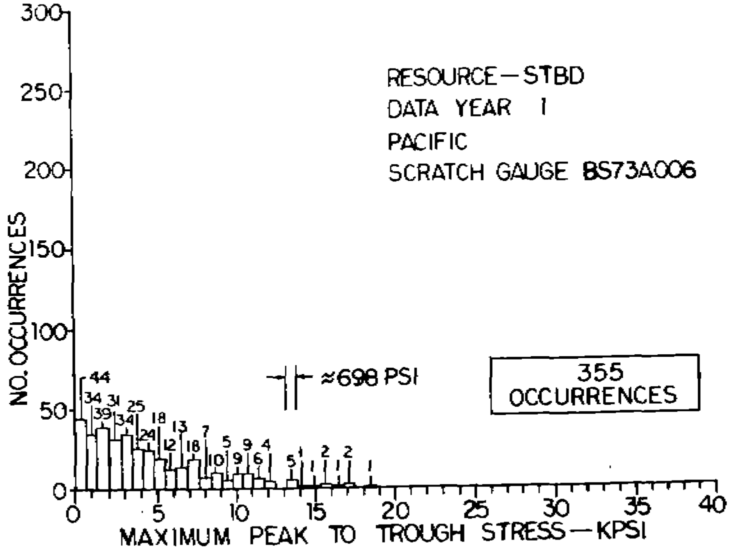

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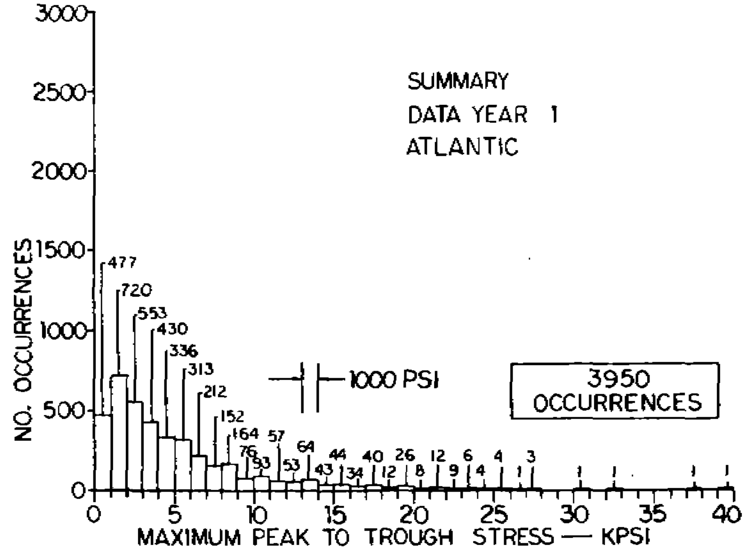

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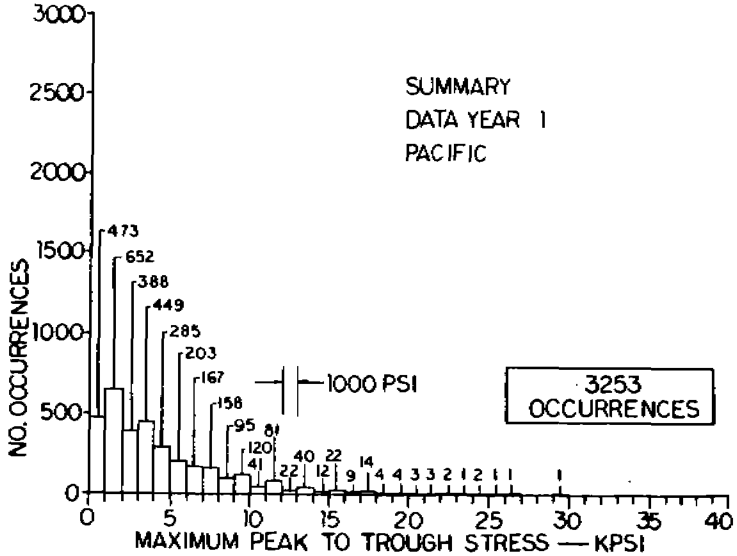

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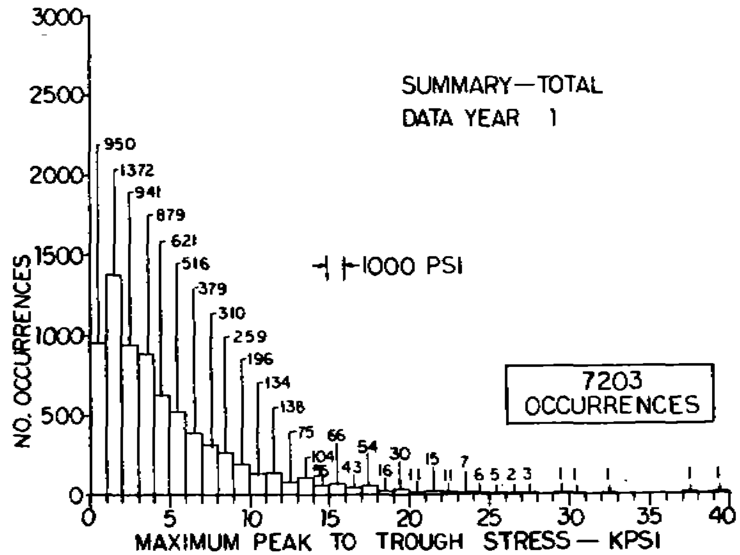

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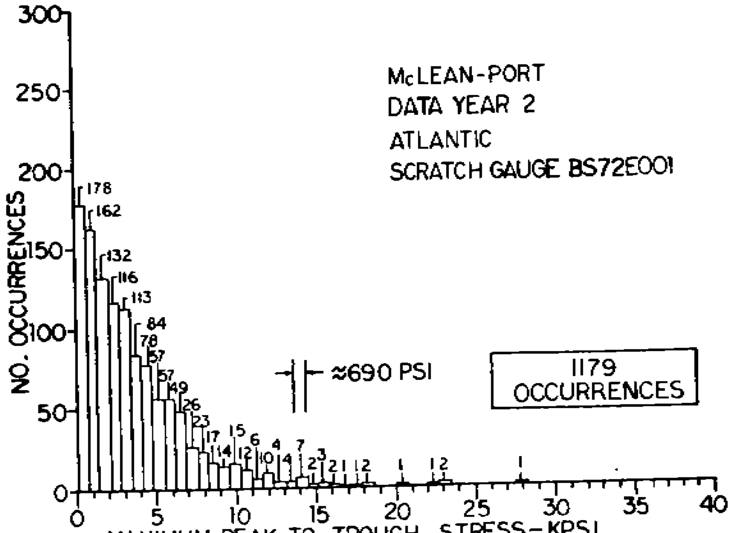

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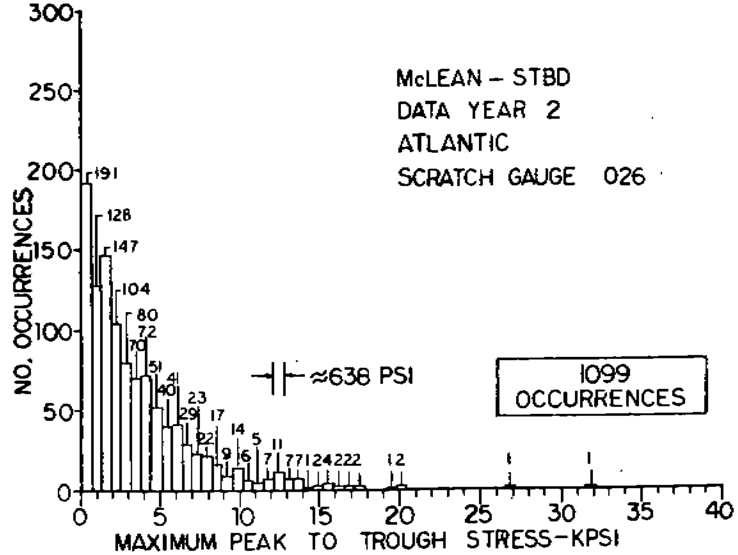

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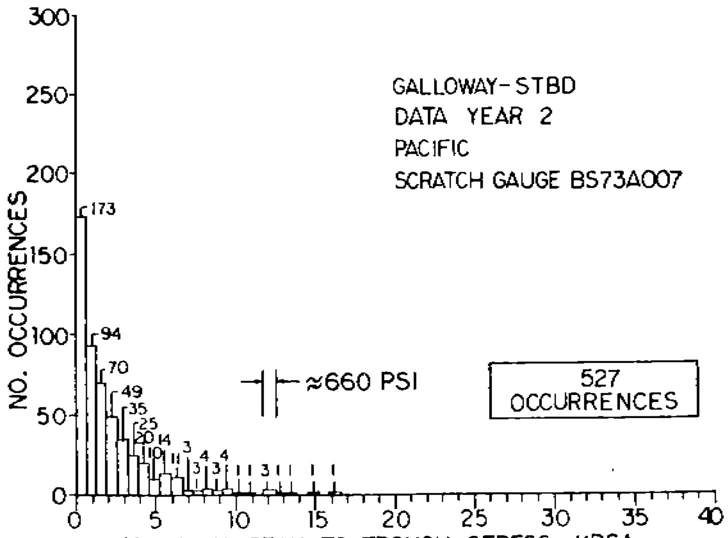

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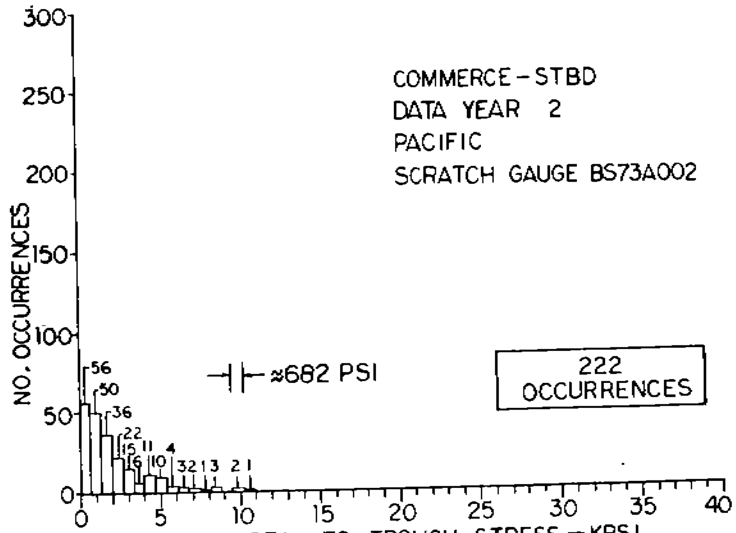

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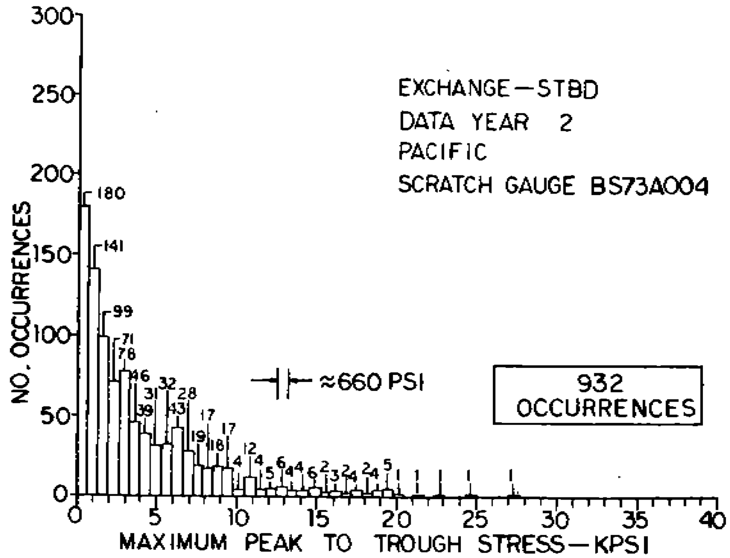

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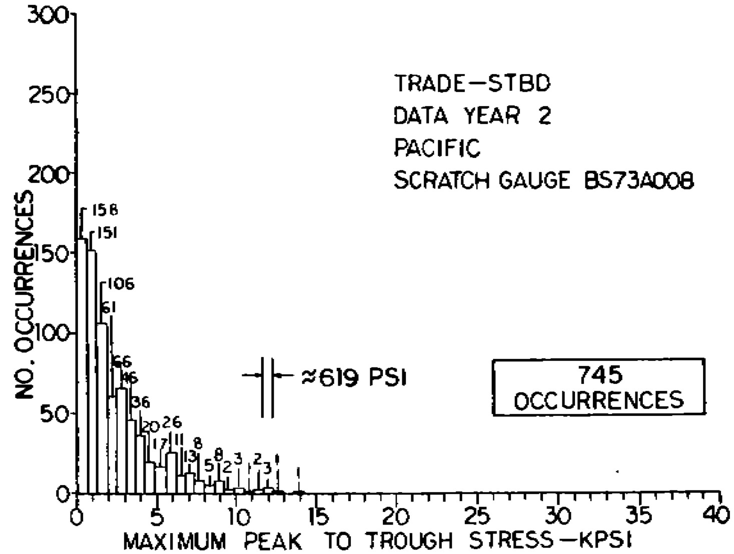

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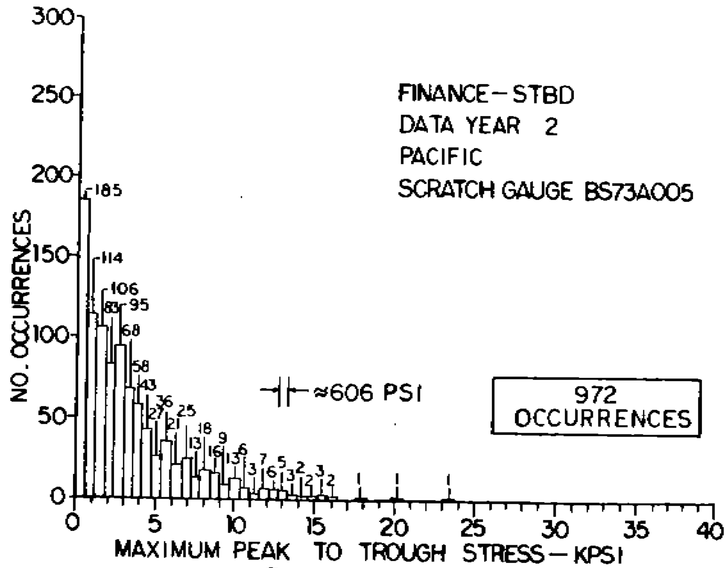

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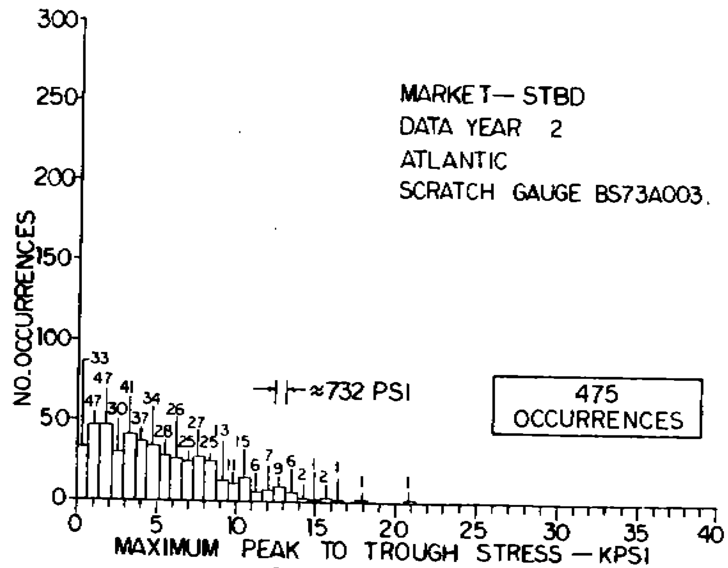

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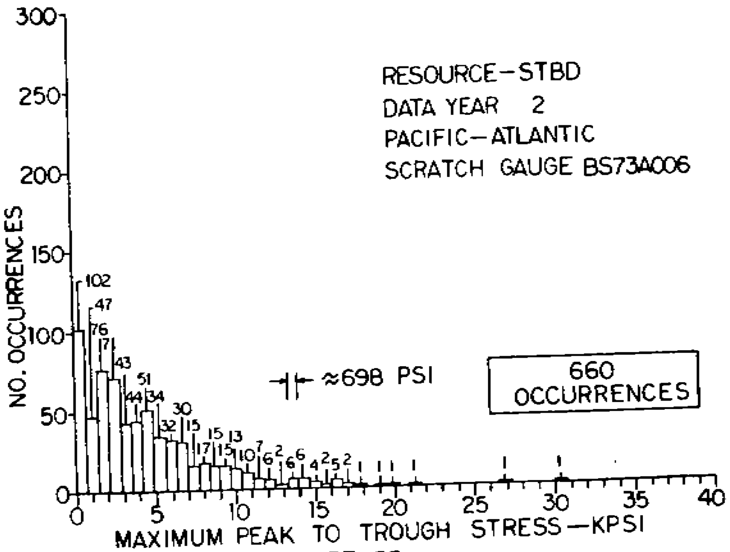

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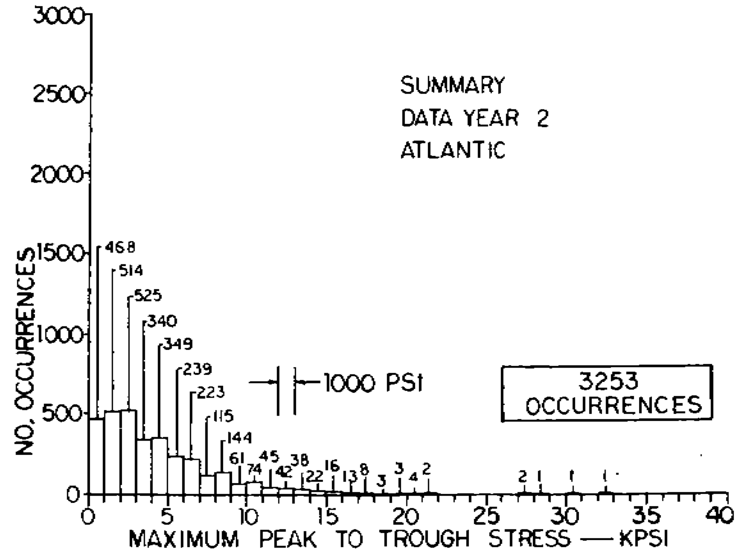

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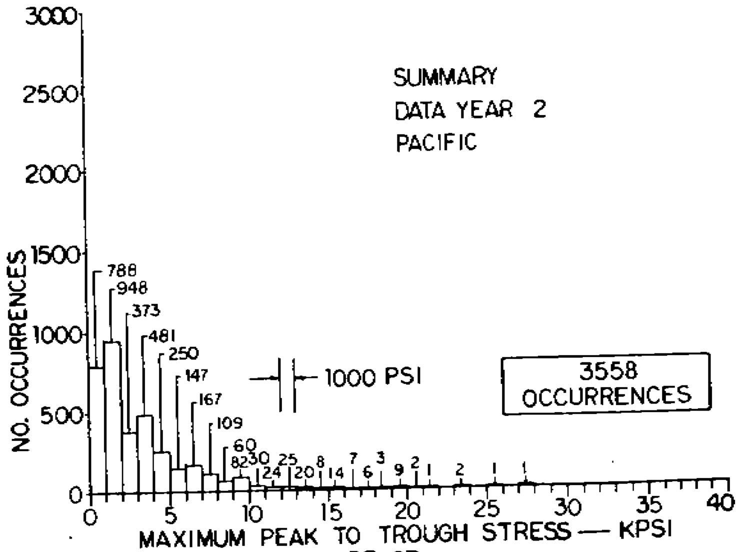

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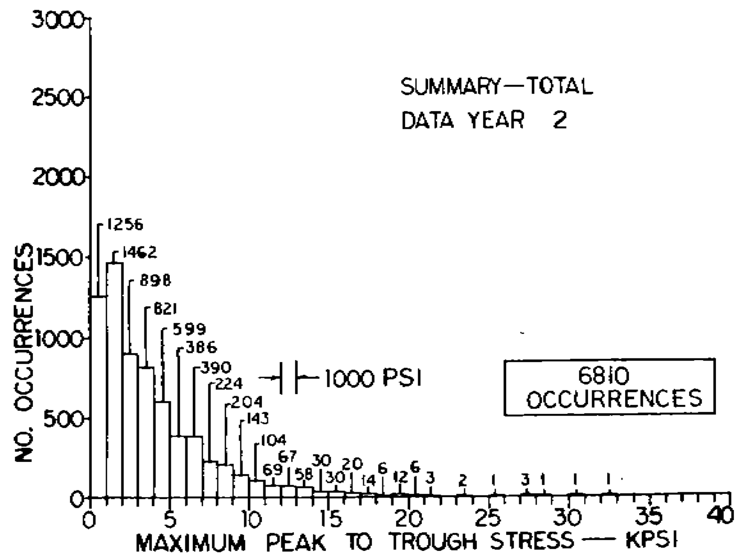

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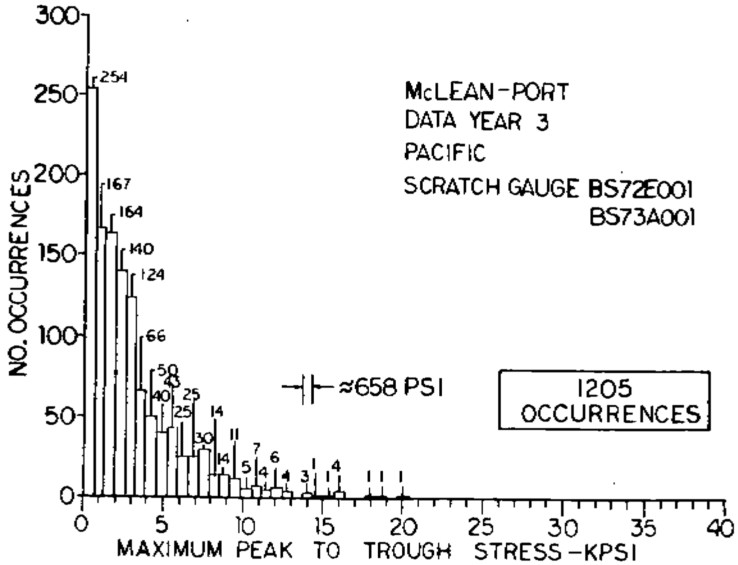

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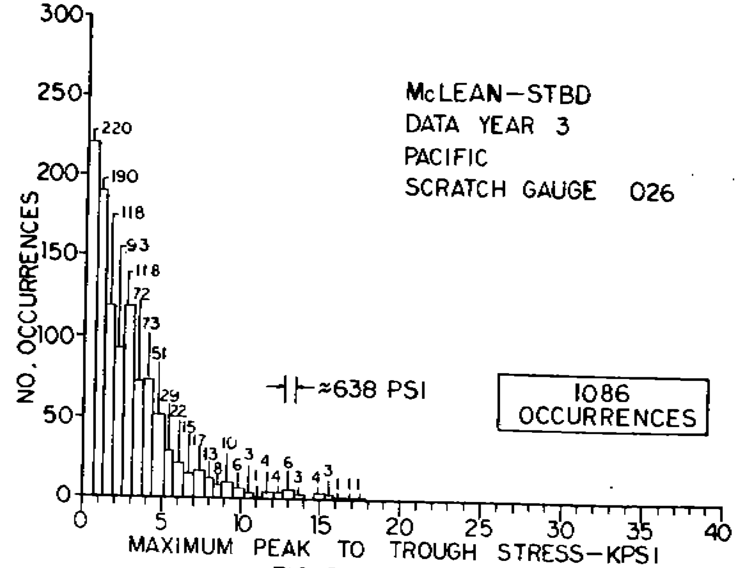

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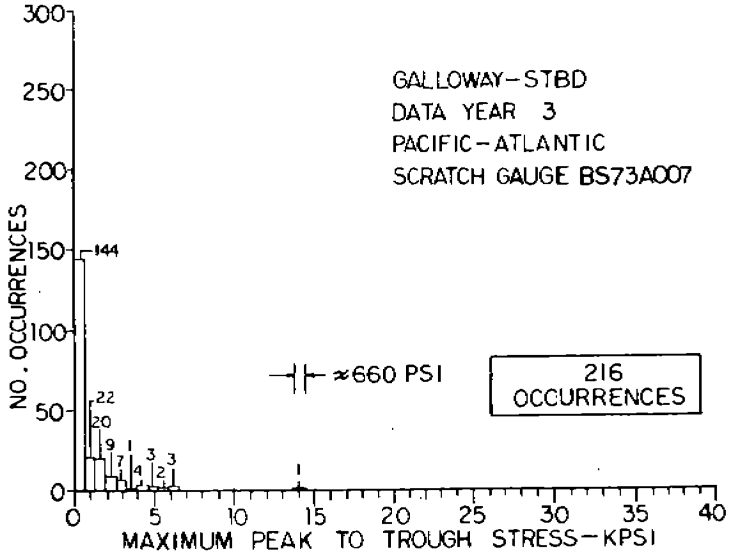

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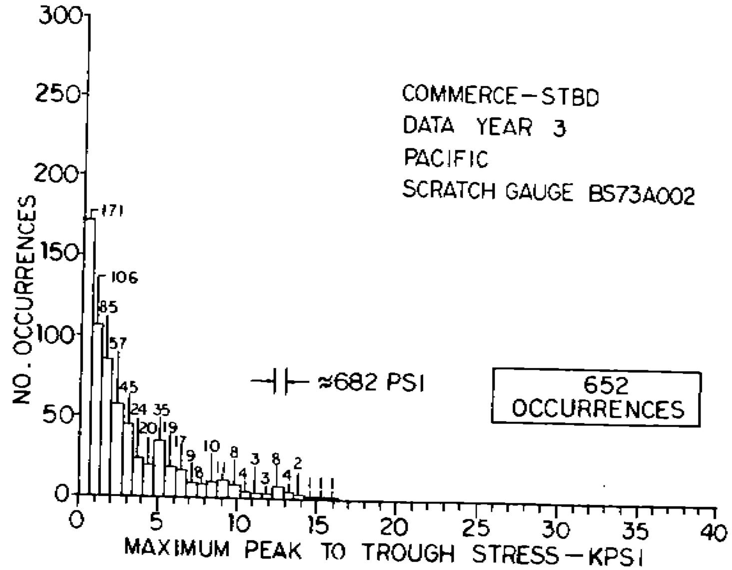

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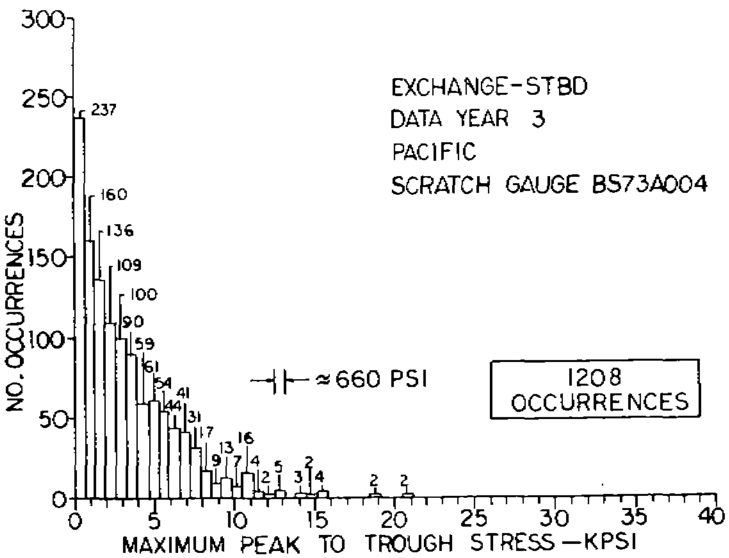

