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FIRST SEASON RESULTS FROM SHIP RESPONSE INSTRUMENTATION ABOARD --ETC(U)

SEP 76 R R BOENTGEN, R A FAIN, J W WHEATON

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(SL-7-8)

FIRST SEASON RESULTS FROM

SHIP RESPONSE INSTRUMENTATION

AROUND THE S-7 CLASS CONTAMINATOR

U.S. NAVY AND BUREAU OF NORTH ATLANTIC OCEAN

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REPORT OF THE NATIONAL SCIENCE FOUNDATION
ON THE PROGRESS OF THE
ATLANTIC OCEANIC SURVEY
IN 1973

REPORT NUMBER
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The report contains a portion of the data with a preliminary discussion and evaluation of the first season of data collection from 8 October 1972 to 5 April 1973. Similar reports on the second season and third seasons of data collection have been published and are available through the National Technical Information Service. Please refer to the outside rear cover for ordering information on those two documents numbered SL-7-9 and SL-7-10.

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This report contains a portion of the data with a preliminary discussion and evaluation of the first season of data collection from 8 October 1972 to 5 April 1973. Similar reports on the second season and third seasons of data collection have been published and are available through the National Technical Information Service. Please refer to the outside rear cover for ordering information on those two documents numbered SL-7-9 and SL-7-10.

SSC-264

(SL-7-8)

Technical Report

on

Project SR-211, "SL-7 Data Collection"

FIRST SEASON RESULTS FROM SHIP RESPONSE INSTRUMENTATION
ABOARD THE SL-7 CLASS CONTAINERSHIP
S.S. SEA-LAND McLEAN IN NORTH ATLANTIC SERVICE

by

R. R. Boentgen, R. A. Fain, and J. W. Wheaton

Teledyne Materials Research

under

Department of the Navy
Naval Ship Engineering Center
Contract No. N00024-73-C-5059



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U. S. Coast Guard headquarters
Washington, D.C.
1976

ABSTRACT

This report contains data, with appropriate evaluation and discussions, collected during the first season on board the S.S. SEA-LAND McLEAN. Data collection began with westbound Voyage 1 on October 8, 1972 and terminated with the eastbound passage of Voyage 12 on April 5, 1973. A total of 80 data tapes were recorded containing in excess of 50,000 separate data intervals from more than 100 transducers.

Discussions include a description of the digitized data, comparisons of stresses with sea state, simultaneous response data from all transducers during selected portions of a rough voyage, and a consideration of torsional responses.

The reports from the second and third data-collection seasons are not being published in the Ship Structure Committee series of reports but they are available through the National Technical Information Service under the following titles.

SL-7-9 - *Second Season Results From Ship Response Instrumentation Aboard The SL-7 Class Containership S.S. SEA-LAND McLEAN In North Atlantic Service. 1976. AD-A034162.*

SL-7-10- *Third Season Results From Ship Response Instrumentation Aboard The SL-7 Class Containership S.S. SEA-LAND McLEAN In North Atlantic Service. 1976. AD-A034175.*

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I. INTRODUCTION

The S.S. SEA-LAND McLEAN is the first of the new SL-7 class of high-speed container ships. Salient particulars of the vessel are given in Table I, and the vessel is shown in Figure 1. A multifaceted program of analysis and experiments, coordinated by the SL-7 Program Advisory Committee of the National Academy of Sciences--National Research Council, has been instituted to study this ship's structure and its responses to imposed loading. One important facet of this program is the collection of data on structural and dynamic responses of the actual (i.e., full scale) ship's structure. This is being accomplished by an on-board instrumentation system with sensors located throughout the vessel measuring strains, stresses, accelerations, various sea characteristics and ship operating parameters (see Reference 1). Presented in this report is a cross-section and summary of the data gathered during the first season of operation on North Atlantic Voyages 1-12 during the period 8 October 1972 to 5 April 1973.

Collection of full-scale data is necessary from a number of standpoints. Any predictions resulting from mathematical analyses or experimental models must accurately characterize the actual structure, or must be correctable, in a known way, to correlate the technique to the actual structure. Full-scale data, properly interpreted, provides the criterion against which all predictive techniques of structural response must be judged. A second but equally important use of full-scale data is to provide the input loads which form the basis of the rational design. Such load criteria can be gathered directly from a characterization of observed service conditions, such as wind and wave probability distributions, or inferred from the response of the vessel to the combination of these conditions. The latter scheme requires a knowledge of the structure's input-output or transfer function which again can be provided by adequate full-scale data describing loads and responses. In sum, full-scale data provides three indispensable parts of rational design: input loads, responses, and the derived characteristics of the link between the two.

Since different aspects of the full-scale data are of interest to different investigators, no summary can provide an exhaustive or even adequate characterization of all the gathered data. Indeed, the basic form of the data, analog or digital records on magnetic tape, is not reproducible here. The objective of this report, therefore, is to document the quantity, limits, and formats of the data now available and to present a cross-section and summary of it in a few of the forms most obviously useful to investigators. As a further aid to those interested, a description is given of some further possible data summary characterization and analysis schemes, along with their relative costs.

II. INSTRUMENTATION SYSTEM

The shipboard instrumentation system is described in detail in Reference 1; therefore, no attempt will be made in this report to duplicate that information. Rather, a brief description of the important features, with special emphasis on the data flow, will be presented as a convenient summary.

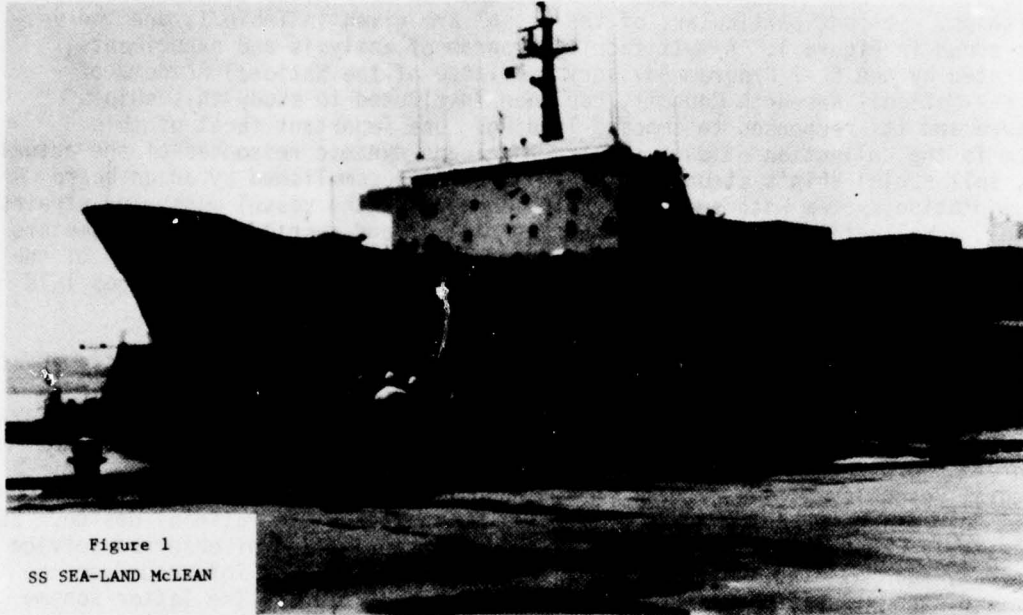


Figure 1
SS SEA-LAND McLEAN

TABLE I
CHARACTERISTICS OF S.S. SEA-LAND McLEAN

Name:	SEA-LAND McLEAN
Builder:	Rotterdam Dry Dock (Hull 330)
Class:	SL-7 Containership
Length, overall	946' 1 1/2"
Length, between perpendiculars	880' 6"
Beam, molded	105' 6"
Depth to main deck, forward	64' 0"
Depth to main deck, aft	68' 6"
Draft, design	30' 0"
Draft, scantling	34' 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

	<u>Container Capacity</u>		
	<u>8' x 8.5' x 35'</u>	<u>8' x 8.5' x 40'</u>	<u>Total</u>
Below deck	554	140	694
Above deck	342	60	402
TOTAL	896	200	1,096

A. Shipboard

All of the information obtained from the various transducers located throughout the vessel is recorded on two 14-track analog FM tape recorders located in the instrumentation room. Recorder No. 1, designated the primary recorder, records the same 13 signals whenever it is placed in operation. The fourteenth channel is used as a noise compensation channel during reproduction.

The second recorder has its first thirteen channels switched through four modes, designated A, B, C, and D. Each mode is recorded for thirty minutes sequentially. Channel 14 is again used as a compensation channel in all modes. Each 30-minute period is a data "interval", and is assigned an interval number. Any particular segment of data can thus be identified by referring to the following nomenclature.

1. Tape number--(All odd numbers are from No. 1 Recorder and all even numbers are from Recorder No. 2).
2. Voyage number and direction (E = East, W = West).
3. Index number (sequential numbering of each four-hour log-book entry accompanying each data tape).
4. Channel number and mode letter (Recorder No. 2 only)
5. Interval number.

Thus, by specifying "Tape No. 1, Voyage 1-W, Index 1, Channel 1-A, Interval 1" a very specific 30-minute data interval is identified. A complete summary of the signal assignments is provided in Table II. This presentation is in the same format used in Reference 1. Table III contains a list of sensor and signal abbreviations used in Table II and throughout this report.

Each interval of 30 minutes, whether on Recorder No. 1 or No. 2 is automatically preceded by a one-minute electrical zero and a one-minute period of calibration signals.

1. Strain Gage Signals

The majority of the transducers used in this system are obtained from various configurations of single-element strain gages with associated bridge completion and calibration resistors. These gages are attached to the surface of various hull structural elements. Each strain gage is constructed with inherent temperature compensation. That is, if the gage is attached to a plate which is subsequently warmed (or cooled) but is otherwise unrestrained, no change in strain will be indicated. If that plate is now restrained from expansion due to the temperature change, a strain, associated with the degree of restoring stress necessary, will be indicated even though no change in length occurred. Such a restraint is generated, for example, when the sun warms the deck or upper hull girder while the lower hull is in cooler water. This diurnal variation tends to induce compressive deck stresses and tensile stresses under the waterline even though the displacement tends to hog the ship.

TABLE FI
SENSOR LIST
72/73 Season and Calibration

Sensor No.	Sensor Nom.	Location (2)		Config.	Orient	Sensitive to	Recorder	Channel	Mode	Full Cal	Units	Circuit No.
		Frame	Position									
1 (1)	LVB	186 1/4	Tunnel Top	Dyadic	Long.	V. Bend.	1	1	-	8214	PSI	1
2	TSM	186 1/4	Side N/A	Shear	Vert.	H.T. Shear	1	2	-	4991	PSI	3
3	Wave HG.	300	Pod Deckhouse (Stbd)	Radar	Angled	Range(3)	1	3	-	3.6	Volt	-
4	Roll	178	26" Pwd 31' ATT	Pend.	Trans.	Roll	1	4	-	20	Deg.	-
5	Pitch	178	26" Pwd 31' ATT	Pend.	Long.	Pitch	1	5	-	20	Deg.	-
6	MAV	178	23" Pwd 31' ATT	Mass	Vert.	V. Accel.	1	6	-	1	g	-
7	MAT	178	23" Pwd 31' ATT	Mass	Trans.	T. Accel.	1	7	-	1	g	-
8	FAV	290	14" Pwd 59' ATT	Mass	Vert.	V. Accel.	1	8	-	1	g	-
9	FAT	290	14" Pwd 59' ATT	Mass	Trans.	T. Accel.	1	9	-	1	g	-
10	Op Para.	-	RPM, (2) Aud, Wind 98D	Multiplex	-	Transmitters	1	10	-	3.6	Volt	-
11	LHB	186 1/4	Side NA	Dyadic	Long.	H. Bend	1	11	-	8214	PSI	2
12	SFP	265	P Side 32' ATT	Shear	Vert.	Shear	1	12	-	5000	PSI	4
13	SFS	265	S Side 32' ATT	Shear	Vert.	Shear	1	13	-	5000	PSI	4
14 (1)	LVB	-	-	-	-	-	2	1	A	-	-	-
15	LSTS	186	S Tunnel Top	Dyadic	Long.	N. Stress	2	2	A	8240	PSI	5
16	LSMS	186	S Side N.A.	Dyadic	Long.	N. Stress	2	3	A	8240	PSI	5
17	LSBS	186	S Side Bottom	Dyadic	Long.	N. Stress	2	4	A	8240	PSI	5
18	LSTP	186	P Tunnel Top	Dyadic	Long.	N. Stress	2	5	A	8240	PSI	5
19	LSMP	186	P Side NA	Dyadic	Long.	N. Stress	2	6	A	8240	PSI	5
20	LSBP	186	P Side Bottom	Dyadic	Long.	N. Stress	2	7	A	8240	PSI	5
21	SAP	87	P Side 26' ATT	Shear	Vert.	Shear	2	8	A	5000	PSI	4
22	SAS	87	S Side 26' ATT	Shear	Vert.	Shear	2	9	A	5000	PSI	4

TABLE II (Continued)
 SENSOR LIST
 72/73 Season and Calibration

II - 2

Sensor No.	Sensor Nom.	Frame	Location (2) Position	Config.	Orient	Sensitive to	Recorder	Channel	Mode	Full Cal	Units	Circuit No.
23	FDH7	307	Level 04 CL	Mass	Vert.	V. Accel.	2	10	A	+1 (4)	g	-
24	FDH1	307	Level 04 CL	Mass	Trans.	T. Accel.	2	11	A	+1	g	-
25	ADHL	130	Level 05 1" P	Mass	Long.	L. Accel.	2	10 (a)	A	+1	g	-
26	ADH1	130	Level 05 1" P	Mass	Trans.	T. Accel.	2	11 (a)	A	+1	g	-
27	BGSI	186 1/4	S Tunnel Top	Shear	Long.	Shear	2	12	A	5000	PSI	4
28	BOSB	186 1/4	S Tunnel Bot	Shear	Long.	Shear	2	13	A	5000	PSI	4
29 (1)	LVB						2	1	B		u"/"	6
30	AR-1A	143	Port Side Girder	Single	Long.	N. Strain	2	2	B	334.6	u"/"	6
31	AR-1B	143	Near Deck Cutout	Single	Diag.	N. Strain	2	3	B	334.6	u"/"	6
32	AR-1C	143	Under Deck	Single	Trans.	N. Strain	2	4	B	334.6	u"/"	6
33	AR-2A	143	Stbd Side Girder	Single	Long.	N. Strain	2	5	B	334.6	u"/"	6
34	AR-2B	143	Near Deck Cutout	Single	Diag.	N. Strain	2	6	B	334.6	u"/"	6
35	AR-2C	143	Under Deck	Single	Trans.	N. Strain	2	7	B	334.6	u"/"	6
36	AR-3A	143	Stbd Tunnel	Single	Long.	N. Strain	2	8	B	334.6	u"/"	6
37	AR-3B	143	In Board	Single	Diag.	N. Strain	2	9	B	334.6	u"/"	6
38	AR-3C	143	Under Deck	Single	Trans.	N. Strain	2	10	B	334.6	u"/"	6
39	AR-4A	143	Stbd Tunnel	Single	Long.	N. Strain	2	11	B	334.6	u"/"	6
40	AR-4B	143	Out Board	Single	Diag.	N. Strain	2	12	B	334.6	u"/"	6
41	AR-4C	143	Under Deck	Single	Trans.	N. Strain	2	13	B	334.6	u"/"	6

TABLE II (Continued)
SENSOR LIST

72/73 Season and Calibration

Sensor No.	Sensor Nom.	Location(2) Frame Position	Config.	Orient	Sensitive to	Recorder	Channel	Mode	Full Cal	Units	Circuit No.
42 (1)	LVB	291	Single	Long.	N. Strain	2	1	C	334.6	μ"/"	6
43	R A	291	Single	Diag.	N. Strain	2	2-13	C	334.6	μ"/"	6
44	R B	291	Single	Diag.	N. Strain	2	VIA	C	334.6	μ"/"	6
45	R1C	291	Single	Trans.	N. Strain	2	RSB	C	334.6	μ"/"	6
46	R2A	291	Single	Long.	N. Strain	2	2-13	C	334.6	μ"/"	6
47	R2B	291	Single	Diag.	N. Strain	2	VIA	C	334.6	μ"/"	6
48	R3C	291	Single	Trans.	N. Strain	2	RSB	C	334.6	μ"/"	6
49	R3A	291	Single	Long.	N. Strain	2	2-13	C	334.6	μ"/"	6
50	R3B	291	Single	Diag.	N. Strain	2	VIA	C	334.6	μ"/"	6
51	R3C	291	Single	Trans.	N. Strain	2	RSB	C	334.6	μ"/"	6
52	R4A	291	Single	Long.	N. Strain	2	2-13	C	334.6	μ"/"	6
53	R4B	291	Single	Diag.	N. Strain	2	VIA	C	334.6	μ"/"	6
54	R4C	291	Single	Trans.	N. Strain	2	RSB	C	334.6	μ"/"	6
55	R5A	258	Single	Long.	N. Strain	2	2-13	C	334.6	μ"/"	6
56	R5B	259	Single	Diag.	N. Strain	2	VIA	C	334.6	μ"/"	6
57	R5C	258	Single	Trans.	N. Strain	2	RSB	C	334.6	μ"/"	6
58	R6A	258	Single	Long.	N. Strain	2	2-13	C	334.6	μ"/"	6
59	R6B	258	Single	Diag.	N. Strain	2	VIA	C	334.6	μ"/"	6
60	R6C	258	Single	Trans.	N. Strain	2	RSB	C	334.6	μ"/"	6
61	R7A	258	Single	Long.	N. Strain	2	2-13	C	334.6	μ"/"	6
62	R7B	258	Single	Diag.	N. Strain	2	VIA	C	334.6	μ"/"	6
63	R7C	258	Single	Trans.	N. Strain	2	RSB	C	334.6	μ"/"	6
64	R8A	258	Single	Long.	N. Strain	2	2-13	C	334.6	μ"/"	6
65	R8B	258	Single	Diag.	N. Strain	2	VIA	C	334.6	μ"/"	6
66	R8C	258	Single	Trans.	N. Strain	2	RSB	C	334.6	μ"/"	6

TABLE II (Continued)
SENSOR LIST
72/73 Season and Calibration

Sensor No.	Sensor Nom.	Location (2) Frame Position	Config.	Orient	Sensitive to	Recorder	Channel	Mode	Full Cal	Units	Circuit No.
67	R9A	258 {Stbd Tunnel	Single	Long.	N. Strain	2	{ 2-13	C	334.6	" / "	6
68	R9B	258 {Out Board	Single	Diag.	N. Strain	2	{ VIA	C	334.6	" / "	6
69	R9C	258 {Under Deck	Single	Trans.	N. Strain	2	{ RSB	C	334.6	" / "	6
70	R10A	226 {Stbd Side Cird	Single	Long.	N. Strain	2	{ 2-13	C	334.6	" / "	6
71	R10B	226 {In Corn. Hat 4	Single	Diag.	N. Strain	2	{ VIA	C	334.6	" / "	6
72	R10C	226 {Under Deck	Single	Trans.	N. Strain	2	{ RSB	C	334.6	" / "	6
73	R11A	226 {Stbd Side Cird	Single	Long.	N. Strain	2	{ 2-13	C	334.6	" / "	6
74	R11B	226 {Out Corn Hat 4	Single	Diag.	N. Strain	2	{ VIA	C	334.6	" / "	6
75	R11C	226 {Underdeck	Single	Trans.	N. Strain	2	{ RSB	C	334.6	" / "	6
76	R12A	226 {Stbd Side Cird	Single	Long.	N. Strain	2	{ 2-13	C	334.6	" / "	6
77	R12B	226 {Near Deck Outout	Single	Diag.	N. Strain	2	{ VIA	C	334.6	" / "	6
78	R12C	226 {Underdeck	Single	Trans.	N. Strain	2	{ RSB	C	334.6	" / "	6
79	R13A	226 {Stbd Tunnel	Single	Long.	N. Strain	2	{ 2-13	C	334.6	" / "	6
80	R13B	226 {In Board	Single	Diag.	N. Strain	2	{ VIA	C	334.6	" / "	6
81	R13C	226 {Under Deck	Single	Trans.	N. Strain	2	{ RSB	C	334.6	" / "	6
82	R14A	226 {Stbd Tunnel	Single	Long.	N. Strain	2	{ 2-13	C	334.6	" / "	6
83	R14B	226 {Out Board	Single	Diag.	N. Strain	2	{ VIA	C	334.6	" / "	6
84	R14C	226 {Under Deck	Single	Trans.	N. Strain	2	{ RSB	C	334.6	" / "	6
85 (1)	LWB					2	1	D			
86	TGFS1	244 Fwd Top	Single	Trans.	N. Stress	2	2	D	10038	PSI	6

TABLE II (Continued)
SENSOR LIST
72/73 Season and Calibration

Sensor No.	Sensor Nom.	Location (2)		Config.	Orient	Sensitive to	Recorder	Channel	Mode	Full Cal	Units	Circuit No.
		Frame	Position									
87	HLSST	289	S Side 1' BT	Single	Long.	N. Stress	2	2 (a)	D	10038	PSI	6
88	TCFS2	244	Pwd Bot.	Single	Trans.	N. Stress	2	3	D	10038	PSI	6
89	HLSSE	289	S Side 1' ATT	Single	Long.	N. Stress	2	3 (a)	D	10038	PSI	6
90	TCFS3	242	Aft Bot	Single	Trans.	N. Stress	2	4	D	10038	PSI	6
91	HLSPT	289	P Side 1' BT	Single	Long.	N. Stress	2	4 (a)	D	10038	PSI	6
92	TCPS4	242	Aft Top	Single	Trans.	N. Stress	2	5	D	10038	PSI	6
93	HLSPE	289	P Side 1' ATT	Single	Long.	N. Stress	2	5 (a)	D	10038	PSI	6
94	TCMS1	196	Pwd Cird. Top	Single	Trans.	N. Stress	2	6	D	10038	PSI	6
95	TCMS2	196	Pwd Cird Bot.	Single	Trans.	N. Stress	2	7	D	10038	PSI	6
96	TCMS3	194	Aft Cird Bot.	Single	Trans.	N. Stress	2	8	D	10038	PSI	6
97	TCMS4	194	Aft Cird Top	Single	Trans.	N. Stress	2	9	D	10038	PSI	6
98	TCMS1X	194	Pwd Cird Mid	Single	Trans.	N. Stress	2	6 (a)	D	10038	PSI	6
99	TCMS2X	195	Bot Cird Mid	Single	Trans.	N. Stress	2	7 (a)	D	10038	PSI	6
100	TCMS3X	194	Aft Cird Mid	Single	Trans.	N. Stress	2	8 (a)	D	10038	PSI	6
101	TCMS4X	195	Top Cird Mid	Single	Trans.	N. Stress	2	9 (a)	D	10030	PSI	6
102	TGSS1X	196	Pwd Cird Q Top	Shear	Trans.	Shear	2	6 (a)	D	5000	PSI	4
103	TGSS2X	196	Pwd Cird Q Bot	Shear	Trans.	Shear	2	7 (a)	D	5000	PSI	4
104	TGSS3X	194	Aft Cird Q Bot	Shear	Trans.	Shear	2	8 (a)	D	5000	PSI	4
105	TGSS4X	194	Aft Cird Q Top	Shear	Trans.	Shear	2	9 (a)	D	5000	PSI	4
106	TGAS1	80	Pwd Top	Single	Trans.	N. Stress	2	10	D	10038	PSI	6
107	TGAS2	80	Pwd Bot	Single	Trans.	N. Stress	2	11	D	10038	PSI	6
108	TGAS3	78	Aft Bot	Single	Trans.	N. Stress	2	12	D	10038	PSI	6
109	TGAS4	78	Aft Top	Single	Trans.	N. Stress	2	13	D	10038	PSI	6

TABLE II (Concluded)

SENSOR LIST

72/73 Season and Calibration

- Notes: (1) LVBS is Recorded on Channel 1 of Both Recorders in All Modes
 (2) To Nearest Frame
 (3) Slant Range: Deckhouse to Wave
 (4) Calibration Step 2g (+ 1g from zero)

Abbreviations: Sensor Nomenclature - See Table II

Position - ATT is Above Tank Top

NA is Neutral Axis; BT is Below Tunnel

FR is Frame; Q is Quarterpoint

S is Starboard; P is Port; CL is Centerline (Longitudinal)

V Bend is Vertical Bending; H. Bend is Horizontal Bending

H.T. Shear is Horizontal and Torsional Shear

N. Stress is Normal Stress (as opposed to shear stress)

V. Accel., T. Accel., L. Accel. is Vertical, Transverse, Longitudinal, Acceleration, respectively

Channel - (a) Denotes alternate channel assignment.

TABLE III
SENSOR AND SIGNAL NOMENCLATURE

ADNL	After Deck House Longitudinal (Acceleration)
ADMT	After Deck House Transverse (Acceleration)
AR ₁₋₄ (α)	Aft Rosettes, (α) denotes gage element: A is longitudinal orientation B is diagonal (45°) orientation C is transverse (athwart) to longitudinal
BGSB	Box Girder Shear Bottom
BGST	Box Girder Shear Top
FVV	Forward Acceleration Vertical (Hull)
FAT	Forward Acceleration Transverse (Hull)
FDMT	Forward Deck House Transverse (Acceleration)
FDMV	Forward Deck House Vertical (Acceleration)
HLSPB	Hull Longitudinal Strain Port Bottom
HLSPT	Hull Longitudinal Strain Port Top
HLSSB	Hull Longitudinal Strain Starboard Bottom
HLSSY	Hull Longitudinal Strain Starboard Top
LHB	Longitudinal Horizontal Bending (Combination of LHP and LHBS)
LHP	Longitudinal Horizontal Bending Port (Stress)
LHBS	Longitudinal Horizontal Bending Starboard (Stress)
LSBP	Longitudinal Stress Bottom Port
LSBS	Longitudinal Stress Bottom Starboard
LSMP	Longitudinal Stress Mid Port
LSMS	Longitudinal Stress Mid Starboard
LSTP	Longitudinal Stress Top Port
LSTS	Longitudinal Stress Top Starboard
LVB	Longitudinal Vertical Bending (Combination of LVP and LVBS)
LVP	Longitudinal Vertical Bending Port (Stress)
LVBS	Longitudinal Vertical Bending Starboard (Stress)
MAT	Midship Acceleration Transverse (Hull)
MAV	Midship Acceleration Vertical (Hull)
R ₁₋₄ (α)	Rosettes (Forward), (α) denotes gage element: A is longitudinal orientation B is diagonal (45°) orientation C is transverse (athwart) to longitudinal
SAP	Shear Aft Port
SAS	Shear Aft Starboard
SFP	Shear Forward Port
SFS	Shear Forward Starboard
TGAS	Transverse Girder Aft Starboard (Strain)
TGFS	Transverse Girder Forward Starboard (Strain)
TGMS ₁₋₄	Transverse Girder Midship Starboard (Strain)
TGMS _{1X-4X}	Transverse Girder Midship Starboard (Strain, midpoints)
TGSS _{1X-4X}	Transverse Girder Shear Starboard (Midships, vertical quarterpoints)
TSN	Torsional Shear Midship (Combination of TSNP and TSMS)
TSNP	Torsional Shear Midship Port
TSMS	Torsional Shear Midship Starboard

Sketches summarizing the locations of the strain gage sets are presented in Figures 2 and 3. It should be noted that the single-element strain gages used are installed in various configurations which have different properties. These are described in detail in Reference 1, but can be summarized as follows:

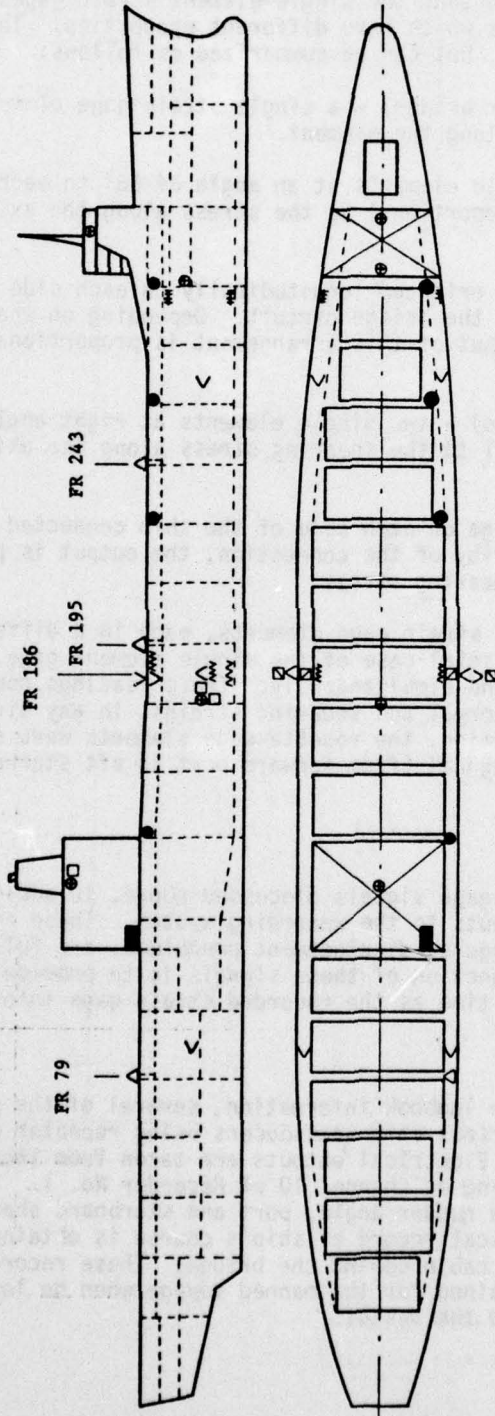
- a. Single element (quarter bridge) - a single strain gage element. Its output is proportional to the strain along the element.
- b. Dyadic gage - two single elements at an angle of 56° to each other. In this configuration the output is proportional to the stress along the axis of symmetry.
- c. A dyadic pair of gages oriented longitudinally on each side of the ship, each pair connected to one arm of the bridge circuit. Depending on whether the arms are opposite or adjacent, the output of this arrangement is proportional to the vertical or horizontal bending stress.
- d. Shear gage (half bridge) - two single elements at right angles to each other. The output is proportional to the shearing stress along the axis of symmetry.
- e. A shear gage half bridge on each side of the ship connected to form a full bridge. Depending on the polarity of the connection, the output is proportional to the vertical or torsional shearing stress.
- f. Rosette - three single strain gage elements, each in a different direction, near a point. This is a special case of the single element gage. Each signal output is recorded separately and simultaneously. These readings completely define the state of strain (both the normal and shearing strains, in any direction) at this point. In the McLEAN installation, the rosette gage elements were oriented in a longitudinal, athwartship and diagonal (from forward port to aft starboard) direction.

2. Transducer Signals

In addition to the strain gage signals discussed above, 10 additional transducer signals are provided as inputs to the recording system. These signals, eight linear accelerometers and two angular displacement pendulums, are fully described in Table IV. The primary function of these signals is to provide a record of ship motions occurring at the same time as the recorded strain gage information.

3. Ship Operating Parameters

In order to supplement the logbook information, several of the ship operating parameters are obtained from various ship transducers using repeater devices located in the instrumentation room. Electrical outputs are taken from these devices and multiplexed prior to recording on Channel 10 of Recorder No. 1. The five parameters obtained in this manner are rudder angle, port and starboard shaft RPM, and wind speed and direction. A physical record of ship's course is obtained from an analog recorder located in the sea cabin behind the bridge. These records are available at any time and will be obtained for the manned voyage when no longer required by regulation to be kept aboard the vessel.