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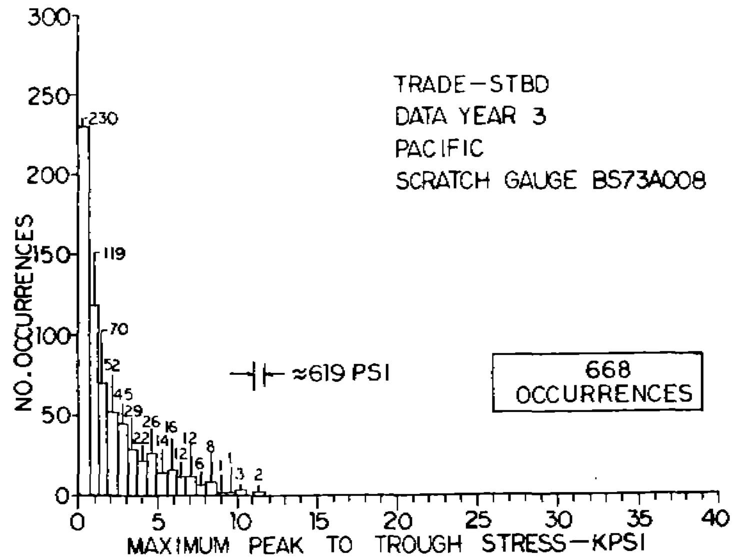

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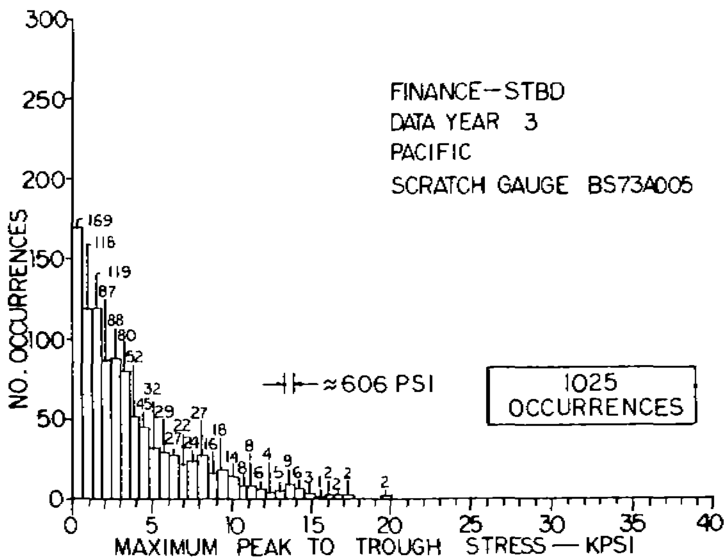

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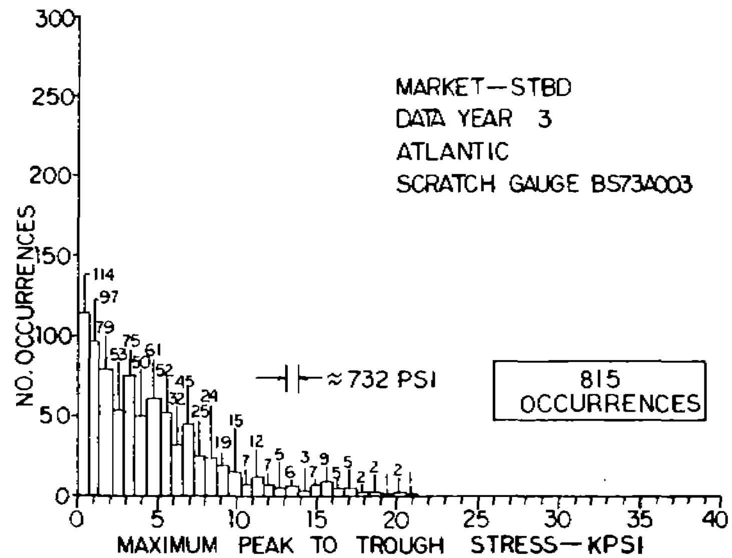

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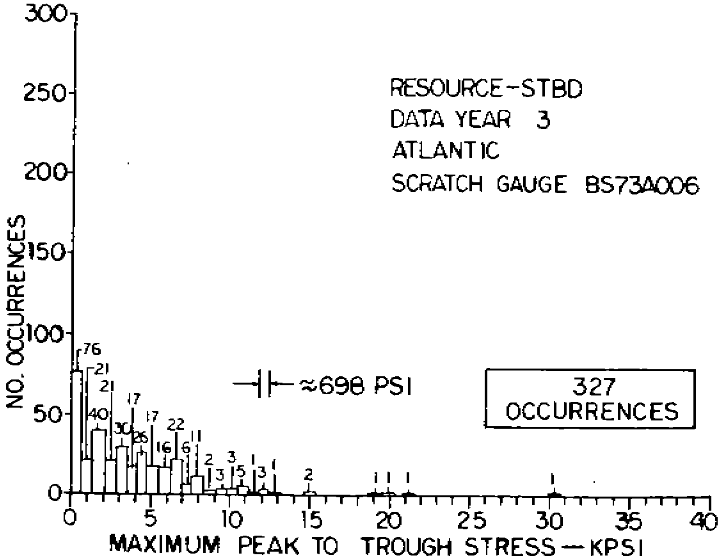

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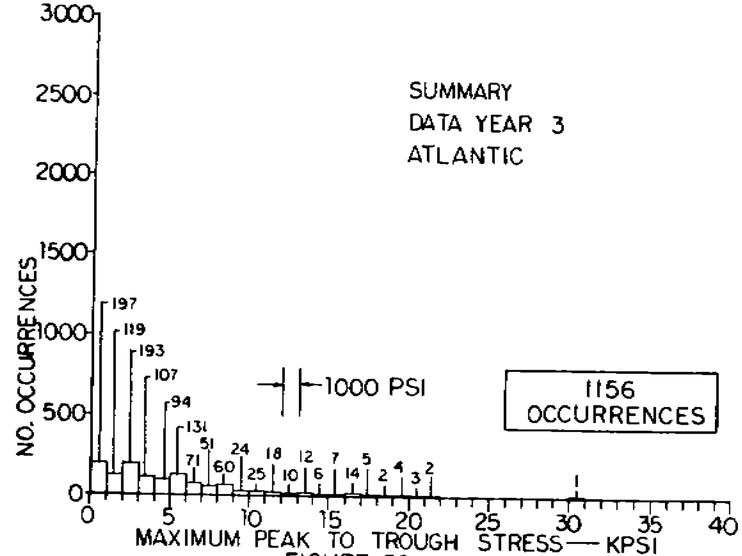

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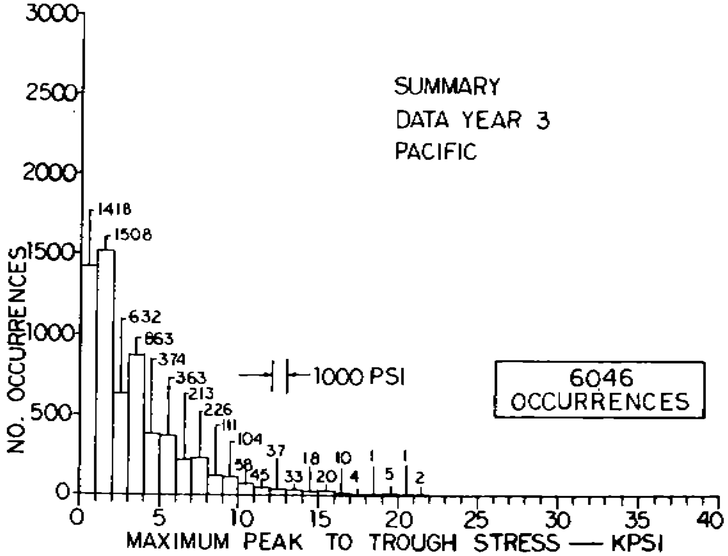

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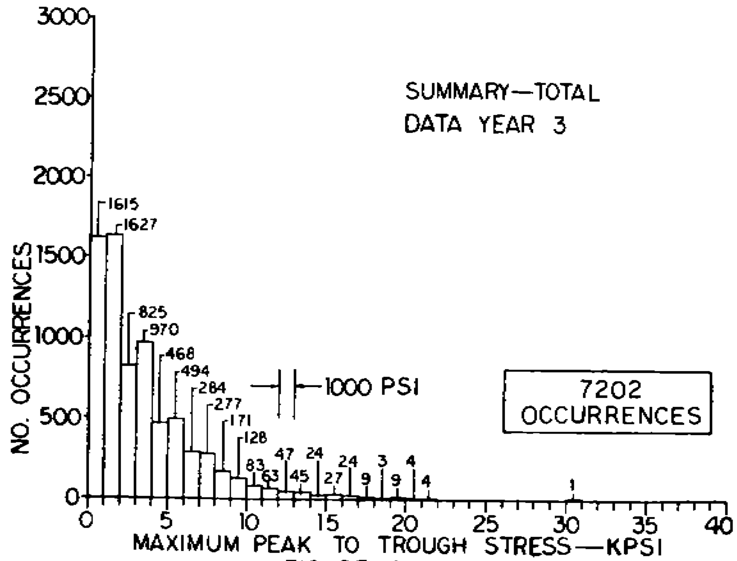

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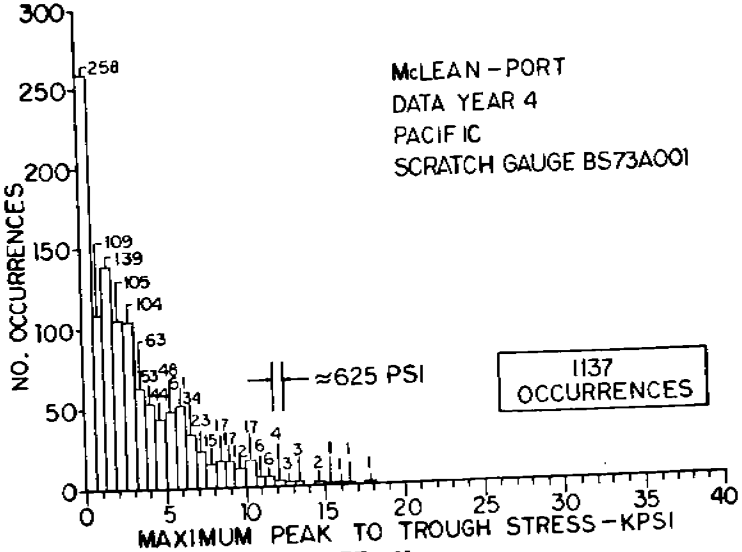

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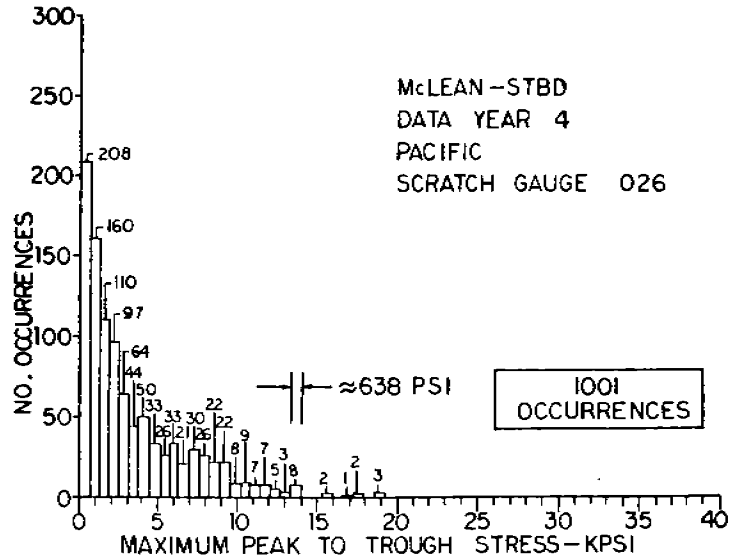

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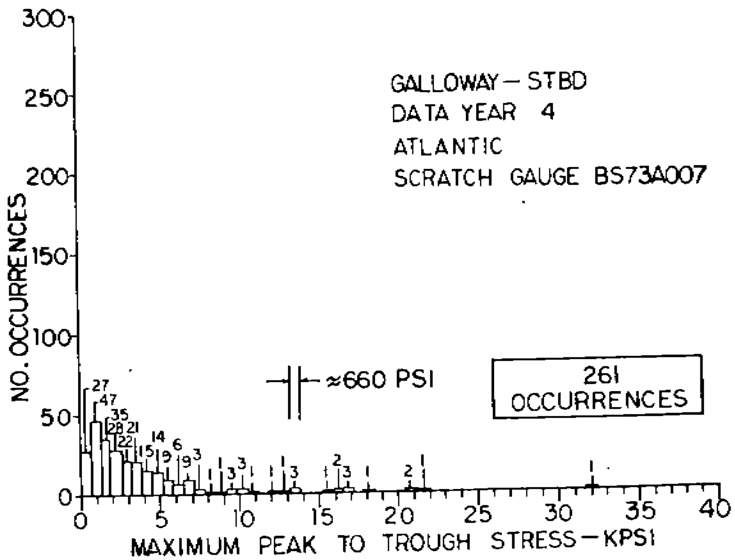

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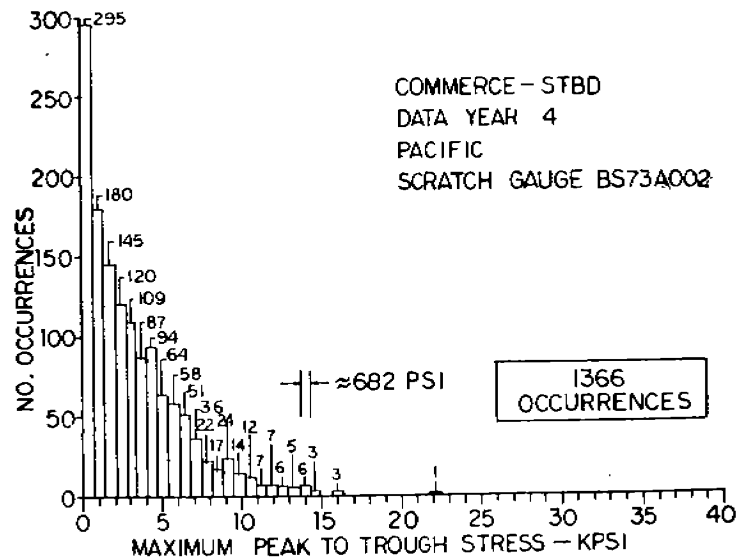

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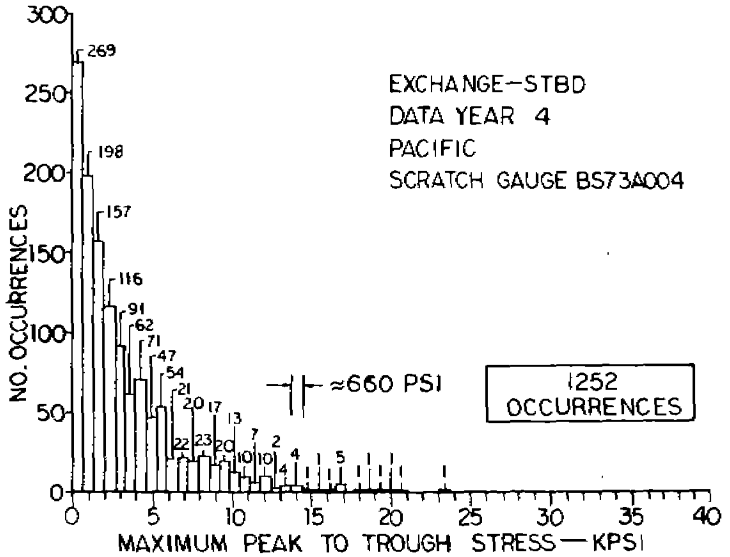

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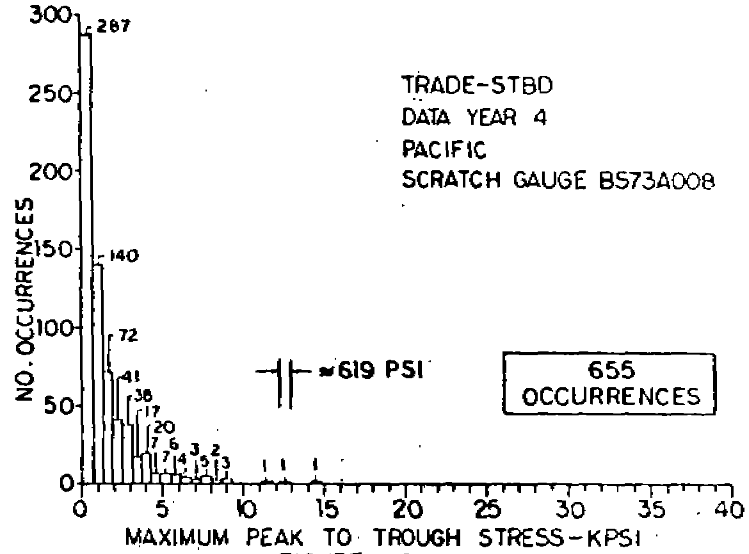

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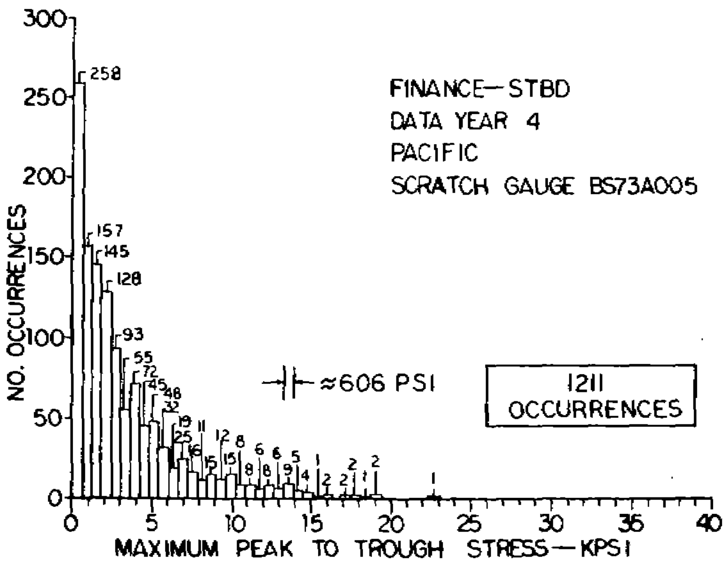

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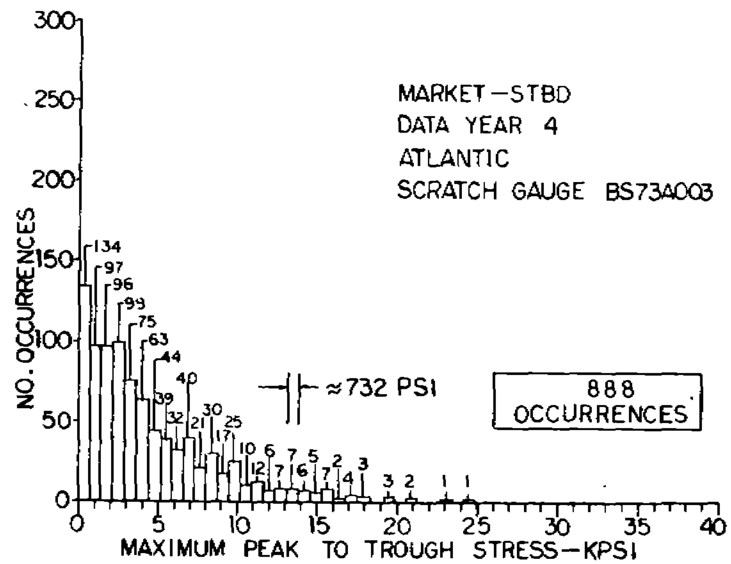

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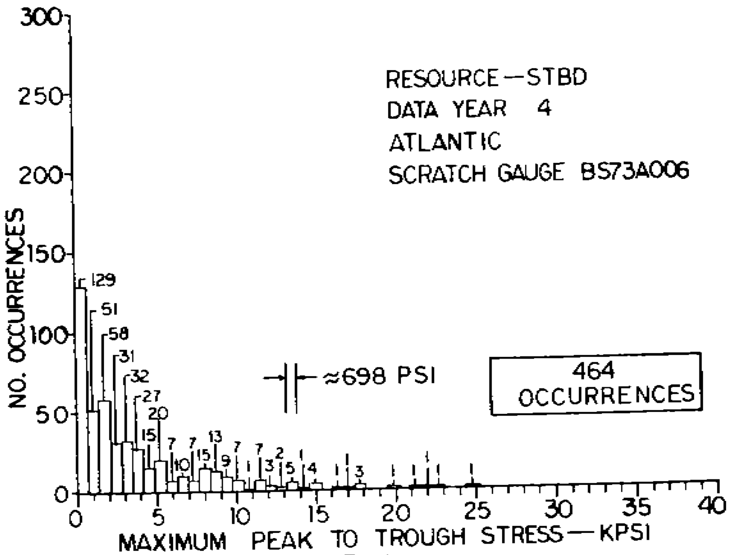

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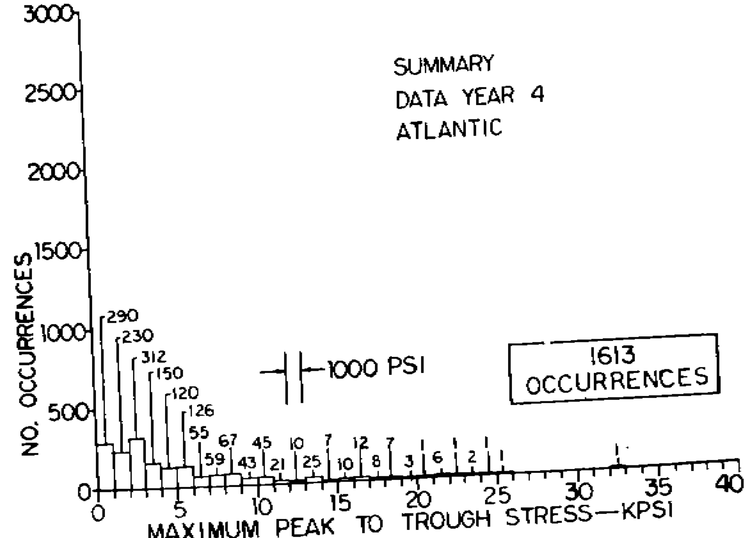

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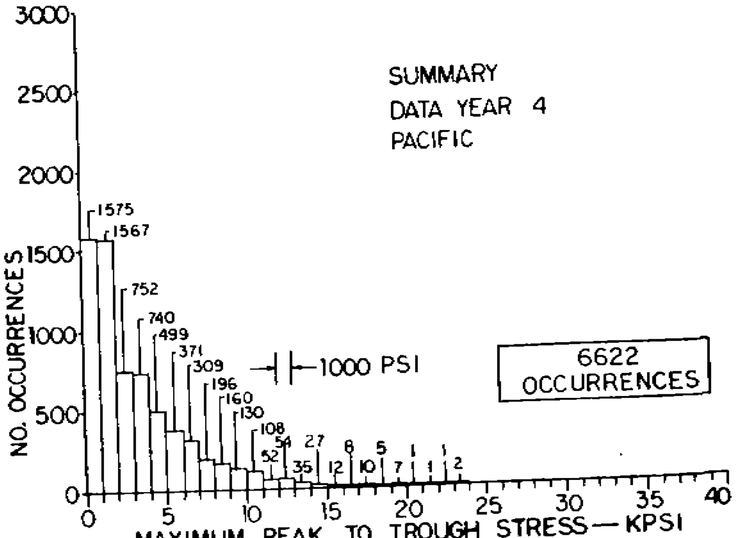

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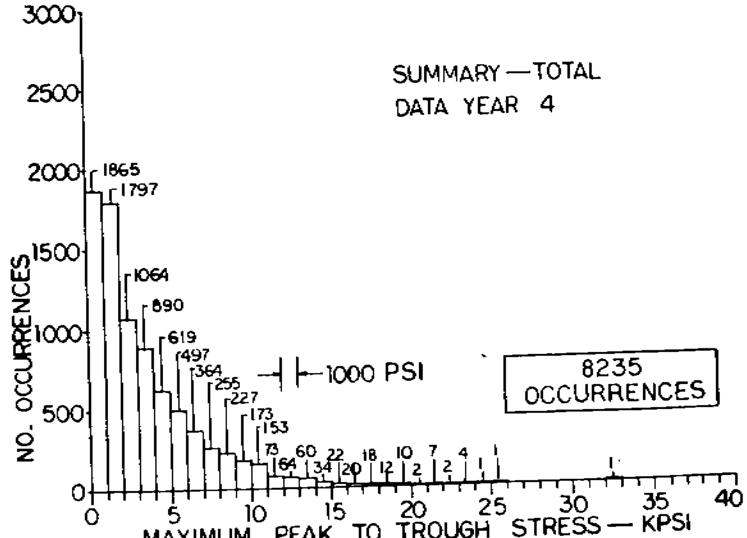

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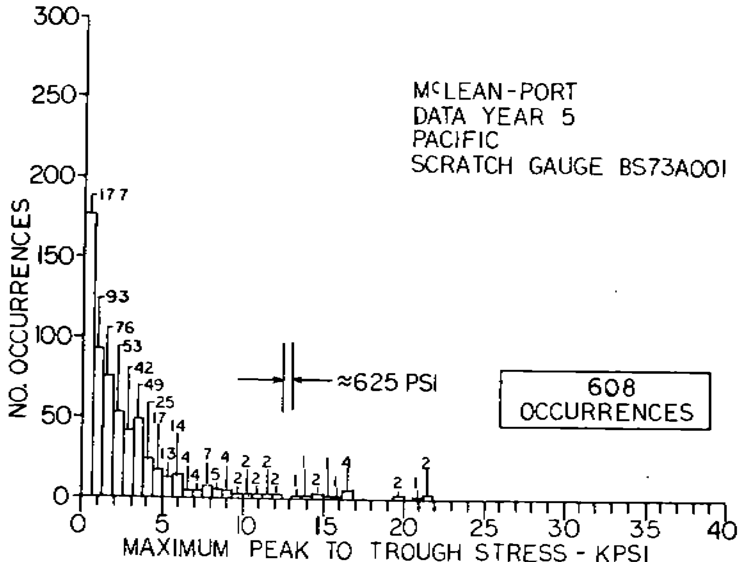

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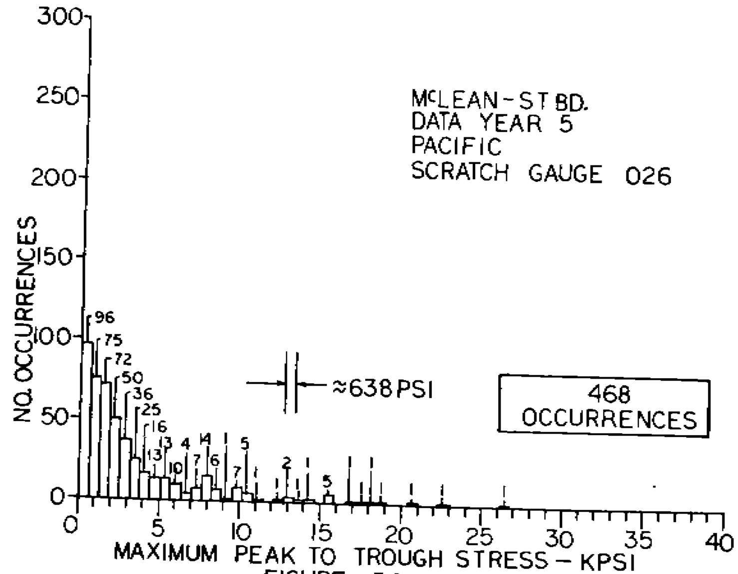

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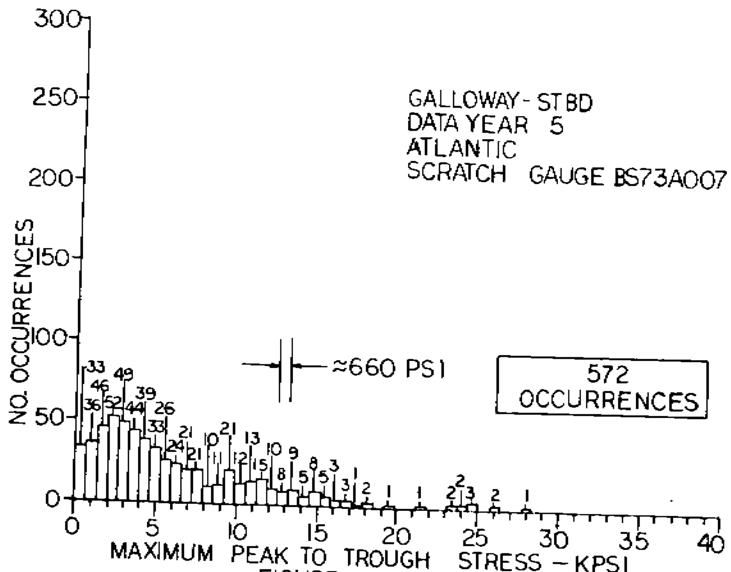

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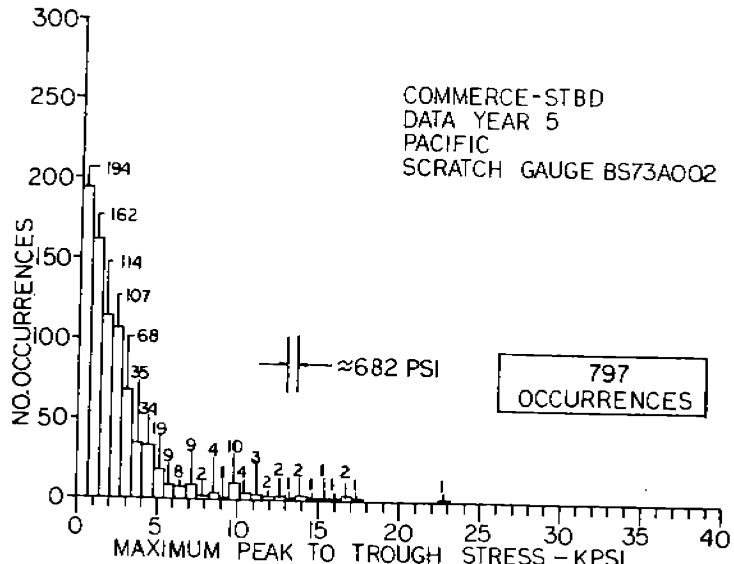

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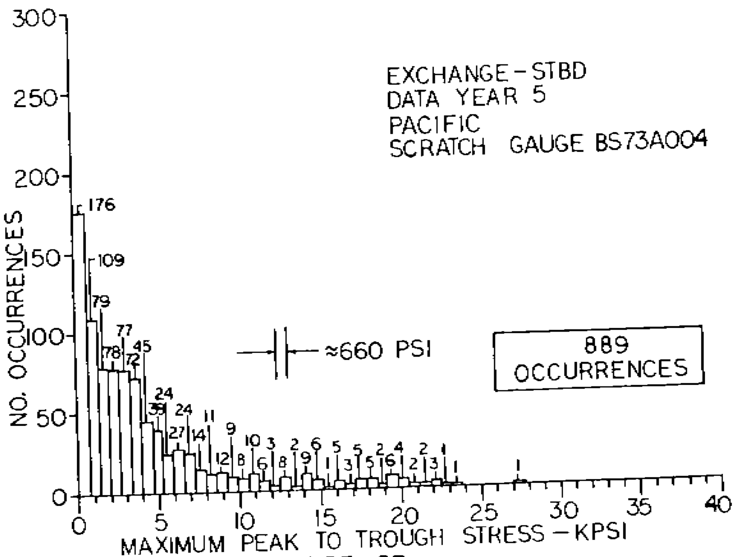

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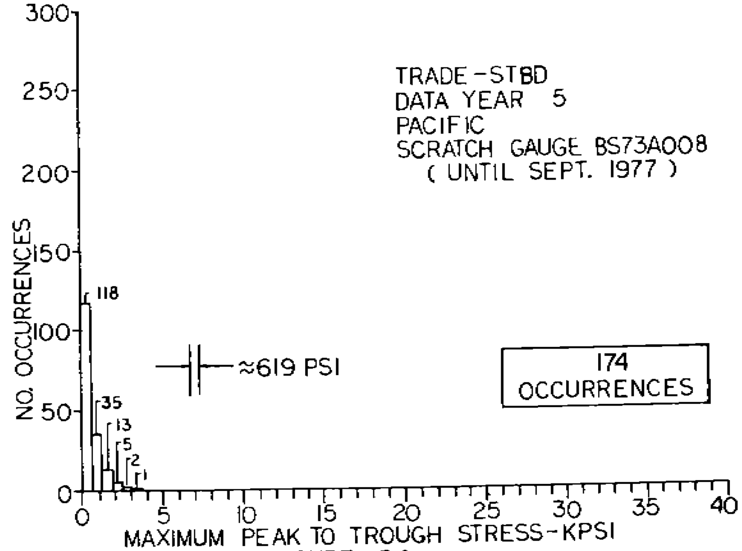

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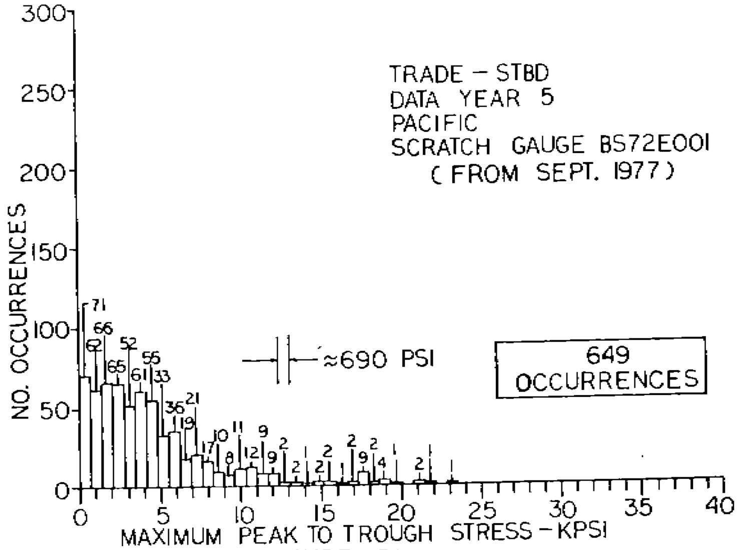

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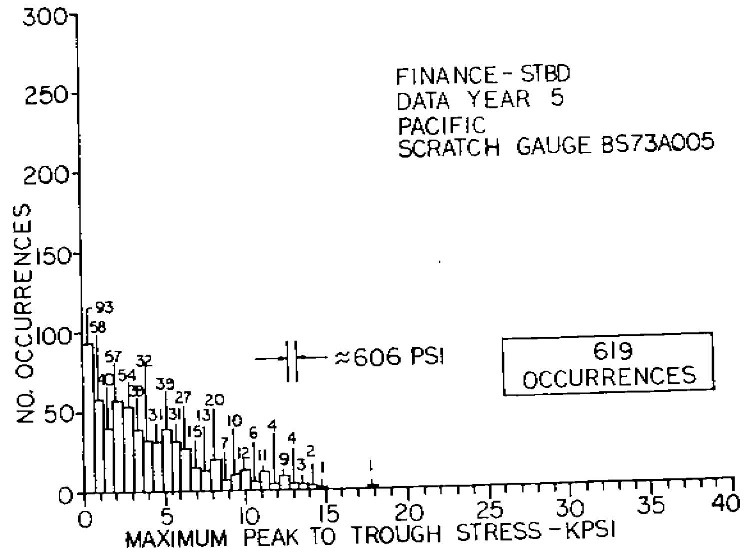

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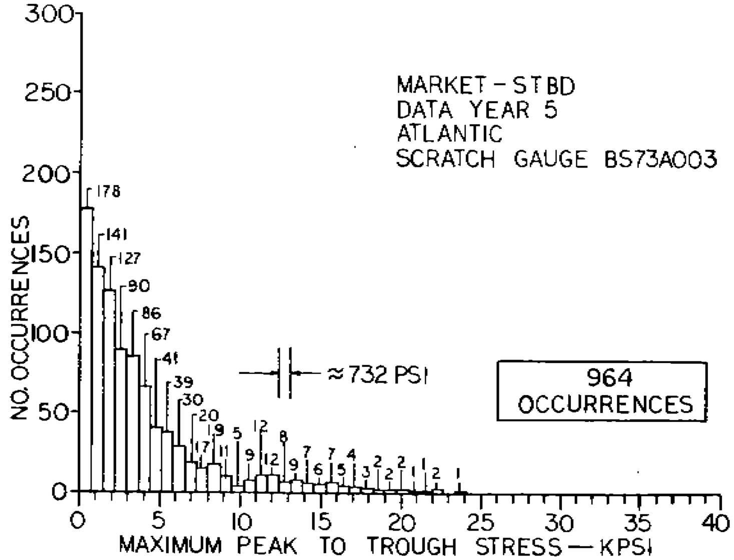

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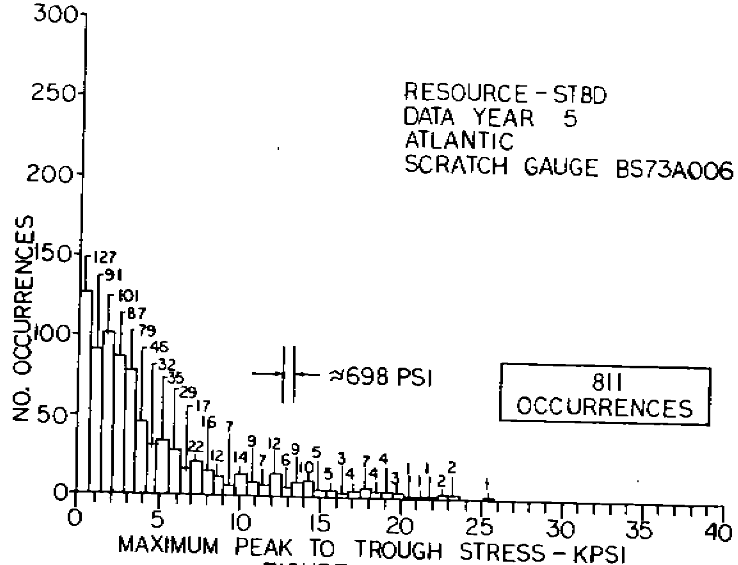

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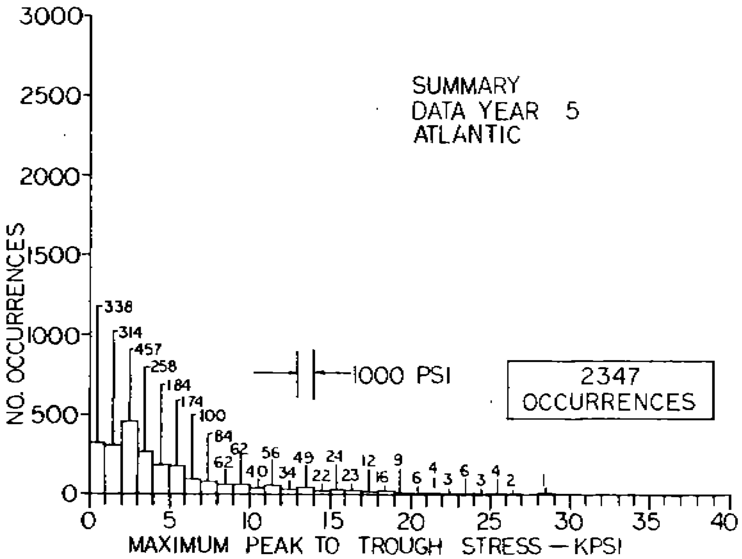

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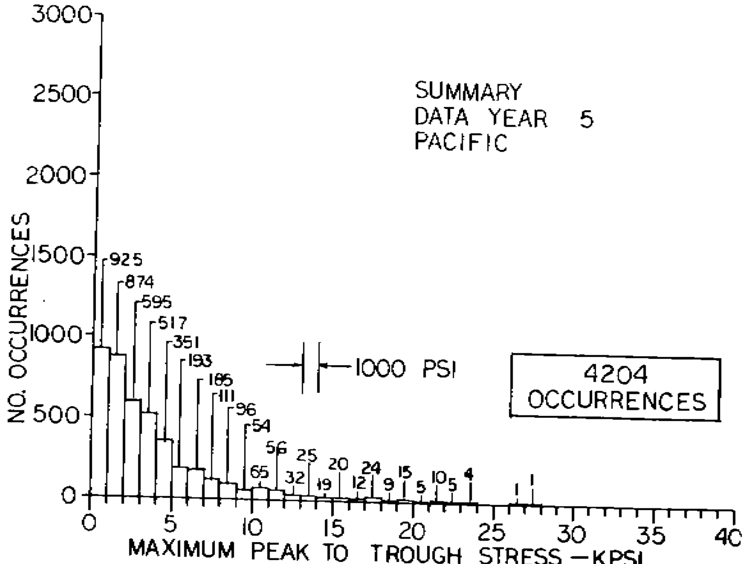

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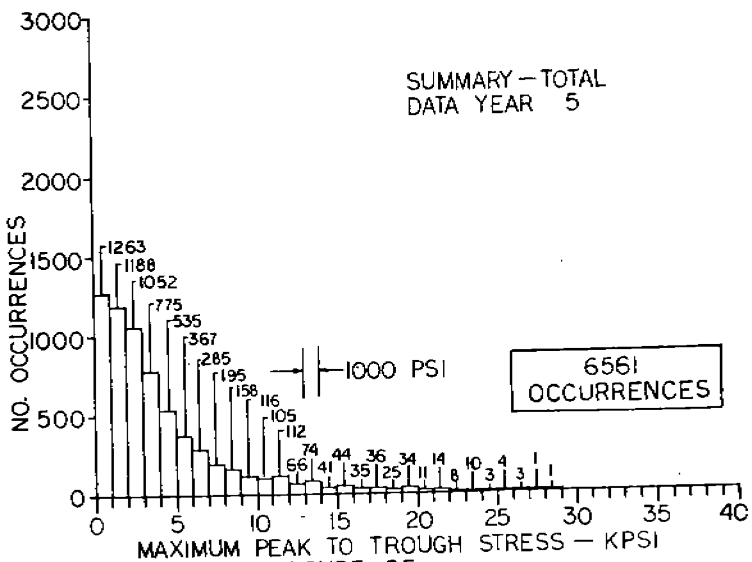

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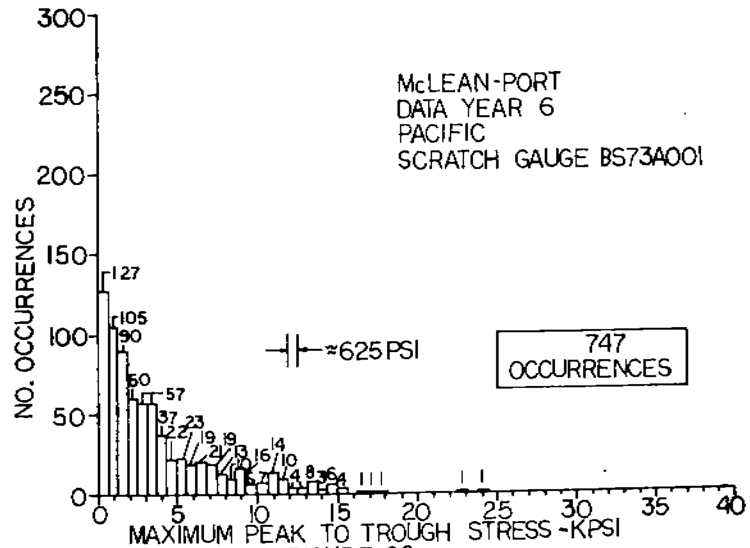

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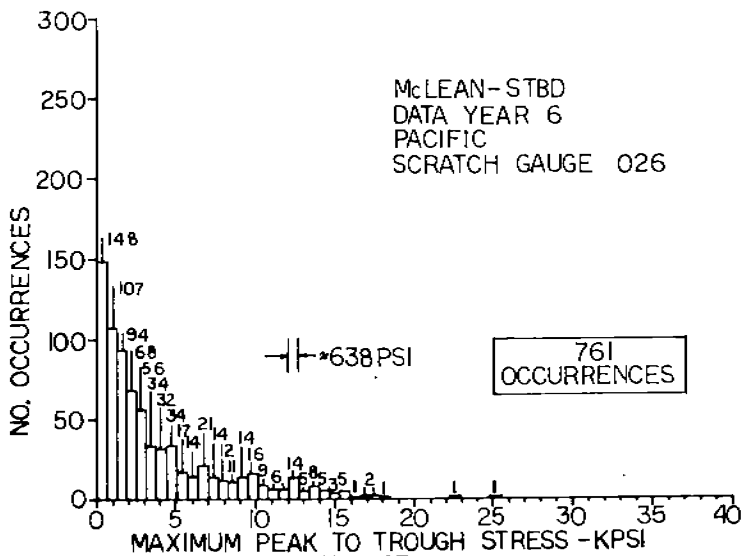

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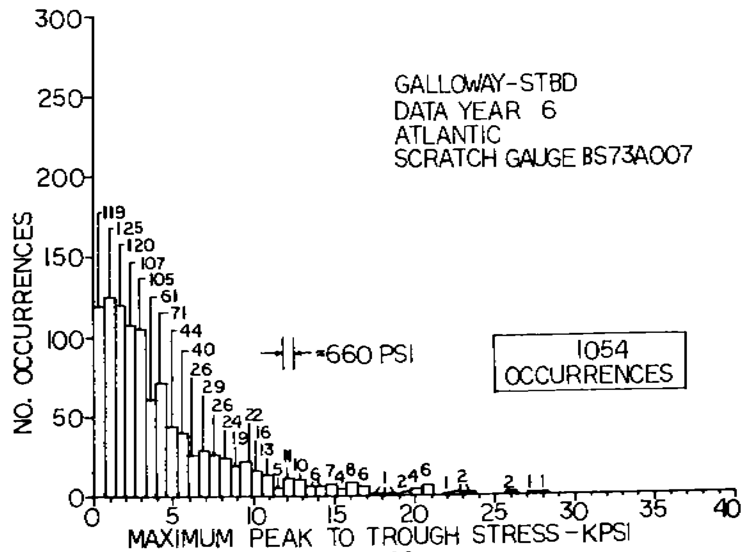

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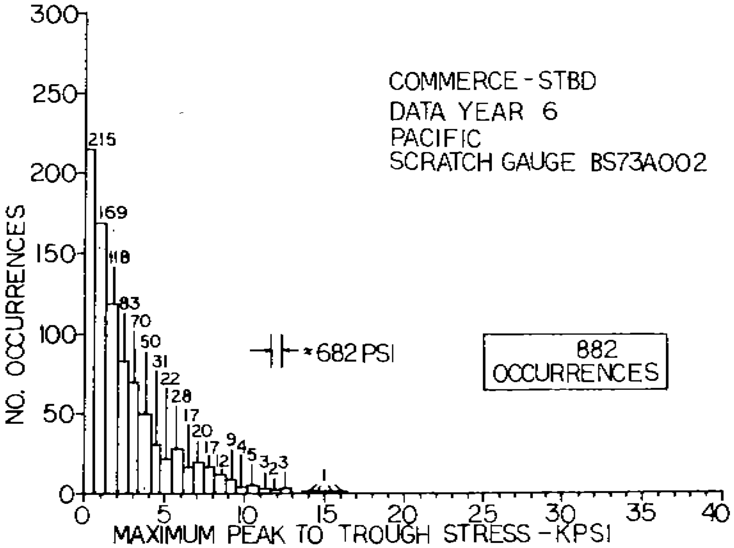

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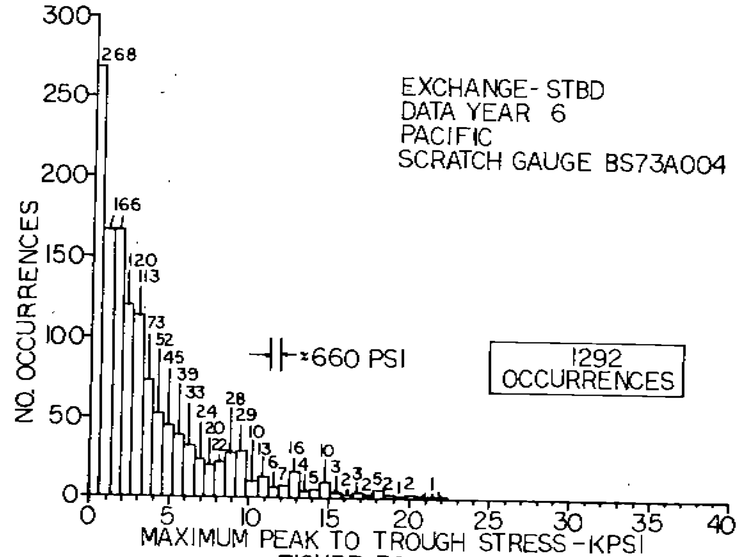

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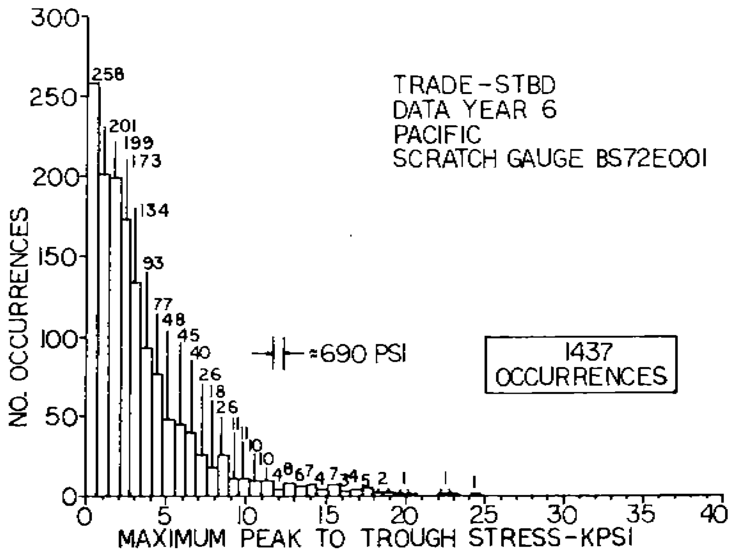

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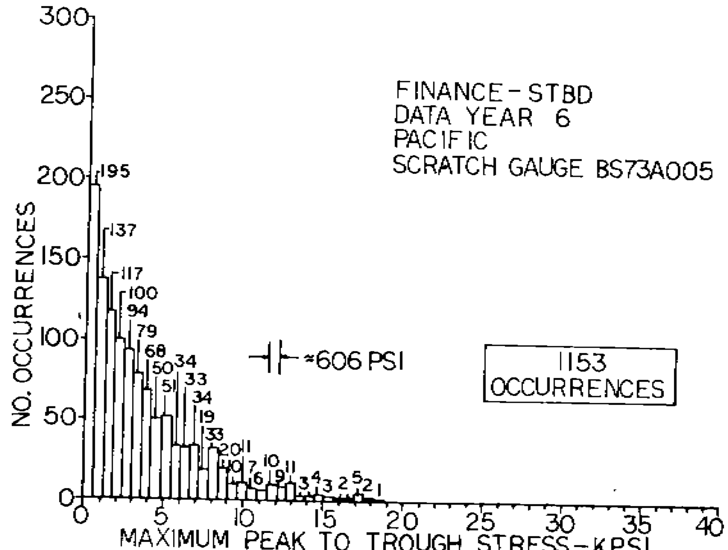

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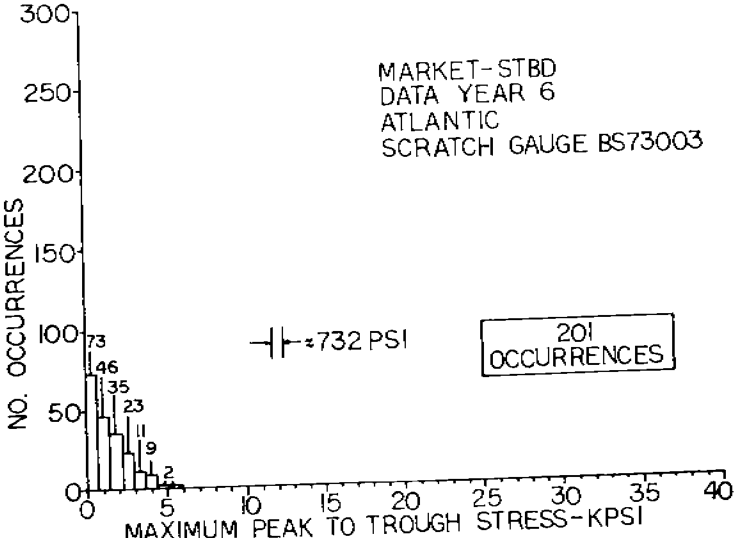

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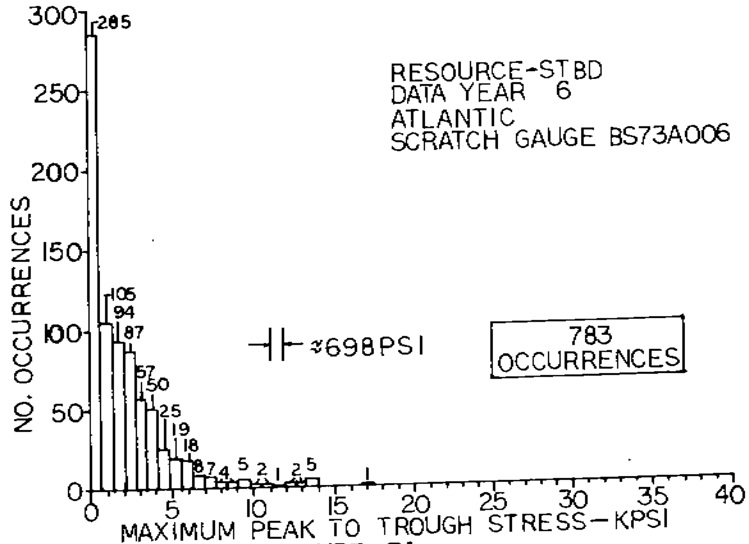

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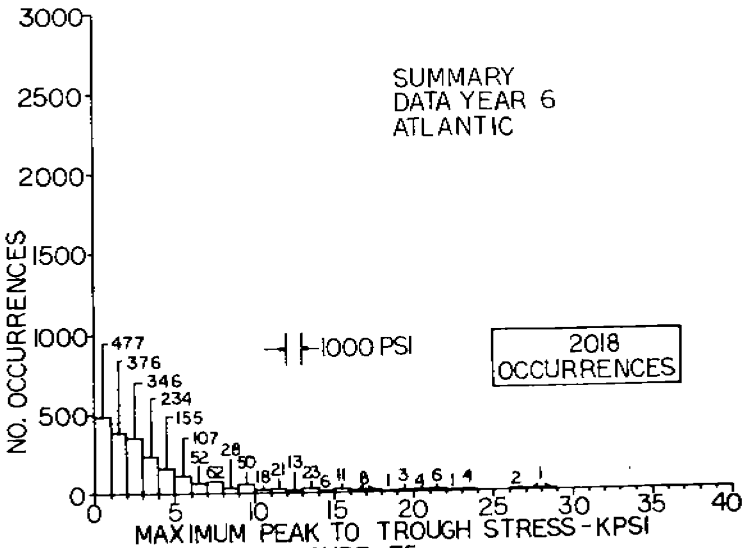

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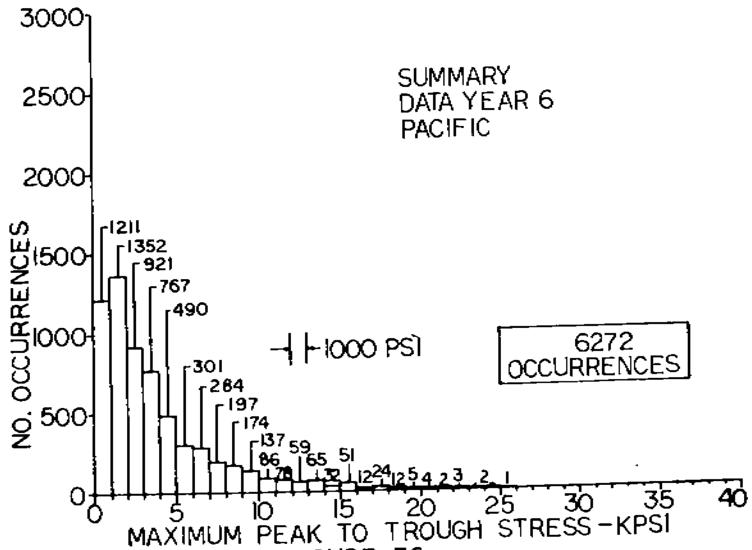