- ⊕ Bidirectional Accelerometer
- Pitch & Roll Pendulum
- ⊠ Longitudinal Vertical Bending Element
- ∨ Torsional Shear Gage
- < Shear Gage
- mw Longitudinal Stress Gage
- △ Transverse Girder Gage
- Three Arm Rosette
- ∧ Midship Torsional Shear Element
- ⊞ Longitudinal Horizontal Bending
- ## Hull Longitudinal Strain

LEGEND

FIGURE 2 GENERAL SENSOR LAYOUT

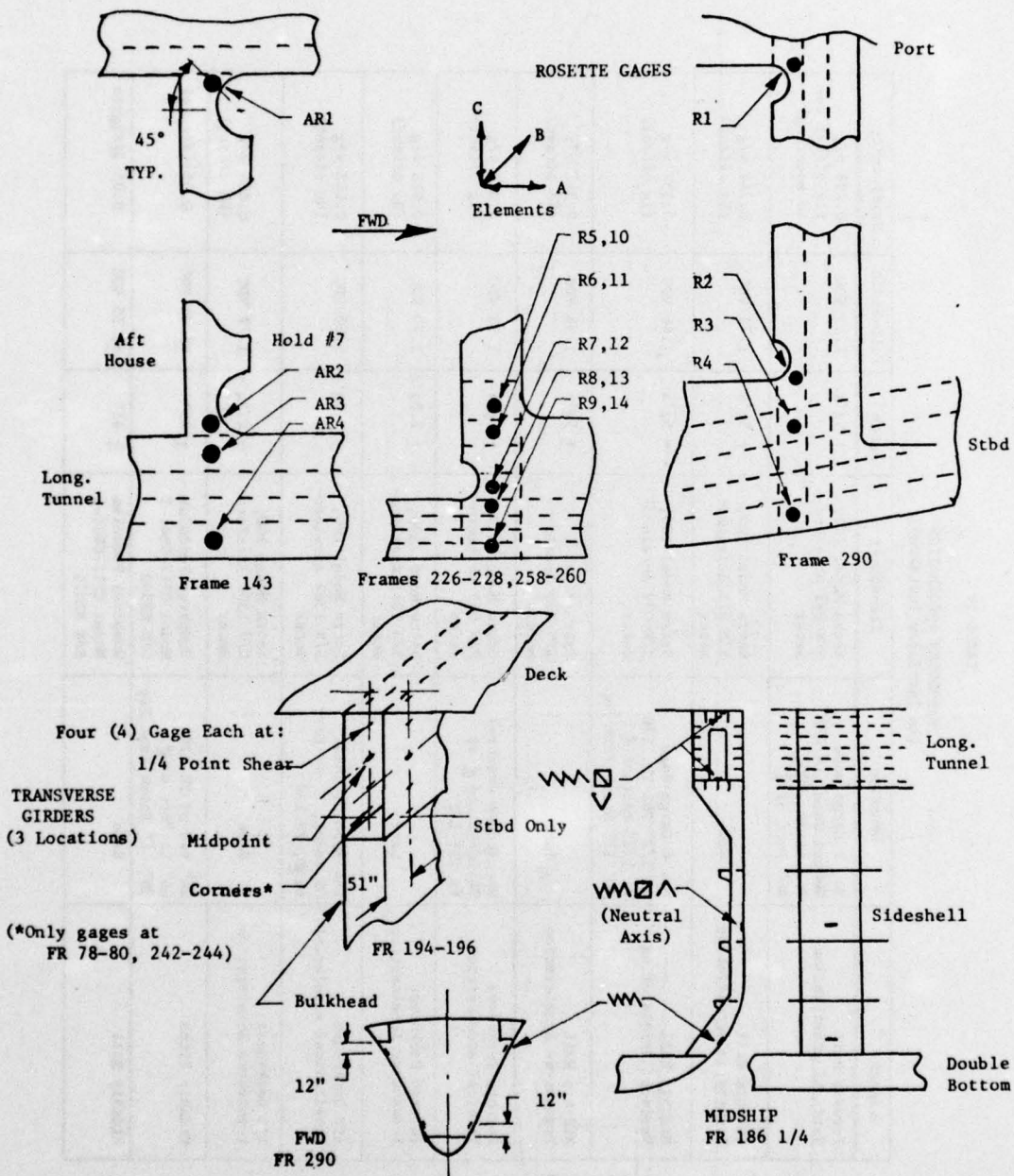


FIGURE 3
 DETAILS OF STRAIN GAGE LAYOUT

TABLE IV
 TRANSDUCER INFORMATION
 (As Initially Installed)

Signal	Location	Transducer	Range	Full-Scale	Sensitivity
Forward Hull Vertical Acceleration	No. 2 Cargo Hold Second Deck, 14 1/2" Fwd of FR. 290, 40" Port of ϵ	Setra Model 100, S/N 068 Accelerometer	\pm 5g's	1.49 VDC	0.298 v/g (1g offset due to mounting)
Forward Hull Transverse Acceleration	Same	Setra Model 100, S/N 071 Accelerometer	\pm 5g's	1.72 VDC	0.344 v/g (No offset)
Midship Hull Vertical Acceleration	No. 6 Cargo Hold 23 1/2" Fwd FR. 178 11 1/2" Port of ϵ 30' 11" Above Tank Top	Setra Model 100, S/N 072 Accelerometer	\pm 5g's	1.66 VDC	0.332 v/g (1g offset)
Midship Hull Transverse Acceleration	Same	Setra Model 100, S/N 070 Accelerometer	\pm 5g's	1.58 VDC	0.317 v/g (No offset)
Forward Deckhouse Vertical Acceleration	Wheelhouse Overhead 04 Level, on ϵ at FR 307 1/2	Setra Model 100, S/N 069 Accelerometer	\pm 5g's	1.55 VDC	0.317 v/g (1g offset)
Forward Deckhouse Transverse Acceleration	Same	Setra Model 100, S/N 1361 Accelerometer	\pm 2.5g's	1.70 VDC	0.678 v/g (No offset)
Aft Deckhouse Longitudinal Acceleration	Fan Room Overhead 05 Level, 1" to Port of ϵ , FR 130	Setra Model 100, S/N 1362 Accelerometer	\pm 2.5g's	1.60 VDC	0.642 v/g (No offset)
Aft Deckhouse Transverse Acceleration	Same	Setra Model 100, S/N 1360 Accelerometer	\pm 2.5g's	1.72 VDC	0.686 v/g (No offset)
Midship Pitch	26" Fwd of FR 178 26" to Port of ϵ 30' 11" Above Tank Top	Humphrey Pendulum Model CP17-0601-1 S/N H3390	\pm 45°	\pm 2.25 VDC	0.05 ∇ /degree
Midship Roll	Same	Humphrey Pendulum Model CP17-0601-1 S/N H2075	\pm 45°	\pm 2.25 VDC	0.05 ∇ /degree

4. Wave Height Radar

One parameter which has always presented a problem to the researcher is the measurement of the actual wave condition in a continuous manner. A new attempt to solve this problem has been made by including an "Ocean Wave Height Radar System" (OWHRS) developed by the Naval Research Laboratory as part of the instrumentation package. This device was operational for several voyages during the past season and the data, in the form of slant-range information, was recorded on Channel 3 of Recorder 1.

The signal, as recorded, contains the components of the various ship motions. These parameters must be removed before the true sea profile can be reproduced. No detailed analysis of this information will be presented in this document, but several samples of the data will be presented in subsequent sections.

5. Tucker Wave Meter System

A second attempt to achieve wave data has been made in this program by the inclusion of a Tucker Wave Meter aboard the vessel. This British device, which consists primarily of pressure cells and accelerometers mounted both port and starboard, was installed at the end of the first season's operation. Evaluation of data from this device will be one of the tasks undertaken when reducing second-season data.

6. Scratch Gages

As a supplementary program, mechanical scratch gage installations at a midship location have been installed on all eight vessels of the class. The device consists of a simple extensometer with mechanical amplification which causes a stylus to mark on sensitive paper. The paper is advanced once every four hours and the record thus obtained shows the maximum positive to maximum negative excursion of the stylus in a four-hour period. One scratch gage is located in each ship's starboard tunnel near the midship frame except for the McLEAN, which has one scratch gage in each tunnel. Data tapes are being sent directly to the Ship Structure Committee after collection by Teledyne. No data analysis is presently being undertaken by TMR, nor is the data presented in this report.

7. Logbook

An important adjunct to the data recorded on the two magnetic tape recorders is the data logbook kept by the instrumentation observer. Figure 4 shows typical logbook entries. Environmental conditions are noted here along with information to index the tape recordings. All sea, wind and wave conditions reported in this document are derived from this source.

8. Quick-looks

The data reduction process actually begins with "quick-look" playbacks made aboard the ship. Each tape is played back on an oscillograph at a relatively high speed, with a low paper speed. This produces a compact hard-copy record for review. Signal peaks, relative levels and overall variations may be judged from these records but details of the waveform cannot be seen.

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DATA LOG

Figure 4-A

6 Index No.	21 SWELL			22 Barometer Reading	23 Sea Temp.	24 Air Temp.	25 Weather	26 Initials	WATCH FOR FALSE START TAPE 21-22 27 (Change of Course, Change of Speed, Change of Ballast, Slamming, Change Tape, Reel Number) (Wave buoy launching) TAPES 21 & 22 RUB = 1, 2, 3, 4 - G.S.B. = 1, 2, 3, 4 FDH ACCUS. & F.T.G.
	21a Avg. Height'	21b Avg. Length	21c Relative Direct.						
1	2-3'	5-600'	0	30.10	54	45/47	CLDY RAIN	ETB	
2	10'	5-600'	45° NE	30.08	52	52/45	0'CAST		
3	10'	600'	45° NE	30.30	62	52/48	CLDY		
4	10-12	600	42° NE	29.97	64	57/54	P'CLDY		
5	10-12	600	42° NE	29.93	68	53/52	0'CAST RAIN		SHIP DIRECTIONS IN LOG SUCCESS - LIGHT ROLL SPRAY OVER AHEAD FIRST TIME SEEN THROUGH
6	12-15	600	37° NE	29.80	67	55/52	0'CAST		
7	12-15	600	37° NE	29.77	65	54/52	P'CLDY		
8	12-15	600	37° NE	29.63	68	52/51	CLDY		PITCH & SILENT ROLL SPRAY FROM TOP OF BOW
9	10-12	600	31° NE	29.48	64	53/52	CLDY		
10	10-12	600	31° NE	29.50	64	53/55	0'CAST		RUB-5-6-7-8 & HLG CSN-5-6-7-8
11	10-12	600	31° NE	29.38	64	62/60	CLDY		
12	8-10	500	31° NE	29.48	64	62/60	CLDY		
13	8-10	500	53° NE	29.50	64	64/63	P'CLDY		END TAPE # 21 & 22
14	8-10	500	31° NE	29.51	66	61/60	P'CLDY		START TAPE # 23 & 24
15	6-8	500	31° NE	29.63	66	64/63	0'CAST		

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DATA LOG

Figure 4-8

1 SHIP: SEA LAMB 115 LCAA
 2 VOYAGE: 04 E 3 FROM: AT. ELIZABETH 4 TO: BREMERHAVEN 5 DATES: 11/11/72 6 TO: 11/16/72

6 Index No.	7 Date (M,D,Y) Time (GMT)	8 Time Meter Rdg.	9 Noon Position		10 Course	11 (Past 4 hours) Avg. Speed		12 WIND		13 Beaufort Sea State Number	14 Relative Wave Direct.	15 (Ft.) Avg. Wave Height	16 (Sec.) Avg. Wave Period	17 (Ft.) Avg. Wave Length
			Lat.	Long.		Speed Knots	Engine R.P.M.	Wind Speed Knots	Wind Direct.					
1-4	11/12/72 0400	000.0			090	32.8	154/132	15	0	4-5	E	3		
5-8	11/12/72 0800	0125.0			090	32.0	129/127	10	90	3	N	3		
9-12	11/12/72 1200	0240.0			090	32.0	129/127	15	101 P N.W.	4	N	3		
13-16	11/12/72 1600	0360.1	40.18	02.48	087	32.0	128/128	25	87 P	6	N	6		
17-20	11/12/72 2000	0480.2			087	32.0	128/128	30	64 P N.W.	7	N	10		
21-24	11/12/72 2400	0600.3			082	32.0	128/128	35	60 P N.W.	8	N	12		
25-28	11/13/72 0400	0120.2			082	32.0	125/128	30	82 P	7	N	10		
29-32	11/13/72 0800	0840.6			082	32.0	128/128	30	82 P	7	N	10		
33-36	11/13/72 1200	0961.0			076	32.0	128/128	25	143 P N.W.	6	N	8		
37-40	11/13/72 1600	1081.3	41.37	02.57	076	32.0	128/128	30	166 P	7	N	10		
41-44	11/13/72 2000	1201.5			076	32.0	128/128	30	149 P S.W.	7	N	10		
45-48	11/13/72 2400	1322.3			076	32.0	128/128	25	149 P S.W.	6	N	10		
49-52	11/14/72 0400	1442.9			076	32.0	128/128	20	149 P S.W.	5	N	8		
53-56	11/14/72 0800	0600.0			076	32.0	128/128	20	149 P S.W.	5	N	8		
57-60	11/14/72 1200	0120.6			077	32.0	128/128	20	149 P S.W.	5	N	6		

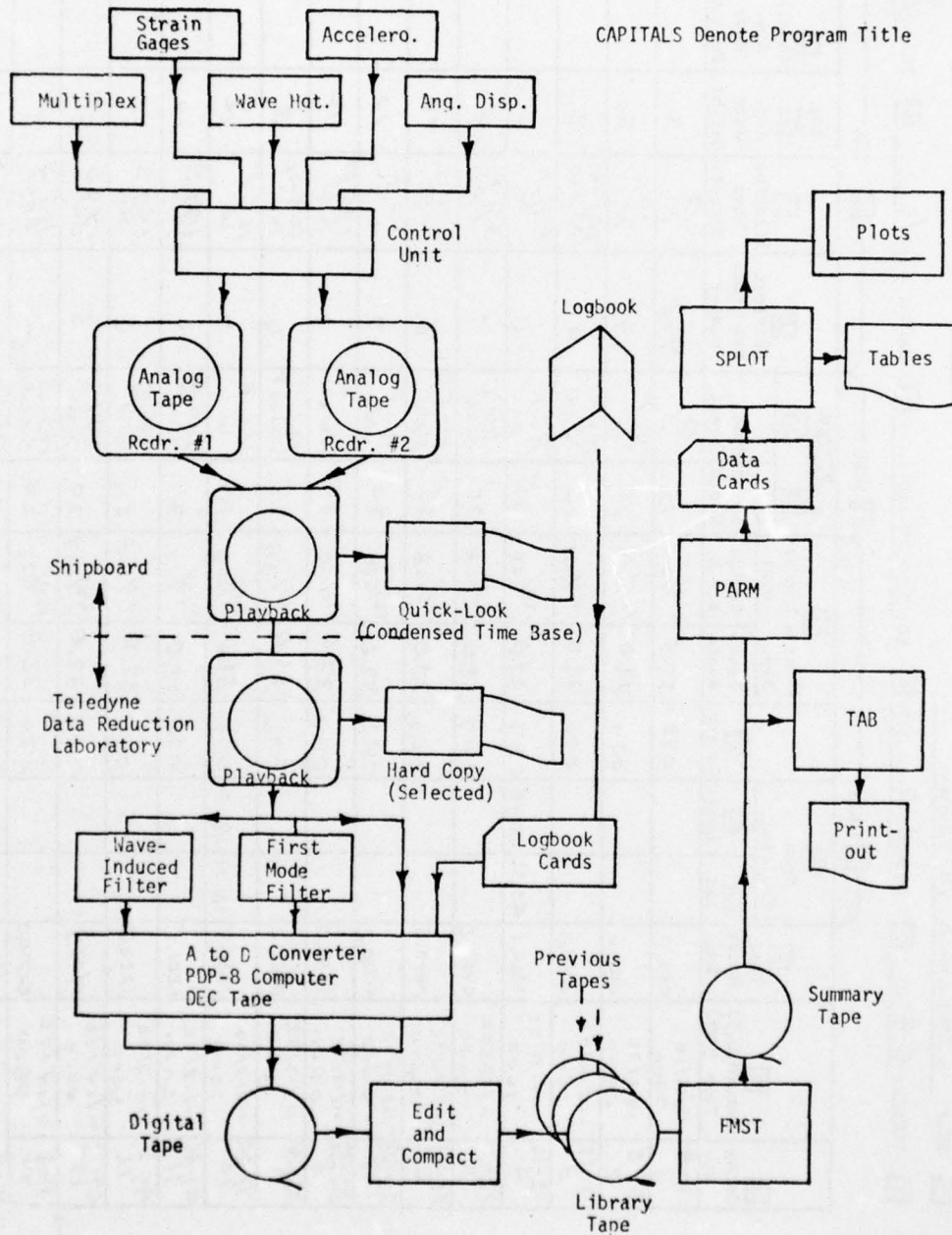


Figure 5 SCHEMATIC OF DATA FLOW

In sum, shipboard data gathering produces analog magnetic tapes of the recorded data from two tape recorders running simultaneously. In addition, a manual logbook record is maintained which correlates the magnetic tape data with the conditions existing at the time of the data. Quick-look records are also produced for on-site quality control purposes, but these have little application to most data analysis procedures except for scaling an overall maximum value for each interval.

B. Data Analysis Operations at TMR

1. Hard-Copy Analog Records

As shown in Figure 5, the preponderance of data reduction takes place after the recordings are removed from the ship. After review of the logbook records and taking into account the notes of the on-board observer, certain sections of data are played back onto hard-copy oscillographic records. Details of this operation depend on the type of analysis being done; it may be desired to compare one channel relative to another for a long period, or only the response for a short period around some event such as a slam. Examples of hard-copy analog records are presented in later sections.

2. Filtering and Digitizing

Most large-magnitude stress records, especially those associated with slamming and similar dynamic events, can be separated into two components: wave-induced, and first mode ("whipping", or "springing"). Each component is characterized by its frequency. First-mode frequencies are typically on the order of 1 Hz, while wave-induced components are lower in frequency (i.e., longer in period). Separation of these components is accomplished by passing the electrical signal representing the stress level or sensor output through electrical filters adjusted for the appropriate bandpass frequencies. The resulting filtered signal (or the original combined signal) may then be reproduced on an oscillograph to produce a hard copy, or it may be digitized in order to change its format for further processing.

Certain channels are selected for digitizing and further processing into library tapes. The details of this process are presented in Reference 2. In this step the logbook record is collated with the corresponding stress or motion data. In addition to a digitized data record, this operation also computes numbers characterizing each data interval, such as the maximum peak-to-trough, root-mean-square (RMS), number of peaks, etc. Some of these data have been used further in various analyses described below.

The library tapes can be further summarized by deletion of the complete digitized record. This summary tape can provide a computer-generated listing of environmental and characteristic data. Examples of these data are provided as a separate Appendix to this report. The summary tape also provides the data base for the parametric studies discussed below. Header block and data summary block formats for summary tapes are given in Tables V and VI, respectively. It should be noted that summary tapes do not contain data on which to base spectra, nor, as presently structured, do they contain computed values for the original waveform. Values reported are only for the wave-induced (maximum, RMS) and first-mode (maximum only) components.

A general summary of the SL-7 data formats currently available is presented in Table VII.

TABLE V		
DIGITAL TAPE HEADER BLOCK FORMAT		
Byte	Information	Format
1 - 134	Tape Identification	8-bit EBCDIC
135 - 138	Number of Voyages on Tape	32-bit binary
139 - 142	First Voyage Number	8-bit EBCDIC
143 - 146	No. Intervals in First Voyage	32-bit binary
147 - 150	Second Voyage Number	8-bit EBCDIC
151 - 154	No. Intervals in Second Voyage	32-bit binary
155 - 158	Third Voyage Number	8-bit EBCDIC
159 - 162	No. Intervals in Third Voyage	32-bit binary
	and so forth	
	unused bytes zero-filled	

-21-
TABLE VI

INTERVAL SUMMARY BLOCK FORMAT

Byte	Information	Format	Byte	Information	Format
1-7+11-12	Analog Tape Number	8-bit	119- 128	Blanks	8-bit
8- 10	Voyage Number & Direct.	EBCDIC	129- 157	Comments	EBCDIC
13- 15	Logbook Index Number		158- 256	Zeros	↓
16- 18	Interval Number		257- 260	No. Wave Induced Cycles	32-bit Binary
19- 26	Date				
27- 30	Time (Eastern Std.)		261- 264	No. of Bursts of Wave-Induced Stress	
31- 37	Latitude				
38- 45	Longitude		265- 268	RMS Wave-Induced Stress, psi	
46- 48	Course				
49- 52	Ship Speed (MPH)		269- 272	Max. P-T Wave-Induced Stress, psi	
53- 56	Shaft RPM		273- 276	Max. P-T 1st Mode Stress, psi	
57- 58	Beaufort Sea State				
59- 62	Relative Wind Dir.				
63- 64	Relative Wind Vel. (knots)		277- 280	Mean Relative Stress Level	↓
65- 66	True Wind Velocity (knots)		401- 404	1st Wave-Induced P-T Detected	32-bit Binary
67- 70	Relative Wind Dir.		405- 408	2nd Wave-Induced P-T Detected	
71- 72	Wave Height (feet)				
73- 74	Wave Period (sec.)		409- 412	3rd Wave-Induced P-T Detected	
75- 77	Wave Length				
78- 81	Relative Swell Dir.			.	
82- 84	Swell Height (feet)			.	
85- 88	Swell Length (feet)			.	
89- 93	Barometric Press, "Hg		2273-2276	469th Wave-Induced P-T Detected	
94- 95	Sea Temp. (°F)				
96- 98	Air Temp. (°F)		2277-2280	470th Wave-Induced P-T Detected	↓
99- 118	Weather	↓			

TABLE VII

SUMMARY OF CURRENT DATA FORMATS

<u>Format</u>	<u>Characteristics</u>
Analog Tapes	Recorded at 0.3 ips, FM IRIG low-band, 270 Hz center frequency--13 data tracks, 1 compensation track--tape 1" wide, 0.001" thick, 3600 feet on 10 1/2-inch reels. Each 30-minute interval preceded by zero and calibration signals.
Oscillograph Records	Quick-looks reproduced aboard ship at 200:1 speed up--3 to 4 tracks per record--all tracks reproduced--30 minutes occupies about 3 inches of record. Expanded time-histories of selected tracks--used for instantaneous comparisons.
Digital Library Tape*	12,000 data points at 10 samples/second (real time) (unfiltered) from each interval of selected transducers on Recorder No. 1, plus logbook data, plus computed values--approximately 700 intervals.
Summary Tape*	The Digital Library Tape with the digital record deleted, leaving computed results and logbook data. One Summary Tape contains data from the entire season from one transducer.
Logbook	Environmental and ship operational data manually entered by system operator. Data is coded and entered on Digital Library Tape.
TAB Printout*	All logbook data plus computed data characteristics for each transducer, from the Summary Tape.
PARM Data Cards*	RMS and maximum data values plus selected logbook data for parametric studies.
SPLIT Output	Plots of data means vs. any parameter (such as Beaufort Number), classified into families of five subgroups. Tabulations also available (see Appendix B).

*See Reference 2-b.

III. RESULTS

In general, the results of the first season of manual data acquisition were gratifying. Large quantities of high-quality data were recorded. In any equipment of this complexity operating over an extended period, some failures or breakdowns are expected. However, due to the presence of the observer/operator, the effects of these were minimized and they were quickly corrected. His presence also assured proper correlation of the vital environmental data.

A. 1972-1973 Operating Season

It was originally planned to have the system operational in time to take part in both builder's and owner's sea trials. Unfortunately, due to the number of additional passengers scheduled during these tests, it was not physically possible to have Teledyne engineers aboard the vessel. At the time of the first trial, the system had been fully installed but had not had its final adjustments completed.

1. Manned Operations

Two Teledyne engineers met the vessel in Rotterdam upon her return from her first sea trials on September 16, 1972. These engineers worked aboard until September 28, 1972 when the vessel went on its second trial. It was decided that it was still impossible for Teledyne engineers to take part in the trials, although the system was operational and ready to record data. The ship left on Sunday, October 8, 1972, for New Jersey with two Teledyne engineers aboard. Recordings began on that date and continued throughout the westbound leg of Voyage 1. Both engineers rode the vessel to New Jersey. During this voyage and subsequent roundtrip Voyages 2 and 3, two Teledyne engineers rode the vessel. This manning scheme allowed TMR to have four engineers trained in system operation, and provided the additional manpower required during the system start-up.

2. Voyage Summaries

A summary of the voyage and data as recorded by dates and tape number is listed in Table VIII. With the exception of the westbound leg of Voyage 5, the vessel was manned by TMR personnel during each crossing from Voyage 1 in October, 1972 to Voyage 12 in April of 1972. Manning was terminated for the season when the ship returned to Rotterdam for drydocking in April, 1973.

3. Logbook Data

During each crossing the operator kept a data log in which he made indicated entries once every four hours. Logbook index numbers begin at No. 1 for each crossing and typically there are 30 to 32 entries per crossing.

The recording plan during the past season was to record for two out of every four hours when operating in the automatic mode. Thus, there are normally four data intervals associated with each log index entry, and, since a tape can run for a maximum of 40 hours real time and each data interval is 30 minutes in length, it is theoretically possible to have 80 intervals per tape. In practice, the operators have changed tape in each machine at the beginning of each voyage. These first tapes normally contain 68 to 72 intervals, allowing for unused tape at the beginning and end of each reel. Usually a little more than half way across two new tapes are loaded. These second tapes have varying numbers of intervals dependent on such items as the ship's speed, associated progress, and just when the system is secured. This

TABLE VIII
ANALOG TAPE AND VOYAGE SUMMARY

<u>Voyage</u>	<u>Direction</u>	<u>Data Collection Dates</u>	<u>Data Tapes Produced (Tape Numbers)</u>	<u>Number of Tapes</u>
1	West	10/8/72 to 10/13/72	1,2,3,4	4
2	East	10/15/72 to 10/19/72	5,6,7,8	4
2	West	10/23/72 to 10/27/72	9,10,11,12	4
3	East	10/29/72 to 11/2/72	13,14,15,16	4
3	West	11/6/72 to 11/10/72	17,18,19,20	4
4	East	11/12/72 to 11/16/72	21,22,23,24	4
4	West	11/19/72 to 11/24/72	25,26,27,28	4
5	East	11/26/72 to 12/4/72	29,30,31,32,33,34	6
5	West	Vessel Not Manned No Data Collection		
6	East	12/29/72 to 1/4/73	35,36 One Recorder Time-Shared	2
6	West	1/7/73 to 1/12/73	37,38 One Recorder Time-Shared	2
7	East	1/14/73 to 1/19/73	39,40,41,42	4
7	West	1/24/73 to 1/29/73	43,44,45,46	4
8	East	1/30/73 to 2/4/73	47,48,49,50	4
8	West	2/8/73 to 2/13/73	51,52,53,54	4
9	East	2/15/73 to 2/20/73	55,56,57,58	7
9	West	2/24/73 to 3/1/73	59,60,61,62	4
10	East	3/3/73 to 3/8/73	63,64,65,66	4
10	West	3/11/73 to 3/15/73	67,68,69,70	4
11	East	3/19/73 to 3/24/73	71,72,73,74	4
11	West	3/26/73 to 3/30/73	75,76,77,78	4
12	East	4/1/73 to 4/5/73	79,80	2

past season an average of 48 to 50 intervals are found on the second tapes. In summary, during each crossing 2 tapes are usually recorded on each tape machine. The interval numbers on each tape can run from 1 to 80 and these intervals are associated with logbook indexes 1 to 32 for each crossing.

4. Sea State Profiles

To assist in understanding the distribution of sea states encountered during the first data season, Figure 6 has been prepared. This figure depicts the occurrences of the various Beaufort Numbers reported divided into eastbound and westbound voyages. The basis for these data is the logbook entry for sea state recorded once every four hours by the operator. A total of 623 entries were made during the recording season; 324 during eastbound crossings and 299 during westbound. Normally, four data intervals (30-minute recording periods) are associated with each log entry. Thus, to obtain the total number of data intervals available at each sea state, it is necessary to multiply the number of logbook entries by four. The dominant Beaufort Numbers are in the range of 3 to 7, with the most entries obtained at Beaufort 4.

A summary of the more important logbook data is presented in Appendix A. This listing contains the following data:

- a. Voyage Number and Direction
- b. Recorder No. 1 Tape Number
- c. Interval Number
- d. Index Number
- e. Date
- f. Time (GMT)
- g. Ship Speed in Knots
- h. Beaufort Number
- i. Relative Wave Direction
- j. Weather Observation
- k. General Comments

5. Static Calibration

In order to obtain verification of the accuracy of the instrumentation system operation a static calibration test was performed on the vessel at the loading terminal in Rotterdam on April 9 and 10, 1973. This test sequence, by judiciously controlling the unloading sequence, was designed to create known, or at least calculable levels of bending and torsional stresses. By comparing calculated values with system outputs a judgment of instrumentation system performance is obtained. The results of this experiment are not reported here but have been issued as a separate document (see Reference 3). However, the following general conclusions can be drawn based on the data gathered during the calibration experiment:

a. The maximum observed normal stress for the calibration loadings occurs in the hatch corner doublers (Hatch 9) just forward of the aft house in a direction parallel to the deck and at an angle of 22 degrees to the ship centerline. Other hatch corners, at stations where hatch width changes are encountered, exhibited high shear stresses near the stress relief cutouts.

b. The maximum calibration stresses are one-eighth to one-half of the maximum peak-to-trough stress observed under normal seaway conditions. To put it

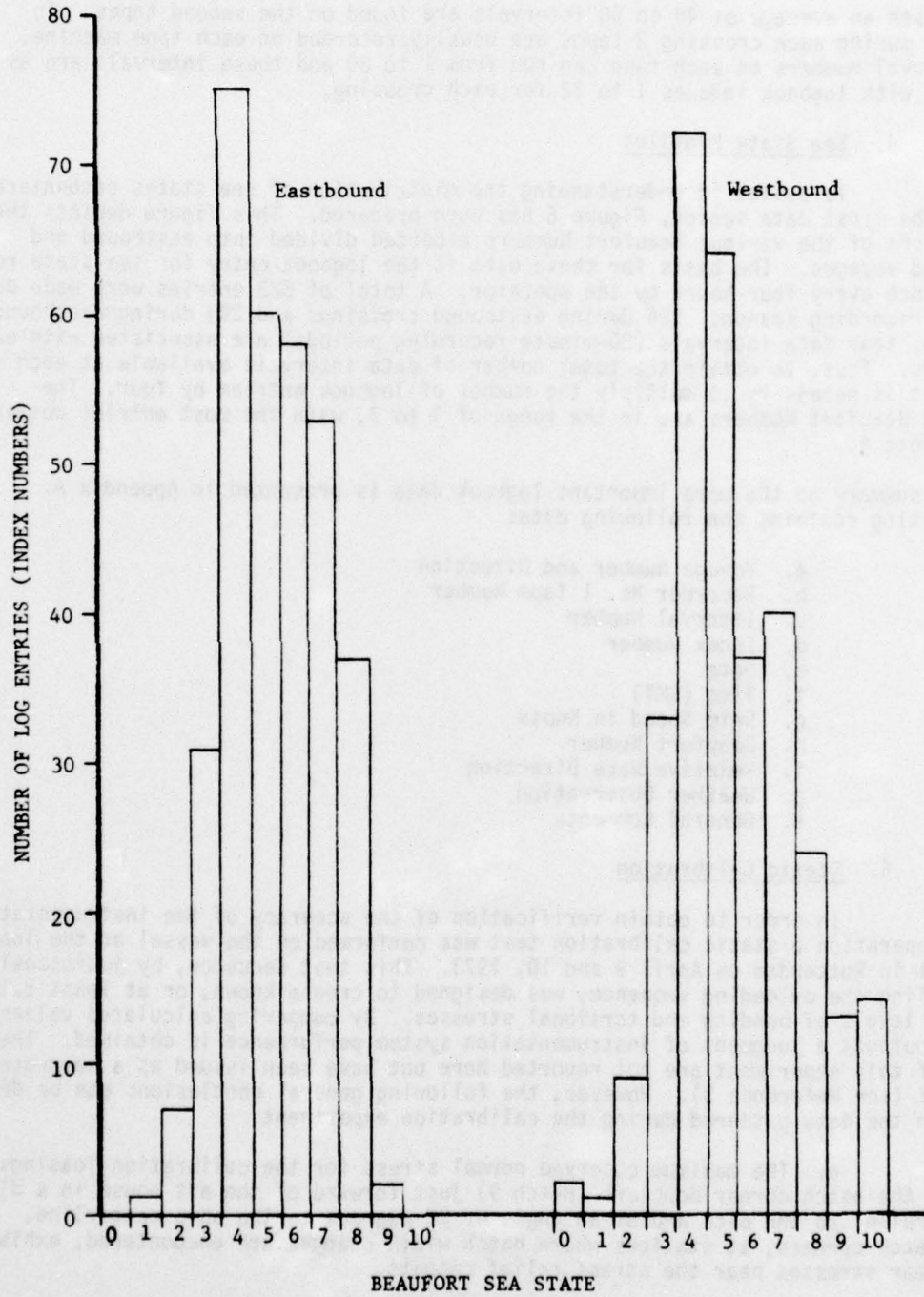


FIGURE 6
Sea State Profiles 1972/73 Season

another way, the applied calibration loads, or load distributions are approximately one-eighth to one-half of those generated in a seaway for most gages.

c. Due to the low strain levels induced and the temperature differences encountered during the calibration, thermal effects could account for a substantial portion of most measured strains.

d. The midship transverse girder is a more sensitive indicator of torsion than the midships torsional shear sensor installation.

6. System Reliability and Performance

System performance during the first season was consistent with that expected from an installation of this magnitude. No strain gage circuits experienced any failures. During Voyage 6 and part of Voyage 7 tape recorder problems were encountered which required the time-sharing of one unit until an additional machine could be obtained and the defective unit repaired. It should be pointed out that most of the equipment in the system is not new and has seen previous sea duty on both the ABS "Large Tanker Program" and two years of operation aboard Sea-Land's S.S. BOSTON.

Several data amplifiers did fail but on-board spares permitted replacement within a short time. In addition, failure of several of the accelerometer units were experienced. By selective switching of units, it was possible to keep the signals of primary interest operational during most of the data intervals.

In general, system performance was good and the fact that it was operator-controlled contributed to its overall excellent reliability.

The system was re-energized in the Fall of 1973 prior to the first manned voyages of the second season.

B. Data Presentation

1. General

As listed in Table VIII, 80 analog data tapes were produced during the past operating season, 40 from each recorder. A data summary book has been prepared for reference wherein every interval on every tape is identified by transducer.

During the first season, Voyage No. 4 presented some of the most interesting data from the standpoint of exhibiting the heaviest weather with a variety of relative sea directions. Since some characterization of the response data from all transducers was desired, but the volume of data available was large, this voyage was chosen for presentation in detail. Parametric studies were undertaken for all voyages, however.

2. Parametric Studies

Starting with the Summary Tapes, eight Recorder No. 1 data channels were selected for processing by the parametric studies computer program (see Reference 2 and Figure 5). These channels were:

- a. Channel 1 - Longitudinal Vertical Bending (LVB)
- b. Channel 2 - Torsional Shear Midships (TSM)
- c. Channel 4 - Roll
- d. Channel 5 - Pitch
- e. Channel 8 - Forward Vertical Acceleration (FAV)
- f. Channel 11 - Longitudinal Horizontal Bending (LHB)
- g. Channel 12 - Shear Forward Port (SFP)
- h. Channel 13 - Shear Forward Starboard (SFS)

The RMS and maximum peak-to-trough wave-induced component of each of the above parameters was plotted against Beaufort Number (although this is a wind scale, the number reported corresponds generally to a well-defined sea condition) in various families of ship speed or relative sea directions. In order to derive a single characteristic value within each Beaufort Number, the mean of both the maximum and RMS values per interval were plotted. These results are presented in Appendix B. Three types of data presentations are included for each data set:

- a. A dot-plot of all values, interval RMS or maximum peak-to-trough.
- b. A mean value plot of interval data set against ship speed or relative wave direction groups.
- c. A tabular listing giving the number of points upon which the curves are based and the set of standard deviations.

Extensive tabulations of digitized stress, motion, and logbook data are available to those interested through the Ship Structure Committee.

3. Maxima Observed on Recorder No. 2, Voyage 4

In order to present a sampling of the extreme data seen by Recorder 2, all of the data for Voyage 4 (E&W) was played back on an oscillograph, annotated, and scaled. In this manner a maximum peak-to-trough value was measured for each transducer for each interval. These data are presented in Table IX. As noted previously, Recorder No. 2 data are monitored in four consecutive modes. Some of these modes are switched, however, to record other data. This is reflected in Table IX. It should also be noted that the various maxima listed for any one interval did not necessarily occur at the same time.

4. Simultaneous Response Data

It is often useful to compare a response waveform occurring at one spot with that occurring at another spot at the same time. The complete records (all Recorder No. 1 and No. 2 signals recorded at the selected instances) from four examples of high sea state conditions are presented in Figures 7, 8, 9, and 10, each representing a different relative sea direction; i.e., head, broad-on-the-bow, quartering and following.

5. Averaged Midship Maximum Stresses, Voyage 4

Six longitudinal strain gage arrays are located at midship, on the top, mid and bottom sideshell, port and starboard. These are some of the most interesting

(Text continued on Page 105)

Sheet 1 of 8

TABLE IX

VOYAGE 04 EASTBOUND
TAPE 22 RECORDER #2

Index No.	Interval No.	Sea State	MAXIMUM PEAK-TO-TROUGH SIGNAL VALUE (psi)													(G's)	
			LSTS	LSMS	LSBS	LSTP	LSMP	LSBP	SAP	SAS	BCST	BCSB	FWD HOUSE VERTICAL	FWD HOUSE TRANS.			
1	1	4	2017	659	1281	2746	484	1236	1111	1200	277	333	.18	.12			
2	5	3	4852	1648	2014	4504	1977	2333	2333	2333	444	599	.40	.12			
3	9	4	7049	2636	2197	6921	1744	1977	3333	3000	833	733	.53	.16			
4	13	6	6866	2966	4486	8899	2423	5850	3722	4066	833	733	.71	.20			
5	17	7	9430	4944	5218	9338	3392	8240	4666	5466	1277	799	.98	.34			
6	21	8	10712	6592	5676	10986	4362	8157	5166	5266	1222	1066	1.16	.46			
7	25	7	7690	4065	3021	5273	3199	5932	3055	2800	833	666	.89	.34			
8	29	7	5310	3076	2563	4724	2423	4120	2333	2133	666	599	.71	.38			
9	33	6	8697	3296	4577	8432	2617	6427	4111	4333	944	733	.89	.40			
10	37	7	5493	2526	3112	4504	1938	3213	1777	2600	611	533	.93	.28			
11	41	7	5584	2856	3387	5053	2035	3625	2277	2266	833	599	.62	.40			
12	45	6	5127	2966	2746	4174	1841	3296	2000	2666	833	466	.67	.34			
13	49	5	7324	3405	3662	8789	2423	4532	2555	2800	888	466	.76	.44			
Tape 24 Recorder #2																	
14	1	5	7873	3186	3939	6321	2472	5022	3222	3600	833	533	.67	.32			
15	5	5	5493	2966	2929	5822	2197	4316	2222	2733	777	666	.67	.32			
16	9	5	5218	2526	3204	4065	1831	3845	1944	2666	611	733	.49	.26			
17	13	5	4303	2526	2655	4065	1831	3139	2333	1866	722	466	.49	.28			
18	17	4	4852	2417	2197	3845	1464	2982	2055	2066	444	333	.58	.20			
19	21	4	4211	2197	2014	3735	1648	3139	1555	1733	444	400	.49	.22			
20	25	5	2838	2197	1922	2746	1556	2354	1611	1733	555	466	.53	.26			
21	29	6	3204	2197	2472	3296	1464	2197	1166	2200	777	400	.36	.30			
22	33	6	3021	2197	2014	2856	1556	2040	1277	1600	666	466	.22	.26			
23	37	5	4303	3076	4211	4394	2288	2511	1722	2400	888	400	.22	.26			
24	41	6	2380	1538	2197	2307	1007	1412	1111	1133	388	266	.13	.20			

TABLE IX (Continued)

VOYAGE 04 EASTBOUND
TAPE 22 RECORDER #2

"B" MODE MAXIMUM PEAK-TO-TROUGH SIGNAL VALUE (psi)

Index No.	Interval No.	Sea State	AR ₁ A	AR ₁ B	AR ₁ C	AR ₂ A	AR ₂ B	AR ₂ C	AR ₃ A	AR ₃ B	AR ₃ C	AR ₄ A	AR ₄ B	AR ₄ C
1	2	4	1896	4015	1003	2141	526	903	2788	1330	537	1873	669	669
2	6	3	4015	8030	1896	3346	1535	1806	4572	2409	1003	3078	1115	936
3	10	4	8030	11242	3457	5755	2598	3513	7361	4015	1673	5353	1673	1606
4	14	6	10038	12447	4349	8298	3306	5019	10595	5487	2007	7896	2453	2409
5	18	7	12491	14990	5799	11777	5904	8130	10930	9770	2899	10305	3234	2944
6	22	8	12268	18336	6022	10439	4723	6926	12268	8164	2788	11242	3680	3613
7	26	7	6134	12580	2788	5353	2361	3011	6915	3747	1449	4818	1673	1606
8	30	7	8699	13380	3011	8164	3542	4316	10818	5353	1673	6825	2007	2007
9	34	6	6468	11644	2899	7093	2716	2911	9368	4684	1338	6424	2007	1873
10	38	7	6580	11777	2230	5219	2598	2107	6692	3747	1338	5487	1673	1606
11	42	7	5799	9904	2585	6290	2598	3513	7807	4282	1003	4282	1338	1338
12	46	6	6692	10439	2230	4684	2243	3412	5911	3346	1449	3613	1338	1472
13	50	5	6245	12045	2788	6692	2479	3714	7807	4684	1561	3747	1784	1338
14	54	5	5799	8030	2565	5755	2119	2868	7138	3747	1236	4416	1449	1472
15	58	5	5688	10573	3011	5353	2119	3346	6245	3613	1338	3078	1561	1472
16	62	5	6357	10573	2342	5621	1896	2294	6692	3613	1449	4282	1338	1472
17	66	5	4684	8967	2788	5353	2119	3350	6022	3479	1115	3479	1115	1338
18	70	4	3650	8298	2230	5487	1561	2581	6692	3613	1115	3078	892	936
19	74	4	3792	5219	1449	3479	1449	2007	4126	2007	669	2275	892	803
20	78	5	4238	6156	1784	4684	1673	2294	5799	3212	892	2676	893	936
21	82	6	3457	6424	1784	4282	1784	2485	5019	2944	780	2542	780	803
22	86	6	2788	6022	1449	3479	1449	2007	4126	2275	669	1873	780	803
23	90	5	4684	7227	2342	5085	2230	3059	6022	3479	892	2409	1003	803
24	94	6	2453	4952	892	2944	1226	1338	3680	1873	669	2275	669	803

TAPE 24 RECORDER #2

TABLE IX (Continued)

VOYAGE 04 EASTBOUND
TAPE 22 RECORDER #2

"C" MODE
MAXIMUM PEAK-TO-TROUGH SIGNAL VALUE (psi)

Index No.	Interval No.	Sea State	R _{1A}	R _{1B}	R _{1C}	R _{2A}	R _{2B}	R _{2C}	R _{3A}	R _{3B}	R _{3C}	R _{4A}	R _{4B}	R _{4C}
1	3	4	2342	1338	557	2141	1417	502	-	803	669	1204	780	535
2	7	3	2899	1738	669	4015	2834	602	-	1338	1003	1606	1115	803
3	11	4	4507	2676	892	8565	6022	903	-	2810	1673	3212	1338	1070
4	15	6	9034	4282	1561	13517	8857	1606	8922	4149	2453	5621	2453	1739
5	19	7	9480	4149	1784	11911	8975	1606	8922	4282	2676	5353	2453	1739
6	23	8	10372	5487	1896	14856	10864	1706	9034	4818	3122	6825	3011	2275
7	27	7	12268	4952	1449	13250	9447	2007	6915	4149	3569	5487	2342	1739
8	31	7	9926	4952	1449	12714	8857	1806	7026	4015	2788	4550	2119	1739
9	35	6	9257	3831	1226	9636	7403	1505	5465	3078	2565	3747	1784	1472
10	39	7	1561	936	1784	1606	2598	1204	3346	5353	1784	4416	2565	1338
11	43	7	1896	936	2119	1739	3306	1003	2899	4952	2007	3613	2342	1204
12	47	6	1896	936	2007	1472	3306	1204	2899	4818	2230	4416	2899	1338
13	51	5	1896	1070	2230	7007	3306	1003	3346	5755	1784	4952	2342	1204
14	3	5	1784	803	2230	1873	3122	956	2899	4684	1896	3881	2230	1070
15	7	5	1561	936	1896	1472	2342	1051	3234	6022	1673	4416	2453	1070
16	11	5	1338	936	1338	803	1673	764	-	3346	1115	3747	1115	1070
17	15	5	1561	936	1226	1070	2119	860	-	2810	1226	3747	1226	1070
18	19	4	1338	1204	1003	803	1896	764	-	3078	892	4282	1003	1070
19	23	4	1338	803	669	803	1561	573	-	2542	892	2810	1003	669
20	27	5	1338	803	892	803	1784	573	-	2409	1338	2810	892	803
21	31	6	1561	1070	669	803	2007	573	-	2676	1226	2409	1003	669
22	35	6	1449	1070	780	803	1673	669	-	2810	1115	2810	892	803
23	39	5	1896	936	1226	936	2676	669	1226	2944	1338	2676	1003	936
24	43	6	1226	669	669	803	1338	573	1115	2007	1003	2810	669	803

TAPE 24 RECORDER #2

TABLE IX (Continued)

VOYAGE 04 EASTBOUND
TAPE 22 RECORDER #2
MAXIMUM PEAK-TO-TROUGH SIGNAL VALUE (psi)

"D" MODE

Index No.	Interval No.	Sea State	MAXIMUM PEAK-TO-TROUGH SIGNAL VALUE (psi)															
			TGFS-1	TGFS-2	TGFS-3	TGFS-4	TGMS-1	TGMS-2	TGMS-3	TGMS-4	TGAS-1	TGAS-2	TGAS-3	TGAS-4				
1	4	4	2007	1873	1115	2007	2125	1806	1226	2409	1115	1070	1226	1472				
2	8	3	5242	3881	1784	4149	3306	2810	1673	4282	2788	2275	2230	2810				
3	12	4	5353	5487	3011	7361	6022	4416	3346	6959	3792	3212	2788	4015				
4	16	6	6692	9502	5576	12545	8620	6825	5019	10841	6580	5353	4349	6156				
5	20	7	9814	9101	3680	12714	8575	6022	4684	9636	8141	6558	4572	6959				
6	24	8	14945	5904	6468	13785	12399	8030	5799	11510	7584	6022	4907	6959				
7	28	7	11153	8833	4684	10305	7794	5420	3903	7495	5019	4015	5755	5755				
8	32	7	8365	5621	4126	8030	6495	4215	3346	6692	3903	2844	2788	2544				
9	36	6	7361	4952	3011	6959	7321	4316	3792	7628	3349	3078	2676	3613				
			HLSS-1		HLSS-2		HLSS-3		HLSS-4		TGMS-1X		TGMS-2X		TGMS-3X		TGMS-4X	
10	40	7	3011	3881	3234	4282	2834	803	780	1070	2899	2810	3457	4684				
11	44	7	3903	4684	3903	4952	2834	803	892	1070	4238	3212	3569	4684				
12	48	6	3792	4550	3680	4282	3188	803	1003	803	5576	4282	3569	5487				
13	52	5	2899	4149	3792	4684	3070	803	892	1070	4461	4149	3680	5353				
			TGFS-1		TGFS-2		TGFS-3		TGFS-4		TGSS-1X		TGSS-2X		TGSS-3X		TGSS-4X	
14	4	5	3011	3747	3680	3881	3457	764	892	936	3792	3212	2453	3479				
15	8	5	3346	4149	4461	4416	3569	669	892	936	3569	3747	3011	4149				
16	12	5	7138	5888	3011	7093	1277	1714	1388	2133	5242	4149	3569	5487				
17	16	5	7138	4416	2788	6022	1166	1285	1055	1933	3903	2342	3747	3747				
18	20	4	6803	4684	2899	5888	1388	1285	888	2066	2565	2007	2342	3312				
19	24	4	6803	4818	2788	6022	1055	1142	944	1666	2565	2542	1896	2944				
20	28	5	5019	4550	3234	6959	1166	857	833	1866	2676	3346	1784	2409				
21	32	6	5688	3747	3122	6692	1333	857	944	2133	3680	2810	1896	3078				
22	36	6	6468	4282	2899	6959	1166	714	777	2000	2899	2141	1561	2141				
23	40	5	5465	3613	2788	5888	1166	666	833	2000	3903	2810	1449	2676				
24	44	6	4238	2944	2119	4684	1111	571	722	1533	2453	2409	1673	2409				

TABLE 24 RECORDER #2

TABLE IX (Continued)

VOYAGE 04 WESTBOUND
TAPE 26 RECORDER #2

Sheet 5 of 8
(G's)

MAXIMUM PEAK-TO-TRough SIGNAL VALUE (psi)

"A" MODE

Index No.	Interval No.	Sea State	LSTS	LSNS	LSRS	LSIP	LSMP	LSDP	SAP	SAS	BGST	BGSB	FWD HOUSE VERTICAL	FWD HOUSE TRANS.
1	1	7	1854	659	732	1098	640	863	555	666	222	200	.13	.10
2	5	7	3399	1867	1464	3076	1464	3060	1666	1400	666	400	.18	.18
3	9	8	5974	2746	1831	4724	2380	4708	2388	2333	611	599	.49	.16
4	13	9	16895	3076	9338	16919	2472	7847	7777	8399	1111	1066	1.07	.18
5	17	10	20806	5273	11261	17249	4852	8240	7777	8999	1355	1466	1.20	.30
6	21	10	16383	4944	10712	16809	4669	9181	7222	9666	1611	1133	.93	.36
7	25	10	17510	4724	13550	16919	3936	8318	8611	8999	1777	999	1.20	.30
8	29	10	15141	3735	10328	17029	4028	8867	6722	8466	1388	1133	1.11	.28
9	33	9	10815	4394	7599	11755	4120	5100	4388	5599	1333	866	.89	.30
10	37	5	9064	4394	8972	12854	4120	6748	5277	5733	1722	799	.98	.34
11	41	4	7416	3296	4577	7141	2563	2982	3111	3666	833	733	.80	.30
12	45	5	3914	2866	3662	4284	2197	3060	1944	1933	777	466	.53	.44
13	49	7	5562	3735	5676	6921	2929	4080	2611	3000	1111	599	.74	.60
14	53	7	6386	5493	6317	9887	3753	5493	3222	3333	1722	666	.49	.90
15	57	8	5768	3296	5493	8459	2838	4551	3333	3600	944	599	.53	.62
16	61	7	6695	4504	6042	9338	3479	4002	3388	3600	1111	599	.40	.52
17	65	7	7107	3186	4760	7800	2563	5100	3666	2600	1000	666	.27	.56
TAPE 28 RECORDER #2														
18	1	7	6500	3405	5035	7622	3112	3221	2777	3333	1055	599	.22	.42
19	5	7	4944	2417	3662	7416	1831	2254	3277	3666	722	533	.13	.46
20	9	7	6134	4724	4028	4738	3753	6367	3055	3466	1055	666	.49	.40
21	13	5	11352	5163	4028	9476	3622	6891	5111	5133	1000	1133	.80	.36
22	17	4	8056	3625	6408	9064	2838	5168	3777	4600	1222	1133	.58	.36
23	21	3	6225	2746	4303	7210	2380	3071	2555	2666	1111	533	.58	.40
24	25	7	4577	2966	2746	4429	2014	2621	2555	2600	833	599	.44	.38
25	29	9	9979	3515	5676	9682	2929	5693	5555	6199	1277	1200	.27	.54
26	33	9	10437	4065	7599	13493	3753	5618	6111	6666	1777	1133	.49	.64
27	37	10	9979	6152	8972	12669	5035	7715	6055	6733	1888	666	.94	.94
28	41	10	9979	5163	7690	15450	2288	6891	5666	6333	1277	999	.53	.68
29	45	10	5493	4504	6042	8034	1648	4494	3333	4000	1333	533	.53	.52
30	49	8	3479	3296	3845	4635	3570	2322	1277	2333	888	533	.31	.28
31	53	5	3021	2197	2288	2575	3936	1573	888	1333	555	400	.22	.24
32	57	5	1556	1648	1281	1339	1007	1348	833	999	388	466	.22	.24

TABLE IX (Continued)

VOYAGE 04 WESTBOUND
TAPE 26 RECORDER #2

Sheet 6 of 8

"B" MODE

MAXIMUM PEAK-TO-TROUGH SIGNAL VALUE (psi)

Index No.	Interval No.	Sea State	AR ₁ A	AR ₁ B	AR ₁ C	AR ₂ A	AR ₂ B	AR ₂ C	AR ₃ A	AR ₃ B	AR ₃ C	AR ₄ A	AR ₄ B	AR ₄ C
1	2	7	1380	2275	669	1070	557	573	1338	803	334	732	466	401
2	6	7	4391	6424	1873	3747	1449	1912	4238	2542	892	2509	780	936
3	10	8	4015	7361	1873	2676	1115	1720	3569	2007	2788	2258	669	803
4	14	9	15809	22083	3457	15391	6468	7074	15057	10707	2788	12547	4461	4015
5	18	10	14555	22217	4349	16462	7138	6883	18291	11510	2452	12296	4572	3881
6	22	10	12547	21146	4461	17131	7361	6883	18403	12045	2343	11920	4238	3479
7	26	10	14304	22217	3457	16328	8365	8317	18960	13651	2230	11543	3903	3747
8	30	10	11794	20911	3466	15926	6803	7074	18626	10974	2342	12171	4349	3747
9	34	9	12672	16997	3234	16462	7026	6022	18960	11108	1673	10665	3569	3479
10	38	5	7026	13517	3011	12447	4684	4588	16395	8565	1226	7653	2788	2542
11	42	4	6022	10573	2342	6538	2788	3250	8030	4550	1338	3387	1226	1204
12	46	5	5646	9234	2565	5621	2230	3346	7138	3881	1276	3136	1338	1304
13	50	7	8155	14187	3011	6558	2899	3919	8365	4932	1673	4642	1673	1472
14	54	7	6901	12045	3122	7361	3122	4302	9257	5353	1449	4391	1561	1606
15	58	8	7904	15257	4126	8030	3680	4971	10484	5621	1896	4642	1449	1472
16	62	7	7030	13651	2899	6692	3122	4397	9480	4684	1784	4642	1673	1338
17	66	7	808	15123	3903	7093	3346	3537	8922	7495	1561	4893	4572	1739
18	2	7	6803	15793	3457	7152	3346	4380	9480	5353	1673	4391	1449	1472
19	6	7	9480	20879	4572	7277	3346	6022	9368	5219	2230	5395	1673	1739
20	10	7	8141	17666	3346	8155	3346	3741	11487	6022	1561	6148	2119	2007
21	14	5	9034	16060	4015	7328	3346	5110	9591	5219	1673	5144	1784	1472
22	18	4	5242	10573	2565	5646	2565	2920	7918	4149	1226	3889	1561	1070
23	22	3	4238	8565	2453	4266	1673	2098	5799	2810	1115	3011	1115	1070
24	26	7	8609	18202	4461	8281	3680	5110	10038	6022	2342	5897	2007	2007
25	30	9	11034	23957	5353	12547	4907	5292	17399	9368	2453	9159	2788	3078
26	34	9	12603	23020	4372	12045	5576	6387	16395	8164	2676	7904	3122	2944
27	38	10	11487	22083	4572	11669	2565	4197	15280	8565	1896	5897	2565	2007
28	42	10	7918	17533	4461	7403	1338	4927	11153	5888	1561	4768	1561	1338
29	46	10	4795	9770	2342	5019	4349	3376	6134	3881	1226	2007	1338	936
30	50	8	2565	6022	1226	2634	3903	1551	3122	2007	892	1505	780	803
31	54	5	1673	3346	892	1882	892	1186	2119	1472	669	1505	669	669
32	58	5	1673	3346	892	1882	892	1186	2119	1472	669	1505	669	669

TAPE 28 RECORDER #2

TABLE IX (Continued)

VOYAGE 04 WESTBOUND
TAPE 26 RECORDER #2

"C" MODE MAXIMUM PEAK-TO-TROUGH SIGNAL VALUE (psi) Sheet 7 of 8

Index No.	Interval No.	Sea State	R _{1A}	R _{1B}	R _{1C}	R _{2A}	R _{2B}	R _{2C}	R _{3A}	R _{3B}	R _{3C}	R _{4A}	R _{4B}	R _{4C}
1	3	7	3011	1204	446	2409	2119	573	1338	936	892	1254	669	535
2	7	7	4768	2007	892	4015	3680	956	2342	1472	1338	2509	1449	936
3	11	8	10038	4684	1338	9234	6357	1434	4795	2676	4015	4266	2330	1606
4	15	9	8406	2810	2007	9502	5799	2390	6915	2944	1896	5771	1896	2007
5	19	10	15558	8030	3457	12447	7807	3728	7472	3613	4795	6524	4015	2409
6	23	10	12547	6692	2230	11376	8253	2963	5465	3881	3903	6273	2899	2542
7	27	10	12547	5487	2119	12179	8141	2963	6468	3881	3346	6273	2119	2275
8	31	10	11041	4684	1896	9368	6915	2103	4907	3078	2565	4768	2342	1338
9	35	9	13672	5487	1784	10171	7695	2007	5353	3346	2453	4015	2119	1338
10	39	5	13927	5621	1449	12714	8588	1912	6915	4015	3346	4391	2342	1472
11	43	4	13551	5621	1449	13384	9034	1720	7026	4015	3346	4391	2342	1739
12	47	5	2509	3881	1338	3747	6022	2390	3903	3346	1449	3513	2676	1204
13	51	7	3262	6825	1784	4684	7584	3250	5353	4416	1673	4015	3346	1338
14	55	7	2760	5487	1561	4684	6915	2868	5353	4015	1449	3513	3011	1070
15	59	8	2760	4952	1673	5755	8922	3346	5376	4282	1449	3136	2342	1204
16	63	7	2258	4416	1673	4015	6915	3134	3680	3212	1784	3513	2342	1070
17	67	7	2007	3881	1673	3881	6468	2676	4126	3212	1784	4266	2230	1739
18	3	7	2007	4550	1561	4015	6468	3011	4795	3346	1561	3513	2676	1338
19	7	7	1338	3747	1226	2007	3346	1277	-	1873	1784	5897	2007	2007
20	11	5	1449	2844	1561	2634	4349	1551	-	2275	2230	6775	1673	2275
21	15	4	1338	3078	1115	1756	3792	1733	-	1873	1673	3889	1226	1472
22	19	3	892	1873	669	1505	3346	1186	-	1204	1115	3262	1115	1338
23	23	3	1226	2944	1003	1882	4015	1551	5130	1338	1338	4893	1338	1338
24	27	7	1561	3078	1784	3136	6022	1916	8365	2275	2230	6901	1784	2275
25	31	9	1449	3487	2342	3638	7695	1825	9703	2610	2676	8030	2453	2676
26	35	10	1449	6692	2119	3387	6134	1916	9480	2676	2676	7403	3122	2676
27	39	10	1449	5085	1784	2509	3346	2463	6468	2141	2119	5019	2230	2141
28	43	10	1115	4149	1115	2007	2119	2372	5242	1739	1115	4391	1784	1070
29	47	8	1115	3346	780	1380	5799	1642	3457	1338	892	1882	1338	1070
30	51	5	892	1873	557	1003	4126	1095	2230	936	892	1631	780	803
31	55	5	669	1070	446	1003	1226	730	1338	803	669	1756	669	803
32	59	5	669	1070	446	1003	1226	730	1338	803	669	1756	669	803

TAPE 28 RECORDER #2

VOYAGE 04 WESTBOUND
 TAPE 26 RECORDER #2
 TABLE IX (Concluded)
 MAXIMUM PEAK-TO-TROUGH SIGNAL VALUE (psi)

Sheet 8 of 8

"D" NODE

Index No.	Interval No.	Sea State	HLSS-1	HLSS-2	HLSS-3	HLSS-4	TGMS-1	TGMS-2	TGMS-3	TGMS-4	IGAS-1	IGAS-2	IGAS-3	IGAS-4
1	4	7	1882	1606	1673	1739	2230	1720	1226	2676	1896	1831	1549	2676
2	8	7	3764	3212	3122	4416	7584	6309	4572	9368	5576	4391	3909	5755
3	12	8	3764	4952	4907	4550	6692	3824	2788	5755	4572	3513	3792	4684
4	16	9	6324	6358	5911	6692	9703	6883	5242	11108	5576	5200	6022	7361
5	20	10	6324	6692	6580	6022	12157	9655	7807	16328	8365	6273	6022	7272
6	24	10	6148	7495	6803	5487	15057	8986	6468	13919	8476	6273	5911	6959
7	28	10	4140	5888	5465	4952	12491	7265	6022	13116	9591	6901	3792	6692
8	32	10	7528	10707	7249	7628	13941	9273	6915	15123	7249	6775	5576	7495
9	36	9	3889	7762	6468	6290	10372	6118	8030	10305	9480	7152	4684	7896
10	40	5	3638	5487	4349	4952	7918	5253	4126	8967	6915	5144	3457	5888
11	44	4	3387	4952	3903	4416	5576	3824	3122	6558	6022	4140	2230	4416
Index No.	Interval No.	Sea State	IGFS-1	IGFS-2	IGFS-3	IGFS-4	TGMS-1X	TGMS-2X	TGMS-3X	TGMS-4X	IGAS-1	IGAS-2	IGAS-3	IGAS-4
12	48	5	14555	8699	5019	11376	3011	860	780	1070	4349	3513	2453	3747
13	52	7	21958	13115	8141	15926	5242	956	1115	1204	5799	4391	2453	4282
14	56	7	16060	10439	5799	13517	4349	1147	892	1070	3457	3262	2899	3747
15	60	8	16939	10439	6580	15257	4461	1147	1115	1338	6357	4517	2788	4015
16	64	7	15057	10707	6022	14722	4126	1051	1115	1204	6692	4517	2899	4684
17	68	7	12547	8164	5019	11242	3680	956	1115	1204	5019	3513	2676	4282
Index No.	Interval No.	Sea State	HLSS-1	HLSS-2	HLSS-3	HLSS-4	TGSS-1X	TGSS-2X	TGSS-3X	TGSS-4X	IGAS-1	IGAS-2	IGAS-3	IGAS-4
18	4	7	11599	8565	4684	11041	3569	638	1115	936	4795	3011	2342	3613
Index No.	Interval No.	Sea State	HLSS-1	HLSS-2	HLSS-3	HLSS-4	TGSS-1X	TGSS-2X	TGSS-3X	TGSS-4X	IGAS-1	IGAS-2	IGAS-3	IGAS-4
19	8	7	5019	6692	6357	6022	1722	1772	2111	3666	7026	4893	4572	6692
20	12	7	3680	5755	4572	5144	2277	2000	2333	3200	6692	4893	4795	6959
21	16	5	4126	5755	4349	4266	1888	1409	1555	3200	5353	4768	3457	5085
22	20	4	2899	4952	3680	3513	1277	1500	1222	2000	4238	3262	2788	4015
23	24	3	3234	4015	3792	3638	1333	1318	1898	2000	3903	2509	2230	3479
24	28	7	4461	7762	7695	4768	2722	1909	3000	4066	7138	5269	5019	6156
25	32	9	6803	10305	8699	7152	2500	3181	2500	5466	7249	5395	6134	8599
26	36	9	7695	11108	11153	7026	2811	2611	2611	5199	6134	6524	7472	10171
27	40	10	5376	8164	7279	6901	1500	2045	2000	4466	7026	5019	3234	7227
28	44	10	4349	6424	5911	3395	1000	1863	1898	3933	5130	3764	2565	4282
29	48	10	3122	3881	2788	3011	2722	909	1166	2600	3680	3011	1673	3346
30	52	8	2007	2275	1449	1882	2222	454	722	1333	2230	2007	1449	2676
31	56	5	1115	1472	1784	1380	388	318	777	999	1561	1380	780	1338
32	60	5												