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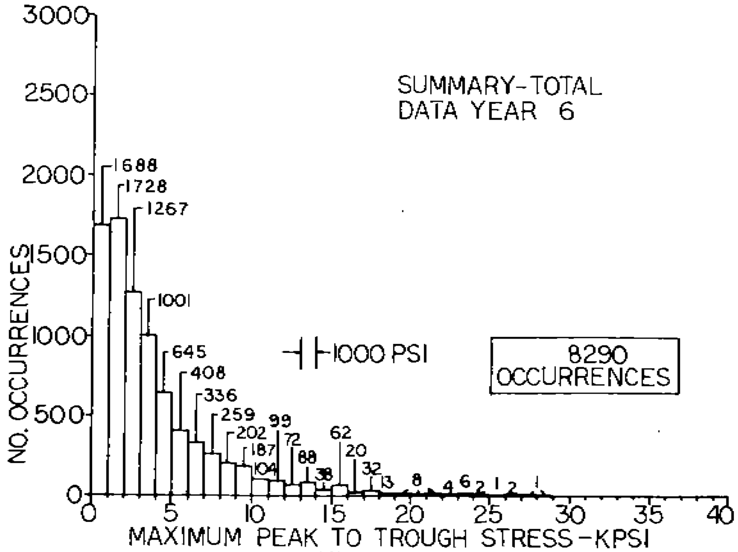

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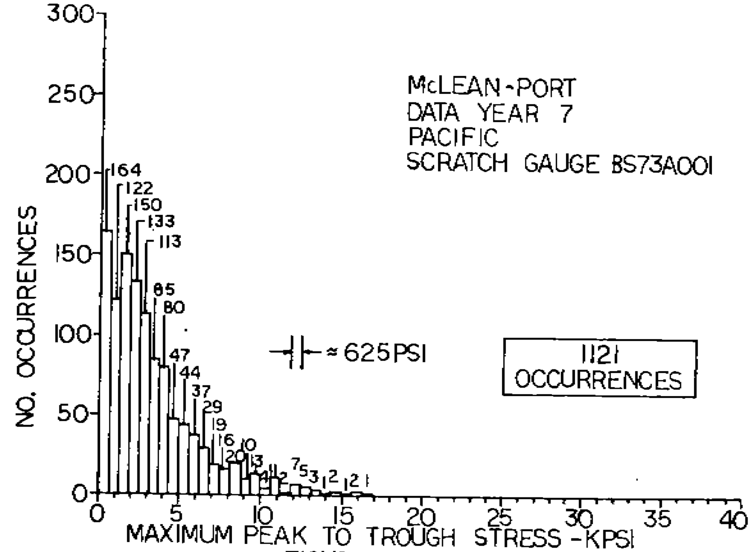

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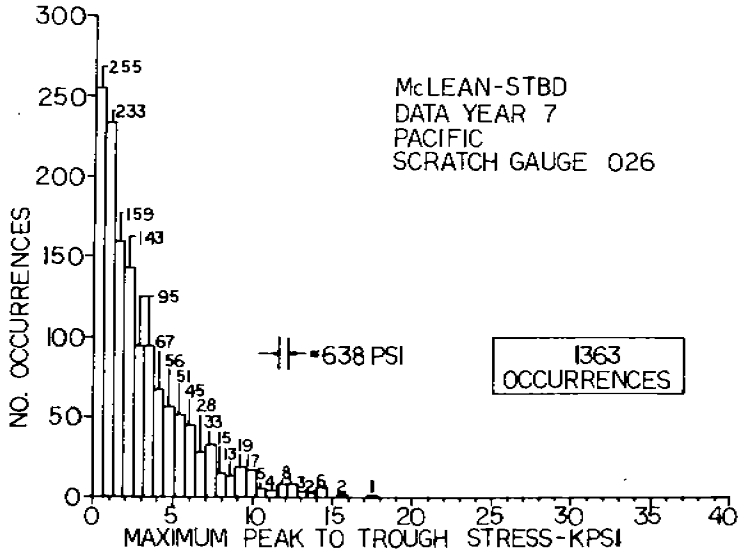

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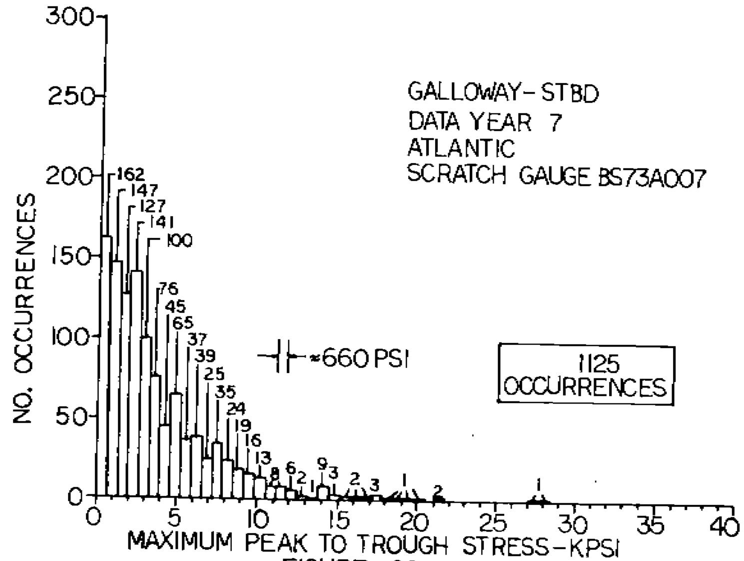

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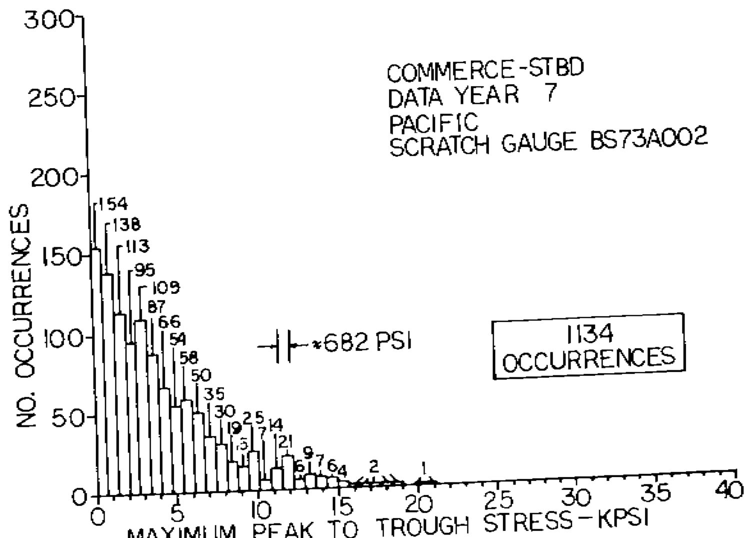

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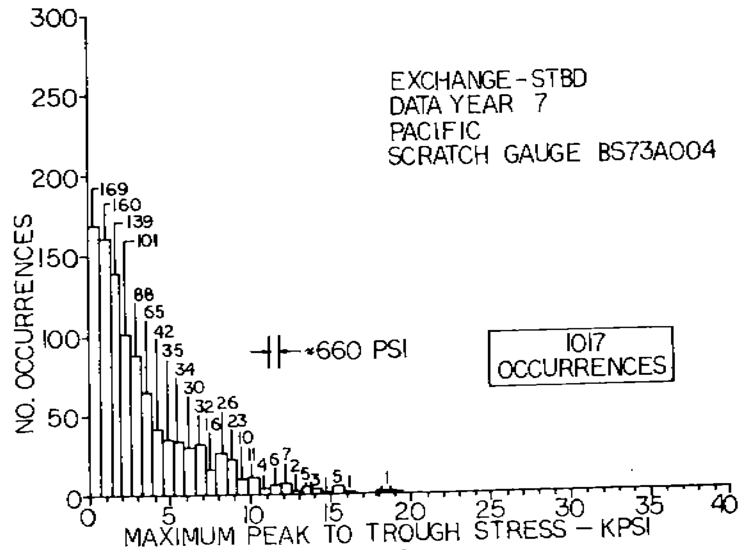


FIGURE 82

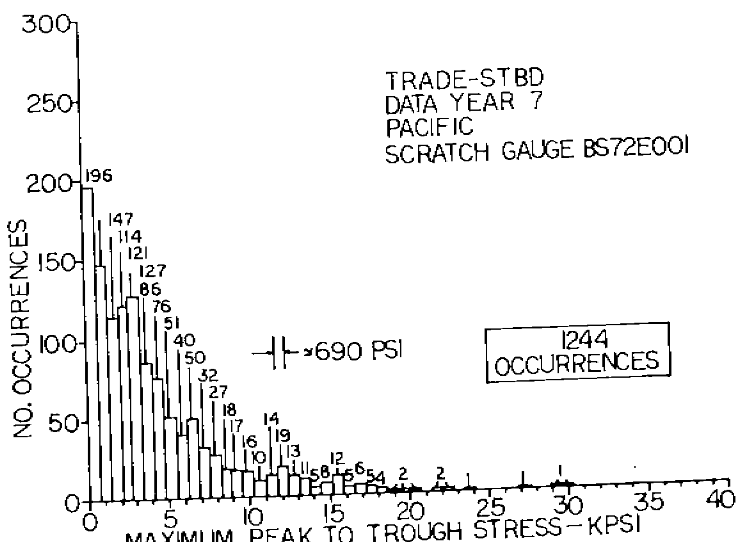


FIGURE 83

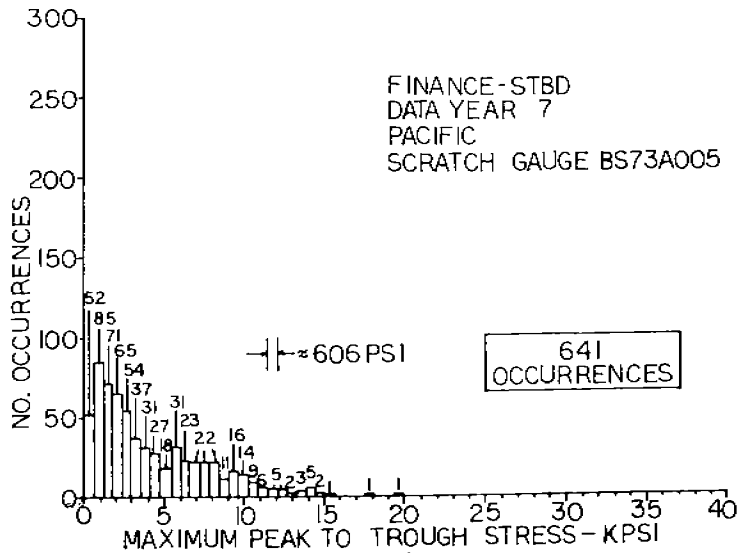


FIGURE 84

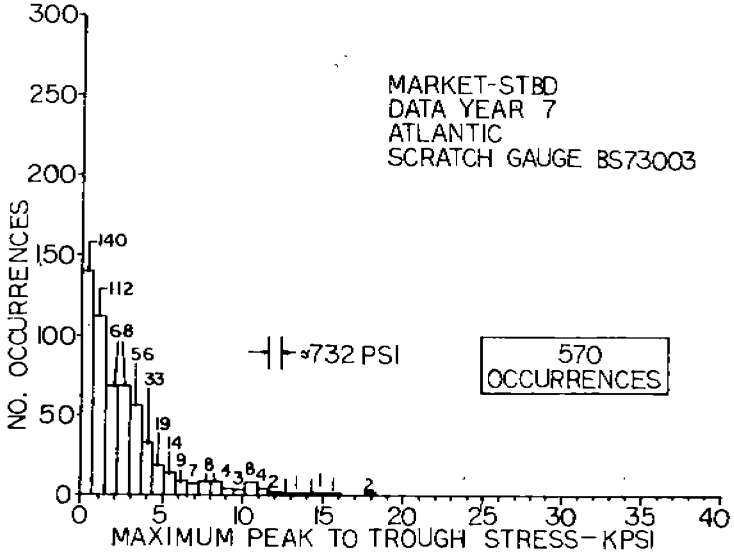


FIGURE 85

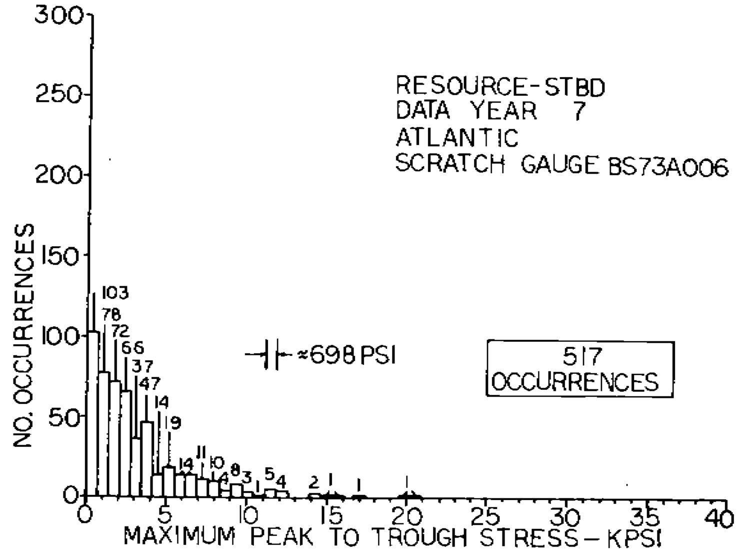


FIGURE 86

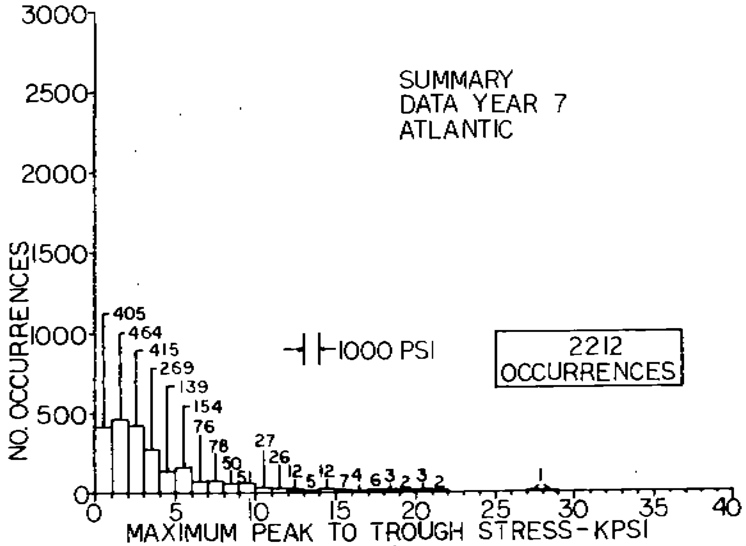


FIGURE 87

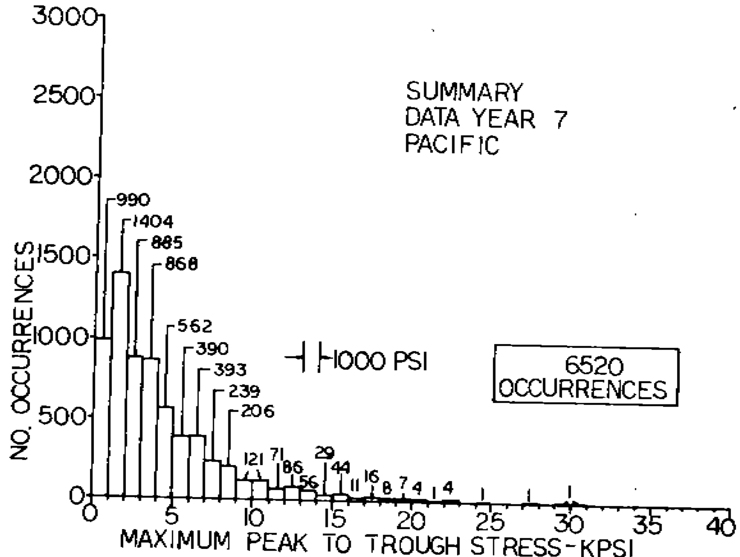


FIGURE 88

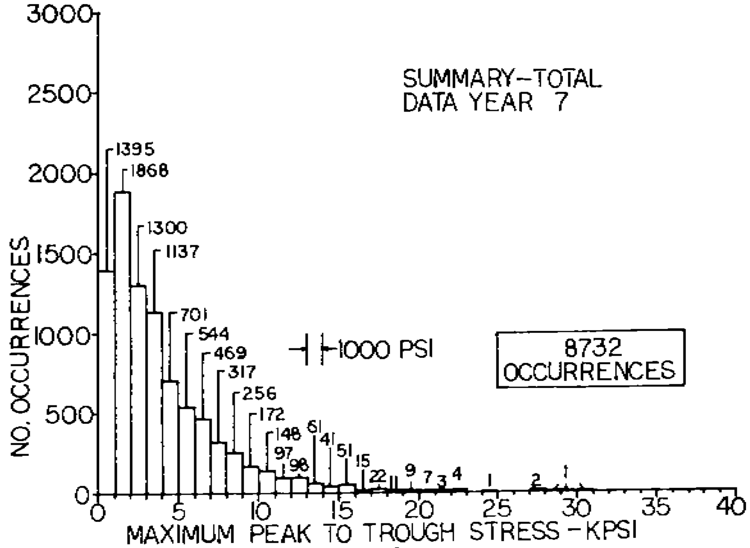


FIGURE 89

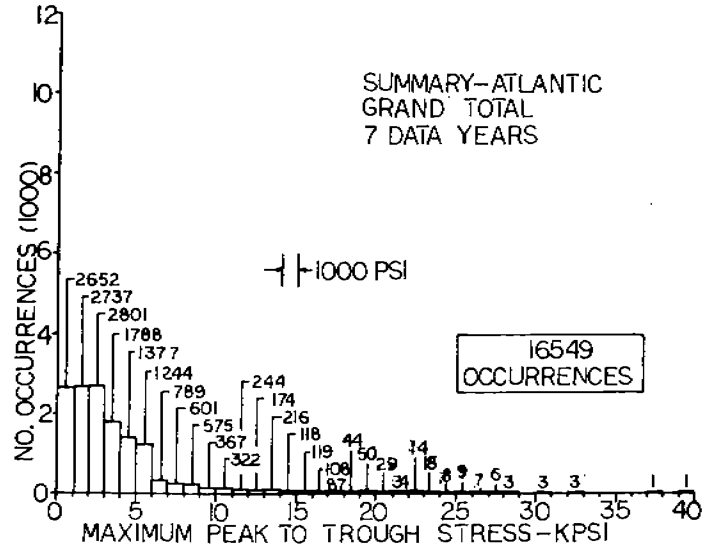


FIGURE 90

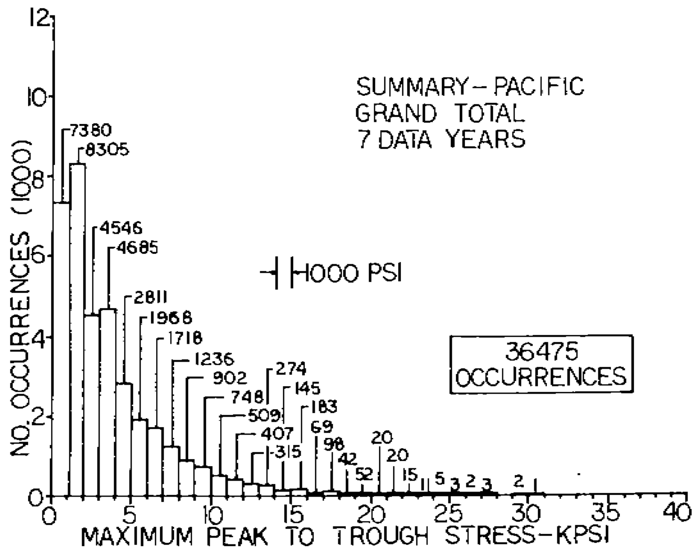


FIGURE 91

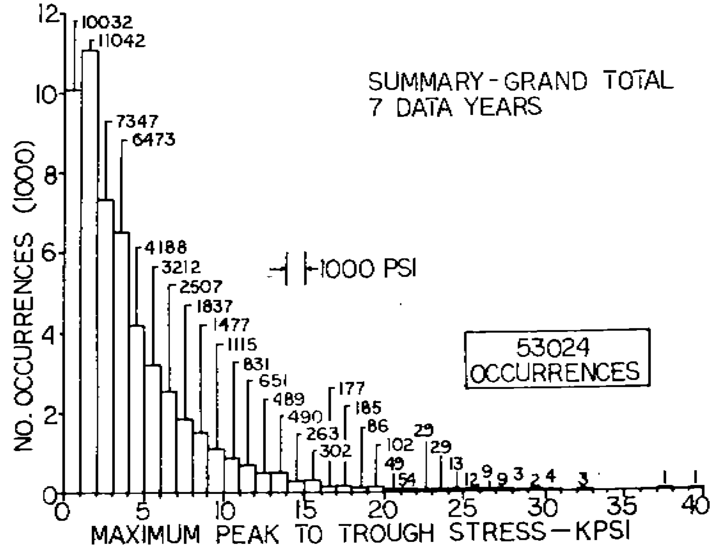


FIGURE 92

The tape-recorded stress data from the MCLEAN was recorded at four-hour intervals. These intervals were identified by time and date, along with other notations. The scratch-gauge folders first had to be identified by the same time and date for correlation with the tape recorded data. The two arrays of stress readings were then input as data to a calculator regression analysis program with the following results:

x inputs = LVB stress

y inputs = Scratch gage stress

$$n = 238$$

$$\Sigma x = 1,413,966$$

$$\Sigma y = 1,059,543$$

$$\Sigma x^2 = 1.444668878 \text{ E}10$$

$$\Sigma y^2 = 9,328,072,353$$

$$\Sigma xy = 1.10976861 \text{ E}10$$

From these quantities the following intermediate quantities were calculated:

$$S_{xx} = \Sigma x^2 - \frac{(\Sigma x)^2}{n} = 6,046,269,246$$

$$S_{yy} = \Sigma y^2 - \frac{(\Sigma y)^2}{n} = 4,611,133,838$$

$$S_{xy} = \Sigma xy - \frac{\Sigma x \cdot \Sigma y}{n} = 4,802,905,522$$

And from these intermediate quantities the following ensues:

$$r = \frac{Sxy}{\sqrt{Sxx \cdot Syy}} = 0.91$$

$$b = \frac{Sxy}{Sxx} = 0.79$$

$$a = \bar{y} - b\bar{x} = \frac{\Sigma y}{n} = \frac{b \cdot \Sigma x}{n} = -267$$

"r" is the correlation coefficient and can vary from -1 to +1. A correlation coefficient of +1 indicates a perfect direct correlation. An r of -1 indicates a perfect inverse correlation and an r of zero indicates a complete non-correlation.

The constants a and b are used in the linear regression equation:

$$y = a + bx$$

Thus, the equation which defines the scratch-gauge variable y in terms of the LVD transducer x is:

$$y = 0.79\,x - 267$$

Without using statistics, a theoretical relationship between the scratch gauge and LVB transducer can be established by determining the ratio of the distance of the two transducers from the neutral axis. The LVB transducer is mounted on the underside of the main deck. The scratch gauge is mounted four longitudinal stringers below the main deck.

Dimensions taken from the Midship Section Drawing of the ship are:

Total Depth = 19510 mm

Scratch-Gauge Location = 2440 mm below deck

Neutral Axis = 10743 mm below deck

The Neutral Axis Dimension was provided by J. J. Henry personnel at the time of original strain-gauge transducer installation in Holland.

In this case, the scratch gauge's moment arm as a proportion of the LVB transducer's moment arm is:

$$y = \frac{10743 - 2440}{10743}\,x$$

$$y = 0.77\,x$$

The LVB transducer was wired to record vertical bending only. The scratch gauge sees transverse and torsion stresses as well as vertical bending. It is difficult to state what effect these other stresses have on the scratch-gauge excursions. However, the correlation of the statistical calculations from experimental data and the simple distance calculation is quite close, and would indicate that stresses other than pure vertical bending have little effect on scratch-gauge recordings.

The analysis presented above demonstrates that the scratch gauge on the McLean measures the extreme stresses experienced with reasonable accuracy. The other seven ships have no such independent means of verifying scratch-gauge accuracy, but by similarity, analogy, and consistency of the data, the data have every appearance of validity.

A static calibration of the entire McLean instrumentation system was conducted in Rotterdam on April 9-10, 1973. Full particulars are published in report number SSC 263 (SL-7-7). The scratch gauges were manually advanced for each load condition and their values compared with strain gauge values. The starboard gauge is in close agreement with the Longitudinal Vertical Bending Stress Strain Gauges. The port gauge also was in close agreement, with the exception of loading condition No. 1. The stress values obtained during this calibration were extremely low, varying from -1500 to +2700 psi. The changes in stress for each condition produced scratch-gauge deflections in the order of 0.02 inch or less, making accurate measurement difficult. However, the scratch-gauge values were within the expected range.

V. DISCUSSION

Over 53,000 measurable readings of midship bending stress have been tabulated and presented in histogram form in the preceeding section. Appendix C shows a sample of the computer card listing of all the data by ship, ocean, folder number and approximate date, with the number of occurrences at each stress level. The scratch-gauge recorders, operating continuously, have also recorded numerous 4-hour intervals where no noticeable change has occurred. These intervals include such periods as time spent alongside the dock, calm weather operation, dry docking and repair layups. The scratch-gauge recorder provides a continuous bending stress history of the vessel. If the individual reducing the data from the tapes is familiar with the vessel's route and he has a known starting point on the tape, it is possible to trace the ship's movement out of port to the next port, observe the change in stress caused by loading and unloading, and the return to sea. As the ship departs a port and returns to sea, a distinct stress is recorded as the ship picks up speed. This stress is more pronounced when the ship's sea speed is over 20 knots. Recordings have been made when the vessels have gone into and out of drydock, and the static change can be easily noted. In many cases, it averages approximately 3000 psi change.

There are possibly other correlations that could be derived from this simple device, but a detailed loading distribution and the ship's log entries would be required to separate them.

In reviewing the histograms, it becomes evident that very few stress events exceed 20 kpsi. The McLean's highest stress occurred on December 19, 1973. This author was aboard at the time operating the instrumentation system. The strain gages recorded a maximum peak-to-trough stress of 53,600 psi while the port scratch gauge read 37,950 psi and the starboard scratch gauge read 32,857 psi. The ship was hove-to at the time in a Force 12 sea condition with the sea on the bow. The Galloway, eastbound earlier, was in the same storm and had a reading of 29,700 psi. The winter season of 1973-1974 was a series of heavy storms in the Atlantic. The Market also had a reading of 39,528 psi in January 1974. To return to the McLean data, the high strain reading was the result of one wave cycle occurring very rapidly. The scratch gauge, due to its mechanical operation, may not have responded fast enough to have measured the total stress, yet the ratio is close (0.71 vs. 0.79) to the statistical relationship between the two transducers. On the SL-7 class of vessel, the ship may roll heavily and also have a corkscrew type of motion, yet the vertical bending recorded will be quite low. With the sea on the bow or stern and a low pitching motion, the vertical bending is considerably higher.

The McLean recorded high stress again in December 1977, enroute to Seattle in the Gulf of Alaska. This time the wind and sea were on the stern, approximately Force 9.

The Galloway has recorded a few high stresses during its operation, however, correlation of the ship's activity and location has not been possible. The "Mariners Weather Log" published by the Department of Commerce is a valuable tool, as ships report unusual weather conditions and log entries. For example, the Galloway reported a severe storm on September 27, 1979 but the scratch-gauge records indicate a maximum stress of only 9900 psi. At the time, she was in the North Sea approaching Bremerhaven.

The Trade reported 50-knot winds and 33-foot waves on September 27, 1979. Stress levels from the scratch gauge have three instances in the low 20 kpsi range. Again in December, 1979 the Trade experienced 29-30 kpsi stress from 60 knot winds and relatively low seas.

Severe sea and weather conditions contribute to high bending stress, but the effects can be sharply reduced by the Captain of the vessel if he can reduce speed and/or change course.

All of the original data and summaries developed for this report are available in the SL-7 data library maintained at the Waltham, Massachusetts facility of Teledyne Engineering Services.

VI. SUMMARY

This seven-year program has been very successful in amassing a wealth of quality data. It has allowed the collection of bending data over a total of fifty-six statistical ship-years of operation. The cooperation of both vessel and port personnel on both coasts has been excellent. The scratch-gauge recorders and clocks have been removed from the vessels. Most of the units are in full operating conditions, and are available for further use.

The opinions and conclusions presented in this paper are those of the author, and not necessarily those of the Ship Structure Committee nor the United States Coast Guard.