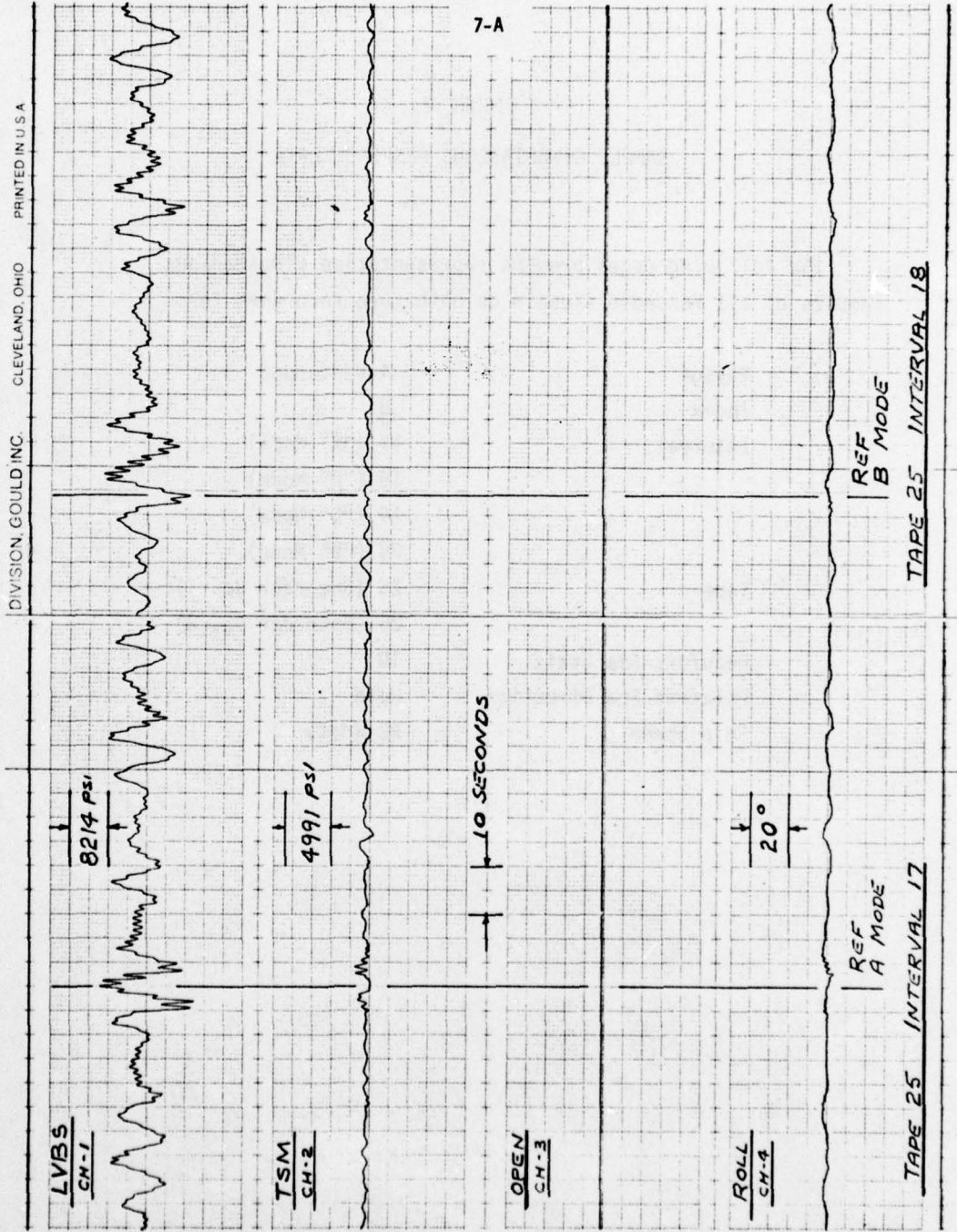
TAPE 28 RECORDER #2

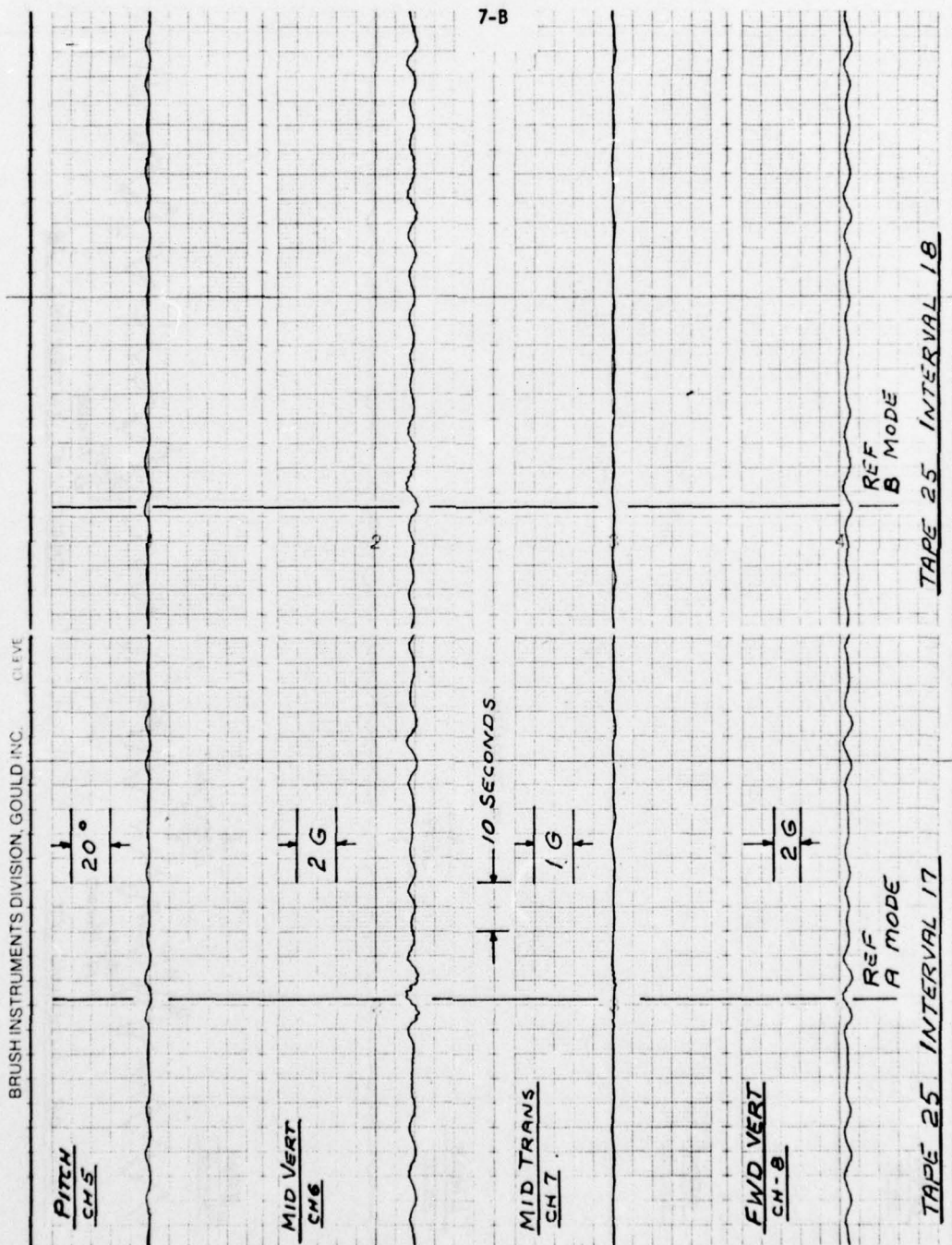
FIGURE 7
SAMPLE SIMULTANEOUS RESPONSE DATA

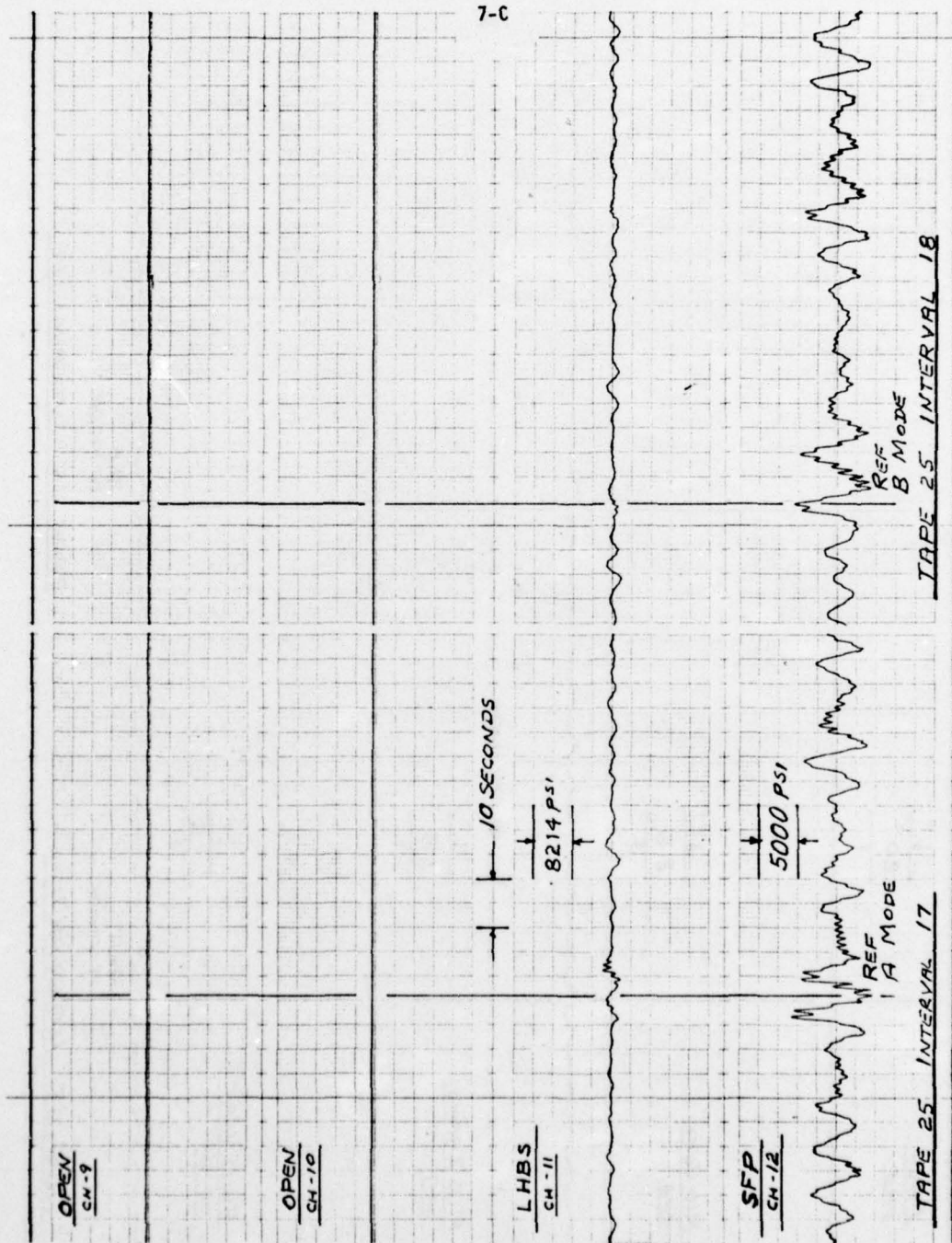
The following pages present representative simultaneous samples of all recorded signals on both tape recorders for:

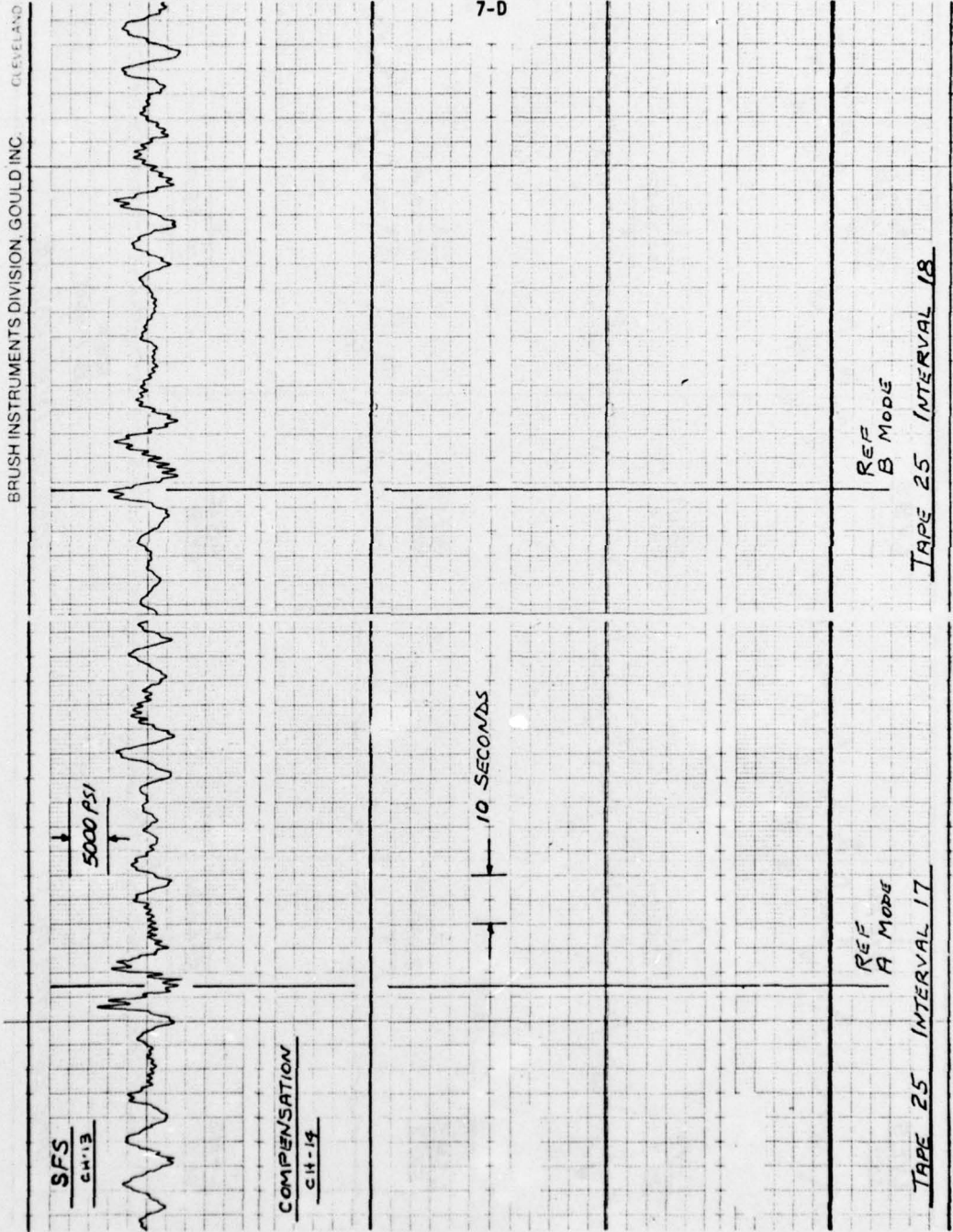
Voyage	4 Westbound
Index	5
Interval	17 ("A" Mode)
	18 ("B" Mode)
	19 ("C" Mode)
	20 ("D" Mode)
Tape	25 (Recorder No. 1)
	26 (Recorder No. 2)
Beaufort Sea State	10
Relative Sea Direction	Head
Ship Speed	22 Knots

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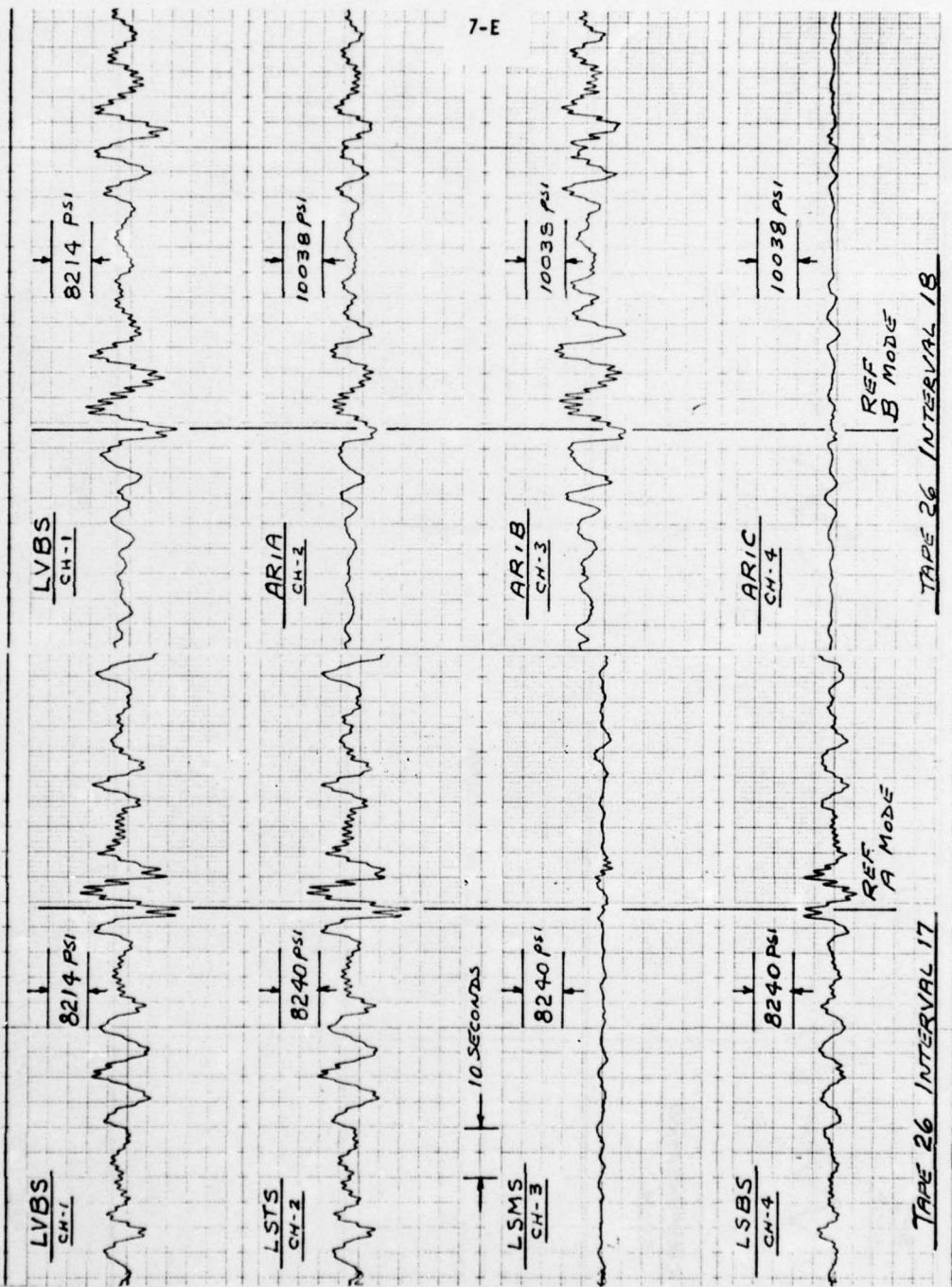


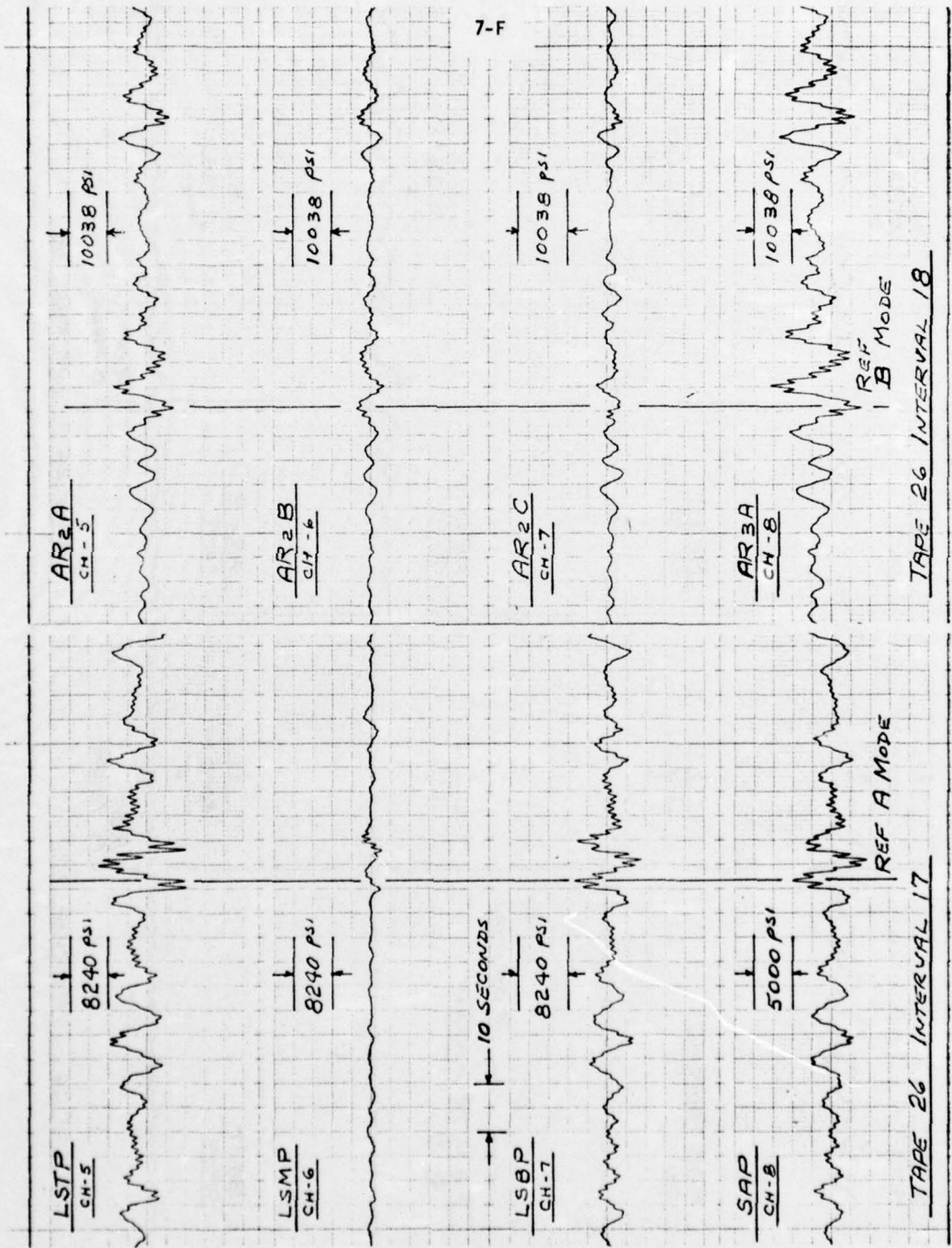


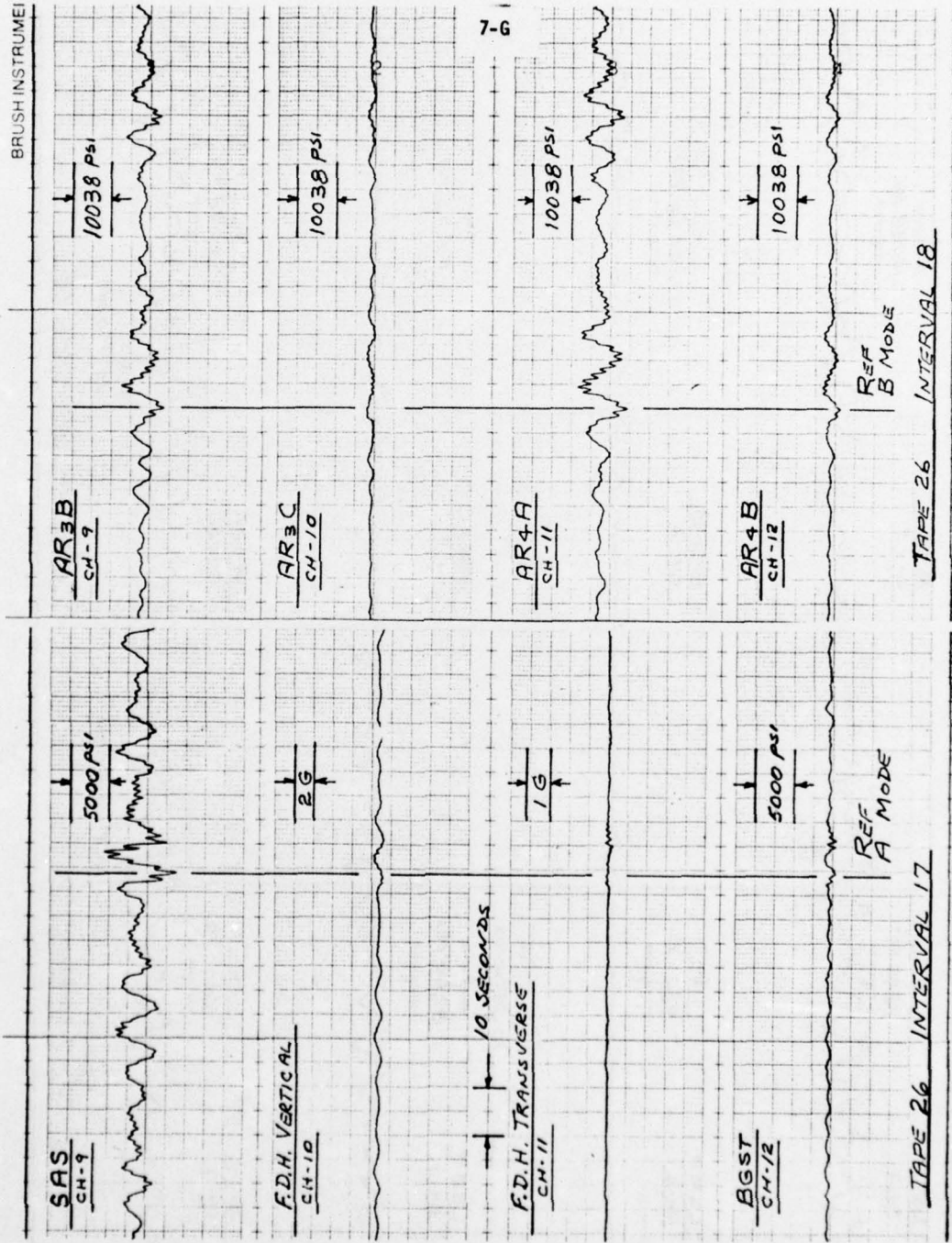




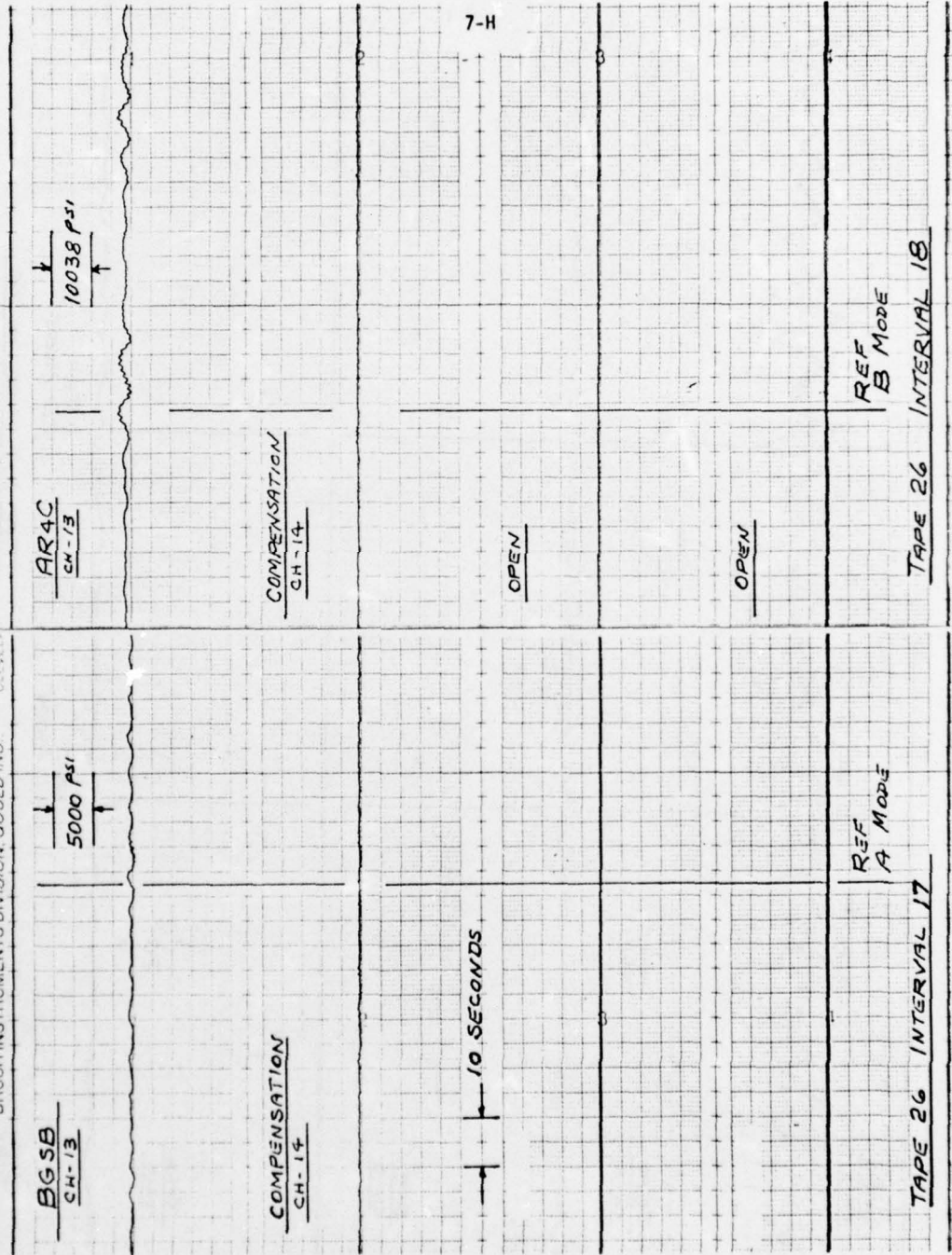
INSTRUMENTS DIVISION, GOULD INC. CLEVELAND, OHIO PRINTED IN U.S.A.

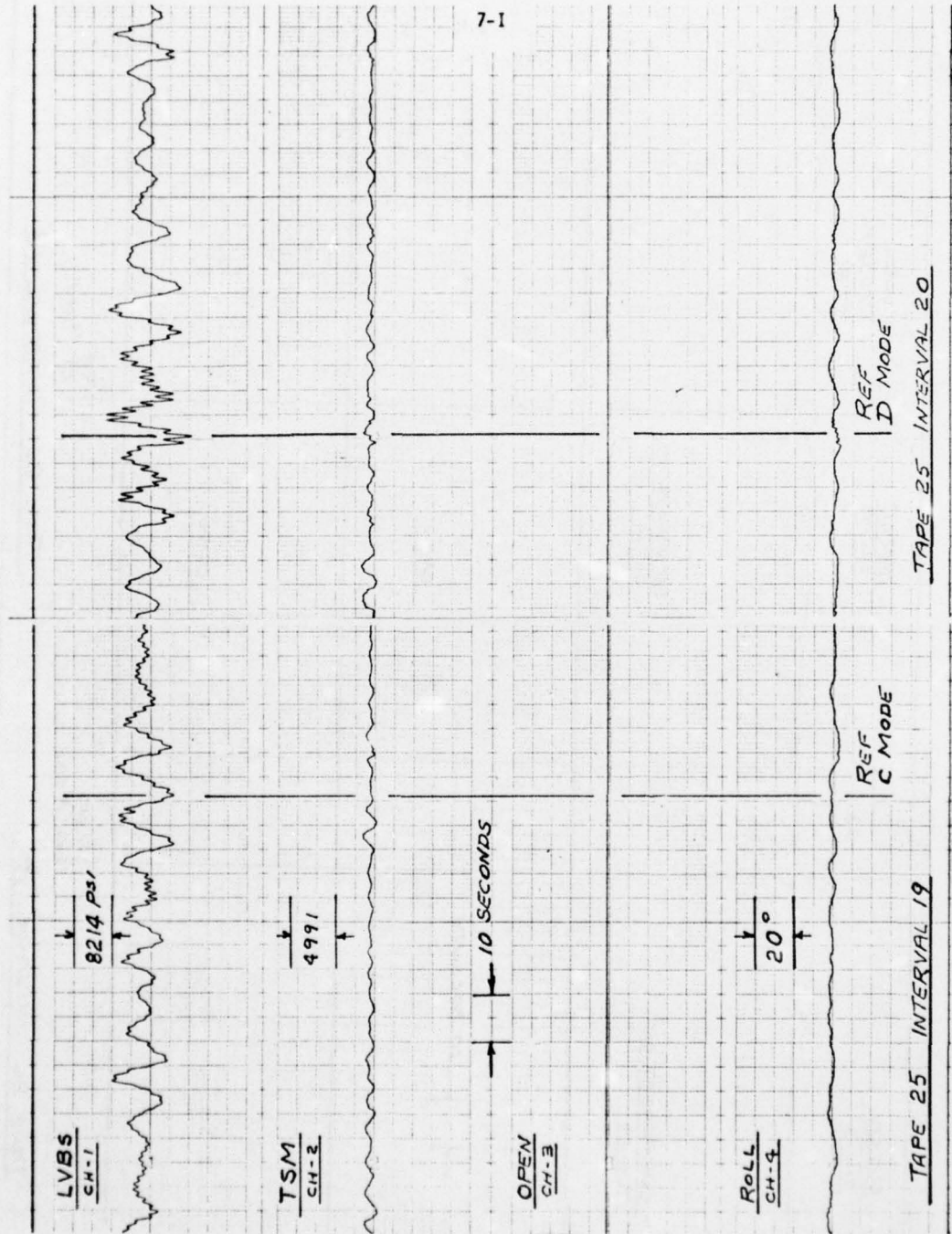




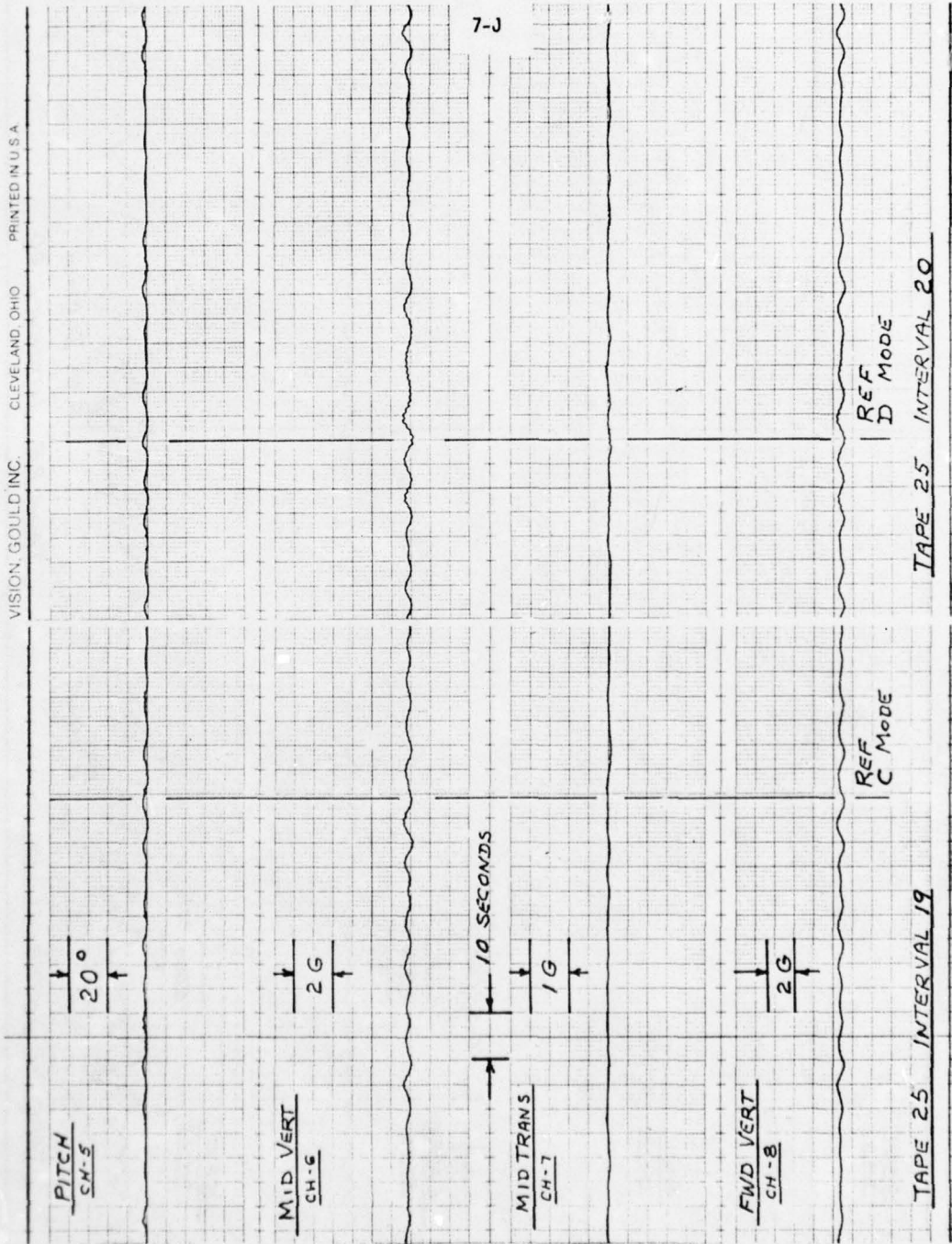


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BRUSH INSTRUMENTS DIVISION, GOULD INC