VII. ACKNOWLEDGEMENT

The data presented in this report could not have been collected without the interest and assistance of the crew of each SL-7. Particular thanks go to the Chief Engineer of each vessel, who provided the on-board attention these installations require. In addition, we thank the Sea-Land shore personnel who assisted in mailing the tapes and keeping us informed of vessel locations and problems.

APPENDIX A

SCRATCH-GAUGE INSTALLATION

1. GENERAL

The installation of a scratch-gauge recording system aboard an SL-7 involves the mounting and wiring of three major components; the gauge itself, the clock assembly and the protective enclosure. With the exception of the MCLEAN, all vessels have single recorder installations located at approximately Frame 186 in the starboard longitudinal box girder (tunnel). The McLEAN has installations in both the port and starboard tunnels. Figure A-1 shows the configuration of the SL-7 class containership and the location of the scratch gauge. Figure A-2 shows the physical relationship of the recorder location to the rest of the vessel. The installation is made on the second-from-the-deck outboard longitudinal girder either at Frame 186 1/4 or 186 3/4 depending upon local interference problems.

2. PREPARATION

At the installation site, all components are physically placed in position and clearances checked. To ensure a minimum of effect on the vessel structure, all components are bolted to 1/4 - 20 studs which are welded to the steel with a stud welding machine. The first task is to mark all stud locations: six for the recorder,* four for the clock assembly and eight for the enclosure assembly.

Once the stud locations are marked, each area is cleaned to bare metal with a hand-held grinder and a center punch used to mark the stud center. This ensures that when the stud is welded a clean and strong weld is achieved.

---

* Although only 2 studs are required to mount the recorder, three pairs i.e., six studs were installed to provide spares in case of stud failure during the operational life. One such failure has occurred and the quick movement of the recorder to a spare set of studs was accomplished with a minimum of data loss.

3. INSTALLATION (Ref. Fig. A-3)

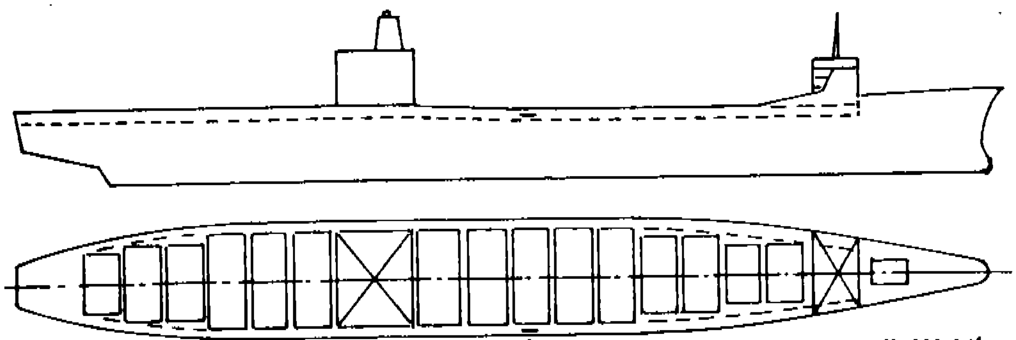
The clock assembly, the clock and its mounted plate, is bolted to the studs on the side shell. Next, the recorder is positioned and tightly secured. It is very important that the recorder studs be tight to ensure that the conical bearing points of the instrument are making good contact with the longitudinal girder.

The connecting cable from the clock to the recorder is then positioned and connected. With batteries in the clock unit, the hands are physically turned to ensure that the recorder advances at the desired 4-hour increments. When operation is satisfactory, the plexiglass enclosure (Fig. A-4) is positioned and bolted in place. Clear RTV (Room Temperature Vulcanizing) silicone rubber is then put around all edges to make a nearly watertight seal around the enclosure.

The lamp unit on the enclosure is wired to a local service of 115 V, 60 Hz, Single Phase power to operate the 40-watt lamp in the top.

A final check of the recorder ensures free movement of the stylus arm, and proper marking pressure on the paper tape. The clock is set to GMT and the front door of the enclosure closed.

We have requested that the chief engineer mark the tape with the date at least once a week. Each roll of tape lasts approximately 3 months, at which time both the tape and clock batteries should be changed. Spare tape, batteries, and lamp are kept inside each enclosure.



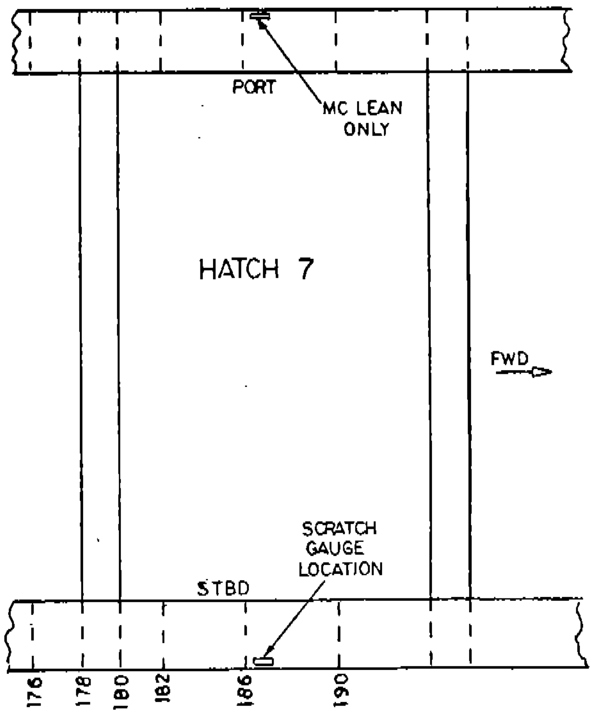
Class:	SL-7 Containership
Length, overall	946' 1 1/2"
Length, between perpendiculars	880' 6"
Beam, molded	105' 6"
Depth to main deck, forward	65' 3"
Depth to main deck, aft	69' 9"
Draft, design	30' 0"
Draft, scantling	33' 0"
Dead weight - long tons	27,315
Displacement (34' 0" draft) - long tons	50,315
Machinery	Two separate cross-compound steam turbines driving two propeller shafts
Shaft Horsepower-maximum continuous, both shafts	120,000
Propeller RPM	135
Speed, maximum, knots	33
Center of gravity - full load	399.32' forward of aft perpendicular 42.65' above base line
Section modulus, FR 186, top:	$1,745 \times 10^6$ in^3
Section modulus, FR 186, bottom:	$2,166 \times 10^6$ in^3
Neutral axis, FR 186	342.5 in above base line

Container Capacity

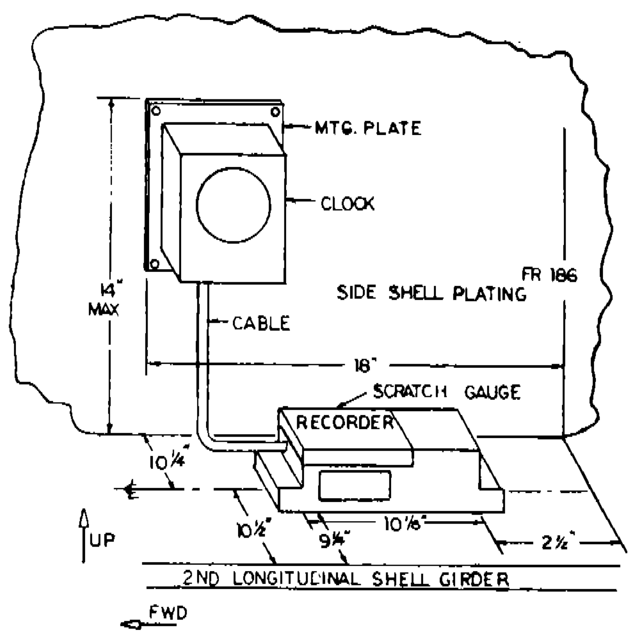
	8' x 8.5' x 35'	8' x 8.5' x 40'	Total
Below deck	554	140	694
Above deck	342	60	402
TOTAL	896	200	1,096

SL-7 Class Containership

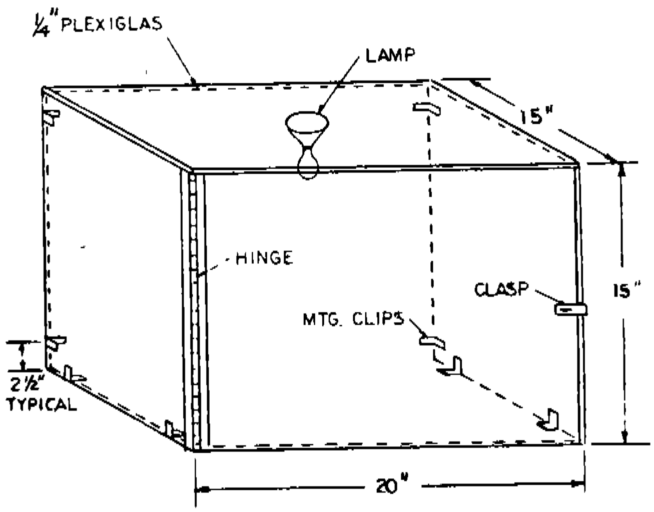
FIGURE A-1



SHIP GAUGE LOCATION
FIGURE A-2



COMPONENT LAYOUT
FIGURE A- 3



SCRATCH GAUGE ENCLOSURE
FIGURE A- 4

APPENDIX B

TABLE B-1

Scratch-Gauge Calibrations

Stylus Deflection, inch

Structure Deflection inch	McLean Port (original)	McLean Port* (recal.)	McLean Port (10/18/75)	McLean Stbd	Galloway Stbd	Commerce Stbd	Exchange Stbd	Trade Stbd	Finance Stbd	Market Stbd	Resource Stbd
0.010	0.85	0.95		0.874							
0.009											
0.008	0.692	0.76		0.712					0.76	0.64	0.70
0.007									0.66	0.56	0.62
0.006	0.536	0.57	0.58	0.560	0.53	0.53	0.64	0.56	0.60	0.49	0.54
0.005			0.45		0.45	0.45	0.54	0.46	0.488	0.42	0.44
0.004	0.338	0.37	0.38	0.388	0.33	0.33	0.44	0.36	0.40	0.34	0.36
0.003			0.30		0.28	0.28	0.36	0.28	0.30	0.26	0.28
0.002	0.172	0.20	0.20	0.198	0.16	0.16	0.18	0.20	0.20	0.17	0.18
0.001			0.10		0.12	0.12	0.10	0.06	0.12	0.10	0.09
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-0.001			-0.100		-0.072	-0.072	-0.08	-0.128	-0.10	-0.10	-0.08
-0.002	-0.176	-0.15	-0.20	-0.170	-0.16	-0.16	-0.18	-0.232	-0.20	-0.18	-0.16
-0.003			-0.28		-0.30	-0.30	-0.26	-0.252	-0.24	-0.26	-0.24
-0.004	-0.350	-0.33	-0.37	-0.378	-0.39	-0.39	-0.36	-0.408	-0.392	-0.34	-0.33
-0.005			-0.47		-0.48	-0.48	-0.46	-0.50	-0.48	-0.41	-0.40
-0.006	-0.540	-0.53	-0.55	-0.558	-0.51	-0.51	-0.552	-0.60	-0.58	-0.48	-0.48
-0.007			-0.68				-0.64		-0.66	-0.58	
-0.008	-0.688	-0.72		-0.716			-0.72				
-0.009	-0.768										
-0.010		-0.91									
Figure	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10	B-11

* Installed on TRADE September 1977.

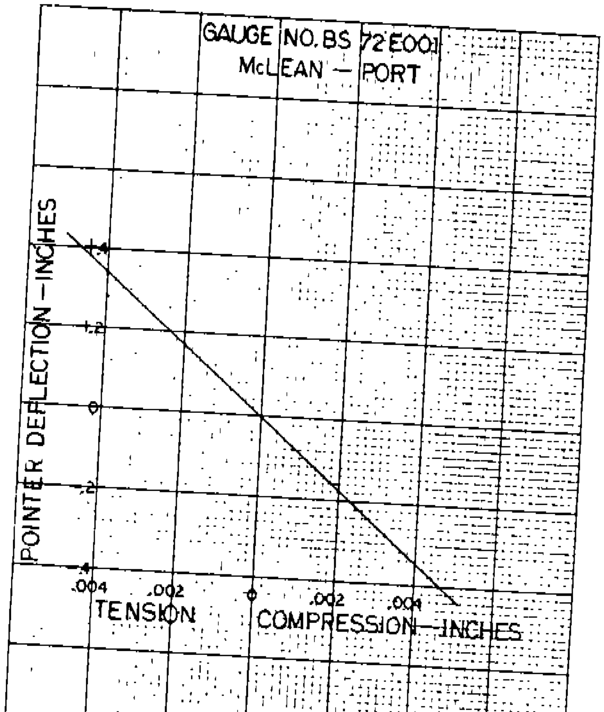


FIGURE B-1

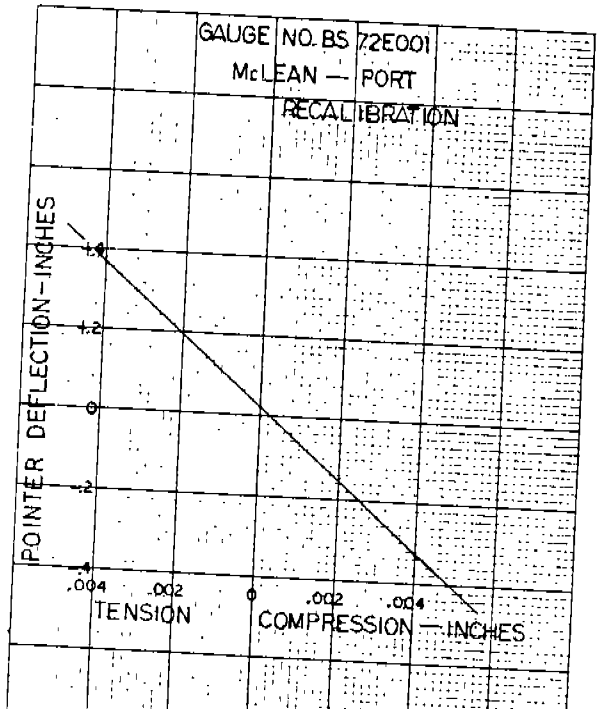


FIGURE B-2

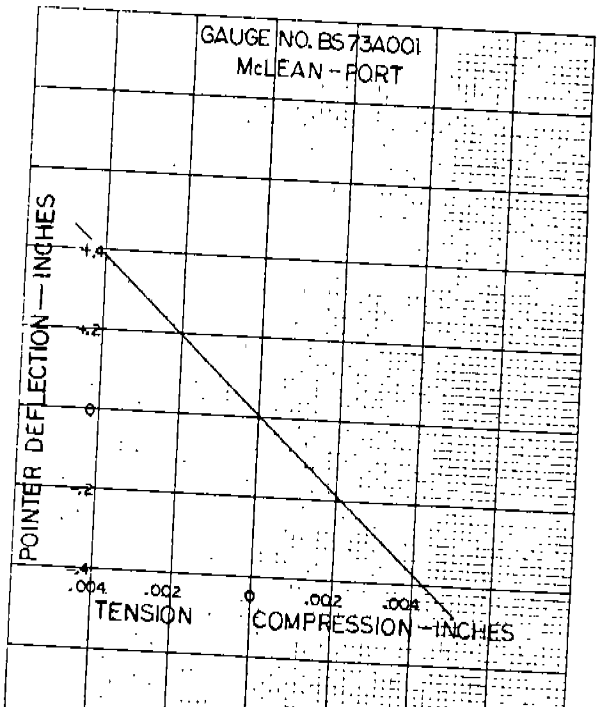


FIGURE B-3

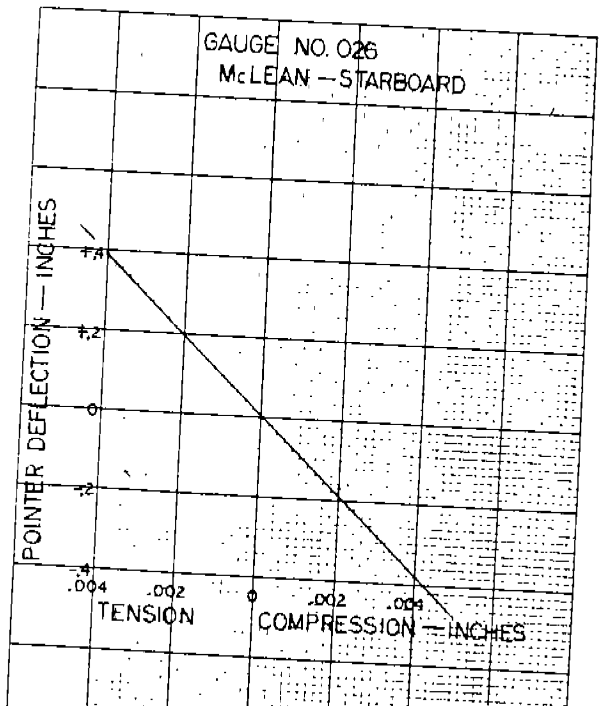


FIGURE B-4

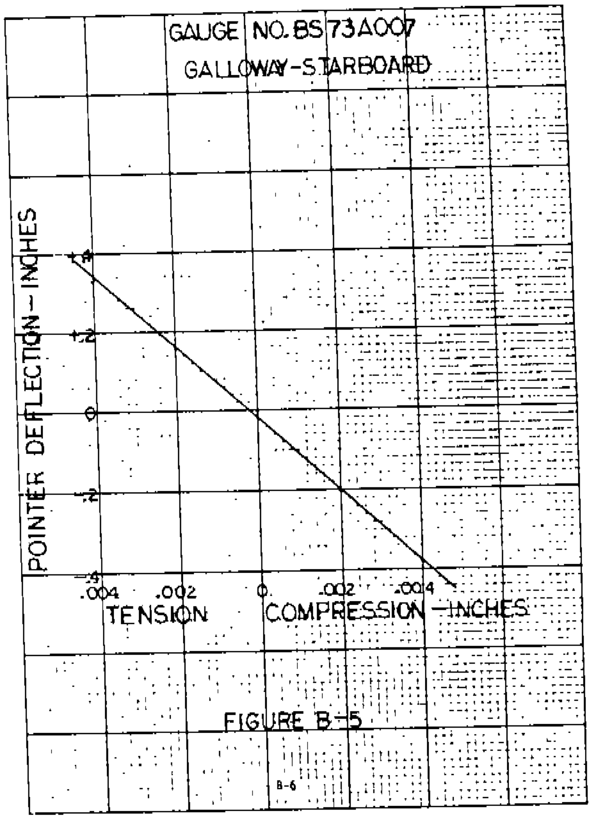


FIGURE B-5

B-6

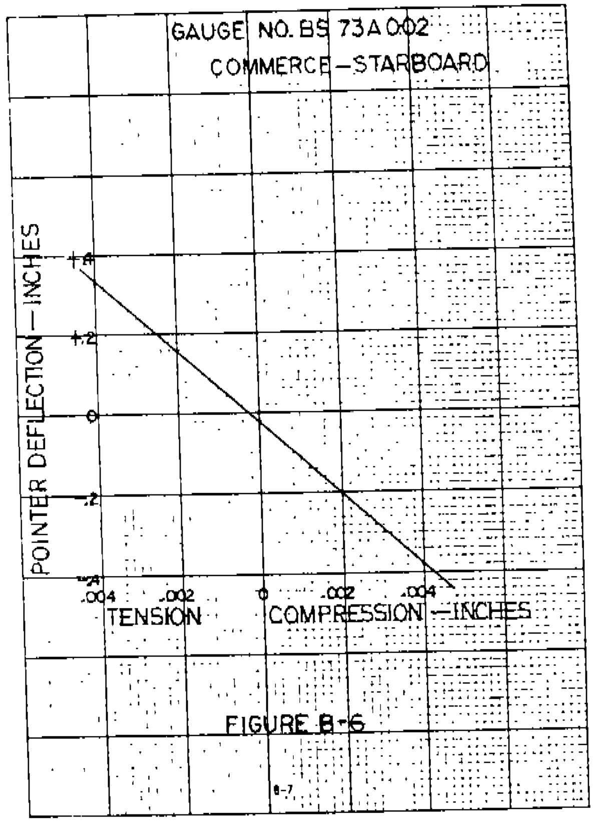


FIGURE B-6

B-7

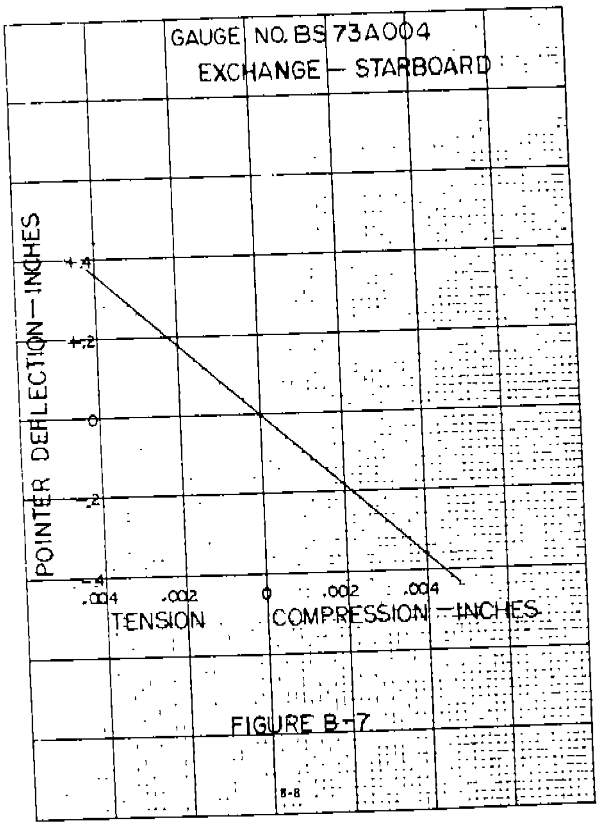


FIGURE B-7

B-8

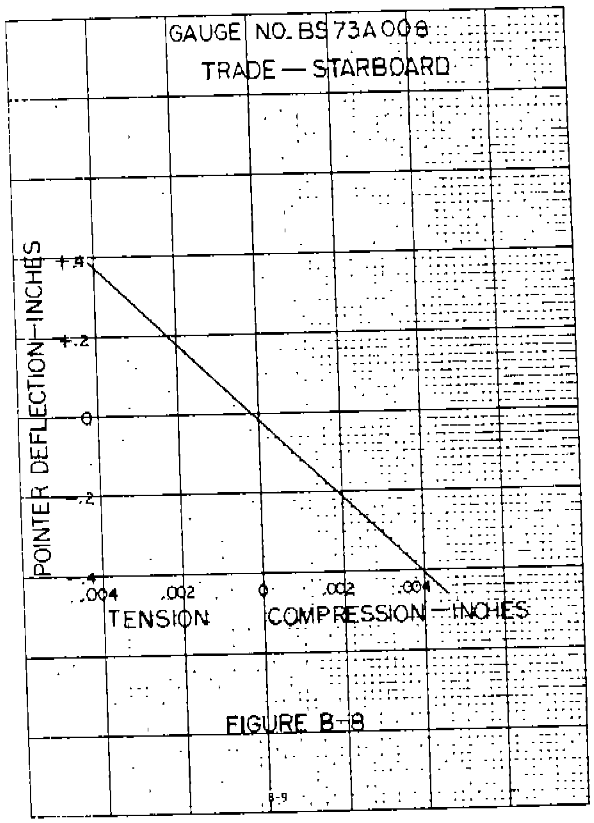


FIGURE B-8

B-9

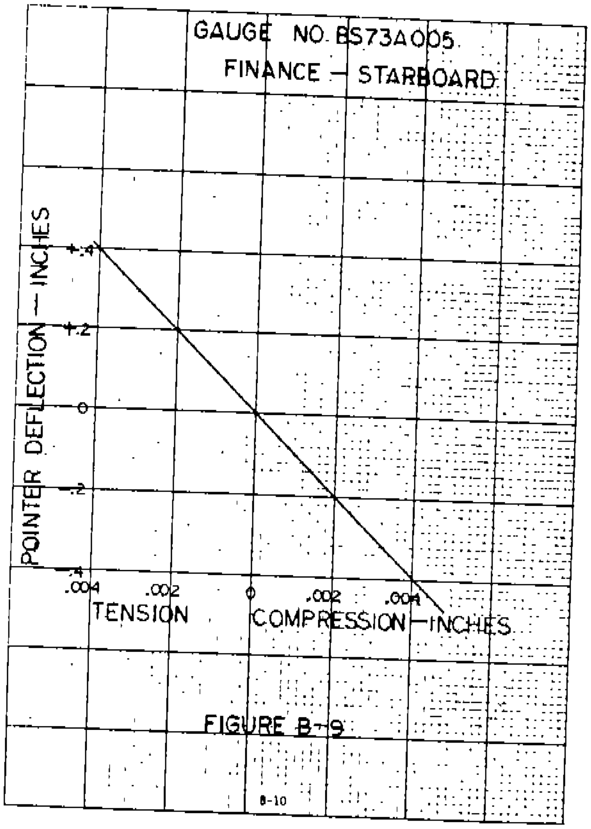


FIGURE B-9

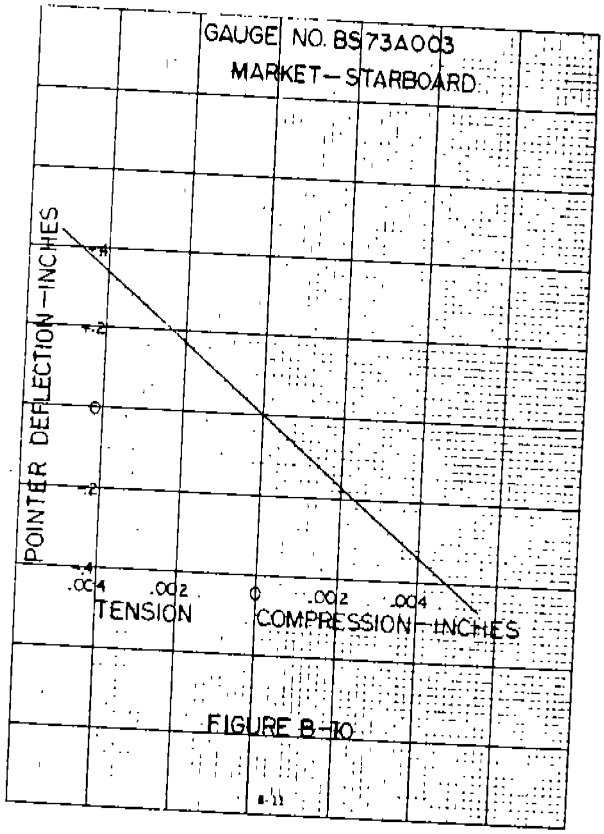


FIGURE B-10

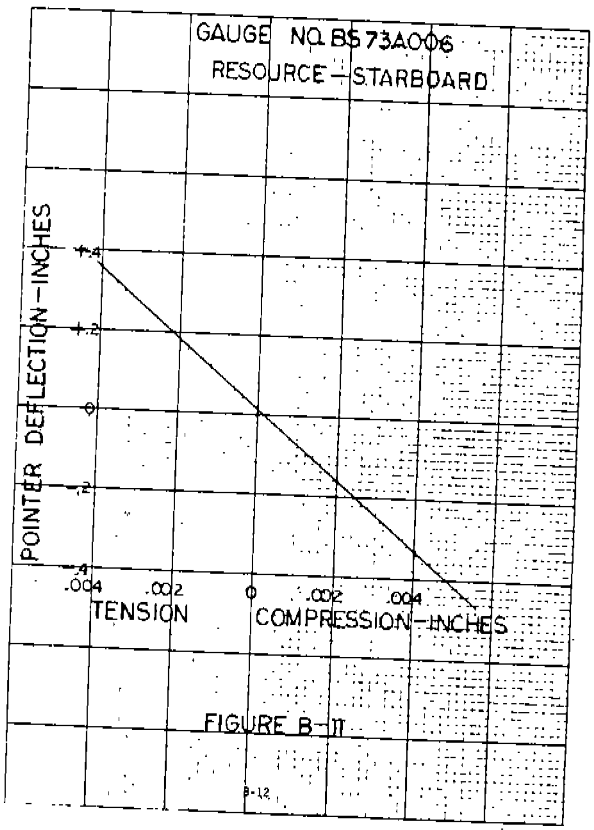


FIGURE B-11

APPENDIX C

HISTOGRAM COMPUTER LISTING

To facilitate future use of the data presented in the histograms included in this report, all of the data have been inputted on computer cards. The data are listed by data folder. Each folder (approximately 2 weeks of data) has a header card that lists in order: the vessel name, ocean, folder number, date and data year. This card is followed by data cards that list the number of occurrences at each stress level for that folder.

This encoded data are the result of measuring the scratch length and calculating the eqivalent stress for each gage as described in Section IV, A sample of the listing is included as Figure C-1. The complete listing is available on request.

```
MCLEAN  STRD    ATLANTIC    1  10/72                     YEAR 1
 5   1276  5    1914  4     2552  2     3190  3     3828  6    4466  2   5104  2    5742
MCLEAN  STRD    ATLANTIC    2  10/72                     YEAR 1
 13    638 12   1276  7     1914  7     2552  5     3190  2    5104  1   5742
MCLEAN  STRD    ATLANTIC    3  10/72-11/72               YEAR 1
 8     638 13   1276 14     1914  6     2552  1     3190  2    4466
MCLEAN  STRD    ATLANTIC    4  11/72                     YEAR 1
 3     638  4   1276  9     1914 11     2552  8     3190 10    3828  5   4466  9    5104
 10   5742  7   6380  5     7018  5     7656  5     8294  2    8932  4   9570  4   10208
 2   10846  3   14036  1    16588  1    31900
MCLEAN  STRD    ATLANTIC    5  12/72                     YEAR 1
 0     000
MCLEAN  STRD    ATLANTIC    6  01/73                     YEAR 1
 2     638  6   1276  2     1914  2     2552  4     3170  4    3828  5   4466  2    5104
 2    5742  3   6380  2     7018  3     7656  4     8294  1    8932  2   9570  3   10208
 2   12122  1   12760  2    13398  1   14036  1    19140
MCLEAN  STRD    ATLANTIC    7  01/73                     YEAR 1
 4    1276  3   1914  2     2552  4     3190  3     3828  1    4466  5   5104  3    5742
 2    6380  3   7018  6     7656  3     8294  2     9570  2   10208  2  13398
MCLEAN  STRD    ATLANTIC    8  02/73                     YEAR 1
 1     638  6   1276  5     1914  3     2552  3     3190  2    3828  3   4466  4    5104
 3    5742  4   6380  1     7018  1     7656  3     8932  2    9570  4  10208  3   10846
 1   11484  1   12122  1    12760  1   13398  2    14674  1   15950  1  16588  1   21692
MCLEAN  STRD    ATLANTIC    9  02/73                     YEAR 1
 3     638  6   1276  9     1914  9     2552 10     3190  8    3828 11   4456  6    5104
 6    5742  2   6380  2     7656
MCLEAN  STRD    ATLANTIC   10  03/73                     YEAR 1
 7     638  4   1276  5     1914  6     2552  5     3190  2    3828  2   4466  3    5104
 1    7018  2   9570  1    10208  1    11484  1    12760  1   14674  2  17226  1   21054
 1   21692
MCLEAN  STRD    ATLANTIC   11  03/73                     YEAR 1
 6     638  3   1276  8     1914  2     2552  9     3190  5    3828  5   4466  5    5104
 8    5742  9   6380  1     7018
MCLEAN  STRD    ATLANTIC   12  03/73                     YEAR 1
 6    1276  8   1914  4     2552  4     3190  3     3828  5    4466  2   5104  3    5742
 1    6380  1   8294
MCLEAN  STRD    ATLANTIC   13  04/73                     YEAR 1
 9    1276 10   1914  7     2552  1     3190  3     3828  1    4466  1   5104
MCLEAN  STRD    ATLANTIC   14  05/73                     YEAR 1
 9     638 16   1276  7     1914  5     2552  4     3190  4    3828  2   4466  1    6380
 1    7018  1   8932
MCLEAN  STRD    ATLANTIC   15  06/73                     YEAR 1
 14    638  7   1276  3     1914  2     3828  1     4466  1    7656  1   8294
MCLEAN  STRD    ATLANTIC   16  06/73                     YEAR 1
 13    638  4   1276  7     1914  1     2552  3     3190  1    4466  1   5104  1    5742
 1    6380  1   7018  2     8932  1     9570  1    12122  1   12760  2  13398
MCLEAN  STRD    ATLANTIC   17  07/73                     YEAR 1
 13    638  5   1276  3     1914  2     2552  1     4466
MCLEAN  STRD    ATLANTIC   18  07/73                     YEAR 1
 2     638  1   1276  1     2552  1     4466  1     7018  1    8294
MCLEAN  STRD    ATLANTIC   19  08/73                     YEAR 1
 7     638  3   1276  3     1914  2     3190  1     4466  1    5742  1   7656
MCLEAN  STRD    ATLANTIC   20  08/73                     YEAR 1
 7     638 10   1276  4     1914  4     2552  3     3190  1    3828  2   5104  2    5742
 2    6380  1   7018
MCLEAN  STRD    ATLANTIC   21  08/73                     YEAR 1
 7     638 11   1276  4     1914  4     2552  2     3190  4    3828  3   4466  1    5104
 1    7018
MCLEAN  STRD    ATLANTIC   22  08/73-09/73               YEAR 1
 6     638  4   1276  1     2552  2     4466  2     5104  1    5742  1   7018  1    8294
 1   11484  1   12760  1    14674
```

APPENDIX D

DATA AVERAGES

As required by the contract for the final portion of the scratch-gauge project, the top and bottom of each four-hour scratch mark on the data tape was measured from a reference line. The numerical average of each scratch was then calculated. The purpose of this calculation was to determine if it was possible to read diurnal stress or other static changes from the scratch-gauge records.

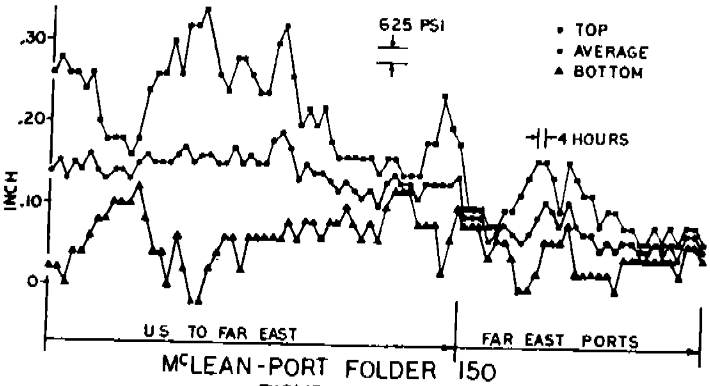
The measurements made were encoded on computer punch cards. A listing of these is presented in this Appendix. Each folder of data consists of a header card listing the vessel, ocean, folder number, date and data year, followed by data cards with Bottom-Top readings in hundredths of an inch (reading horizontally).

Although all the data areshown in the listing, only one folder of each ship's scratch gauge data is plotted and included here.

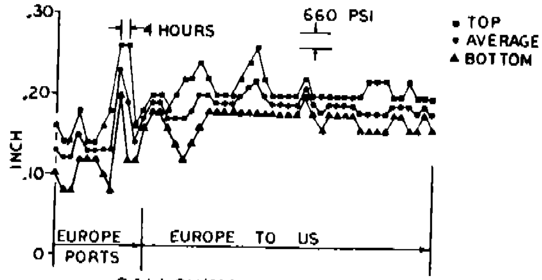
Each data point represents the four-hour extreme stress experienced underway with the time in port excluded. Each plot is divided into an ocean crossing portion, and time spent between ports, with all data in correct time sequence.

With the exception of the Market and Resource plots, the average stress change compared to peak-to-trough maximum stress during ocean crossings is quite low. There is no evidence of diurnal stress on any of the plots. On the McLean and Galloway plots and all of the others to some extent, there is evidence of bias to one side. This is shown as a repeated lower or upper reading regardless of the length of the total scratch excursion. The only explanation that I can conceive is that while at sea these vessels present a large sail-area to the wind and tend to sail with a constant list. This phenomenon is also observed in the ships roll where the roll to the windward is much less and more constant than the opposite roll. In reviewing expanded oscillograph records of McLean Bending Stress Data, the same bias was observable.

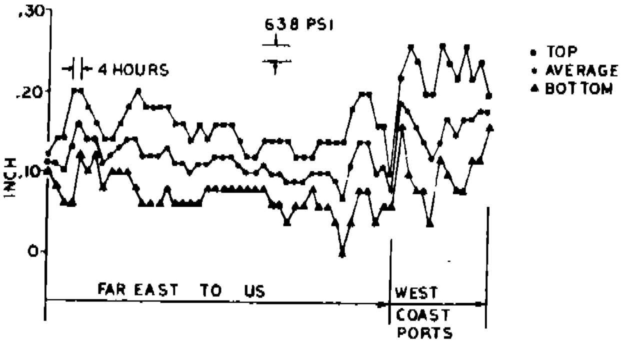
The trim of these constant-draft vessels is important, and as a result the crew monitor the fuel consumption and ballast conditions, and adjust them as required a minimum of twice a day and more often as required. This constant trim keeping would result in the small change of average stress evidenced by the data.



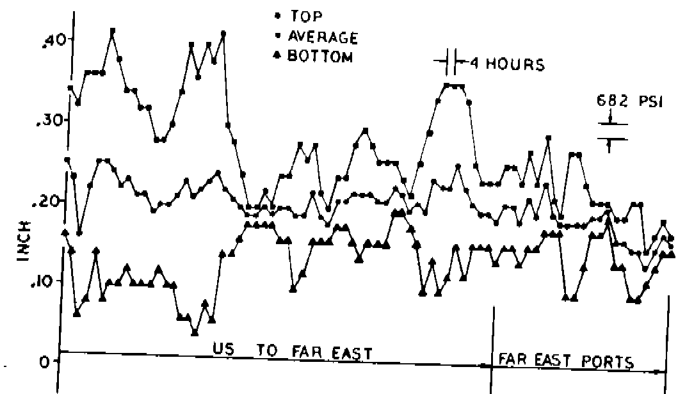
McLEAN-PORT FOLDER 150
FIGURE D-1



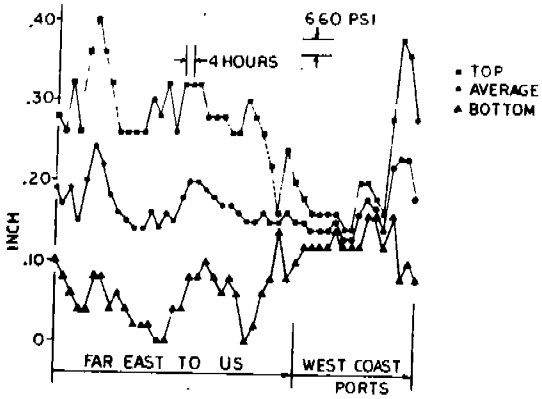
GALLOWAY FOLDER 142
FIGURE D-3



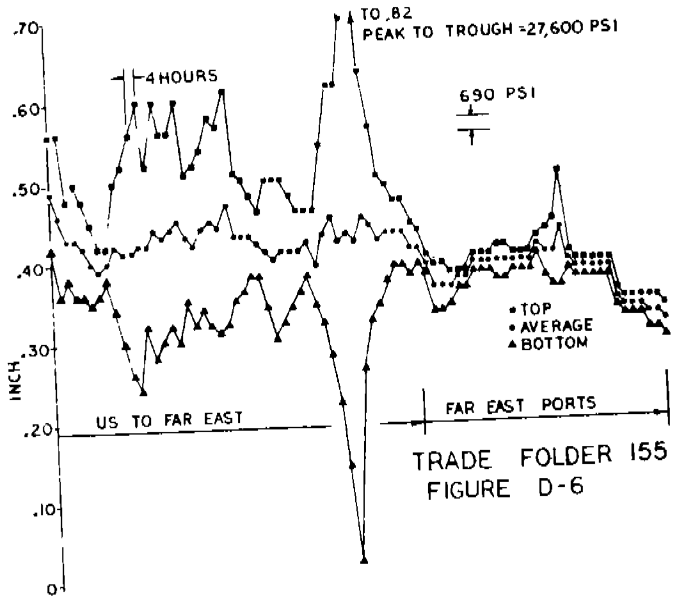
McLEAN-STBD. FOLDER 155
FIGURE D-2



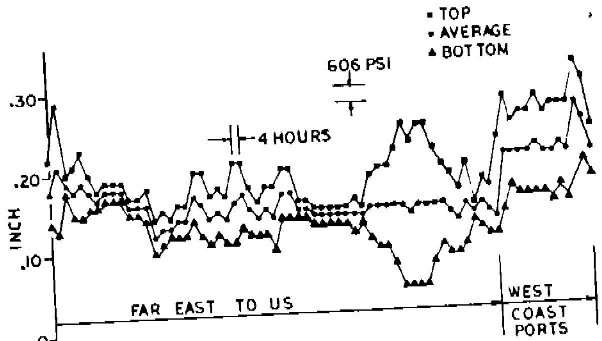
COMMERCE FOLDER 145
FIGURE D-4



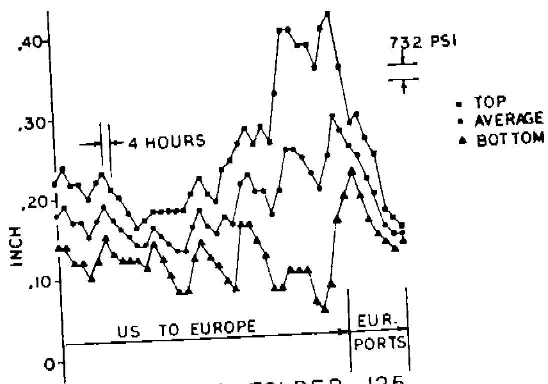
EXCHANGE FOLDER 153
FIGURE D-5



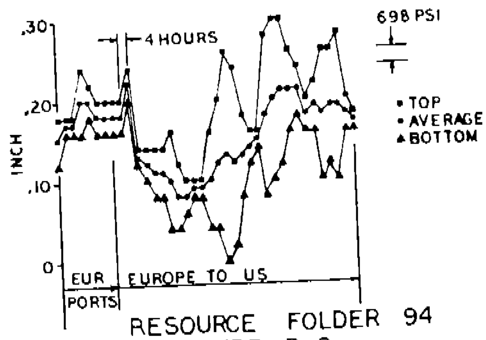
TRADE FOLDER 155
FIGURE D-6



FINANCE FOLDER 135
FIGURE D-7



MARKET FOLDER 125
FIGURE D-8



RESOURCE FOLDER 94
FIGURE D-9

MCLEAN STBD PACIFIC 142 10/79 YEAR 7

20	28	22	24	22	24	22	24	22	32	22	32	21	29	20	28
20	26	26	32	26	38	24	34	24	32	24	30	29	33	24	32
24	30	26	30	22	32	20	32	22	36	20	34	21	35	20	36
24	34	24	32	20	30	18	32	18	34	14	33	16	40	14	36
12	34	16	34	16	32	16	30	18	32	16	32	16	32	17	29
19	29	14	34	8	36	16	40	16	32	15	25	12	36	12	36
20	32	16	32	21	33	20	32	23	31	24	30	26	30	26	30
28	30	28	30	26	32	26	32	26	34	26	36	26	36	24	38
26	32	22	28	21	33	18	36	18	32	16	34	12	36	10	42
16	46	16	36	16	36	8	44	6	48	6	46	8	42	16	36
24	32														

MCLEAN STBD PACIFIC 143 10-11/79 YEAR 7

16	32	18	28	16	22	20	24	14	18	14	18	14	20	12	20
10	24	8	30	6	38	4	38	12	40	12	38	12	40	10	36
8	38	12	34	12	32	10	34	12	32	12	26	14	28	18	32
16	28	14	24	14	24	14	20	14	22	14	24	12	26	14	20
14	18														

MCLEAN STBD PACIFIC 144 11/79 YEAR 7

26	36	24	32	22	30	28	34	24	28	24	26	24	26	22	24
22	26	22	26	24	32	22	32	20	36	20	38	20	36	20	44
20	38	22	38	20	38	22	38	24	38	18	42	10	50	12	44
22	40	22	32	26	32	26	30	26	30	26	32	24	36	22	40
22	40	24	44	22	38	20	38	20	44	22	42	18	44	20	38
22	36	22	36	24	30	26	30	24	34	24	34	20	34	26	32
22	34	18	38	14	42	16	40	20	38	24	32	24	28		

MCLEAN STBD PACIFIC 145 11-12/79 YEAR 7

24	26	26	30	22	34	22	36	24	32	12	36	20	26	24	30
24	32	26	30	14	34	6	44	14	34	16	34	22	26	20	24
22	24	22	24	22	26	20	26	20	24	22	24	22	28	20	28
20	22	16	26	20	24	18	22	16	22	18	24	18	24	20	24
20	24	18	28	18	20	18	22	20	22	18	20	18	22	18	22
10	26	6	32	10	28										

MCLEAN STBD PACIFIC 146 12/79 YEAR 7

12	30	14	30	14	22	16	28	14	28	14	30	16	26	16	28
16	28	18	28	16	28	16	28	16	28	18	26	18	26	18	26
16	26	18	26	18	26	20	30	18	30	18	30	16	30	16	26
16	24	24	28	24	26	26	28	22	24	26	28	22	32	20	32
20	34	28	26	22	26	22	26	20	26						

MCLEAN STBD PACIFIC 147 12/79-01/80 YEAR 7

26	34	28	30	26	28	24	30	22	32	20	32	20	34	18	40
18	38	16	40	20	50	18	48	16	46	18	46	18	36	20	42
20	42	20	40	20	40	18	38	20	36	22	38	22	32	24	34
24	34	24	32	26	28	24	30	26	30	26	30	26	30	26	30
26	30	26	30	28	30	26	28	24	32	22	30	22	36	22	36
22	32	22	34	24	32	24	36	22	34	22	34	22	34	22	36
24	34	24	28	28	30	26	30	24	28						

MCLEAN STBD PACIFIC 148 01/80 YEAR 7

28	48	32	62	28	56	30	50	28	48	26	50	34	48	36	52
32	48	32	46	34	42	24	32	38	46	36	44	34	48	36	46
32	48	32	50	32	46	32	46	30	48	30	48	32	48	36	44
38	42	38	44	36	42	36	42	32	44	32	48	32	52	32	50
32	50	30	46	34	46	34	46	30	52	26	52	30	42	32	48
32	48	34	38	42	44	36	56	38	50	42	56	40	46	38	48
40	45	40	46	36	48	38	48	38	42	36	40	36	40	36	44
34	46	34	42	30	66	38	40	38	40	38	42	38	42	38	44
36	50	32	50	34	52	36	56	36	54	36	50	36	60	34	60
32	62	34	54	38	52	36	44	38	42	40	44	38	44	38	46
36	46	34	56	32	52	34	48	38	48	34	48	30	54	30	50
34	48	24	68	18	68	20	66	24	56	28	50	28	60	30	62
28	58	28	56	32	56	34	48	36	46	34	44	36	44	34	40

36	42	36	40	42	40

MCLEAN STBD PACIFIC 149 12/80 YEAR 7

20	22	20	22	20	22	16	24	14	28	14	24	18	26	16	26
18	24	10	32	14	26	16	28	16	24	14	30	14	26	16	20
20	22	20	24	12	26	6	26	6	18	16	24	16	24	18	26
16	24	18	28	16	24	18	24	20	24	18	22	20	26	22	24
14	18	14	24	14	26	12	24	14	22	14	20	12	20	14	24
12	24	10	26	8	26	8	28	6	26	6	30	10	30	10	24
10	22	12	24	10	22	18	28	16	32	12	38	14	26	16	26
14	22														

MCLEAN STBD PACIFIC 150 02/80 YEAR 7

20	32	20	32	16	30	14	22	16	24	16	26	20	24	20	24
20	26	18	24	16	24	14	26	20	24	20	24	20	22	6	30
4	42	8	32	10	34	14	32	18	30	22	28	20	30	18	30
18	28	20	34	22	42	14	44	20	40	16	40	24	38	20	36
20	38	18	36	20	32	18	32	14	34	16	38	16	34	10	40
12	42	20	34	20	28	20	28	20	28	20	28	22	26	22	24
26	28	20	26	14	38	10	48	6	46	10	42	14	44		

MCLEAN STBD PACIFIC 151 03/80 YEAR 7

20	40	16	42	12	44	8	50	10	44	16	40	14	40	12	44
6	40	10	38	10	36	10	34	18	30	18	30	14	44	6	52
2	58	4	50	8	46	8	40	12	34	24	32	26	32	26	28
18	26	16	24	14	18										

MCLEAN STBD PACIFIC 152 03/80 YEAR 7

16	28	14	24	14	22	16	24	16	20	18	22	18	20	18	24
20	24	18	20	16	20	14	30	10	28	10	32	8	30	10	38
10	40	4	42	4	42	2	38	4	42	6	50	4	54	4	44
2	48	6	36	6	34	6	38	4	38	0	40	0	40	0	46
0	48	0	40	2	34	8	44	4	34	10	34	10	32	10	30
10	28	12	32	12	26	14	26								

MCLEAN STBD PACIFIC 153 03/80 YEAR 7

14	22	16	24	14	20	14	20	16	18	16	24	16	22	18	22
16	20	16	20	20	26	20	26	20	26	20	28	20	24	20	28
10	40	16	32	14	24	10	28								

MCLEAN STBD PACIFIC 154 04/80 YEAR 7

28	50	26	48	28	46	28	46	30	42	30	42	32	40	30	40
32	38	32	30	32	36	32	36	28	44	24	48	24	50	20	52
24	46	18	48	12	50	20	56	22	50	24	42	26	44	28	44
26	46	28	44	28	40	30	42	26	46	28	50	30	44	30	40
32	40	32	40	30	42	30	40	30	40	34	38	34	36	34	38
36	38	34	38	36	40	36	40	36	38	34	36	32	40	30	44
26	46	20	50	26	50	28	44	30	36	30	36	30	30	22	34
24	28	26	30	26	30	26	30	26	30	26	28	26	30	28	30
26	42	24	40	24	36	24	30	24	30	22	28	24	26	24	26
22	28	20	30	22	26										

MCLEAN STBD PACIFIC 155 04/80 YEAR 7

30	32	28	34	26	34	26	40	32	40	30	38	32	36	28	34
30	34	30	36	30	38	28	40	26	38	26	38	26	38	28	38
26	36	26	36	26	34	26	36	28	34	28	36	28	36	28	36
28	34	28	32	28	32	28	34	26	34	26	34	24	34	26	32
26	32	28	32	26	34	26	34	24	34	20	34	24	38	28	40
28	40	24	36	26	36	26	36	36	42	30	46	28	44	28	40
24	40	32	46	30	44	28	42	28	46	32	42	32	46	36	46

MCLEAN STBD PACIFIC 156 05/80 YEAR 7

38	40	36	44	30	54	30	54	30	54	32	54	34	54	36	50
36	50	38	48	38	50	38	52	36	52	30	58	36	50	40	42
36	38	36	38	34	38	30	42	30	44	36	44	32	46	32	50
36	44	34	42	32	48	34	42	38	40	36	40	36	40	34	42
36	44	38	42	40	44	36	46	36	44	36	42	38	40	36	40
36	40	36	44	38	46	36	38	36	38	32	36	36	40	34	40
34	40	30	46	30	44	32	40	38	40	36	38	34	36	28	40

```
  28   40   30   36   30   32
MCLEAN STRD    PACIFIC  157  05/80        YEAR 7
  28   34   24   36   24   36   26   30   26   36   28   34   28   34   28   32
  28   32   24   30   28   34   28   34   26   34   24   36   26   36   24   30
  24   32   26   32   26   30   26   28   24   28   22   28   24   26   26   28
  26   30   28   30   28   30   24   30   24   30   24   30   26   26   30   32
MCLEAN STRD    PACIFIC  158  06/80        YEAR 7
  30   32   32   38   26   30   28   32   28   32   26   34   24   38   28   28
  28   30
MCLEAN STRD    PACIFIC  159  06/80        YEAR 7
  28   36   30   36   30   34   32   36   32   36   34   36   32   34   32   34
  32   34   32   34   30   32   28   34   28   34   22   40   24   42   24   44
  24   36   28   34   28   32   30   32   32   34   32   34   32   34   30   34
  28   30   28   30   28   30   28   30
MCLEAN STRD    PACIFIC  160  07/80        YEAR 7
  16   20   16   18   12   20   12   22    4   30    6   30   10   26   12   20
  16   18   14   20   14   20   16   22   16   22   16   20   16   18   16   20
  16   18   16   16   16   18   16   12   16   18   18   20   18   20   18   20
  18   20   18   20   18   20   18   20   20   24   18   20   18   20   18   20
  18   20   18   20   16   20   16   20   16   20   16   20   16   22   14   24
  14   20   14   20   12   20   12   20   12   20   14   20   14   20   14   20
  14   20   16   18   16   18   18   20   18   20   18   20   18   20   16   22
  14   24   14   28
MCLEAN STRD    PACIFIC  161  07/80        YEAR 7
  12   30   12   30   16   26   14   26   18   24   18   22   18   22   20   22
  20   22   18   22   18   22   20   24   20   24   18   22   18   22   18   20
  18   22   18   22   18   22    8   20    0   26    6   28    4   20    6   18
   8   24    4   24    2   22    2   24    2   24    6   18   14   16   16   18
  16   18   12   14   12   14
MCLEAN STRD    PACIFIC  162  08/80        YEAR 7
  10   14   12   14   10   12    8   12    2   14    8   12    6   12    6   12
  10   16   10   16    8   18    8   12   10   16   12   18   14   16   14   16
  14   16   12   14   12   16   16   20   14   22   10   24   12   22   14   20
  16   18   16   18   16   18   16   18   16   18   16   16   12   14   12   14
   8   16    8   18   16   18   14   20   14   18   16   18   20   26
MCLEAN STRD    PACIFIC  163  08/80        YEAR 7
  18   28   20   26   20   24   20   24   24   26   24   26   22   24   22   24
  22   24   22   24   22   24   18   30   16   30   12   28   20   30   20   26
  22   26   22   24   22   26   22   24   22   24   24   26   22   24   22   24
  22   24   18   30   18   28   20   26   22   28   22   24   22   24   20   24
  20   22   18   22   18   24   20   24   22   24   20   22   20   22   18   20
  18   20   18   20   18   20   18   20   18   20   18   22   18   20   18   22
MCLEAN STRD    PACIFIC  164  09/80        YEAR 7
  16   22   16   26   14   28   14   32   12   34   12   34   12   32   12   32
  18   28   18   28   18   24   18   24   18   30   18   26   16   24   16   22
  16   24   20   22   16   20   16   12   18   22   12   14   12   16
MCLEAN STRD    PACIFIC  165  09/80        YEAR 7
  10   12   10   12    8   12   10   12   10   12   10   16   10   12    8   12
   8   10    8   10   10   12   14   18   16   18   16   16   16   20   16   20
  16   22   16   20   14   20   16   20   16   20   18   20
MCLEAN PORT    PACIFIC  139  10/79        YEAR 7
  24   32   22   32   24   30   22   28   20   30   24   32   22   32   20   32
  20   32   20   34   22   32   22   26   26   32   28   34   24   32   24   30
  26   32   24   30   22   30   22   30   24   34   24   30   24   40   24   38
  22   40   24   36   22   36   24   30   20   36   28   36   28   34   26   34
  22   36   22   32   20   32   24   38   22   36   24   30   26   34   24   36
  28   40   24   38   22   40   20   48   14   50   16   52   16   48   18   50
  16   50   18   44   22   38   20   42   26   44   22   40   24   38   24   36
  24   34   26   36   30   38   30   36   28   32   28   34   26   34   32   40
  30   40   28   36   26   36   26   32   24   30   26   34   22   36   20   28
  20   36   18   38   20   42   20   40   22   32   20   36   12   46    6   48
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```
   6  56  10  54  20  42  26  40  26  30  28  34  28  34  28  32
MCLEAN PORT    PACIFIC  140  10-11/79      YEAR 7
  26  30  22  28  22  30  20  24  20  22  24  26  22  24  22  28
  22  26  22  24  22  24  24  26  24  26  22  24  24  26  24  26
  20  22  20  24  20  22  22  24  22  24  22  24  22  24  20  24
  20  24  20  24  20  26  20  24  18  22  20  22  18  26  18  24
  16  24  12  26  12  30   6  30   4  28   8  28   6  28   6  28
  00  28   4  28   8  28   6  30  10  28  10  26  10  24  12  26
  14  26  14  26  12  26  14  24  14  24  12  26  16  26  16  26
  16  24  20  28  22  28  20  30  22  30  20  30  20  26  22  28
  22  28  20  24
MCLEAN PORT    PACIFIC  141  11/79         YEAR 7
  26  32  26  36  28  36  26  34  26  32  26  32  26  32  24  32
  24  32  24  34  26  36  26  34  22  34  22  34  22  26  20  38
  20  40  20  40  20  38  20  38  20  36  20  36  14  48  10  56
  12  48  16  46  20  38  22  36  24  38  28  38  28  34  26  34
  28  34  26  34  26  38  24  40  24  40  22  40  20  40  20  48
  22  46  22  48  22  44  22  40  24  38  26  36  26  34  22  38
  22  34  20  34  22  32  22  34  22  34  20  36  20  40  22  34
  24  32  22  32  24  30
MCLEAN PORT    PACIFIC  142  11-12/79      YEAR 7
  22  36  14  50  16  44  22  36  20  36  24  28  22  24  20  34
  18  38  20  38  22  28  20  22  26  28  20  36  14  44  20  36
  20  24  22  24  20  34  20  30  22  30  22  30  20  26  22  26
  20  28  20  28  20  32  20  30  20  28  22  26  22  30  20  26
  22  24  18  30  20  30  20  28  20  28  20  28  22  30  20  30
  20  30  22  28  22  30  22  30  20  28  20  30  16  34  16  34
  14  38  10  46  12  44  12  40
MCLEAN PORT    PACIFIC  143  12/79         YEAR 7
  18  32  18  30  16  30  16  32  14  34  16  34  16  36  18  32
  20  32  20  32  18  36  20  34  20  32  20  32  22  34  20  32
  18  32  20  32  22  30  24  26  26  34  24  34  22  34  22  34
  22  34  24  36  24  38  24  38  26  36  26  32  28  30  26  30
  24  28  22  28  26  34  28  30  28  30  26  32
MCLEAN PORT    PACIFIC  144  12/79-01/80   YEAR 7
  24  36  26  36  28  38  24  38  26  38  26  40  20  42  22  42
  20  42  20  44  20  42  20  40  20  40  20  42  18  42  16  42
  18  40  18  38  16  30  20  36  16  38  18  36  24  30  24  32
  24  30  24  30  24  32  24  30  24  30  24  32  26  32  26  32
  24  32  20  36  26  36  26  36  24  36  28  36  26  38  30  40
  32  42  32  46
MCLEAN PORT    PACIFIC  145  1/80          YEAR 7
  20  26  26  32  26  30  22  30  22  28  22  32  20  36  16  40
  14  36  16  38   8  52   0  52   0  52  10  40  20  40  18  40
  12  44  12  44  12  48  12  42  18  40  16  30  16  36  16  30
  16  30  20  32  24  32  24  26  24  26  22  26  22  28  20  28
  22  32  20  38  20  36  12  30  12  40  12  34  12  36  12  40
  12  40  14  30  20  26  22  28  20  30  16  34
MCLEAN PORT    PACIFIC  146  1-2/80        YEAR 7
  18  24  14  26  16  22  26  32  24  30  24  32  24  30  24  30
  20  28  26  30  26  28  18  24  18  24  20  26  20  24  20  24
  18  26  20  28  16  26  20  26  16  26  16  26  16  24  16  24
  14  26  16  26  16  24  16  24  16  26  16  26  20  26  16  28
  14  36  16  32  16  30  16  28  18  30  18  30  16  34  18  30
  20  30  18  32  20  28  20  30  20  30  20  28  20  30  20  30
  20  28  20  26  22  26  22  24
MCLEAN PORT    PACIFIC  147  02/80         YEAR 7
  22  24   8  38   4  46  12  38  14  42  16  40  20  34  22  36
  20  28  18  40  18  36  20  28  24  40  16  46  24  38  24  38
  24  38  22  36  20  36  20  32  24  32  26  34  20  36  20  38
  22  38  12  40  12  38  24  36  24  32  24  34  24  32  22  32
```