OPEN
CH 9

OPEN
CH 10

7-k

10 SECONDS

LHBS
CH 11

8214 PSI

SFP
CH 12

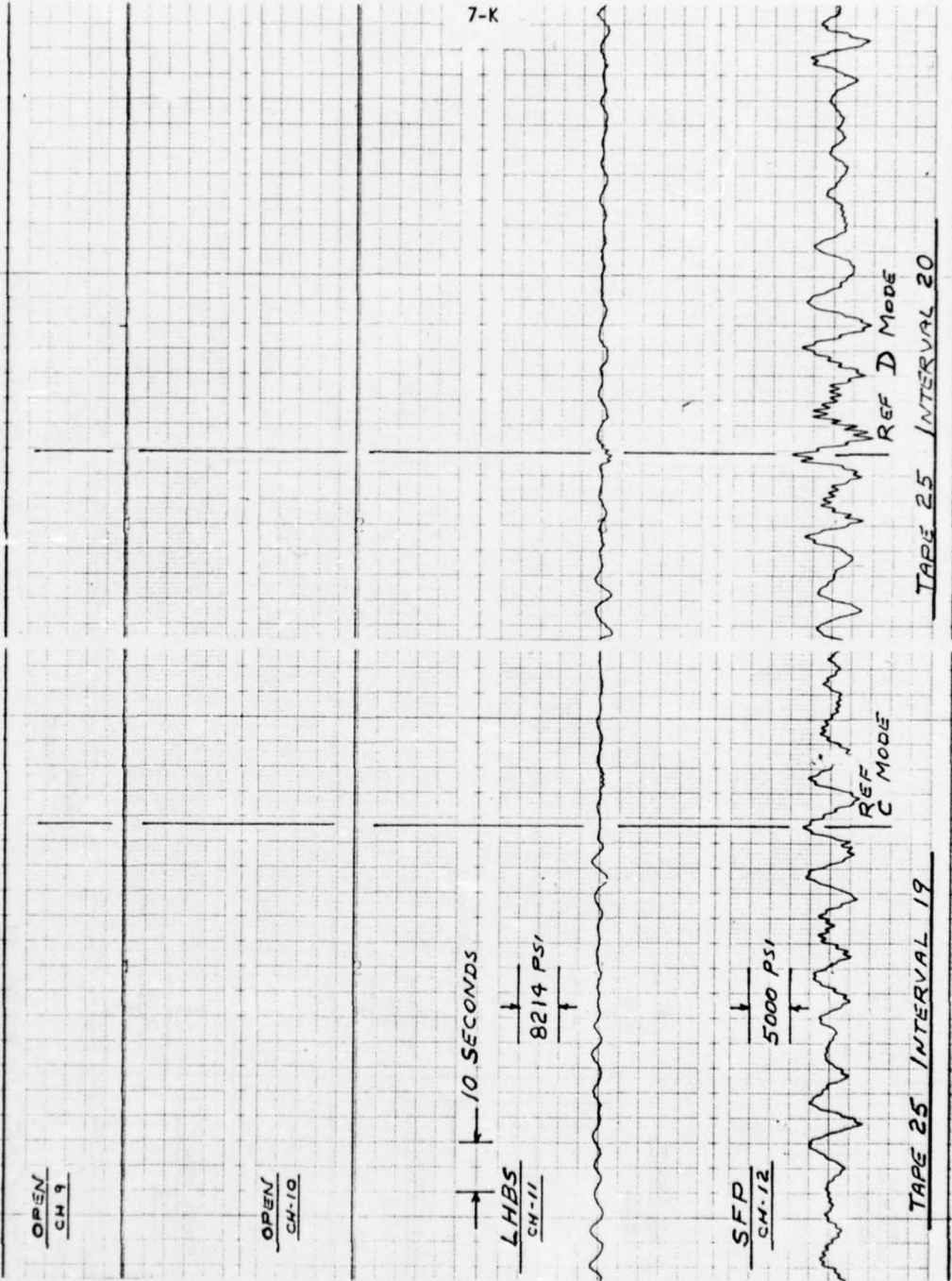
5000 PSI

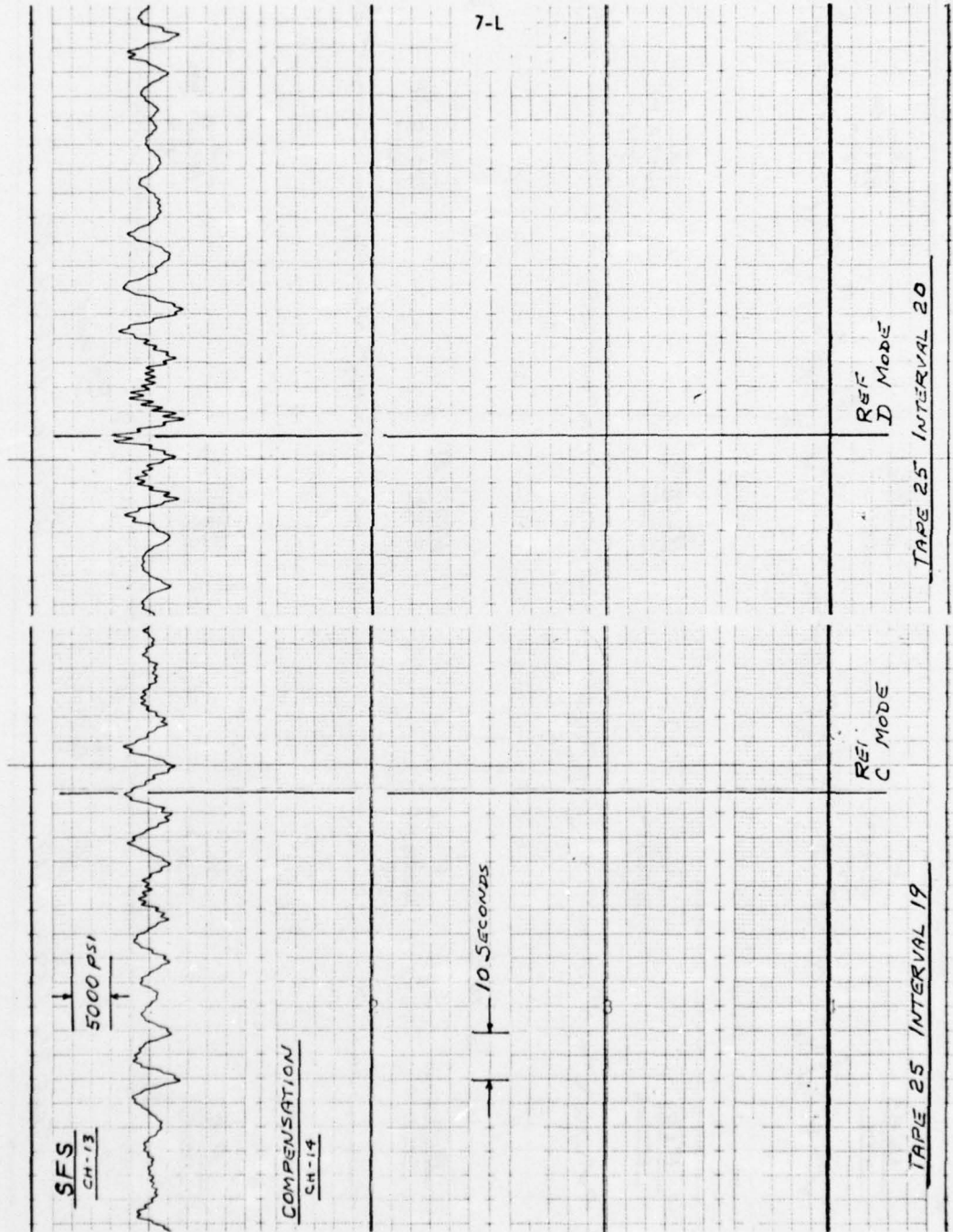
REF
C MODE

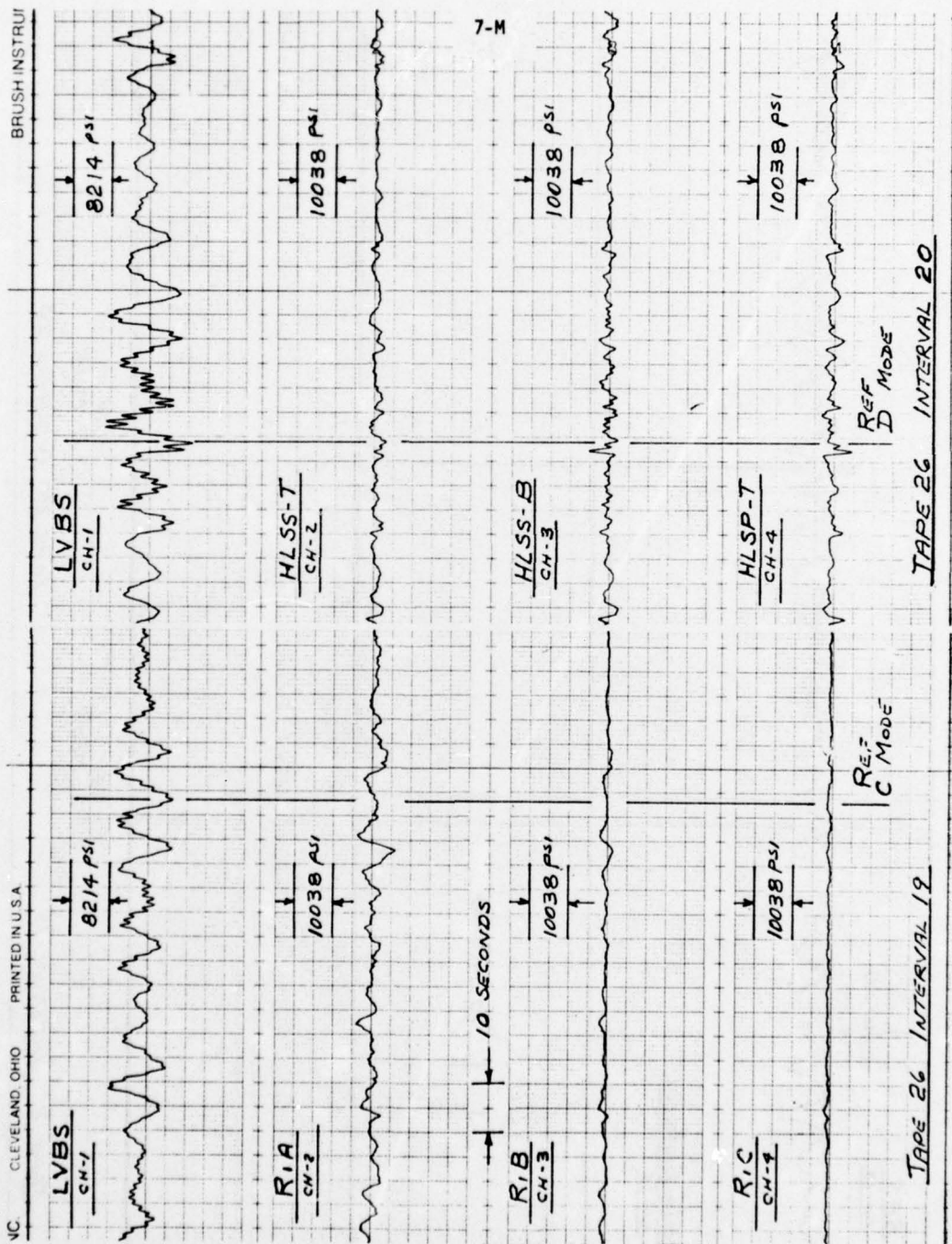
REF D MODE

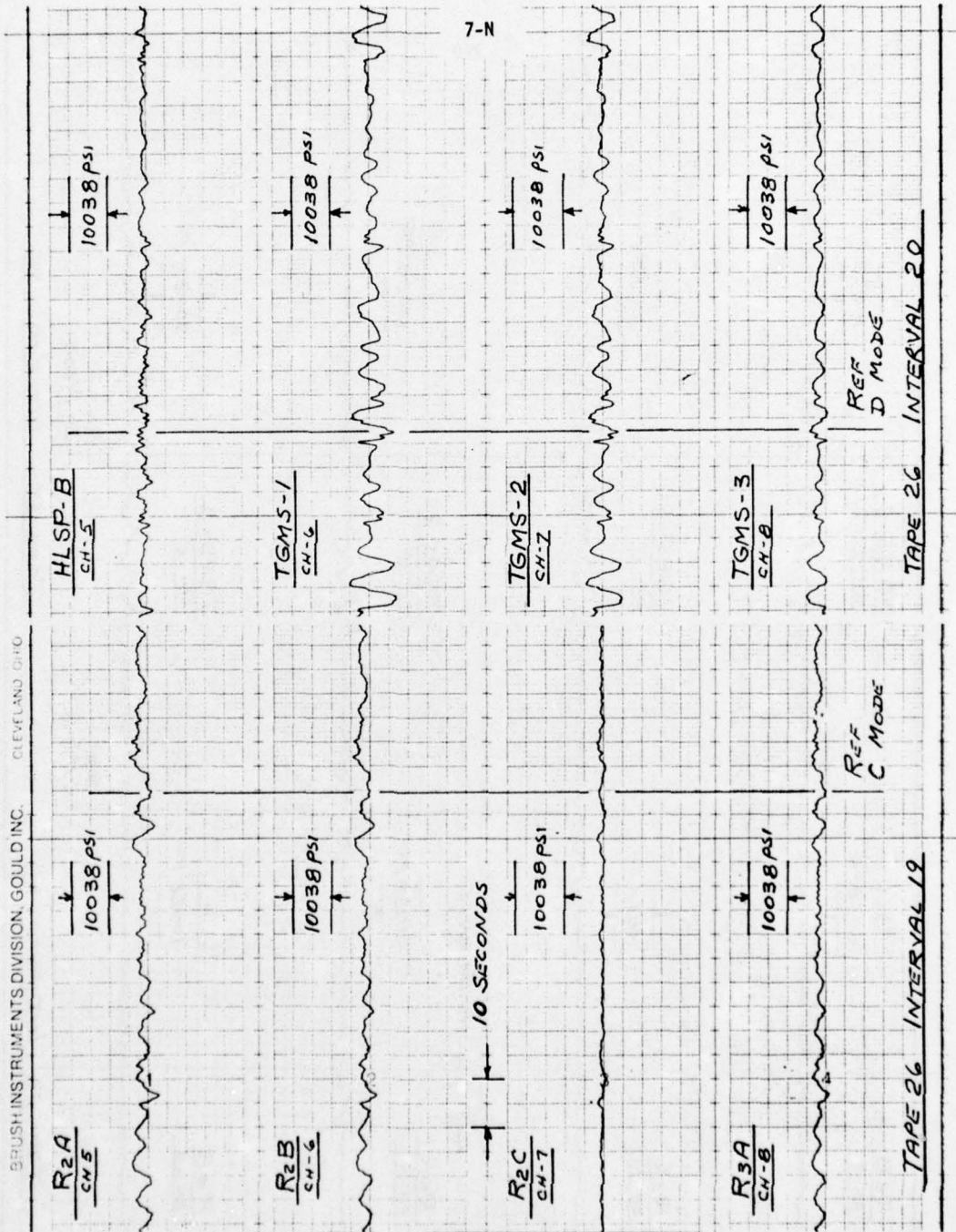
TAPE 25 INTERVAL 19

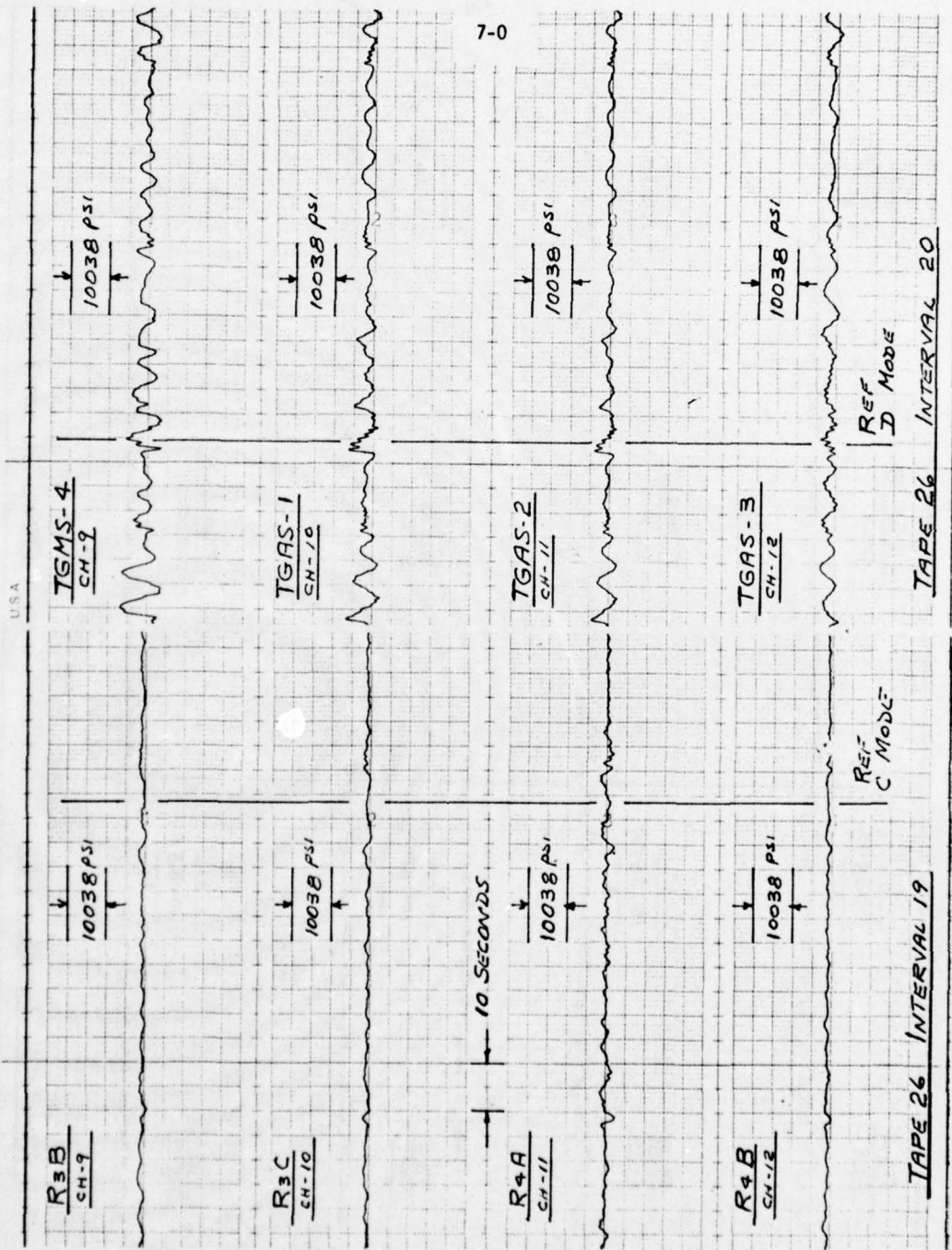
TAPE 25 INTERVAL 20











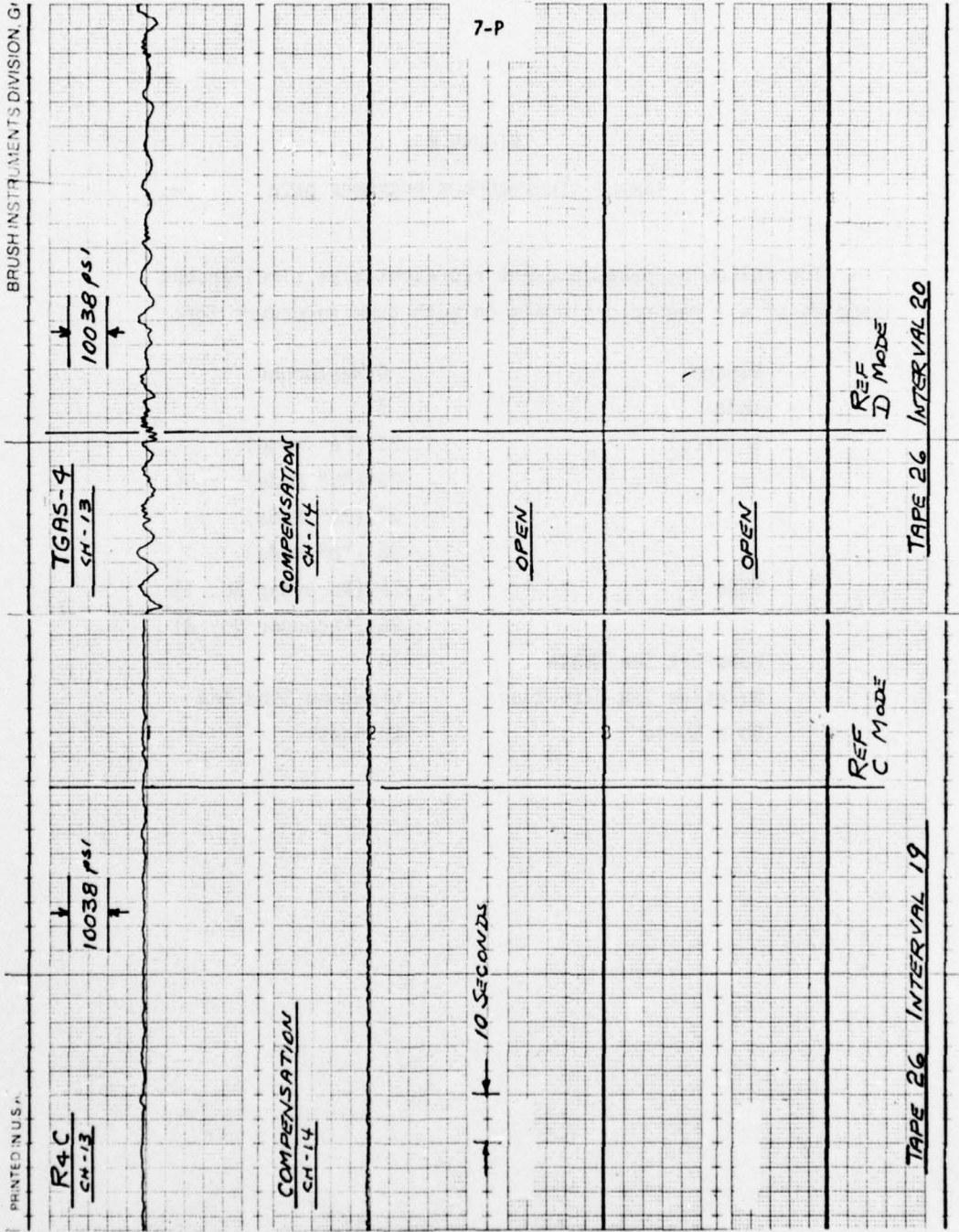
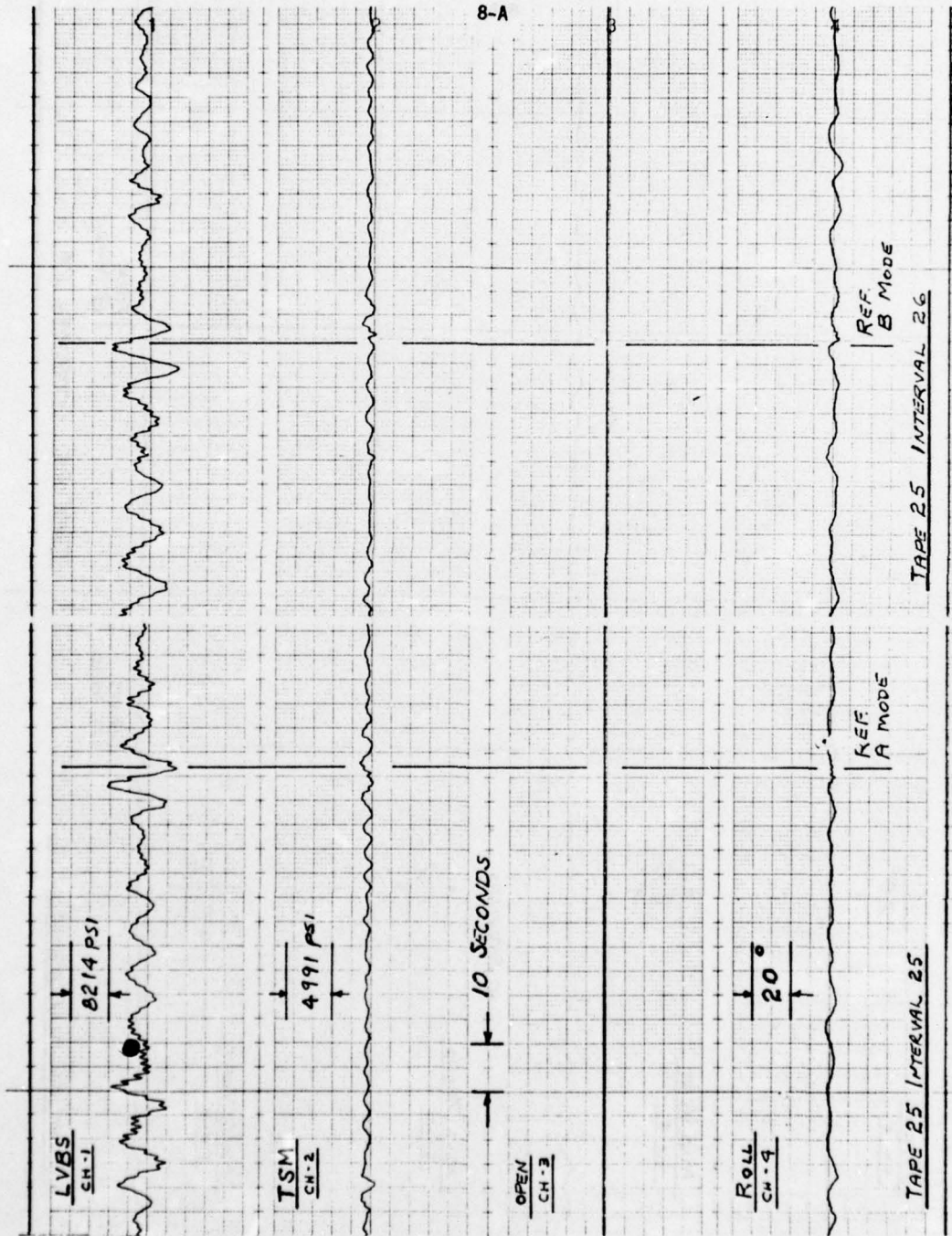


FIGURE 8
SAMPLE SIMULTANEOUS RESPONSE DATA

The following pages present representative simultaneous samples of all recorded signals on both tape recorders for:

Voyage	4 Westbound
Index	7
Interval	25 ("A" Mode)
	26 ("B" Mode)
	27 ("C" Mode)
	28 ("D" Mode)
Tape	25 (Recorder No. 1)
	26 (Recorder No. 2)
Beaufort Sea State	10
Relative Sea Direction	Broad on Stbd Bow
Ship Speed	20 Knots

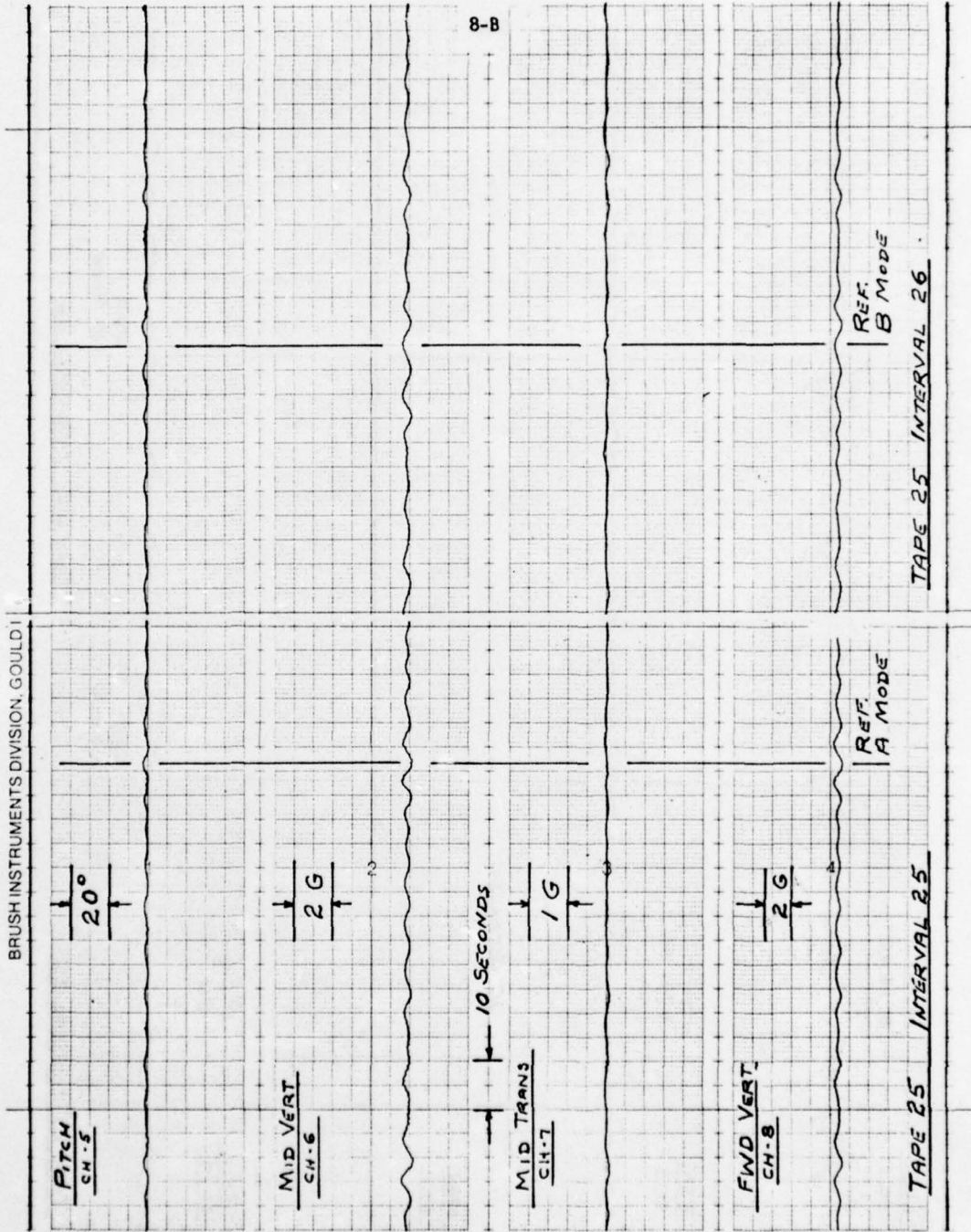


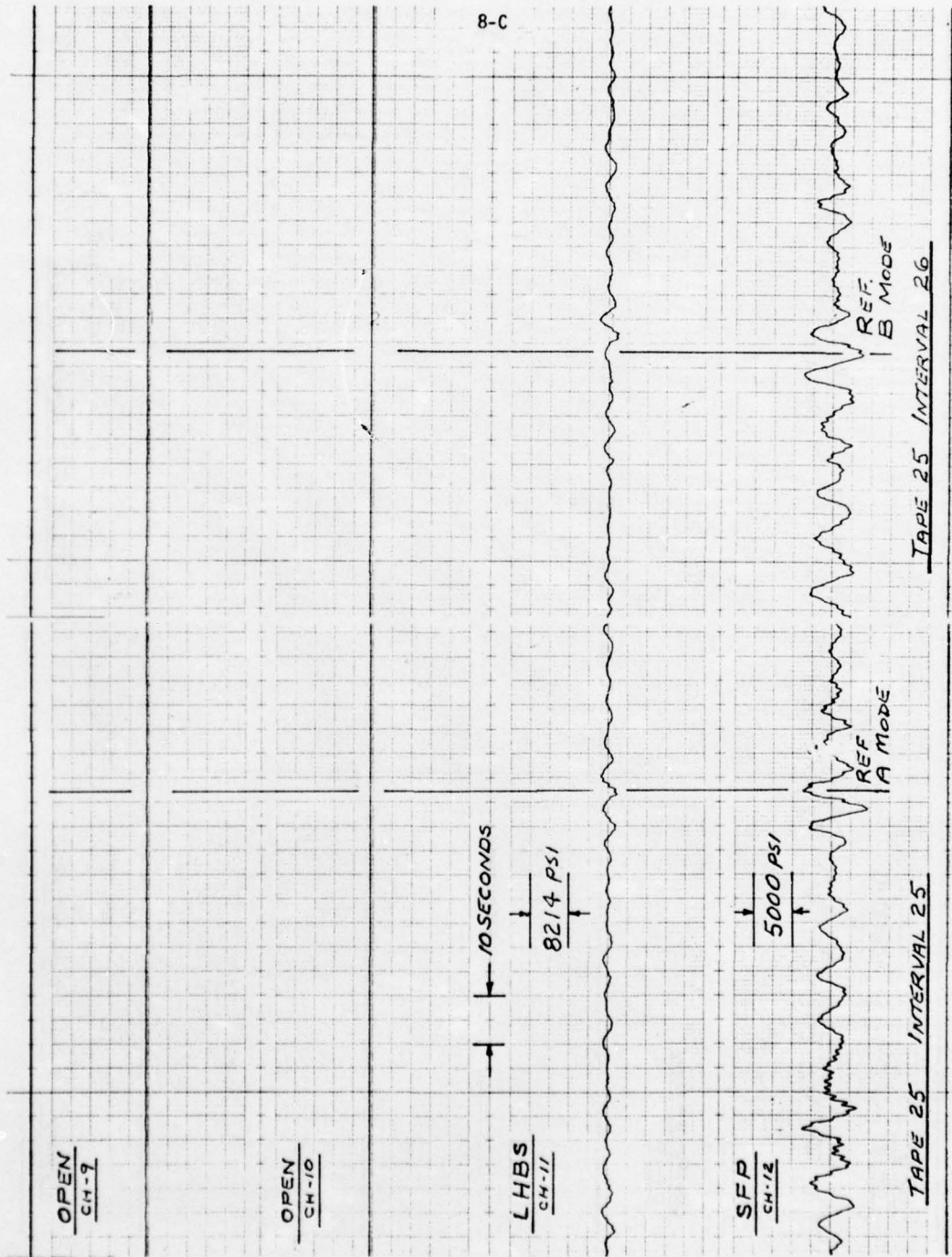
TAPE 25 INTERVAL 25

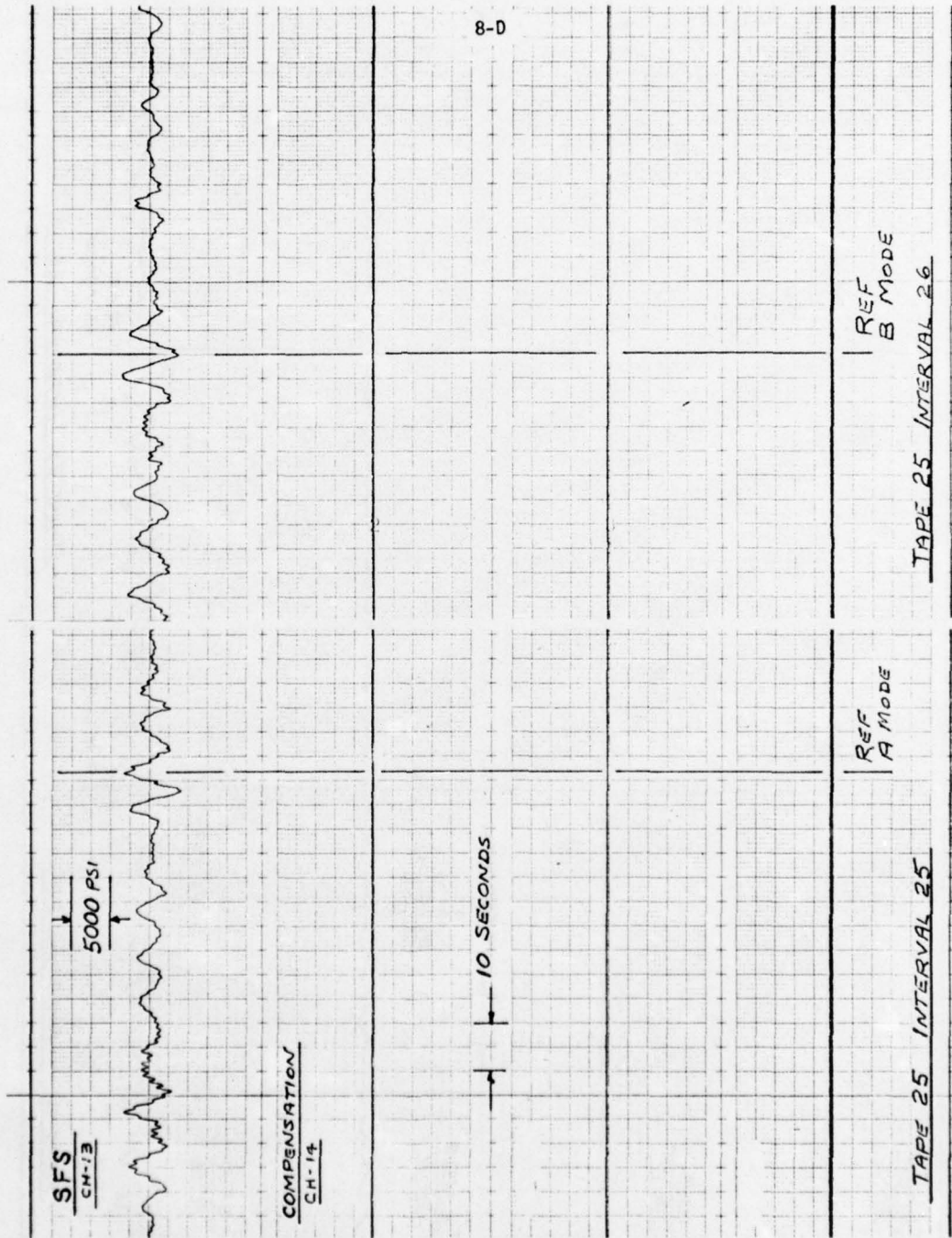
REF. B MODE

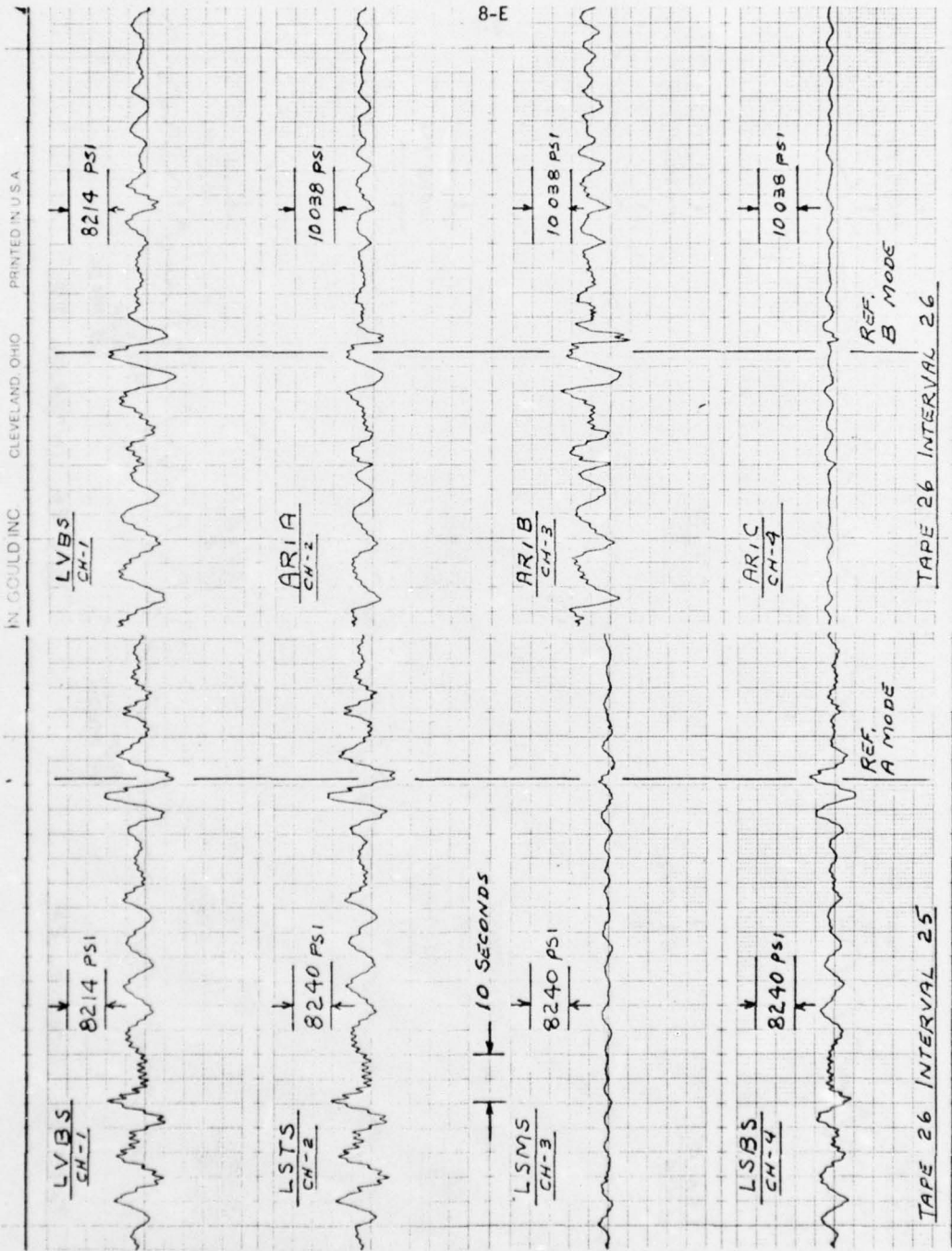
TAPES 25 INTERVAL 26

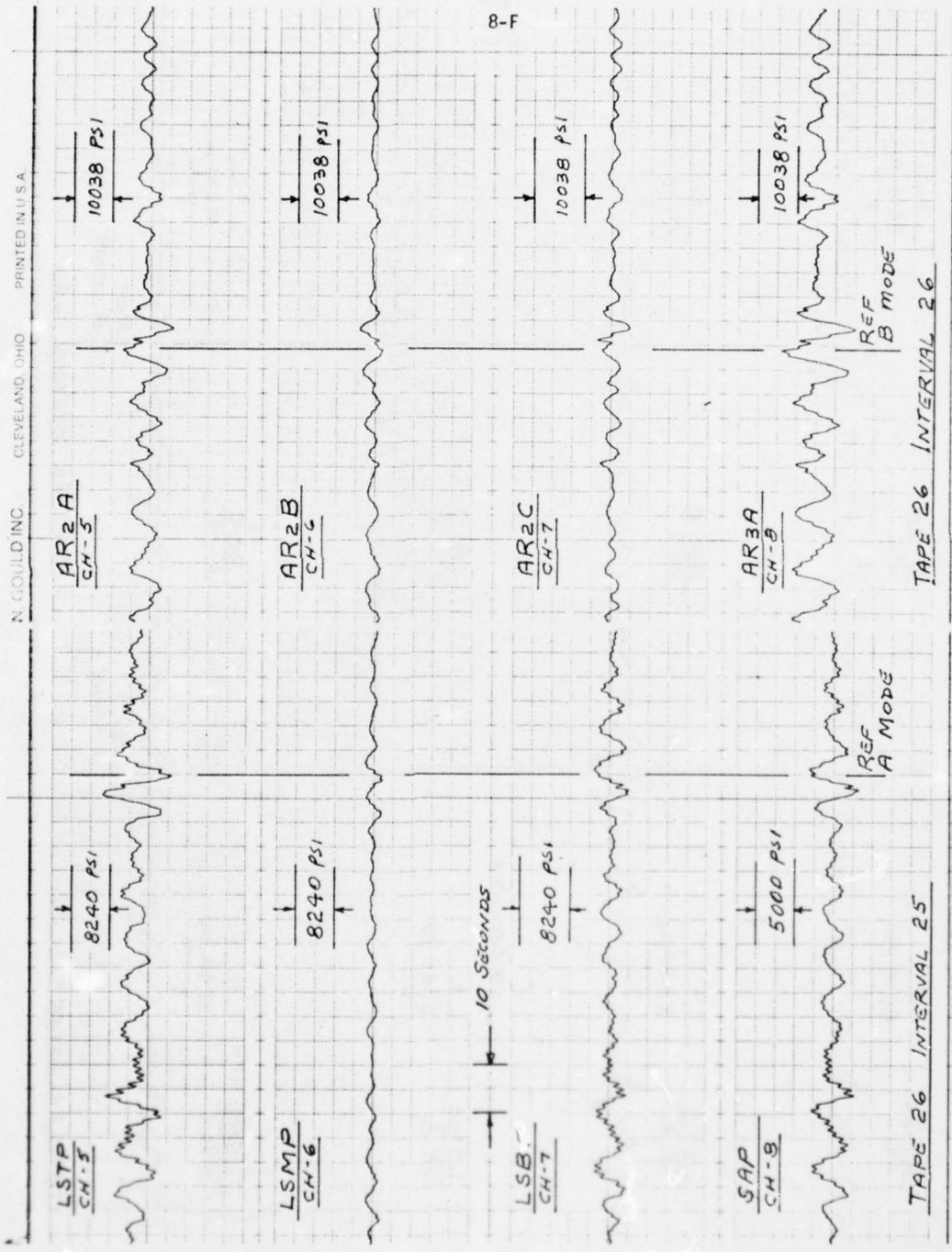
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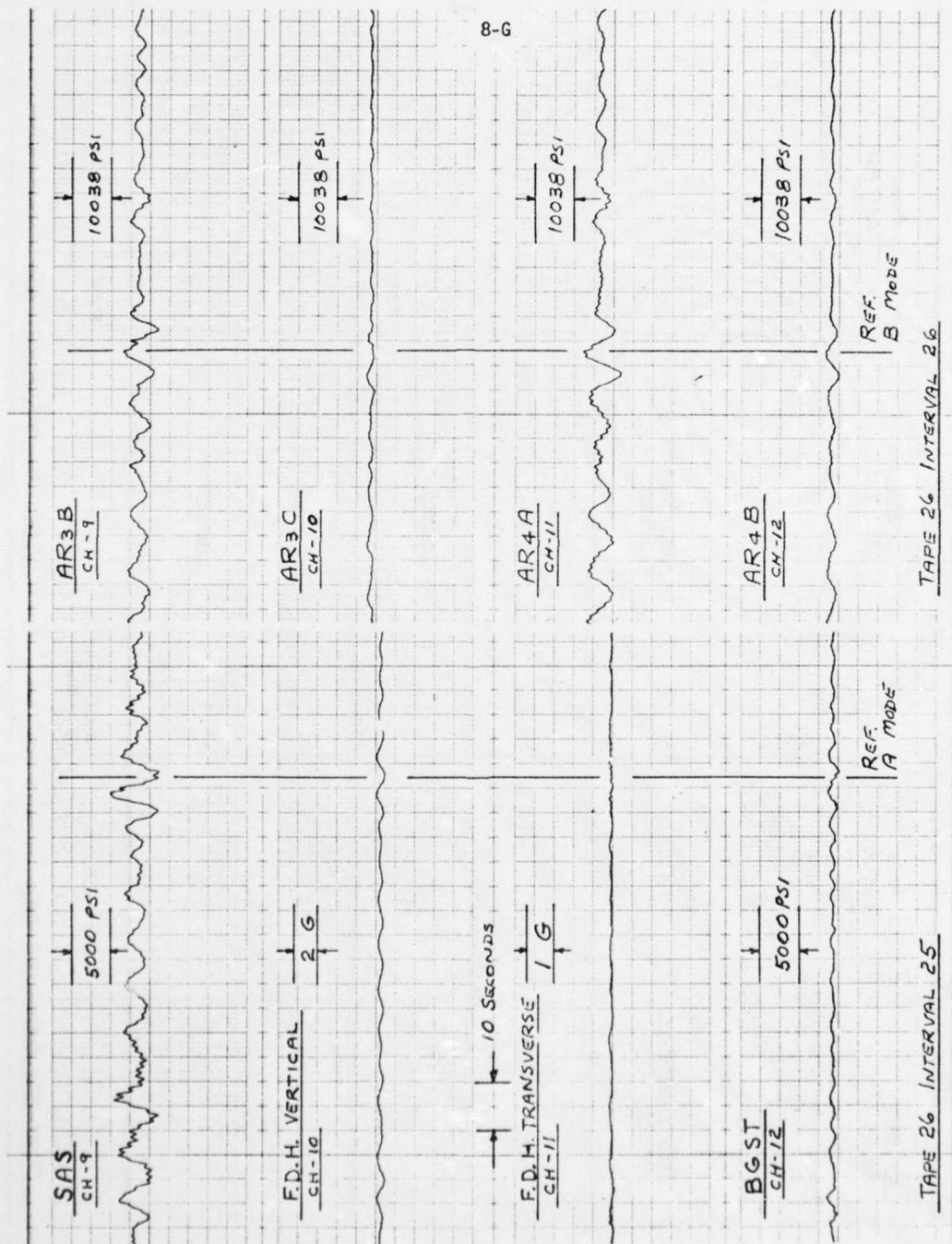


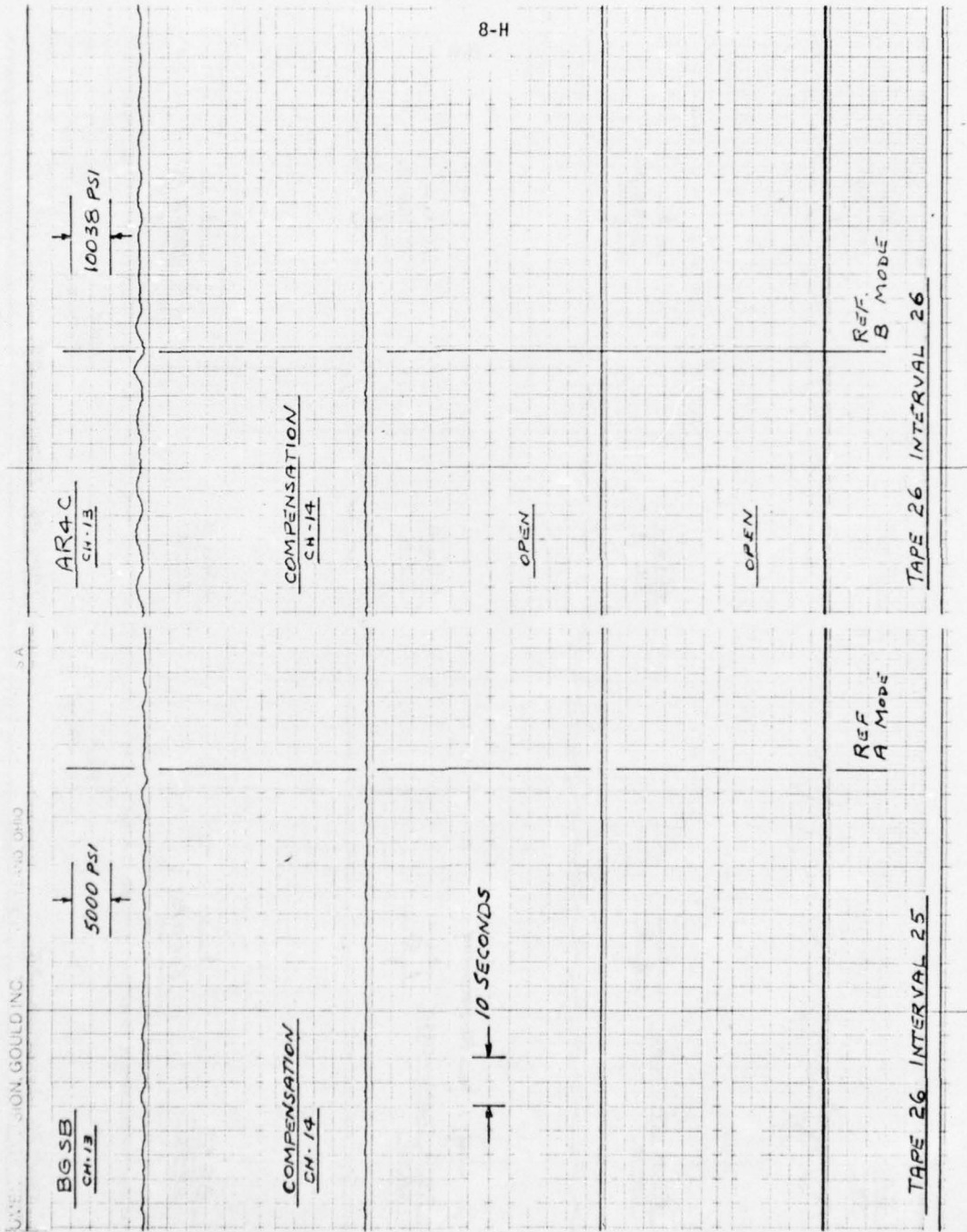




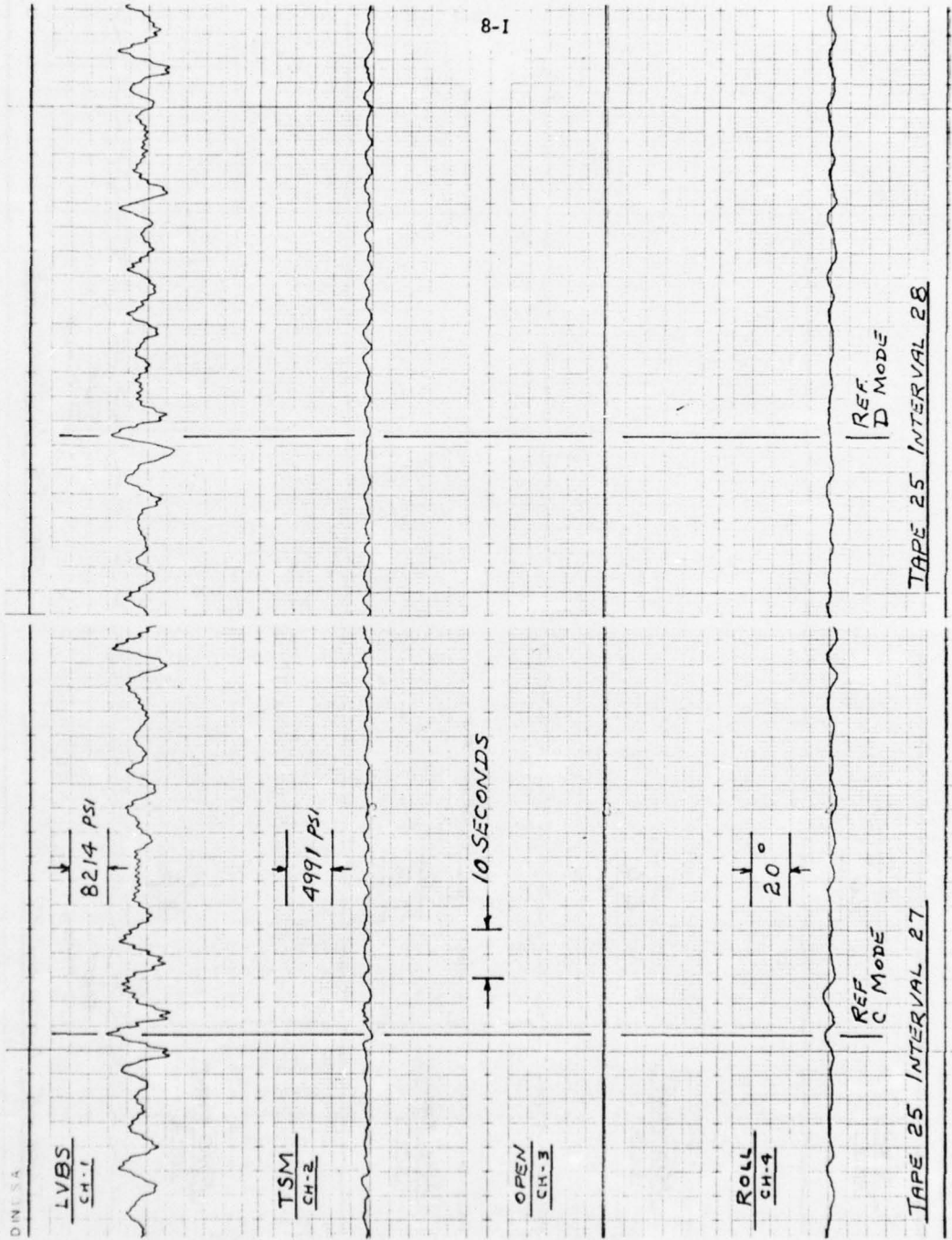


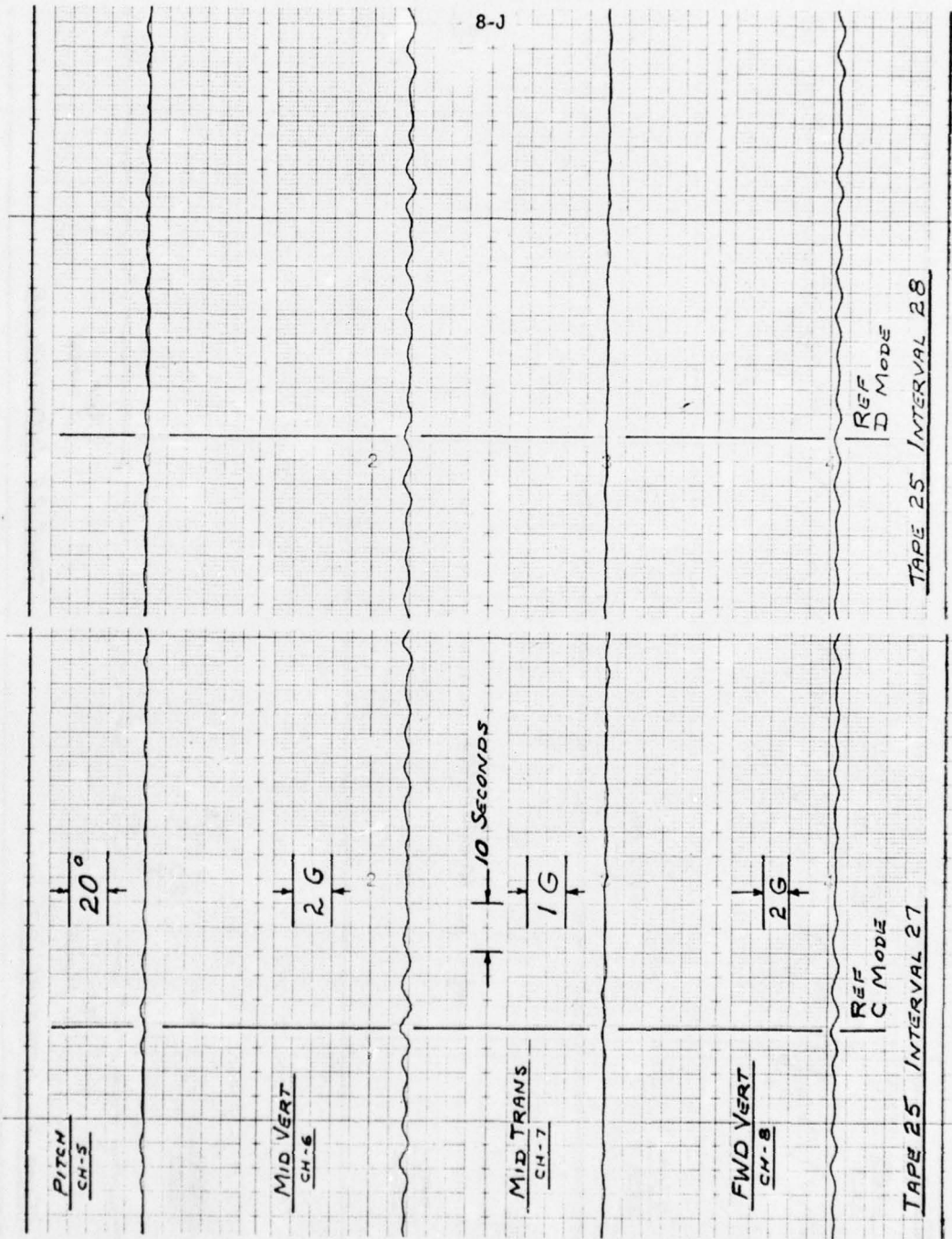






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OPEN
CH-9

OPEN
CH-10

LHBS
CH-11

SFP
CH-12

10 SECONDS

8214 PSI

5000 PSI

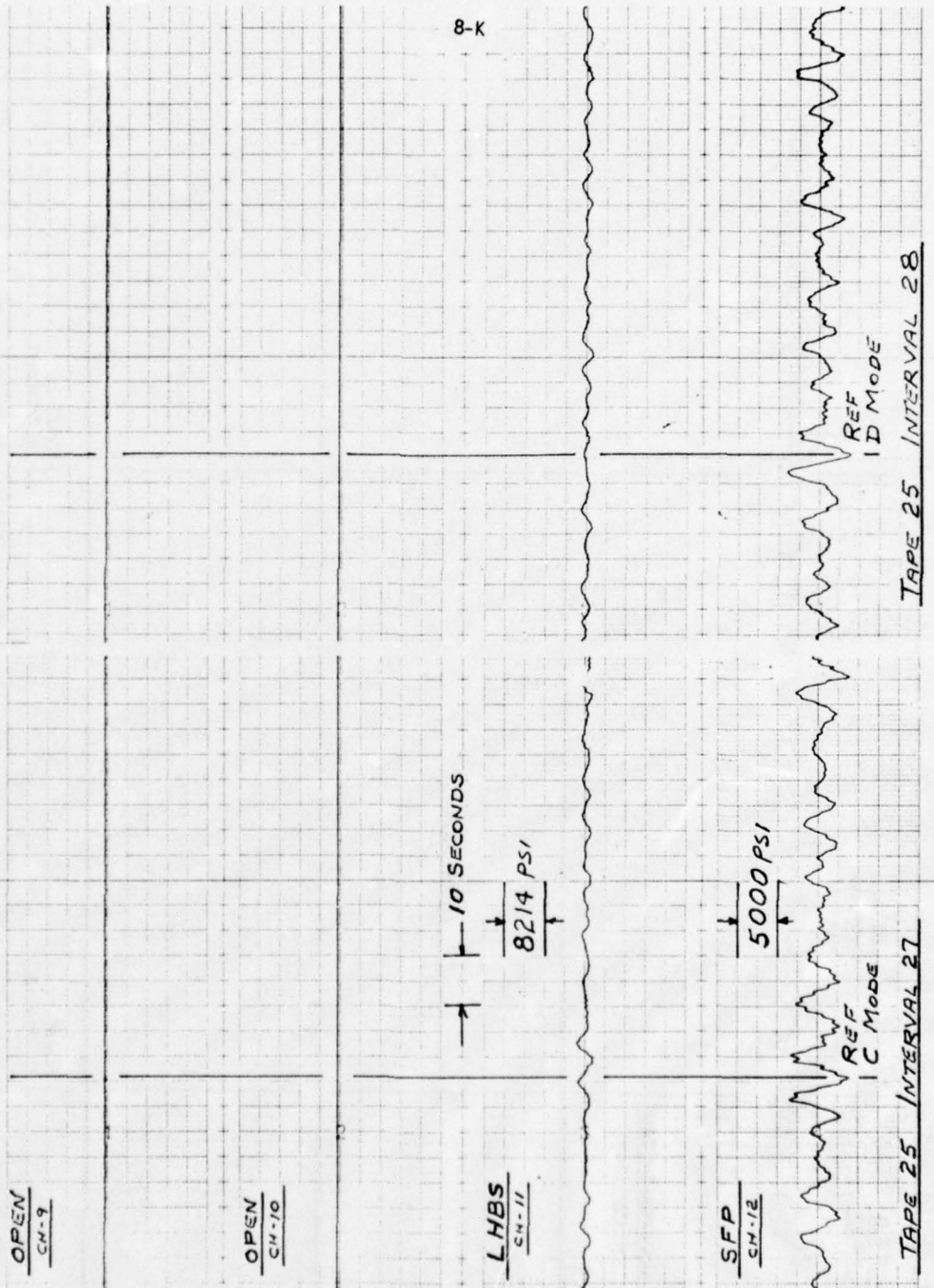
8-K

REF ID MODE

REF IC MODE

TAPE 25 INTERVAL 28

TAPE 25 INTERVAL 27

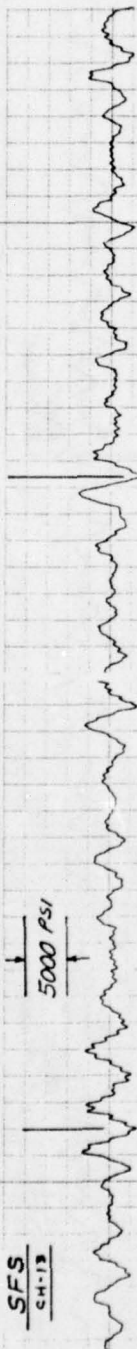


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SFS
CH-13

5000 PSI



COMPENSATION
CH-14



10 SECONDS

8-L



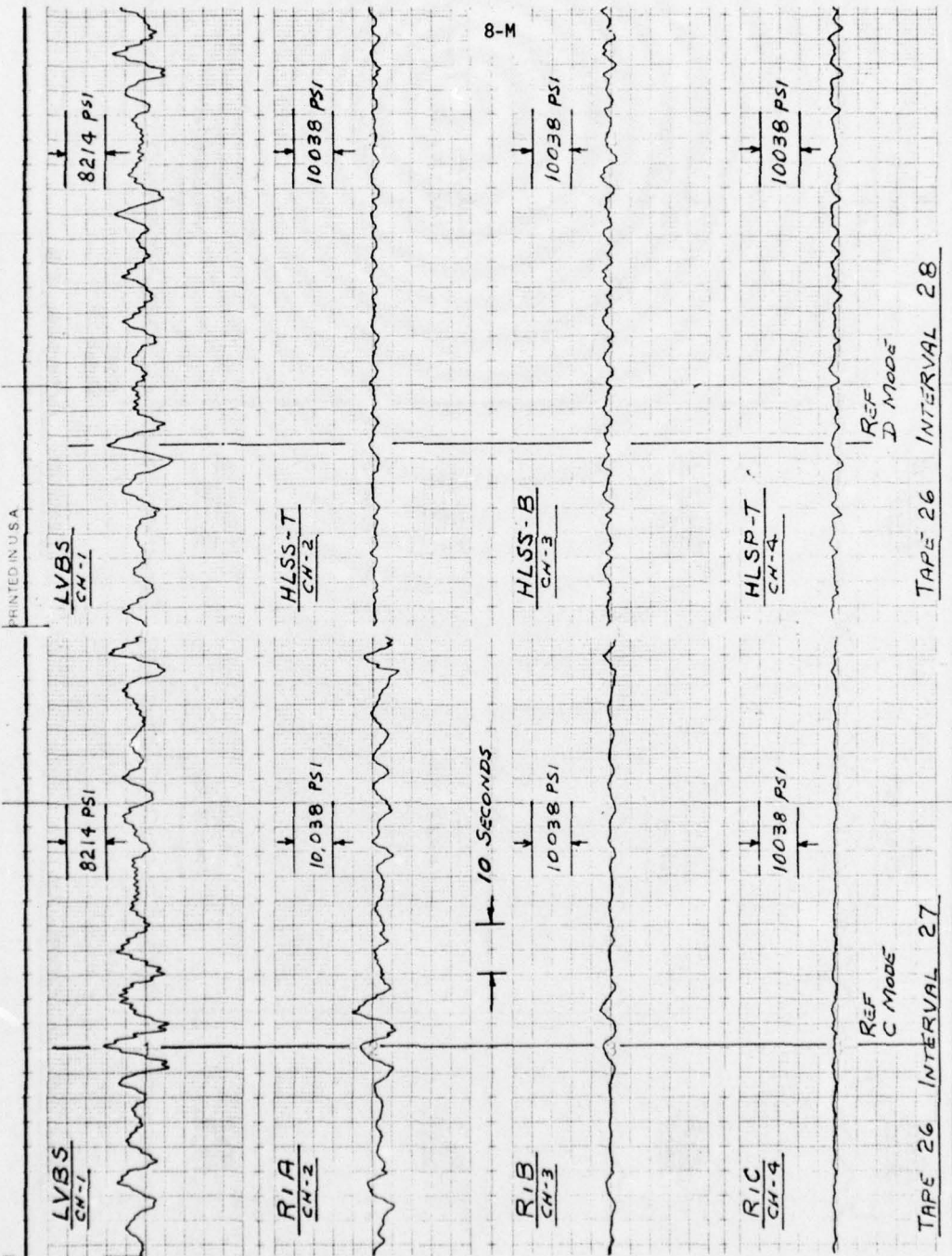
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C MODE