22	30	22	28	24	30	26	30	24	30	24	30	22	30	24	36
32	42	24	46	18	50	14	50	14	50	20	48	22	48	30	44
24	48	20	48	24	56	16	48	20	48	20	50	18	58	10	52
12	52	12	52	12	44	22	50	20	44	18	42	14	52	8	54
6	50	10	52												

MCLEAN PORT PACIFIC 148 03/80 YEAR 7

12	48	14	38	20	38	22	36	18	26	16	22	16	20	22	30
22	30	20	26	22	26	22	26	22	24	22	24	20	24	18	26
20	28														

MCLEAN PORT PACIFIC 149 03/80 YEAR 7

18	22	20	24	20	24	20	26	18	20	18	28	16	30	12	30
12	30	12	34	6	34	10	30	4	32		34	-4	42	4	36
0	40	6	36	8	34	6	34	8	40	6	44	4	44	4	52
-2	52	8	48	8	48	12	40	8	44	8	40	12	40	12	38
12	34	14	36	16	32	16	28	16	26	16	24	16	24	14	24
18	22	20	26	20	28	18	28	20	28	20	30	20	30	20	30
20	28	20	30	20	28										

MCLEAN PORT PACIFIC 150 04/80 YEAR 7

12	36	12	38	10	36	14	36	14	34	16	36	18	30	18	28
20	28	20	28	20	26	22	28	18	34	14	36	14	36	10	40
16	36	12	42	8	42	8	44	12	40	14	36	16	34	16	38
12	38	16	36	16	30	16	34	16	40	16	42	18	36	16	30
18	32	18	30	16	32	18	28	18	26	20	26	18	26	16	26
18	26	16	24	20	26	22	26	22	24	22	24	18	24	18	28
18	28	12	34	16	30	20	28	18	20	18	20	18	20	14	18
16	18	16	20	14	20	10	22	10	24	12	26	16	26	16	24
16	20	18	26	12	24	12	22	12	22	12	18	12	20	10	20
14	18	14	18	14	16	14	16	14	18	14	16	14	18	12	16
16	18	16	18	14	16										

MCLEAN PORT PACIFIC 151 04/80 YEAR 7

14	20	12	22	10	22	6	22	8	20	10	24	12	20	10	20
10	18	10	18	10	20	10	20	10	22	10	20	10	22	10	20
10	22	10	22	10	22	8	24	8	22	8	26	10	26	10	24
12	24	12	22	12	24	14	26	12	20	12	26	12	26	12	24
14	24	14	26	12	24	10	26	10	28	10	30	8	28	10	26
10	30	10	30	12	26	14	16	16	24	16	22	16	22	14	24
16	24	16	26	12	32	10	30	12	32	14	30	18	34	16	30
14	34	14	34	18	28	20	30	22	28	24	26	22	26	18	32
16	30	18	30	18	32	16	34	20	32	20	28	20	26	20	30
22	34	22	34	18	28	22	32								

MCLEAN PORT PACIFIC 152 05/80 YEAR 7

22	24	24	26	22	24	22	24	20	26	18	28	22	30	20	32
18	32	22	28	20	30	14	38	18	36	24	30	24	30	24	30
24	32	24	34	24	28	24	30	24	32	24	32	26	28	26	28
24	28	24	26	26	28	24	22	24	28	20	22	20	24	20	24
20	24	16	26	16	26	18	24	20	24	18	24	14	34	12	32
14	26	18	20	18	24	14	24	12	22	14	20	8	20	6	26
10	24	12	22	12	20	12	18	12	18	10	24	10	24		

MCLEAN PORT PACIFIC 153 05/80 YEAR 7

10	22	8	24	16	20	16	22	16	22	14	18	16	18	14	20
14	20	14	20	16	22	16	20	16	20	14	20	14	20	14	20
16	18	16	18	16	18	14	16	14	16	14	16	14	16	14	16
14	16	16	18	16	18	16	18	16	18	18	20	18	20	18	20
18	20	18	22	18	20	20	22	20	22	18	20	18	24	16	26
14	28	14	26	14	22	16	20	18	20						

MCLEAN PORT PACIFIC 154 06/80 YEAR 7

18	20	14	20	16	20	14	20	14	20	14	20	12	18	14	22
20	22	16	24	16	20	14	20	18	22	18	20	16	20	16	20
16	22	20	22	20	22	20	22	20	22	18	20	18	20	20	22
20	22	20	22	20	22	20	22	20	24	20	26	18	24	18	22
18	20	18	20	18	20	18	20	20	22	18	20	18	20	18	20

```
  18  22  18  20  20  22  18  22  18  30  12  28  14  30  16  24
  16  20  16  26  16  24  18  22  18  24  20  22  20  26  20  22
MCLEAN PORT    PACIFIC  155  06/80        YEAR 7
  20  24  20  24  24  26  24  26  24  26  20  22  18  20  20  22
  16  18  16  18  16  18  16  18  18  20  16  18  16  18  18  22
  16  20  16  20  16  20
MCLEAN PORT    PACIFIC  156  07/80        YEAR 7
  18  26  18  26  20  26  12  30  12  26   6  32   4  30   8  26
  14  18  14  20  14  18  14  18  14  18  12  20  14  18  10  22
  10  22  10  20  14  24  10  24  10  22  12  22  12  20  12  20
  14  18  14  18  14  16  14  16  16  18  16  18  14  18  14  18
  14  16  16  18  14  16  14  16  14  16  14  16
MCLEAN PORT    PACIFIC  157  08/80        YEAR 7
  14  18  16  18  16  18  16  30  18  28  18  20  18  26  20  24
  22  24  22  24  24  32  20  32  22  30  22  30  22  26  14  34
  16  34  18  30  20  30  22  26  22  26  20  26  22  26
MCLEAN PORT    PACIFIC  158  08-09/80     YEAR 7
  18  22  20  24  16  26  14  28  12  28  14  26  14  28  12  26
  18  24  18  22  18  20  16  22  20  26  20  24  18  24  18  20
  14  18  14  18  12  20  14  22  14  20  14  20  14  20  12  18
  14  20  14  18  16  20  14  18  14  18  12  18  14  16  16  20
  14  20  14  18  14  18  14  18  12  16  14  20  14  20  14  20
  12  20  14  20
GALLOWAY       ATLANTIC 134  01-02/80     YEAR 7
  18  22  16  28  16  36  10  36  10  30  10  36   8  40  10  36
  14  42  12  40  14  36  10  34   8  32  10  42  14  40  14  38
  12  38  12  36  10  40  12  40  18  40  14  36  16  36  10  40
  14  34  16  36  18  32  18  34  22  28  24  28  24  26  24  28
  24  30  16  20  18  28   8  40   4  42   8  30  10  28   6  38
  12  28  14  28  16  24  18  24  16  24  14  26  20  28  18  34
  14  38  12  38  16  38  12  40  18  36  20  36  18  32  16  36
  10  44   4  56   2  56   2  50   4  54   2  52   8  46  14  42
  14  38   8  44   8  46   2  62   4  48   4  60   6  52   8  46
  12  44  10  42   2  56   0  52   4  40  14  28  16  24  16  24
  20  38  20  36  18  34  16  32  16  34  16  34
GALLOWAY       ATLANTIC 135  02-03/80     YEAR 7
  14  38  16  36  12  36  14  36  14  34  16  32  16  36  20  38
  18  36  14  34  14  34  10  34  12  36  12  36   6  30   8  28
   6  26   4  26  10  34  12  32   8  28  12  30  12  24  14  22
  18  22  20  24  20  24  22  28  18  24  16  24  14  24  16  22
  14  22  16  20  16  22  14  20  14  20  12  22  22  26  22  30
  20  32  20  32  18  32  18  32  20  30  20  28  20  28  18  34
  18  34  12  38  12  38  10  30  12  28   6  40   2  40   2  46
   0  46 -12  72 -12  50  -6  48   0  34   6  28  12  24  14  24
  14  22
GALLOWAY       ATLANTIC 136  03/80        YEAR 7
  14  24  12  24  12  26  16  32  16  20  14  20  16  20  12  22
  12  22   8  20   6  22   2  22   8  24   8  22   8  24   8  20
   6  18   6  18  10  20   8  22   8  22   6  24   6  22   8  22
   8  24   8  26   6  30   4  32   6  32  12  40   8  42   8  42
  12  34  16  22  20  26  22  30  16  28  16  20  18  20  16  18
  14  18  12  22   8  16   8  12   8  10
GALLOWAY       ATLANTIC 137  03/80        YEAR 7
  10  12  10  12   4  20   4  20   4  22   4  20   4  24   6  22
   8  24   8  24  10  20  10  22  10  24  10  20  12  20  12  20
  12  20  12  20  12  20  12  10  10  20  10  18  10  16  10  18
  10  16   4  22   2  24   6  22   4  22   2  18   2  18   0  16
   2  16  -2  18  -4  18  -4  16   2  14   2  12   4  12   6  14
   4  14   6  12   8  12   8  14  14  26  14  30  12  30  14  26
  12  24  10  26   8  20   8  22   8  24   8  28   8  24   8  24
GALLOWAY       ATLANTIC 138  04/80        YEAR 7
```

6	22	6	24	10	26	10	28	6	24	4	24	4	22	4	26
6	26	10	26	12	24	14	24	16	20	16	24	20	24	18	24
18	22	18	22	18	22	16	22	20	24	18	22	18	20	12	20
14	26	20	22	12	24	14	30	16	20	16	22	16	16	16	16
16	18	14	18	12	18	16	20	16	22	14	20	14	20		

GALLOWAY ATLANTIC 139 04/80 YEAR 7

8	18	12	14	12	14	12	14	12	14	10	14	8	18	2	24
0	24	2	20	8	18	6	16	6	16	8	16	8	26	-4	40
-30	56	-8	32	-8	36	-4	32	-2	32	8	20	8	22	12	20
12	22	4	36	6	44	8	28	12	32	14	24	16	24	12	26
20	24	22	26	18	22	16	20	12	24	18	20				

GALLOWAY ATLANTIC 140 04/80 YEAR 7

4	16	8	14	8	16	10	14	8	14	4	14	4	12	6	16
8	14	12	18	14	18	16	20	8	10	8	10	6	8	6	8
10	12	6	8	6	8	6	8	6	10	-2	20	-6	20	0	16
4	16	4	12	6	10	4	6	4	6	2	10	2	10	2	10
4	10	2	10	0	10	0	8	0	8	2	6	4	6	4	6
4	6	4	6	4	6	4	10	6	8	4	8	0	8	0	8
0	8	0	14	2	10	2	8	2	6	2	6	4	6	4	6
2	6	2	6	2	6	2	6	2	6	4	8	4	6	4	8
4	6	2	6												

GALLOWAY ATLANTIC 141 05/80 YEAR 7

4	10	6	8	0	10	6	8	4	8	6	12	8	16	4	16
6	22	10	26	2	20	8	18	4	6	2	8	4	6	4	6
0	10	4	6	4	8	4	6	2	6	4	6	4	6	4	6
0	8	0	8	2	12	0	16	0	14	0	18	4	12	6	12
4	10	8	10	4	14	2	12	0	2	4	2	0	2	-2	2
-2	2	-2	0	-2	0	-2	0	0	2	0	2	2	4	2	4
0	4														

GALLOWAY ATLANTIC 142 06/80 YEAR 7

0	6	-2	4	-2	4	2	8	2	4	2	4	0	6	-2	8
10	16	2	16	2	6	6	8	8	10	8	10	6	8	4	10
2	12	4	12	6	14	8	12	8	10	8	10	8	10	8	12
8	14	8	16	8	12	8	10	8	10	8	10	8	10	10	12
8	10	6	10	8	10	8	10	8	10	8	10	6	10	6	12
6	12	6	12	8	10	8	10	6	12	6	10	8	10	6	10

COMMERCE PACIFIC 131 10/79 YEAR 7

28	32	32	36	20	40	18	42	20	42	18	42	22	42	22	40
24	42	18	42	16	40	16	52	24	40	24	36	24	36	22	38
20	44	22	44	22	44	16	52	14	54	18	48	14	50	20	44
26	38	26	36	28	34	28	32	28	34	28	36	28	36	30	34
30	34	30	36	30	36	28	38	28	38	28	40	26	42	24	42
24	46	20	48	18	52	20	44	20	42	24	36	24	36	24	30
24	32	22	28	28	30	28	30	28	30	26	30	28	30	28	34
28	30	28	30	28	30	26	30	26	34	26	36	24	36	24	36
26	30														

COMMERCE PACIFIC 132 10/79 YEAR 7

26	32	24	34	26	34	24	30	22	32	24	32	18	36	16	40
24	30	24	36	24	48	18	40	16	44	20	44	22	40	16	44
22	40	22	38	16	40	18	44	20	40	20	40	28	34	22	36
16	44	20	46	24	40	28	30	26	28	26	30	28	36	28	36
26	38	24	42	24	40	30	50	30	50	26	42	24	44	24	42
20	40	22	44	24	42	22	40	22	40	20	40	22	40	20	38
20	40	22	38	22	36	20	40	22	38	22	30	22	34	22	38
24	36	24	36	22	31	20	40	22	36	22	36	24	36	24	36
24	36	24	36	26	36	26	36	24	34	24	34	24	36	24	36
24	36	26	36	24	34	22	32	24	36	28	38	24	34		

COMMERCE PACIFIC 133 10-11/79 YEAR 7

26	32	20	40	26	34	26	32	24	34	26	36	28	38	28	40
28	38	28	34	26	38	28	36	28	34	38	42	32	46	32	46
30	40	24	42	20	46	22	44	16	52	16	50	20	46	24	48

28	40	32	40	32	38	32	38	32	38	32	38	30	44	20	58
20	56	24	52	28	46	30	44	32	38	32	36	28	42	22	48
16	56	12	62	16	52	20	48	24	44	26	44	28	36	28	34
30	38	26	40	20	54	16	54	20	54	16	58	20	50		

COMMERCE PACIFIC 134 11/79 YEAR 7

24	44	22	48	18	54	12	62	14	54	20	44	16	48	16	50
20	46	20	46	24	44	22	42	28	40	30	38	30	38	30	36
30	36	22	44	14	58	10	64	14	60	14	54	18	48	20	42
24	38	32	38	28	42	28	40	28	34	28	34	28	30	28	30
28	30	28	32	28	32	28	32	30	32	30	32	26	38	26	36
26	38	26	40	26	42	28	40	36	42	36	42	36	42	38	40
28	32	28	34												

COMMERCE PACIFIC 135 11/79 YEAR 7

22	34	20	36	22	36	24	30	28	42	28	32	28	32	28	32
26	32	28	30	28	30	28	34	18	44	14	50	30	34	32	36
32	40	28	44	26	32	20	40	6	54	14	48	20	38	20	38
20	38	20	40	20	40	20	38	22	36	20	36	22	34	24	36
22	32	24	32	22	32	22	32	22	32	20	30	20	32	20	32
20	34	20	32	18	34	16	36	16	38	18	36	20	38	20	34
20	32	20	32	20	32	18	36	16	40	18	42	16	54	12	50

COMMERCE PACIFIC 136 12/79 YEAR 7

10	50	24	48	28	38	30	32	30	32	30	32	30	32	30	32
30	32	30	32	30	34	28	36	30	34	30	32	30	32	28	32
28	32	30	32	28	34	28	34	30	34	28	30	28	32	30	32
26	32	20	36	22	36	20	34	20	32	22	34	28	36	26	34
26	30	26	28	28	32	26	30	26	30	26	30	26	30	26	30
26	30	24	32	24	34	26	34	24	32	24	32	24	34	24	34
22	36	20	36	20	38	20	40	20	38	20	40	20	40	20	44
20	42	20	40	20	34	20	34	18	36	20	34	22	32	22	30
22	30	20	28	22	28										

COMMERCE PACIFIC 137 01/80 YEAR 7

20	24	20	28	22	28	22	28	22	28	20	26	18	30	16	30
18	32	18	32	20	32	20	34	22	30	20	30	22	32	24	32
26	34	26	30	20	38	28	36	32	36	30	32	28	32	28	32
26	30	30	36	32	38	32	38	32	40	30	38	28	42	30	44
28	44	26	48	22	54	16	56	18	54	18	52	22	54	22	46
20	48	20	50	18	48	20	42	18	54	16	52	22	46	26	46
22	48	24	46	28	46	28	44	28	44	30	44	30	44	28	46
24	48	20	58	18	60	20	52	22	52	26	50	28	48	30	46
28	46	28	44												

COMMERCE PACIFIC 138 01/80 YEAR 7

28	44	26	44	20	46	18	48	18	48	18	48	22	48	20	50
20	42	20	46	16	46	18	42	16	48	16	46	12	52	12	52
2	60	6	52	4	56	6	50	6	50	10	50	12	46	18	40
20	42	24	38	24	36	20	42	18	46	16	52	12	54	12	48
18	48	18	44	22	40	26	36	28	32	28	30	28	32	28	34
28	32	28	32												

COMMERCE PACIFIC 139 02/80 YEAR 7

16	34	8	44	6	48	8	44	10	46	8	54	12	46	14	44
16	36	18	36	16	34	18	30	20	30	18	20	18	24	18	22
20	26	20	28	20	28	20	26	20	28	22	28	22	26	22	24
22	28	22	28	22	28	20	30	22	32	22	32	22	32	8	42
10	44	8	44	8	40	12	48	14	44	14	52	6	46		

COMMERCE PACIFIC 140 02/80 YEAR 7

22	26	22	30	24	26	22	24	26	28	26	28	26	30	24	30
22	30	24	30	24	32	24	32	26	30	24	30	28	34	28	38
26	40	26	38	26	40	26	46	20	46	22	46	20	42	22	44
20	42	16	46	24	32	24	30	20	34	26	32	28	32	28	32
28	32	28	32	28	32	28	32	28	32	30	32	30	34	30	32

COMMERCE PACIFIC 141 03/80 YEAR 7

28	34	28	32	28	30	24	28	24	28	24	28	24	28	24	28

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  24   26   24   26   24   28   22   28   22   26   20   36   22   34   26   30
COMMERCE        PACIFIC   142   03/80        YEAR 7
  14   42    8   56   16   44   20   40   24   38   24   36   24   36   28   36
  28   34   28   36   28   34   28   36   26   36   24   34   22   36   22   38
  22   42   24   36   24   36   24   32   26   32   26   32   26   32   28   32
  28   32   26   32   26   28   26   28   24   26   20   24   20   24   36   56
  32   56   30   62   34   50   32   58   32   58   36   54   34   52   34   50
  36   50   38   50   38   48   36   48   36   52   34   54   34   52   34   52
  10   72   20   64   16   70   22   66   20   76   24   70   30   60   40   52
  38   48   40   48   40   46   42   44   40   48   30   56   28   56   30   58
  18   30   30   52   32   46   34   46   32   46   32   52   34   46   38   44
COMMERCE        PACIFIC   143   04/80        YEAR 7
  30   34   34   40   34   40   34   40   34   42   34   40   36   40   36   40
  36   40   44   50   42   52   40   50   40   44   40   46   42   44   40   42
  40   42   40   42   38   42   38   40   36   44   34   46   24   56   30   38
  30   34   30   34   32   34   32   34   32   34   32   34   28   32   28   36
  30   34   28   36   28   34   26   36   24   36   26   38   24   40   22   40
  24   40   22   44   22   44   20   42   24   44   22   42   28   42   28   40
  26   40   26   40   26   38   24   38   28   38   30   42   28   42   26   36
  26   36   26   38   26   36   26   36   32   40   30   38   28   38   26   38
  26   38   24   42   22   42   26   40   26   40   28   38   28   36   30   38
COMMERCE        PACIFIC   144   04/80        YEAR 7
  32   48   36   42   34   42   40   44   38   46   38   46   32   46   34   44
  30   46   32   46   34   46   34   44   34   44   34   40   40   44   38   44
  34   44   34   44   22   52
COMMERCE        PACIFIC   145   05/80        YEAR 7
  26   44   20   42   16   46   18   46   24   46   18   52   20   48   20   44
  22   44   20   42   20   42   20   38   22   38   20   40   20   44   16   50
  16   46   14   50   18   48   16   52   24   40   24   38   26   34   28   30
  28   30   28   32   20   30   26   34   26   34   20   34   22   36   26   38
  26   32   26   30   28   34   28   34   26   38   24   40   26   36   24   36
  26   36   30   36   30   34   28   32   26   36   20   40   24   44   20   46
  22   46   26   46   22   44   26   36   26   31   26   34   24   34   26   36
  26   36   24   34   26   38   26   34   28   40   28   32   28   30   20   38
  20   38   24   34   28   32   28   32   30   32   24   30   24   30   20   32
  20   32   22   26   24   28   26   30   26   28
COMMERCE        PACIFIC   146   05/80        YEAR 7
  26   30   26   28   26   28   26   28   26   30   26   36   28   32   30   32
  28   34   26   28   26   28   26   28   24   26   24   26   22   24   20   26
  14   30   10   34   12   32   14   32   16   26   18   28   18   30   18   26
  18   28   20   30   20   28   22   28   24   30   26   28   26   26   26   28
  26   28   26   28   26   28   26   28   26   20   26   28   26   26   26   28
  26   26   18   30   20   20   22   26   22   28   22   26   22   26   22   30
  30   34   30   32   32   44   28   40   28   42   28   44   30   46   28   38
  30   38   30   3
COMMERCE        PACIFIC   147   06/80        YEAR 7
  30   32   30   32   30   32   30   32   30   32   30   34   30   34   30   34
  30   34   30   34   28   34   28   36   30   38   32   40   34   40   36   38
  34   38   34   38   34   38   34   36   34   36   28   30   28   30   28   30
  28   30   28   32   30   32   30   32   26   36   26   36   24   36   28   32
  22   24   22   24   24   28   26   28   24   26   20   30
COMMERCE        PACIFIC   148   06/80        YEAR 7
  24   26   24   26   24   26   26   28   24   26   22   26   24   26   22   26
  22   26   24   26   24   26   22   24   22   24
COMMERCE        PACIFIC   149   07/80        YEAR 7
  18   22   18   22   18   22   28   30   28   30   26   28   24   26   24   26
  26   28   24   26   24   26   22   24   20   24   20   22
COMMERCE        PACIFIC   150   07/80        YEAR 7
  28   32   28   30   28   34   28   30   28   30   28   30   28   30   28   30
  28   30   30   32   30   32   30   32   30   32   30   32   32   34   34   36
  34   36   34   36   34   36   34   36   34   32   32   40   32   40   30   44
```

```
  30  40  28  40  28  40  28  40  28  40  26  38  28  36  28  40
  28  38  26  36  26  34  26  34  28  32  28  34  28  34  30  36
  30  32  30  32  30  32
COMMERCE      PACIFIC  151  08/80         YEAR 7
  30  32  32  34  34  36  32  34  34  36  34  36  32  36  30  38
  26  42  24  42  22  40  28  38  28  30  28  38  32  36  28  34
  28  32  28  34  30  32  26  36  26  32  26  30  28  34  28  36
  28  32  30  32  28  32  28  38  26  42  28  38  30  46
COMMERCE      PACIFIC  152  08/80         YEAR 7
  30  42  22  52  12  56  20  44  24  36  26  30
EXCHANGE      PACIFIC  148  11/79         YEAR 7
  32  38  32  38  32  36  30  40  28  40  28  40  30  36  30  34
  30  36  28  40  32  44  30  40  28  40  28  40  28  40  28  38
  28  38  28  38  30  38  30  38  30  38  32  40  32  40  32  40
  30  42  32  40  32  38  32  40  36  42  36  40  32  36  22  48
  20  54  22  50  26  48  20  48  20  52  22  46  16  42  14  52
  20  44  16  44  18  44  24  40  26  36  32  38  34  36  34  38
  32  38  32  38  32  36  32  38  30  36  32  42  38  46  36  40
  40  42  36  44  32  44  38  46  38  52  34  52  32  48  36  44
  36  44  34  44  32  46  34  46  34  48  36  46  32  48  36  44
  26  54  26  54  20  56  26  58  32  48  30  48  34  44  36  40
  36  40  36  40  38  40  36  42  32  44  32  44
EXCHANGE      PACIFIC  149  12/79         YEAR 7
  32  46  30  52  28  50  28  48  30  42  30  44  34  46  34  44
  36  42  36  42  36  40  36  42  32  48  28  54  28  54  32  46
  34  44  34  42  36  42  36  44  36  42  36  42  36  40  36  40
  36  40  36  38  38  40  38  40  34  42  36  42  36  42  34  42
  36  42  36  42  38  44  38  42  34  44  38  40  32  36  36  42
  34  46  38  42  36  48  36  46  34  44  36  42  30  38
EXCHANGE      PACIFIC  150  12/79         YEAR 7
  32  44  32  44  26  42  26  42  28  40  28  40  28  42  30  44
  28  42  28  42  28  42  26  40  28  42  26  40  24  48  22  48
  20  56  16  54  22  48  18  52  18  50  18  54  18  56  20  56
  20  62  18  66  16  58  16  60  14  62  14  60  18  58  22  54
  20  52  24  46  20  48  24  48  28  54  30  52  28  46  24  46
  20  50  18  46  24  52  28  46  30  40  34  36  20  42  18  58
  20  50  20  46  32  42  34  38  30  38  30  40  28  40  30  40
  32  40  38  40  36  40  36  40  36  44  36  44
EXCHANGE      PACIFIC  151  01/80         YEAR 7
  32  48  36  42  34  50  36  50  36  52  36  48  32  52  36  48
  38  46  36  46  36  48  34  48  36  50  34  50  36  50  36  48
  36  46  38  44  40  44  40  44  38  44  38  42  38  44  36  44
  36  48  34  48  38  44  36  48  36  48  30  54  28  56  30  58
  32  52  32  52  34  52  34  48  32  50  34  48  34  48  34  52
  36  48  36  48  36  44  36  44  36  46  36  48  38  46  40  46
  36  48  38  48  36  42  34  44  34  42  34  38  34  36  38  40
  36  44  38  42  40  42
EXCHANGE      PACIFIC  152  01/80         YEAR 7
  40  42  40  42  38  42  36  42  30  44  34  42  36  44  40  48
  42  44  38  44  38  46  36  48  36  44  38  42  34  40  36  42
  38  40  38  40  38  40  38  40  42  44  36  40  36  40  36  40
  34  38  32  40  30  40  28  42  24  46  26  40  30  48  30  48
  30  44  30  42  26  42  28  40  32  46  30  48  28  44  28  44
  26  42  28  46  32  48
EXCHANGE      PACIFIC  153  02/80         YEAR 7
  30  48  28  46  26  52  24  46  24  56  28  60  28  56  24  52
  26  46  24  46  22  46  22  46  22  50  20  48  20  52  24  46
  24  52  28  52  28  52  30  48  28  48  26  48  28  46  26  46
  20  50  22  40  26  46  28  42  34  36  28  44  30  40  32  38
  32  36  32  36  32  36  34  36  32  34  32  34  32  40  34  40
  36  38  32  36  36  48  28  50  30  56  28  48
```

EXCHANGE PACIFIC 154 02/80 YEAR 7

38	56	36	50	34	48	32	48	36	48	36	44	36	46	36	48
32	50	32	52	32	54	34	50	32	52	30	52	28	58	28	56
28	56	28	56	28	54	30	50	30	48	28	52	28	56	38	40
38	40	36	44	34	44	32	44	36	42	36	40	36	40	36	42
20	62	34	42	32	46	36	40	34	42	32	42	34	40	32	42

TRADE PACIFIC 155 10/79 YEAR 7

102	116	96	116	98	108	96	110	96	108	95	105	96	102	98	102
94	110	90	112	86	116	84	120	92	112	88	120	90	116	92	116
90	120	95	111	92	112	94	114	92	118	91	117	92	122	95	111
96	110	98	108	98	106	94	110	90	110	92	110	94	108	96	106
98	106	94	106	92	114	88	122	82	122	74	132	62	142	86	124
92	116	94	110	97	109	99	107	99	107	98	104	99	103	98	100
93	99	93	99	94	98	96	98	96	98	98	100	98	100	98	100
97	101	97	101	98	100	98	100	98	100	100	102	97	103	96	104
96	110	98	106	97	99	97	99	97	99	97	99	97	99	93	95
92	94	92	94	92	94	90	94	90	94	89	93				

TRADE PACIFIC 156 11/79 YEAR 7

90	98	94	96	92	94	90	96	89	95	86	96	87	101	82	116
82	110	86	100	86	107	86	92	90	98	90	96	88	96	90	98
89	99	89	101	88	102	91	101	91	101	90	100	91	101	91	101
92	102	92	102	92	100	92	100	91	99	91	99	90	100	94	104
92	104	89	103	85	103	86	102	90	100	94	98	94	96	92	94
95	101	96	100	94	100	94	100	97	105	99	105	98	102	98	104
96	104	102	106	100	106	98	104	98	104	94	114	96	108	96	108
96	106	96	106	96	106	95	105	94	106	90	110	92	110	92	106
94	108	94	108	92	108	89	111	88	110	86	120	80	120	83	117
72	130	74	134	74	130	78	124	82	118	86	114	92	112		

TRADE PACIFIC 157 11/79 YEAR 7

94	110	95	105	96	104	97	105	96	103	86	114	92	114	96	110
98	108	99	105	100	108	99	109	98	110	92	116	94	116	94	118
92	120	95	115	96	118	96	120	98	114	100	114	98	114	98	116
99	114	100	112	96	104	96	104	96	102	88	98	86	100	86	102
88	98	86	100	86	102	86	102	88	96	85	98	90	98	90	98
94	104	94	98	92	102	96	104	94	102	93	99	97	107	97	107
98	108	99	107	94	106	96	104	95	103	98	102	98	102	98	104
100	104	99	103	97	101	96	100								

TRADE PACIFIC 158 12/79 YEAR 7

92	98	91	99	94	98	91	95	89	95	91	93	90	94	90	94
89	95	88	96	88	94	88	96	88	96	88	96	89	96	88	96
86	98	82	100	83	101	78	108	78	106	74	110	62	102	82	102
86	98	88	100	88	98	86	100	86	100	86	100	86	102	86	102
86	104	88	100	88	98	88	96	89	97	88	100	89	99	88	100
89	101	96	100	89	101	90	102	88	102	87	101	94	96	94	98
94	102	94	104	94	106	96	106	98	104	95	102	98	100	94	100
96	102														

TRADE PACIFIC 159 12/79 YEAR 7

94	106	91	111	92	110	89	105	91	121	87	125	86	120	86	120
90	118	83	121	86	128	84	126	84	128	84	120	62	148	59	145
74	128	76	120	80	112	87	115	91	105	88	114	81	117	74	126
75	123	74	124	76	122	78	118	78	124	74	138	76	130	78	120
84	114	80	116	80	116	82	112	88	114	94	108	94	104	95	105
93	113	93	111	92	112	90	110	82	130	82	122	72	136	82	120
80	120	82	116	87	113	82	120	76	128	82	122	86	116	96	108
98	104	98	104	84	110	92	114	94	112	95	111				

TRADE PACIFIC 160 01/80 YEAR 7

90	114	91	113	90	110	96	104	99	103	100	104	100	104	100	104
98	106	98	106	98	106	100	106	102	104	98	104	100	104	101	103
99	105	98	104	98	108	98	102	94	98	86	104	84	106	84	98
93	103	94	104	98	104	97	103	96	102	96	102	97	101	97	101
94	102	94	100	95	97	94	98	88	96	92	96				

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TRADE          PACIFIC  161  01/80          YEAR 7
 88  102   86  104   84  106   82  112   80  112   81  107   78  110   77  113
 70  114   76  114   78  112   78  114   76  114   76  112   84  114   84  110
 64  110   66  104
TRADE          PACIFIC  162  01/80          YEAR 7
  6   24    4   26    4   28    6   30    4   26    6   28    6   24    8   26
 10   28    8   24    8   20   10   18   10   14   16   24   18   22   18   22
 18   22   18   22   16   20   16   22   12   24   20   28   20   26   18   22
 16   20   18   20   18   20   18   24   16   24   16   26   10   22   14   22
 12   24   12   24   14   24   12   22   12   24   12   22   12   22   12   20
 12   20   12   20   12   18   12   18   12   20   12   20   10   22   10   20
 10   20   10   20   10   22   10   20   12   18   12   18    8   22    4   24
  6   22   12   20   10   24   12   22   10   24   10   28    8   26    4   30
 -4   50    2   42    4   36    0   36    2   38    2   40    4   40    0   46
  0   44   -4   52   -4   48    4   42   12   30   12   30   16   26   16   26
 16   24
TRADE          PACIFIC  163  02/80          YEAR 7
 18   20   18   22   16   22   16   20   18   20   16   18   16   18   16   18
 16   22   18   22   16   22   14   24    6   24   10   26   16   40   16   20
 18   26   18   28   18   24   16   24   16   34   12   26   10   26   14   18
  8   30    8   24    8   20   10   22   10   18   12   18   12   18   12   16
 10   18    6   20    8   24    4   26    8   24    6   26    8   26    6   24
 10   24    8   22    8   22    8   24    6   24    0   28    0   34   -4   40
 -2   40   -4   42   -4   44    0   38   -4   36    4   36    4   34    4   28
  2   30    8   30   12   32   10   30
TRADE          PACIFIC  164  02-03/80       YEAR 7
  8   24    8   24    8   22    8   24   12   22   12   24   12   20   10   20
 10   16   10   20   -2   32   -6   40    4   24    6   24    8   24   10   24
 12   20   12   22   16   20   16   18   14   20   12   20   12   24   10   24
 12   24   14   24   10   22   12   22   12   26   14   22   14   20   12   20
 12   24    8   30    8   32    6   32   10   28   16   28   18   28   14   30
 12   36   12   40   12   36   12   32   14   32   16   32   16   26   16   26
 14   28   12   34    8   36    4   42   10   38   12   36   10   32    8   36
  8   40   12   30   12   28   14   24   14   26   12   26   12   28    8   34
  6   38    8   30   14   28   16   24   16   24   16   24   14   26   14   24
 16   26
TRADE          PACIFIC  165  03/80          YEAR 7
 14   28   16   28   16   26   16   24   18   20   18   20   20   22   14   30
 12   32   12   32   12   28   10   34   12   32    4   44   10   36   16   26
 14   30   18   24   10   14    8   12   10   14   12   16   12   14   10   14
 12   14   12   14   12   14   12   14   10   18   10   20   12   16   12   14
 10   12   10   12   10   12   18   20   16   20   14   18   16   30   16   20
 16   20   18   22   18   20
TRADE          PACIFIC  166  03/80          YEAR 7
 16   20   18   22   14   22   20   22   10   24   10   24   12   22   14   16
 12   26   12   24   12   24   12   24   12   28   12   24   12   22   12   24
 12   24   10   24   12   26   10   26    8   26    6   26    4   28    6   30
 10   34   12   30    8   32    8   28    8   26    8   34   12   34    8   36
  8   30    8   30    8   28   10   32   14   34    8   30    8   26    6   26
  4   24    8   28   12   30   10   24   10   24    8   20    6   14    8   24
 12   20   12   20   12   20
TRADE          PACIFIC  167  04/80          YEAR 7
 10   28   14   30   12   30   12   28   10   24   10   28   18   24   16   22
 12   24   12   20   12   22   12   30   -2   46   -4   42   -6   44    0   40
  2   38   -2   40    2   34    2   30    6   32    8   26    4   34   10   28
 -4   40   -6   44   -4   44    0   40    4   36    8   36   10   36   12   30
 14   28   12   36    0   46    6   36    4   42   12   34   10   32   12   32
 16   28   16   24   18   28
TRADE          PACIFIC  168  09/80          YEAR 7
 16   24   16   28   16   26   10   30    8   32    4   36    2   36    2   46
 -4   48    0   46   -2   44    2   38    2   40    4   42   14   34   16   28
```

16	28	16	26	18	22	16	20	18	22	16	18	14	16	14	16
14	20	16	22	18	22	16	20	12	18	10	22	12	26	16	22
14	24	12	24	12	24	4	26	6	30	10	24	12	26	16	24
16	22	18	24	18	24	18	24	20	24	20	24	20	24	20	24
20	24	22	24	22	24	20	22	20	22	20	24	18	26	16	26
14	34	10	34	12	32	6	34	12	42	12	42	10	36	10	34
8	34	10	32	14	30	18	32	16	20	20	26	20	24	18	22
18	20	16	22												

FINANCE PACIFIC 134 10/79 YEAR 7

78	80	77	85	78	80	79	81	79	81	75	83	78	84	76	82
77	81	78	80	76	82	78	80	75	85	74	86	70	96	68	96
64	98	64	100	60	108	64	102	70	92	72	92	66	100	54	120
51	103	58	108	58	108	70	88	66	92	74	92	76	88	70	96
62	100	63	99	67	101	67	96	78	92	76	90	76	90	77	87
77	87	77	87	78	86	78	86	78	86	78	84	77	83	78	84
77	81	79	81	79	81	79	81	78	82	78	82	77	83	82	84
82	84	82	84	82	84	80	84	82	84	82	84	82	84	85	87

FINANCE PACIFIC 135 11/79 YEAR 7

74	82	73	89	78	80	75	81	75	83	76	80	76	76	77	79
77	79	77	79	75	77	75	77	74	78	70	74	71	75	72	74
72	76	72	76	74	80	72	80	71	77	72	78	71	77	71	81
73	81	72	78	72	76	72	78	70	78	74	80	74	80	74	76
74	76	73	75	73	75	73	75	73	75	73	75	72	76	73	75
71	79	70	80	70	80	68	82	65	85	65	83	65	85	65	85
68	82	70	80	69	79	69	77	70	80	73	75	72	76	71	77
71	75	74	88	77	85	76	86	76	80	76	88	76	86	75	87
77	87	75	87	32	92	80	90	78	84						

FINANCE PACIFIC 136 11/79 YEAR 7

74	80	74	80	72	80	66	86	72	96	66	92	72	88	72	88
74	86	76	84	76	84	76	84	74	84	78	86	78	84	78	86
76	86	74	88	76	88	72	88	64	94	62	104	60	96	62	92
66	94	70	96	62	102	60	108	63	99	64	96	56	92	74	90
76	86	77	83	77	83	78	82	78	82	78	82	78	82	76	84
74	86	76	90	71	89	70	92	74	94	76	90	76	86	76	90
76	90	78	92	71	98	77	89	76	86	78	82	74	80	72	80
73	79	73	79	73	77	74	78								

FINANCE PACIFIC 137 12/79 YEAR 7

76	78	74	74	72	80	74	80	76	80	76	82	77	83	77	81
77	81	60	80	62	88	68	84	60	84	62	84	71	81	72	80
70	80	70	82	70	80	74	78	70	78	66	82	58	86	56	94
56	96	58	92	55	91	60	84	59	85	64	86	64	86	60	86
60	88	52	82	58	86	58	86	56	90	56	90				

FINANCE PACIFIC 138 12/79 YEAR 7

52	92	56	88	52	88	64	84	64	88	66	82	66	80	64	80
68	82	68	84	66	82	62	82	66	82	62	86	56	86	62	90
60	90	62	92	60	88	62	92	69	92	68	88	68	86	66	82
70	80	62	88	64	86	68	82	70	78	70	78	68	80	69	81
65	81	70	84	72	85	72	80	74	80	82	84	72	94	73	83
76	90	74	92	70	88	68	82								

FINANCE PACIFIC 139 01/80 YEAR 7

68	94	68	96	60	108	60	110	60	100	60	104	58	106	64	96
66	92	72	92	74	84	75	85	76	86	76	86	76	86	78	90
78	86	77	87	76	88	76	88	74	90	68	104	68	106	72	92
78	94	72	94	72	94	62	104	54	108	56	102	56	106	58	98
56	104	62	98	64	96	64	92	68	92	72	90	74	86	72	88
64	94	66	92	76	96										

FINANCE PACIFIC 140 01-02/80 YEAR 7

36	48	32	50	32	48	32	50	32	52	32	52	36	48	36	46
36	46	30	50	22	52	24	52	20	52	24	52	26	50	26	52
32	56	34	56	24	52	24	50	28	50	26	48	30	50	26	50
30	48	24	50	20	52	16	54	18	54	16	52	20	52	20	50

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  24   52   20   68   24   58   30   50   34   48   36   44   38   46   36   40
  34   44   36   44   36   44   36   40   36   40   36   40   34   40   40   44
  40   44   38   48   44   50   44   50   34   62   36   52   34   60   32   64
  34   58   36   56   36   56   34   56   36   54   36   56   36   56   34   56
  30   58   32   60   32   58   34   58   34   56   38   52   38   50   38   48
  40   44   40   44   40   44   40   44   40   44   40   44   40   44   40   44
  40   40   38   50   32   58   32   58   30   60   34   52   32   52   32   52
  38   50   36   50   38   50   40   50   42   48   42   48   42   50   42   50
  42   50   42   50   44   50   44   48
FINANCE        PACIFIC  141  02/80         YEAR  7
  36   40   34   40   36   42   40   42   40   42   40   42   40   44   40   44
  42   46   40   52   40   56   28   48   40   46   40   48   40   46   40   44
  36   40   38   42   36   42   34   40   36   40   34   40   34   42   36   40
  36   40   36   38   36   40   36   42   36   44   32   46   30   46   26   48
  26   48   20   52   20   54   26   48   26   44   26   42   28   44   24   46
  26   48   28   52   28   50   24   48   22   50   22   52   24   58   26   58
  24   56
FINANCE        PACIFIC  142  03/80         YEAR  7
  26   54   24   52   24   58   28   60   28   56   28   54   28   52   32   48
  34   48   34   46   36   44   34   40   36   40   34   38   34   40   32   40
  32   40   32   40   32   38   32   36   34   40   36   38   36   36   36   40
  36   40   40   46   40   46   40   44   40   40   36   44   40   46   42   52
  32   64   32   64   36   50   40   52   40   50   36   48   32   52   36   50
  36   50   36   50   38   48   40   48   40   48   40   48   40   46   40   52
  40   50   40   48   40   52   40   50   42   50   44   50   44   50   44   50
  44   50   44   52   44   52
FINANCE        PACIFIC  143  03/80         YEAR  7
  44   52   44   52   44   52   44   52   48   50   40   46   40   50   36   56
  32   62   28   62   30   62   32   56   28   62   24   62   32   56   30   56
  36   50   38   44   28   64   18   78   24   70   22   60   24   66   30   58
  36   54   36   58   40   52   42   48   44   48   44   48   40   42   38   42
  36   38   36   38   32   38   32   36   34   36   34   38   34   36   34   38
  36   40   36   40   36   40   36   40   38   40   40   44   40   46   40   44
  36   46
FINANCE        PACIFIC  144  04/80         YEAR  7
  30   56   30   54   34   48   34   36   36   38   36   42   34   36   34   38
  36   38   34   38   34   36   34   36   36   36   34   38   36   40   38   42
  36   40   36   40   34   38   32   38   36   42   36   44   34   40   34   38
  30   40   30   40   30   40   30   40   30   38   30   38   30   36   30   40
  30   38   30   38   28   38   28   40   28   42   26   42   30   46   28   48
  28   46   28   44   24   42   28   48   26   50   28   40   28   42   30   40
  32   40
FINANCE        PACIFIC  145  09/80         YEAR  7
  32   40   32   42   34   40   32   38   32   40   32   38   42   46   30   64
  42   48   40   50   40   50   40   50
FINANCE        PACIFIC  146  09/80         YEAR  7
   0   36    6   16    8   10    8   12    0   16
MARKET         ATLANTIC 125  09/79         YEAR  7
  10   22   14   24   12   22   12   22   10   20   12   22   15   23   13   21
  12   20   12   18   12   16   11   17   14   18   12   18   10   18    8   18
   8   18   12   20   14   22   12   20   11   19    9   23    8   24   16   26
  16   28   14   26   12   28    8   26    8   32   10   40   10   40   10   38
   6   38    5   35    8   40   16   42   19   35   22   28   19   29   16   26
  14   24   13   17   12   16   13   15
MARKET         ATLANTIC 126  10/79         YEAR  7
  10   14   14   20   12   18   16   28   10   34   14   34   16   30   16   34
  16   32   18   28   18   28   16   30   14   30   16   24   18   24   17   25
  17   21   16   22   16   20   12   20   13   19   12   16   10   16    9   15
   6   18    7   17    8   16    9   15   10   16   24   28   21   29   19   25
  18   26   19   21   20   22   21   25   21   25   22   24   21   25   16   24
  18   28   18   28   16   26   16   26   14   26   14   26   18   26
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MARKET          ATLANTIC 127  10/79          YEAR 7
  16   26   14   28   13   27   12   24    8   24    8   28    5   31    6   28
   6   24    8   20   10   22   20   26   16   26   16   22   16   20   12   16
  10   14    9   13   10   18   12   18   12   18   10   20   10   16    6   20
   7   23   16   18   16   18   16   20
MARKET          ATLANTIC 128  11/79          YEAR 7
  16   20   16   20   15   19   12   20   12   18   12   16    8   14    6   16
   6   16    4   16    6   16    6   16    8   16    9   13   10   12   10   14
  10   12   12   14   12   14   12   14   12   14   10   12   10   16   16   20
  14   18   12   16   14   16   11   15   14   18
MARKET          ATLANTIC 129  11/79          YEAR 7
  14   20   12   22   10   22   10   22   10   20   10   20   12   20   12   18
  10   18   12   21   11   19   10   20    8   20    7   21    6   26    4   26
   6   24    6   26    8   32    8   28   14   22   16   20   16   20
MARKET          ATLANTIC 130  12/79          YEAR 7
  14   22   11   27   12   28   16   26   18   26   18   22   19   21   18   20
  12   18   10   14   10   16   12   16   12   16   14   16   14   16   12   18
  13   19   12   14   12   16   12   18   10   20   10   20   14   16   12   14
  12   14
MARKET          ATLANTIC 131  12/79-02/80    YEAR 7
  12   14   13   15   12   16   12   16   14   16   15   19   12   26   10   32
  12   28   12   26   14   26   16   20   14   20   12   20    8   20   14   24
  12   20   10   22    6   26   10   24   10   24   12   22   12   28    8   28
  10   28   10   28    6   30    4   34    2   36    4   34    1   33    4   34
   6   28   10   28   10   24    6   28    2   28    4   30
MARKET          ATLANTIC 132  02/80          YEAR 7
   2   34    8   38    7   29    8   24   11   23   12   20   14   20   14   20
  18   20   16   20
MARKET          ATLANTIC 133  02/80          YEAR 7
  22   30   18   30   18   22   24   26   24   26   24   26   22   26   20   24
  20   24   20   26   18   22   24   30   24   28   20   28   20   26   18   26
  16   24   18   22   18   28   20   26   20   26   16   24   16   24   20   30
  20   26   18   22   16   24   16   24   16   20   20   28   22   24   22   26
  26   30
MARKET          ATLANTIC 134  03/80          YEAR 7
  22   24   22   26   22   26   22   30   22   32   20   32   22   30   22   32
  22   30   22   26   22   24   22   24   22   24   22   24   12   24   14   34
   6   50   10   38   16   26   12   26    2   40   14   30   10   32   10   44
MARKET          ATLANTIC 135  04/80          YEAR 7
  24   32   28   34   28   34   30   32   32   34   26   36   24   38
MARKET          ATLANTIC 136  04/80          YEAR 7
  28   32   22   36   20   32   20   32   24   28   18   22
MARKET          ATLANTIC 137  05/80          YEAR 7
  24   28   24   30   10   40   16   40   10   50
MARKET          ATLANTIC 138  05/80          YEAR 7
   4   54    6   42    8   38   16   36   20   30   20   28   16   26   18   26
  24   32   24   32   20   30   26   36   24   38   24   36   24   34   22   40
  24   34   24   30   26   30   28   30   24   26
MARKET          ATLANTIC 139  06/80          YEAR 7
  24   26   20   28   22   26   22   26   20   32   14   38   14   42   18   34
  20   32   26   30   24   30   24   30   24   28   22   28
RESOURCE        ATLANTIC  90  11/79          YEAR 7
  30   34   26   34   24   32   24   28   24   30   24   32   22   30   22   34
  24   34   24   36   20   32   24   42   22   42   22   40   16   40   18   46
  20   48   20   46   20   48   20   44   26   30   32   38   32   40   24   36
  24   28   24   26   24   26   22   24   24   30   22   30   18   34   18   30
  22   30   20   32   20   26   22   24   22   24   22   24   22   26   20   28
  20   30   20   32
RESOURCE        ATLANTIC  91  03/80          YEAR 7
  26   42   20   50   20   54   30   46   32   52   28   52   28   46   22   64
  20   62   26   48   24   52   26   52   22   56   20   52   26   50   24   50
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24	48	20	54	12	70	10	60	16	52	16	50	20	50	12	58
14	58	22	52	26	44	28	40	28	44	28	40	24	46	24	46
24	44	24	44	22	46	22	44	28	48	36	48	32	46	32	34
32	36	34	44	34	40	40	48	34	42	34	54	36	56	40	52
42	54	40	48	38	44	36	44	40	42	34	40	32	54	24	60
38	40	36	40	36	38	32	38	36	42	32	40	32	36	32	38
30	40	30	40	32	40	30	40	26	38	28	38	26	36	26	38
24	36	24	38	26	36	26	36	20	36	24	36	24	36	26	34
26	34	26	32	26	32	28	36	28	36	28	34	28	34	28	34
28	34	30	36	28	40	28	44	30	44	28	44				

RESOURCE ATLANTIC 92 04/80 YEAR 7

36	48	38	50	38	44	36	48	36	50	36	40	38	38	36	38
36	38	34	36	32	36	32	36	30	34	26	38	24	36	24	42
28	46	24	48	20	48	20	48	18	48	22	40	24	36	28	38
28	34	32	36	28	34	30	38	32	40	30	38	32	36	32	36
30	36	32	40	36	40	36	40	34	36	38	40	30	58	18	78
24	60	22	58	36	48	38	42	30	34	30	32	28	32	28	34
26	36	24	34	24	32										

RESOURCE ATLANTIC 93 04-05/80 YEAR 7

26	32	26	28	20	36	16	38	22	34	24	32	20	36	18	38
18	38	24	32	26	32	30	32	30	32	30	34	28	34	32	36
32	36	32	36	34	40	34	38	36	38	32	42	28	44	24	44
28	44	28	40	28	40	30	36	28	34	28	32	26	32	24	34
24	42	24	40	22	40	20	44	20	42	20	44	20	44	26	44
28	40	28	36	28	36	28	40	32	44	34	44	34	42	32	44
32	40	34	46	40	48	38	46	38	44	36	44	36	46	36	44
36	42	38	40	36	38	36	42	36	44	36	44	26	36	30	34

RESOURCE ATLANTIC 94 05/80 YEAR 7

32	38	36	38	36	38	36	44	38	42	36	40	36	40	36	40
36	40	40	40	32	34	30	34	28	34	28	34	24	36	24	32
26	30	28	30	28	30	24	36	24	40	20	46	22	44	28	38
32	36	34	36	28	48	30	50	32	50	36	40	38	44	36	40
36	42	30	46	32	46	30	48	36	40	36	38				

RESOURCE ATLANTIC 95 05/80 YEAR 7

24	26	24	26	26	28	26	28	26	28	26	26	26	30	28	32
30	34	30	34	30	34	30	34	30	36	30	38	32	40	32	36
32	36	34	36	32	38	32	40	32	42	30	42	30	40	28	36
28	36	32	36	30	38	28	36	28	34	28	32	34	36	38	42

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Maritime Transportation Research Board
National Academy of Sciences - National Research Council

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The SR-1245 *ad hoc* PROJECT ADVISORY COMMITTEE provided the liaison technical guidance, and reviewed the project reports with the investigator.

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SHIP STRUCTURE COMMITTEE PUBLICATIONS

These documents are distributed by the National Technical Information Service, Springfield, VA 22314. These documents have been announced in the Clearinghouse Journal U. S. Government Research & Development Reports (USGRDR) under the indicated AD numbers.

SSC-300, *Summary of Nondestructive Inspection Standards for Heavy Section Castings, Forgings, and Weldments* by R. A. Youshaw. 1980. AD-A099119.

SSC-301, *Probabilistic Structural Analysis of Ship Hull Longitudinal Strength* by J. C. Daidola and N. S. Basar. 1981. AD-A099118.

SSC-302, *Computer-Aided Preliminary Ship Structural Design* by A. E. Marsow and A. Thayamballi. 1981. AD-A099113.

SSC-303, *Fatigue and Fracture Toughness Characterization of SAW and SMA A537 Class I Ship Steel Weldments* by J. F. Souak, J. W. Caldwell, and A. K. Shoemaker. 1981.

SSC-304, *SL-7 Extreme Stress Data Collection and Reduction* by E. T. Booth. 1981.

SSC-305, *Investigation of Steels for Improved Weldability in Ship Construction - Phase II* by B. G. Reisdorf and W. F. Domis. 1981.

SSC-306, *Experimental Program for the Determination of Hull Structural Damping Coefficients* by P. Y. Chang and T. P. Carroll. 1981.

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