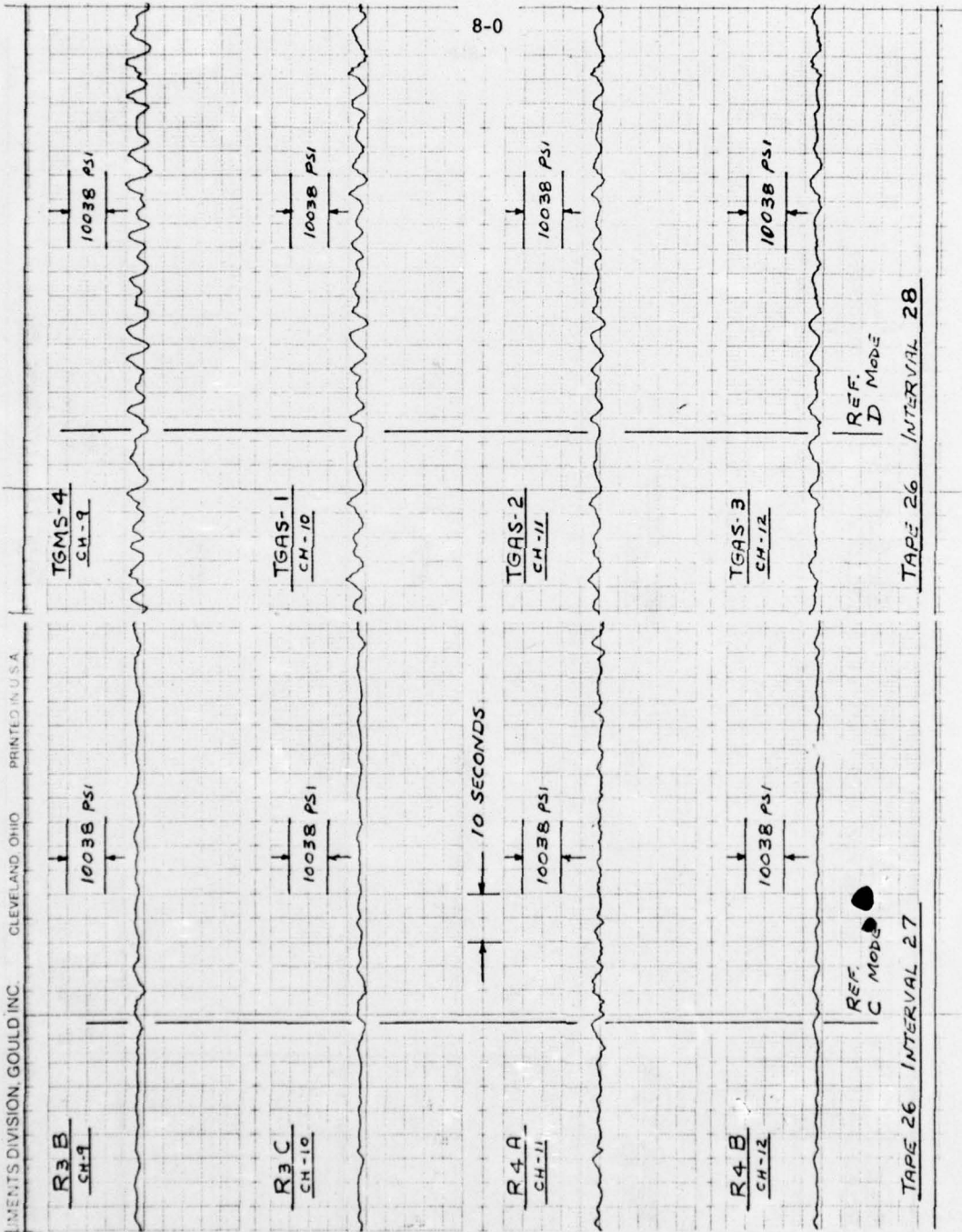
TAPE 25 INTERVAL 27

REF
D MODE

TAPE 25 INTERVAL 28







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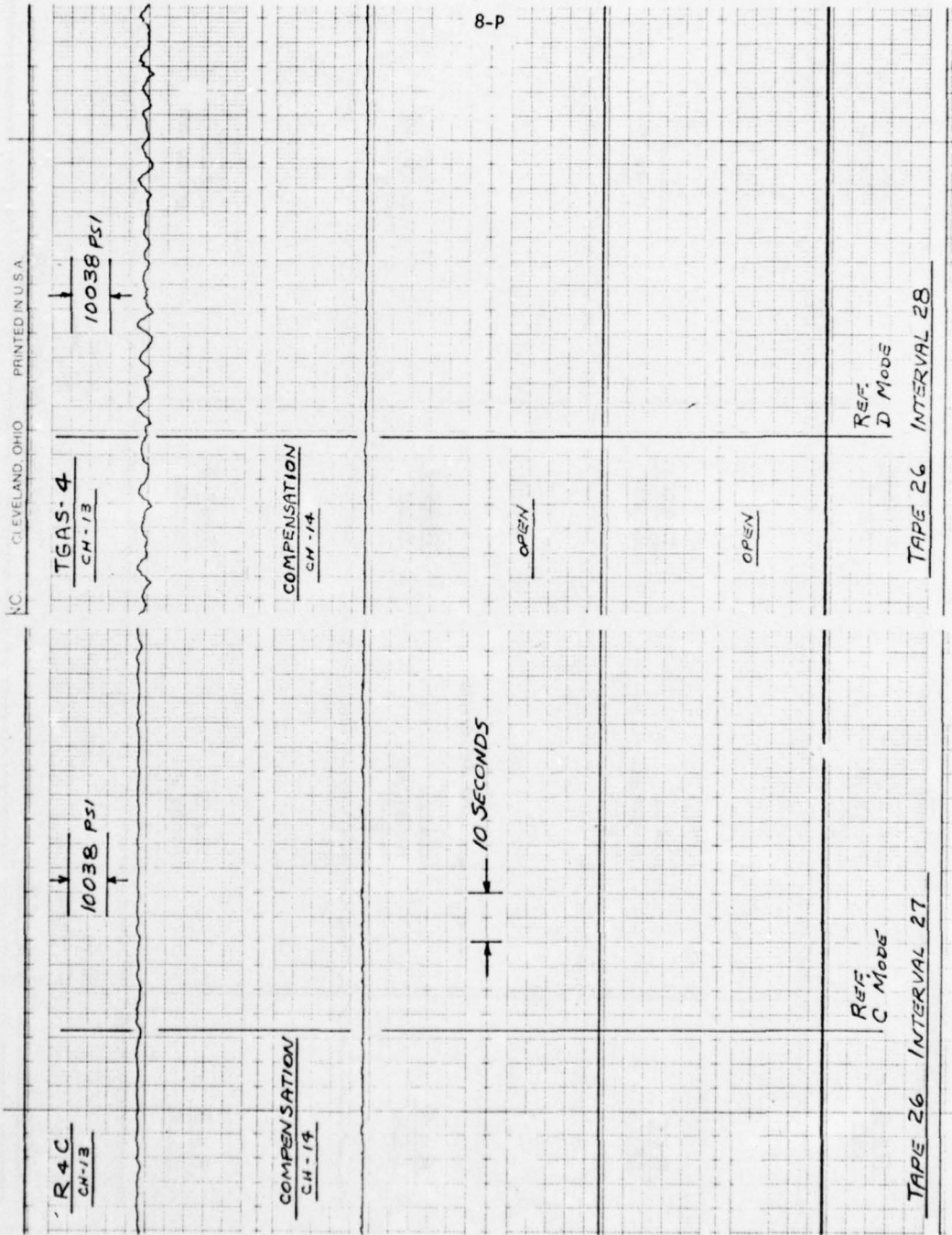
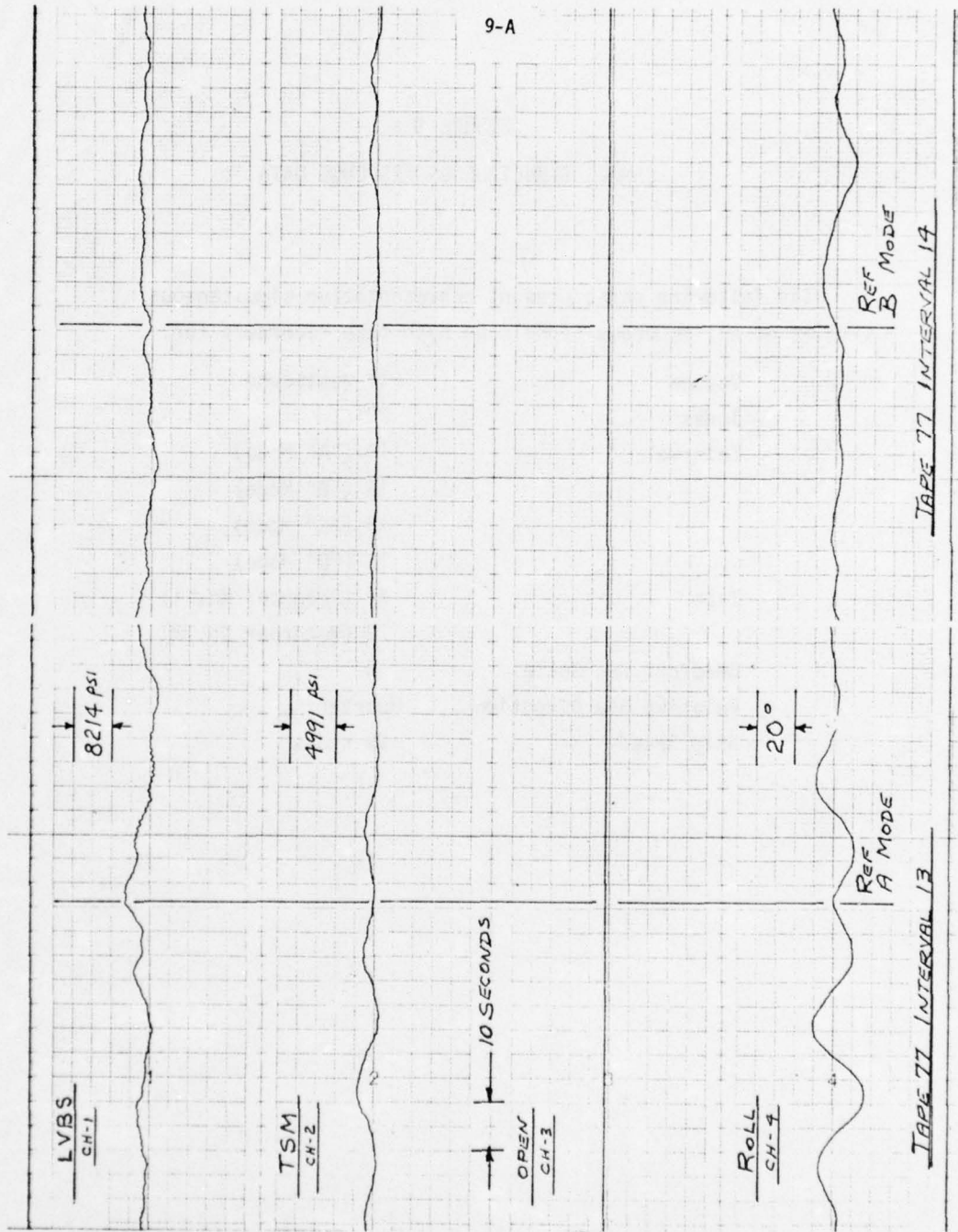


FIGURE 9
SAMPLE SIMULTANEOUS RESPONSE DATA

The following pages present representative simultaneous samples of all recorded signals on both tape recorders for:

Voyage	11 Westbound
Index	22
Interval	13 ("A" Mode)
	14 ("B" Mode)
	15 ("C" Mode)
	16 ("D" Mode)
Tape	77 (Recorder No. 1)
	78 (Recorder No. 2)
Beaufort Sea State	8
Relative Sea Direction	Quartering
Ship Speed	29 Knots



BRUSH INSTRUMENTS DIVISION GOULD INC. CLEVELAND, OH

9-B

PITCH
CH-5
20°

MID VERT
CH-6
2G

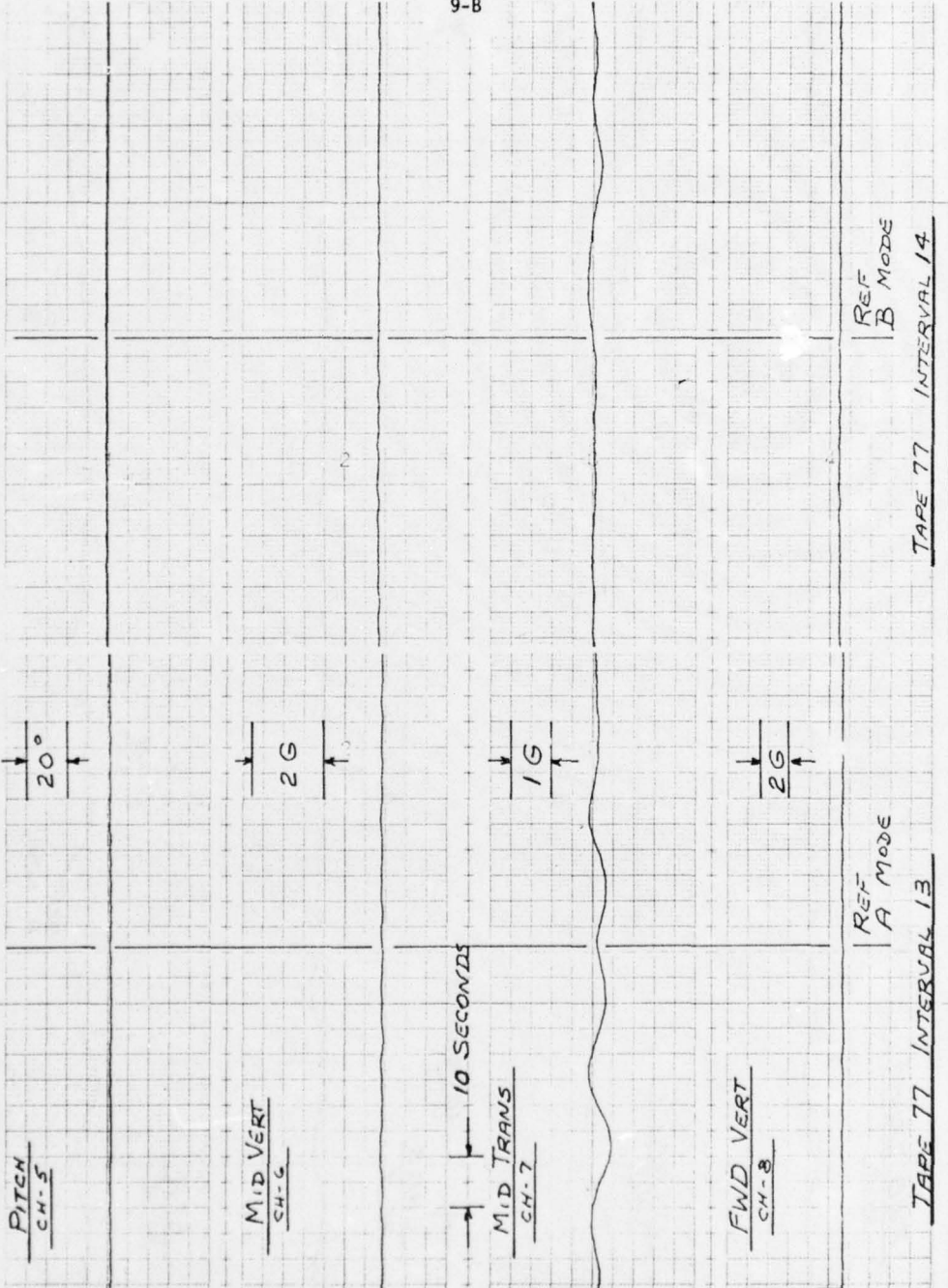
10 SECONDS

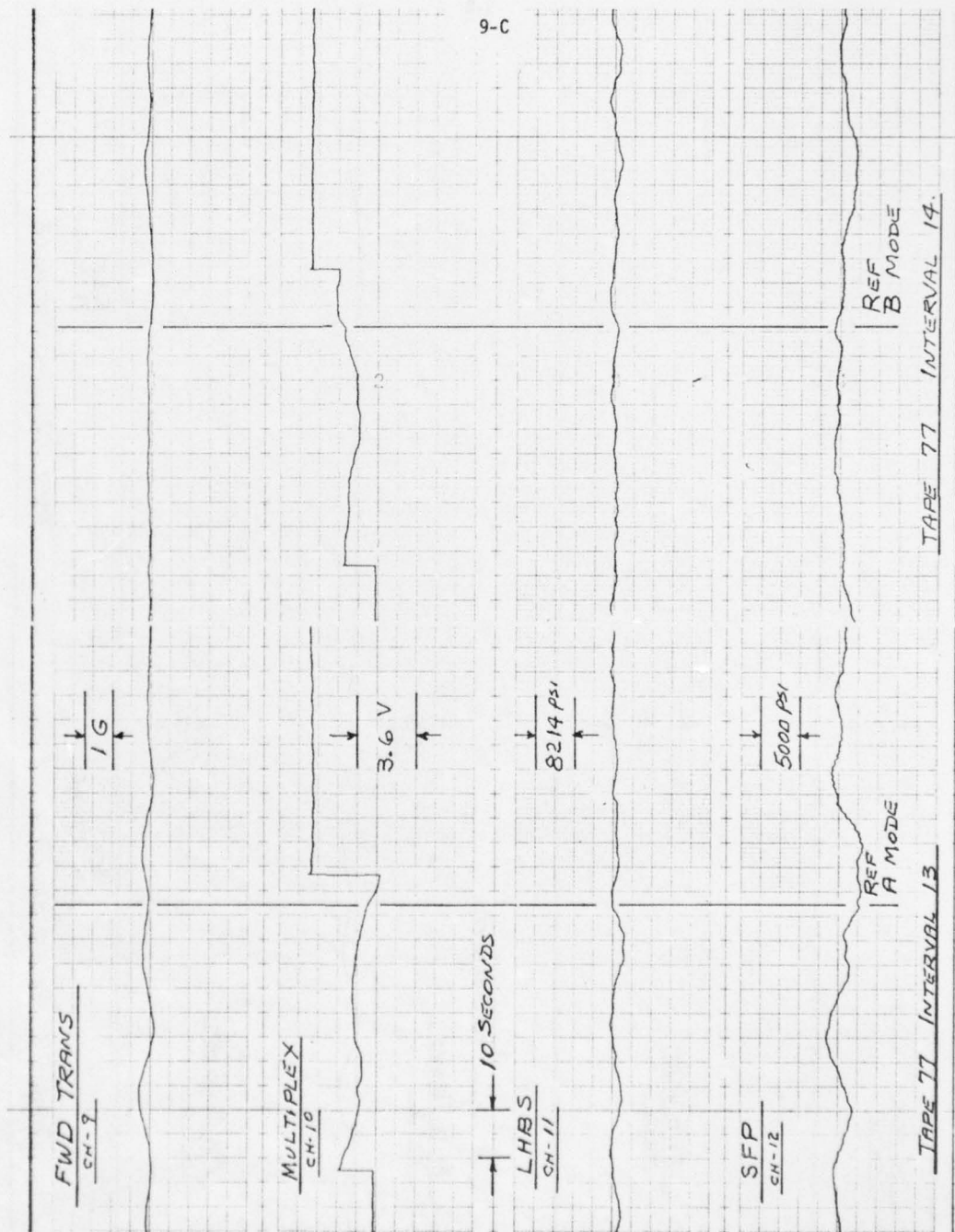
MID TRANS
CH-7
1G

FWD VERT
CH-8
2G

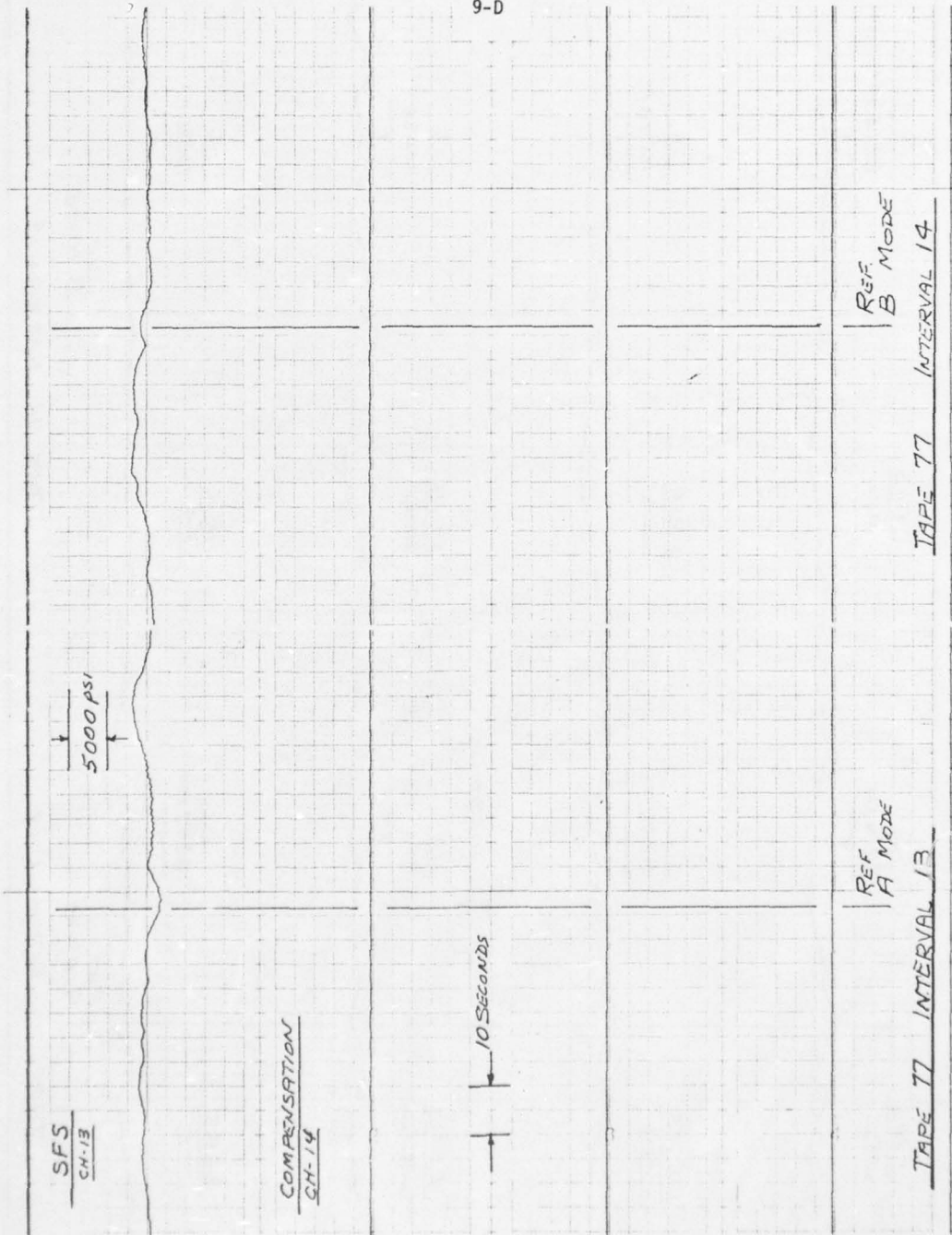
REF A MODE
TAPE 77 INTERVAL 13

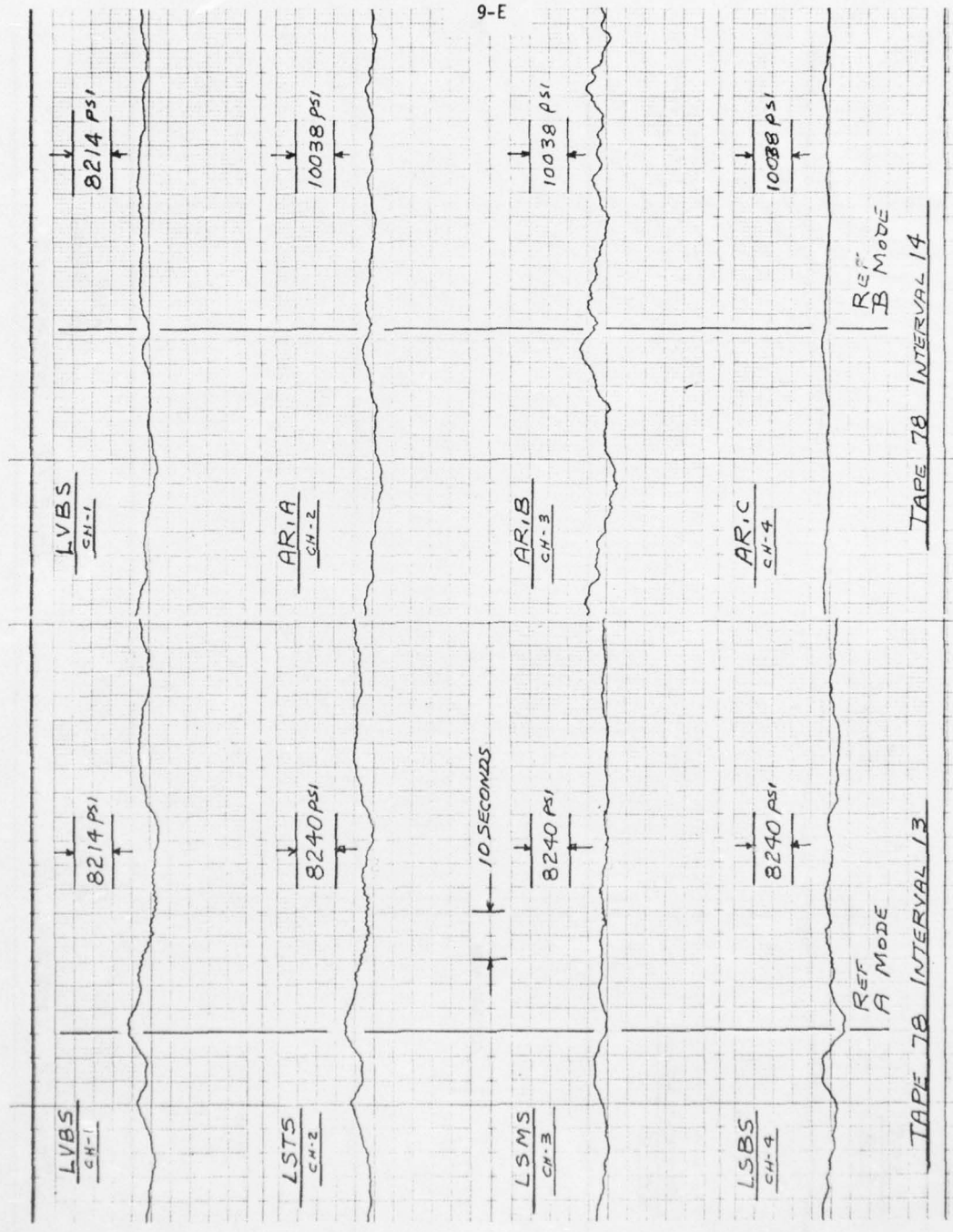
REF B MODE
TAPE 77 INTERVAL 14

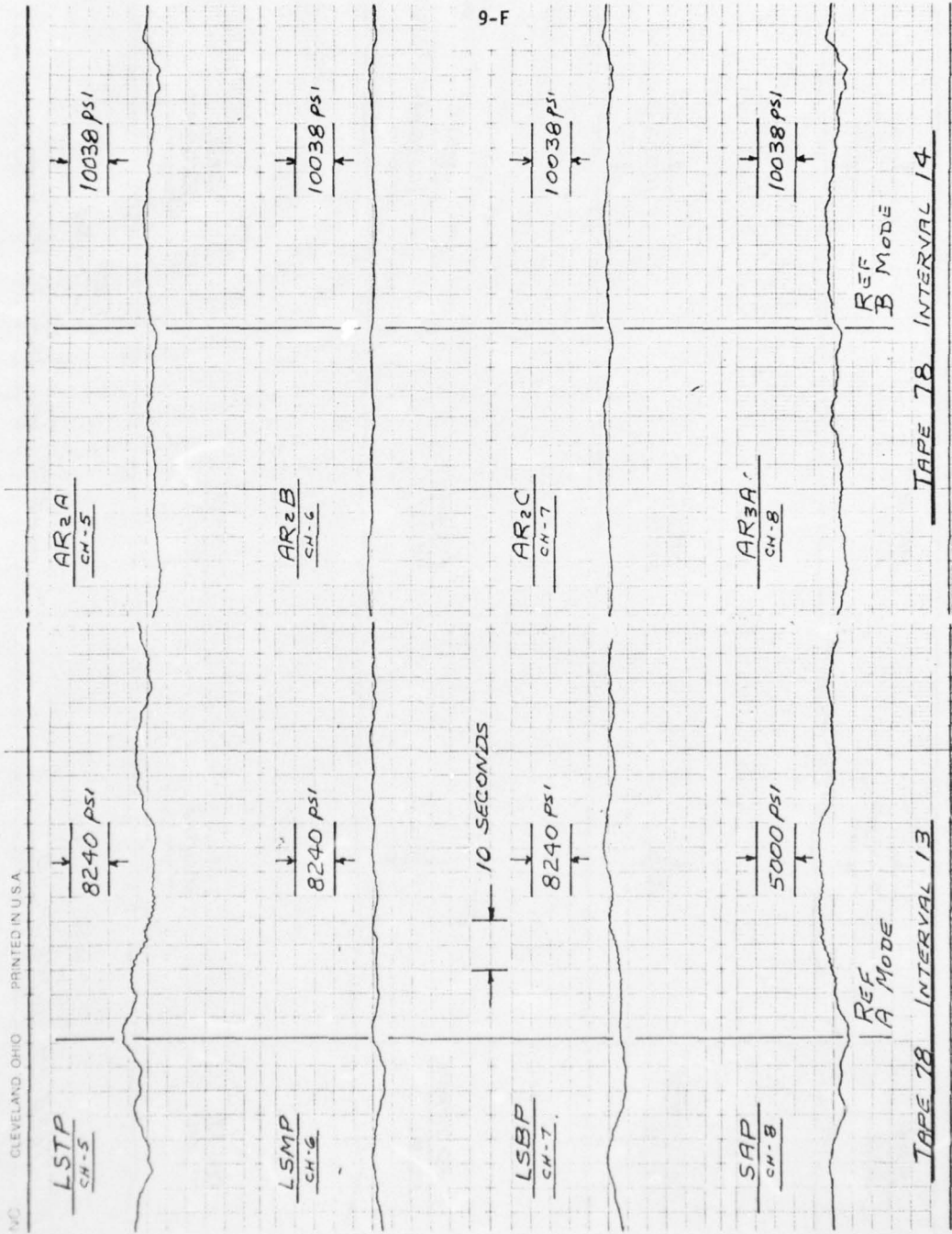




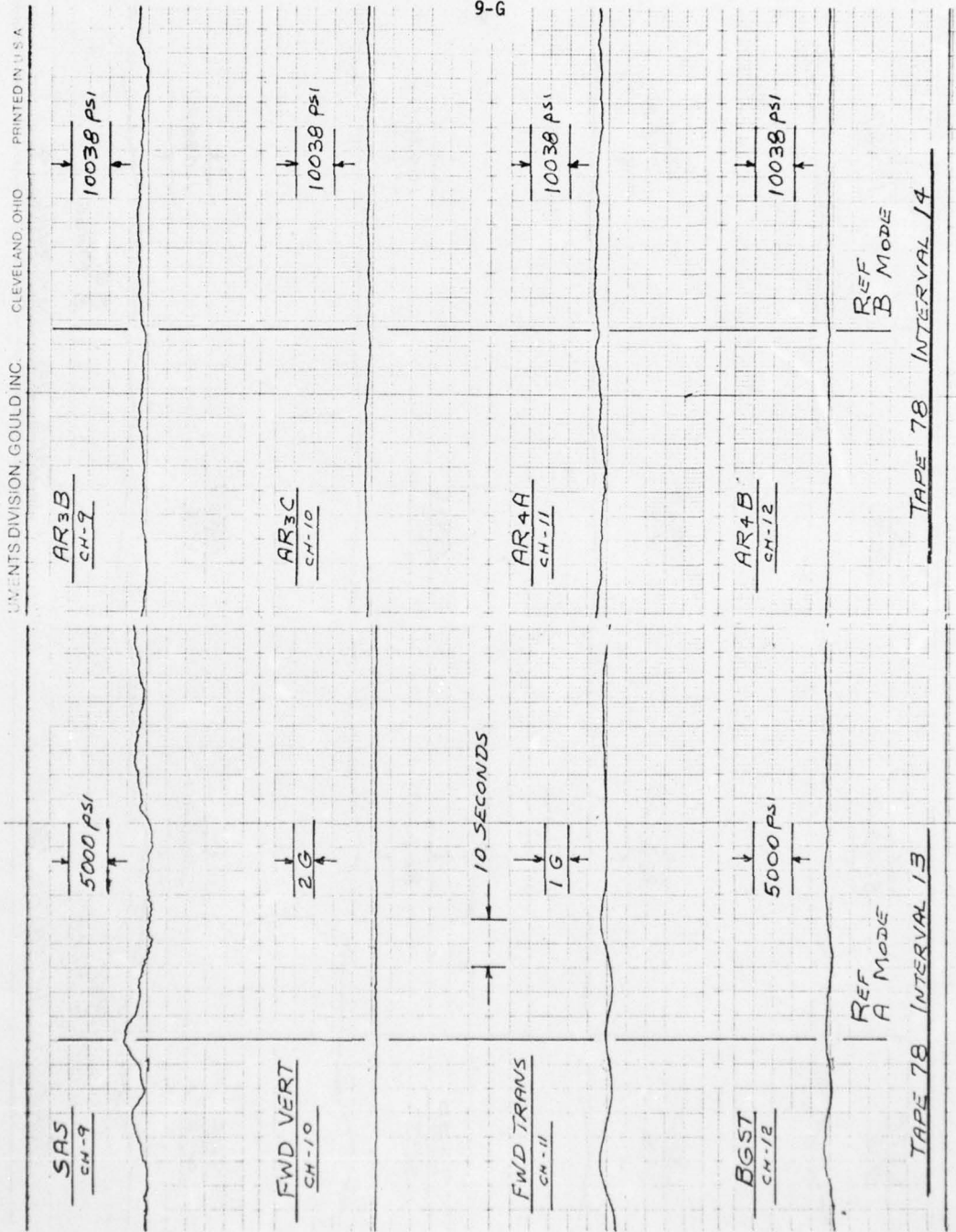
9-D

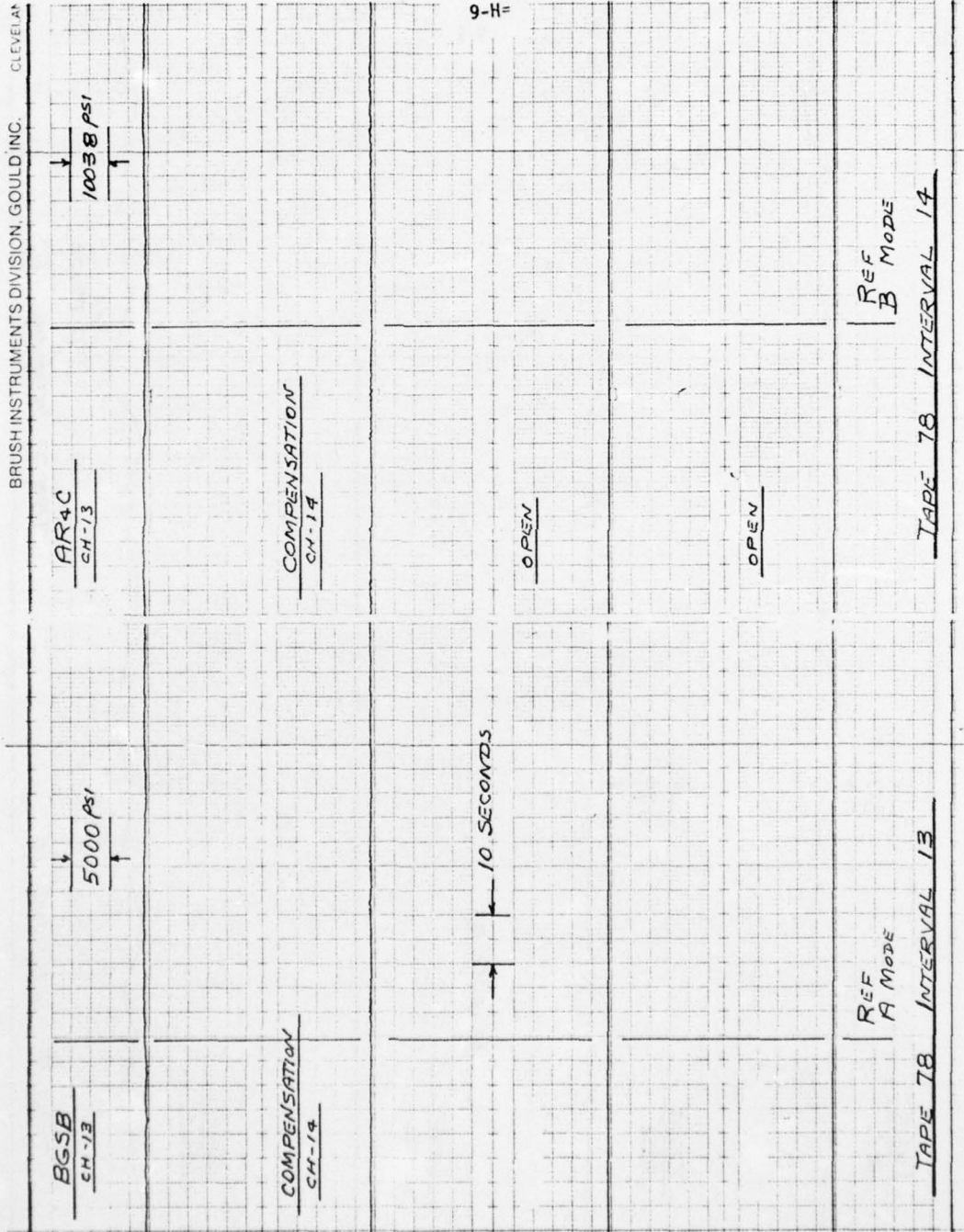




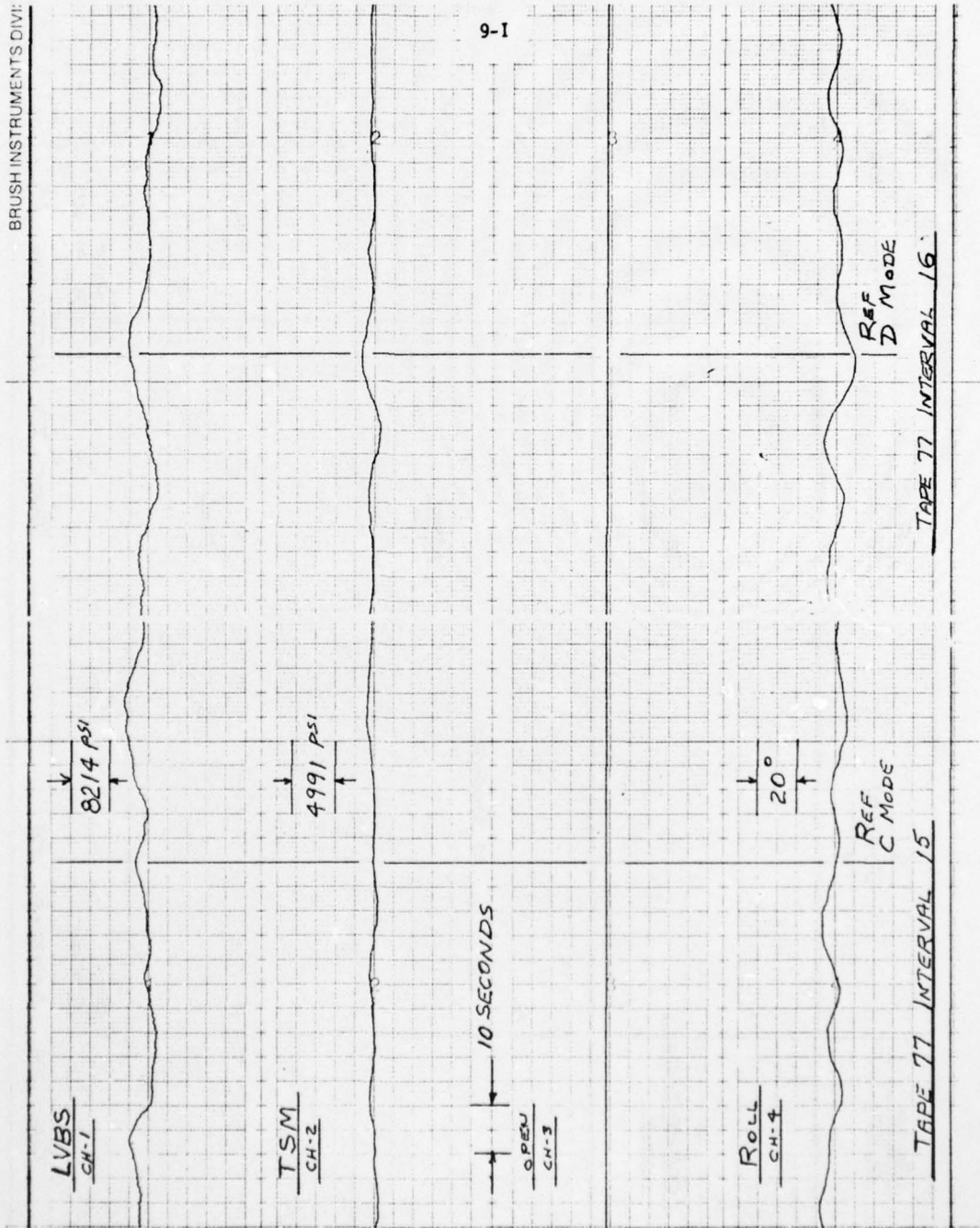


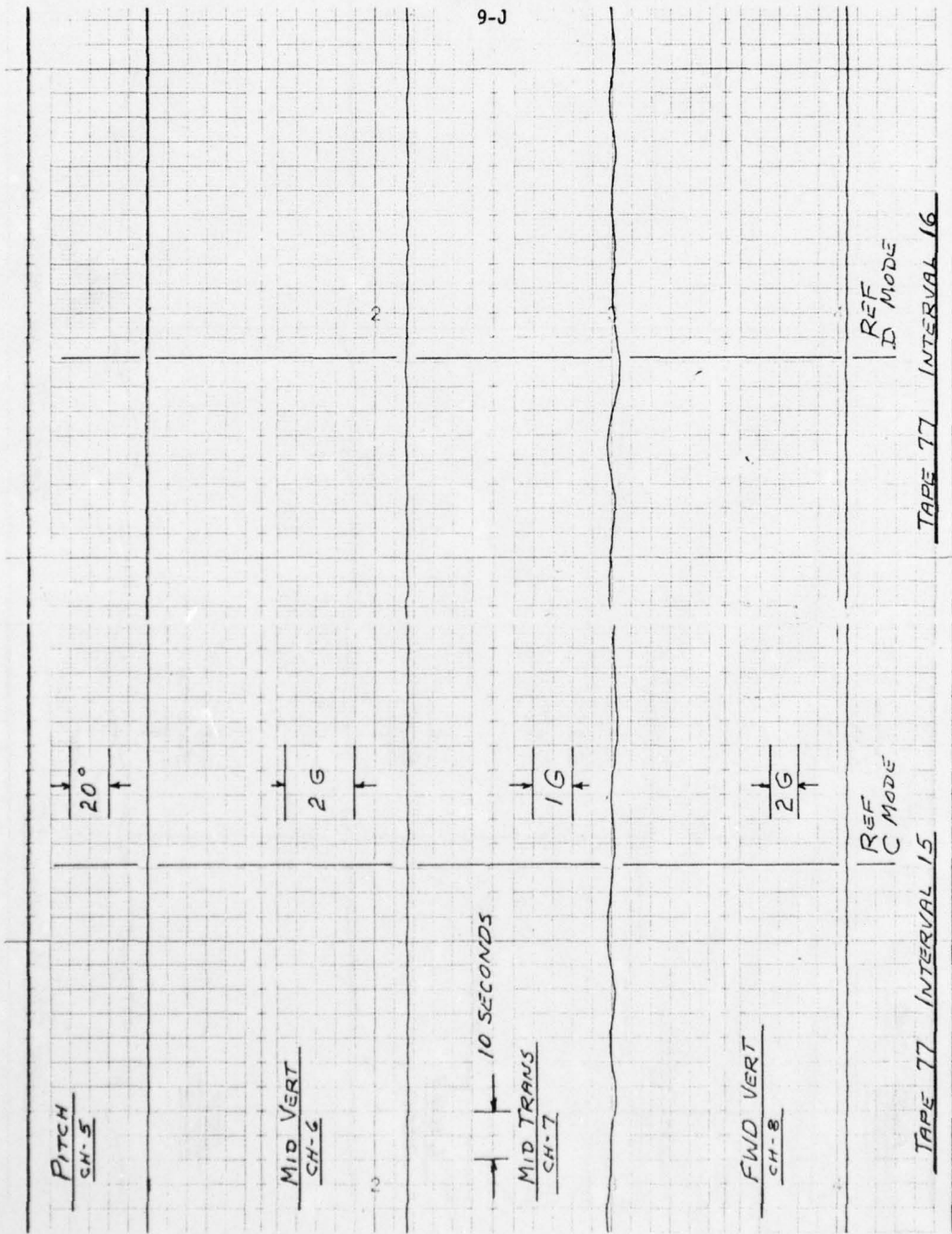
EVENTS DIVISION, GOULD INC. CLEVELAND, OHIO PRINTED IN U.S.A.

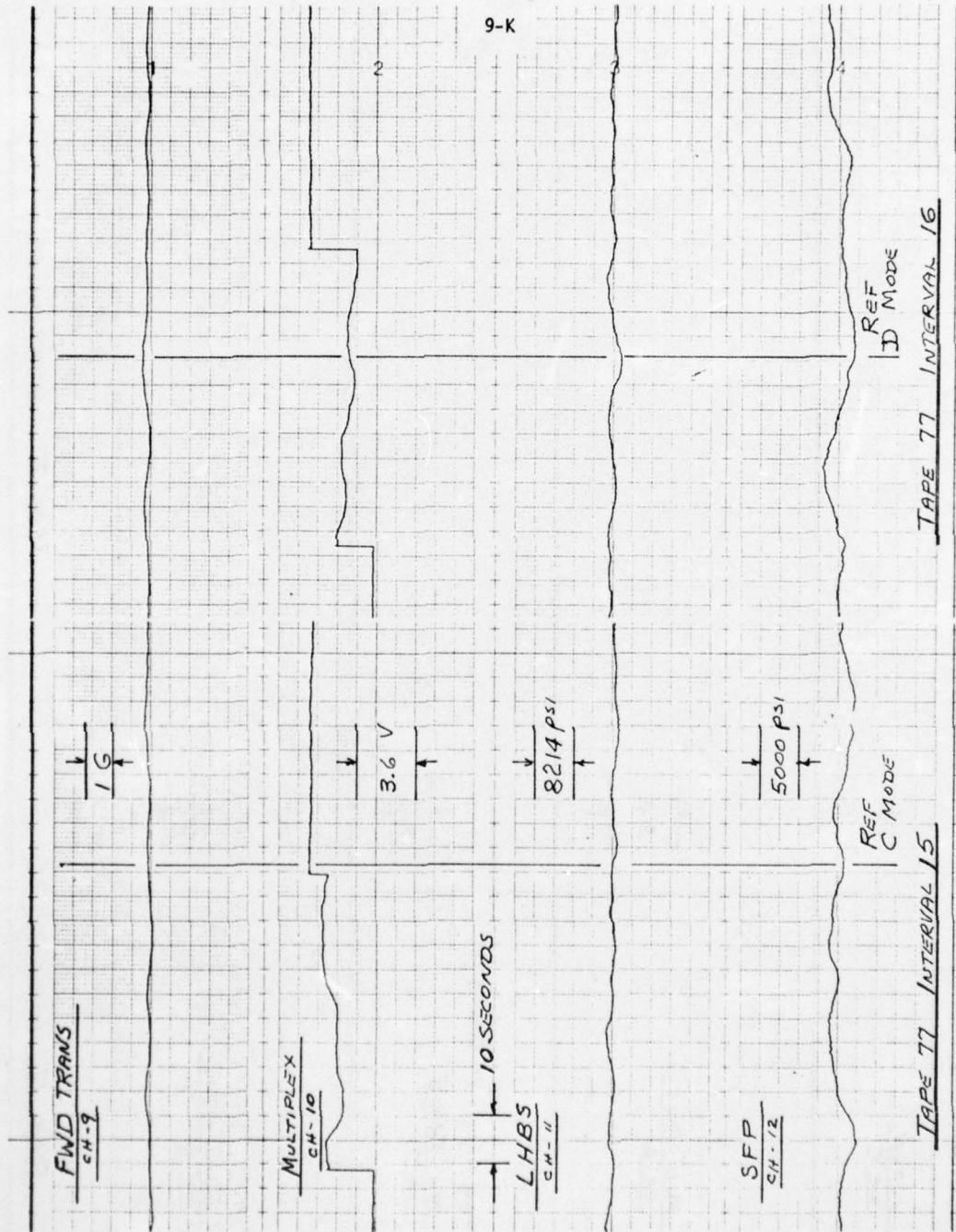




BRUSH INSTRUMENTS DIVI:







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SFS
CH-13

5000 PSI

COMPENSATION
CH-14

10 SECONDS

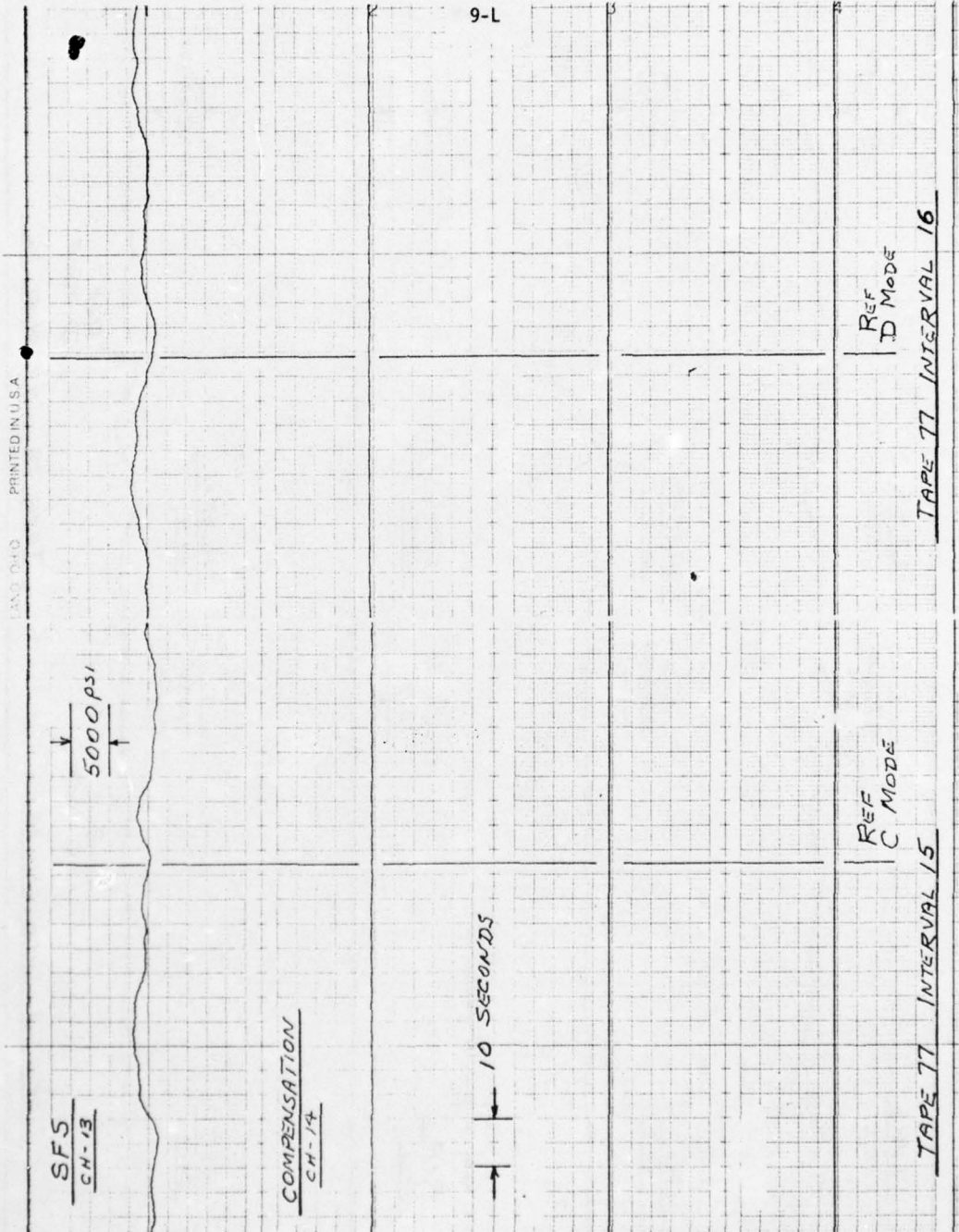
9-L

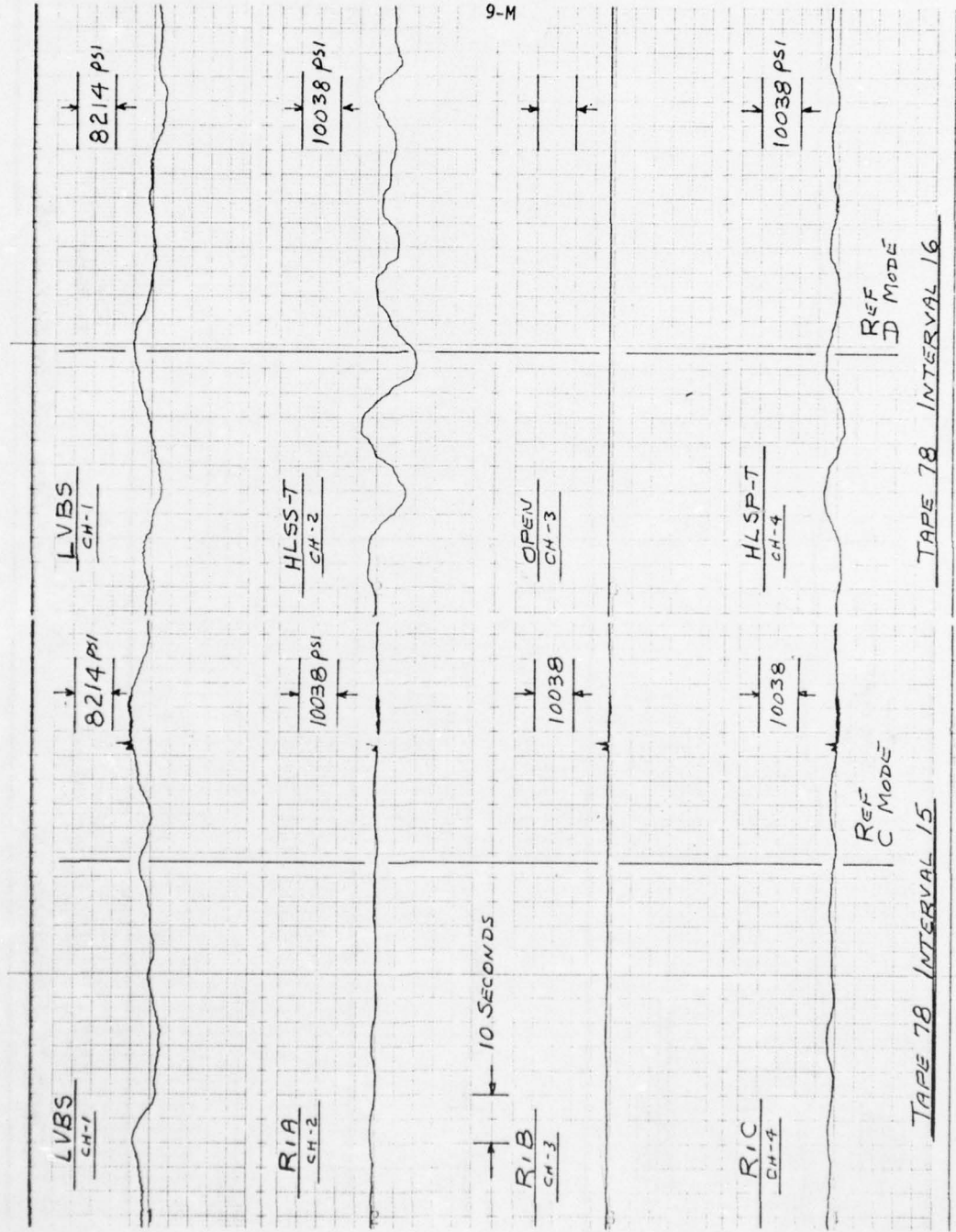
REF
C MODE

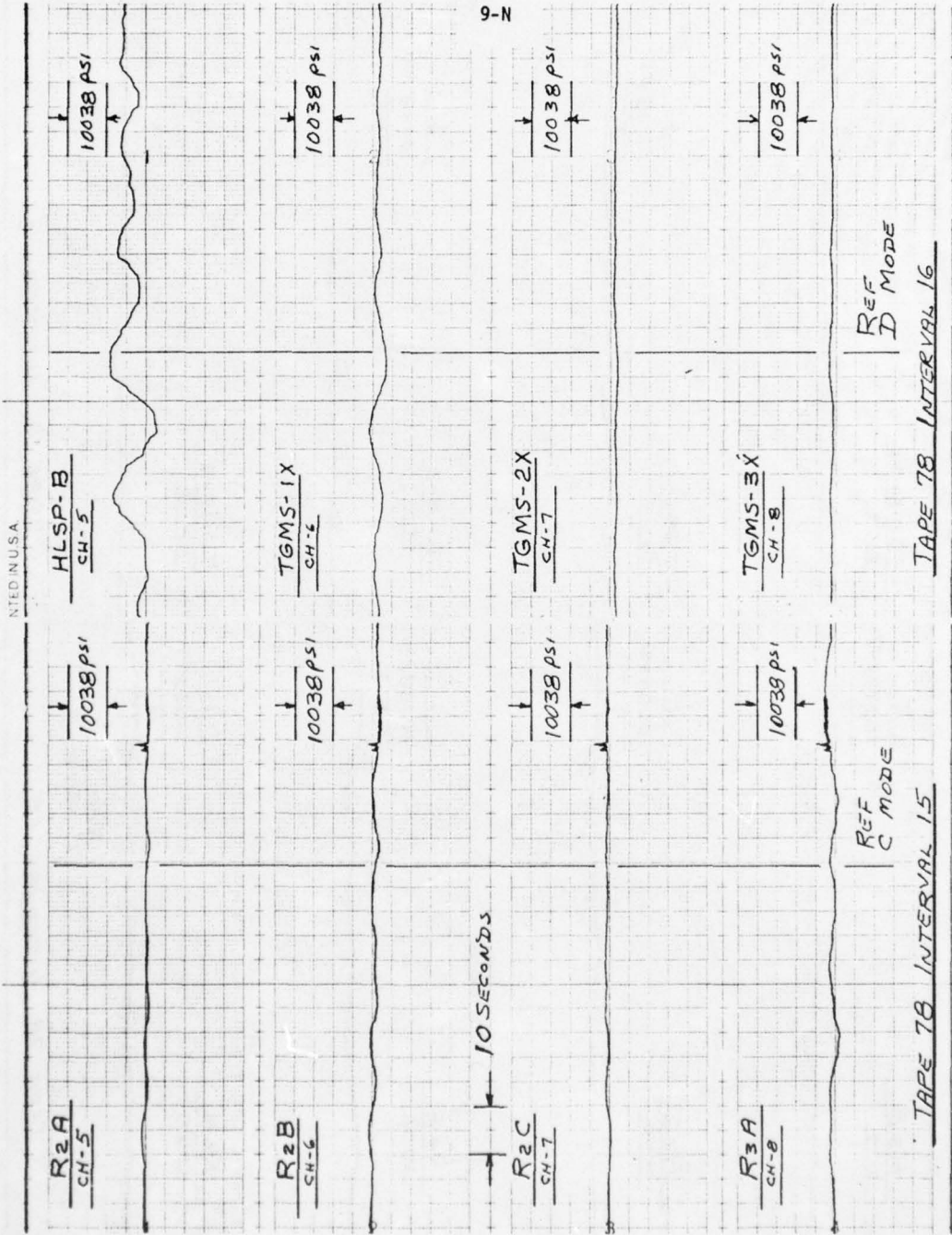
REF
D MODE

TAPE 77 INTERVAL 15

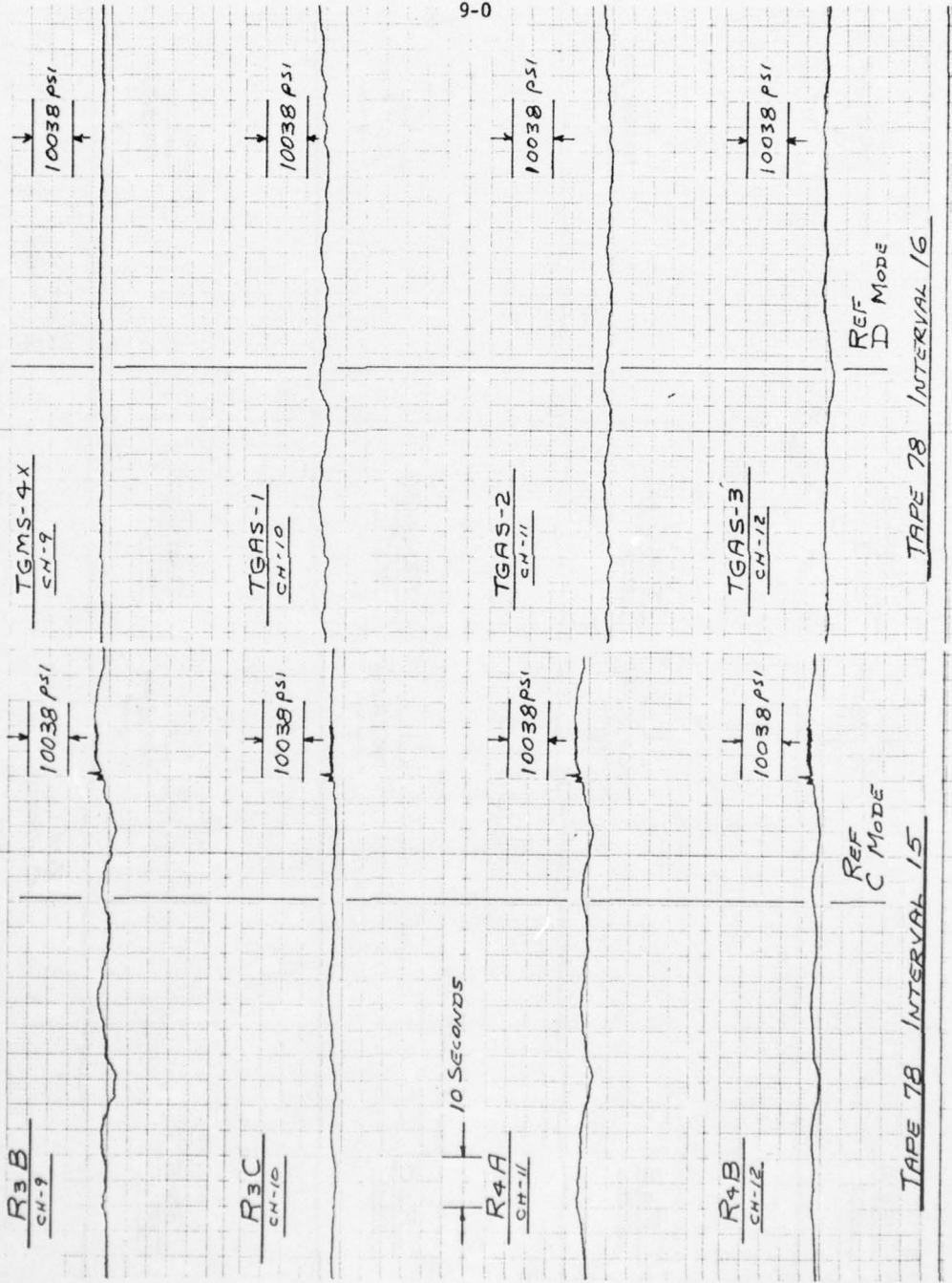
TAPE 77 INTERVAL 16







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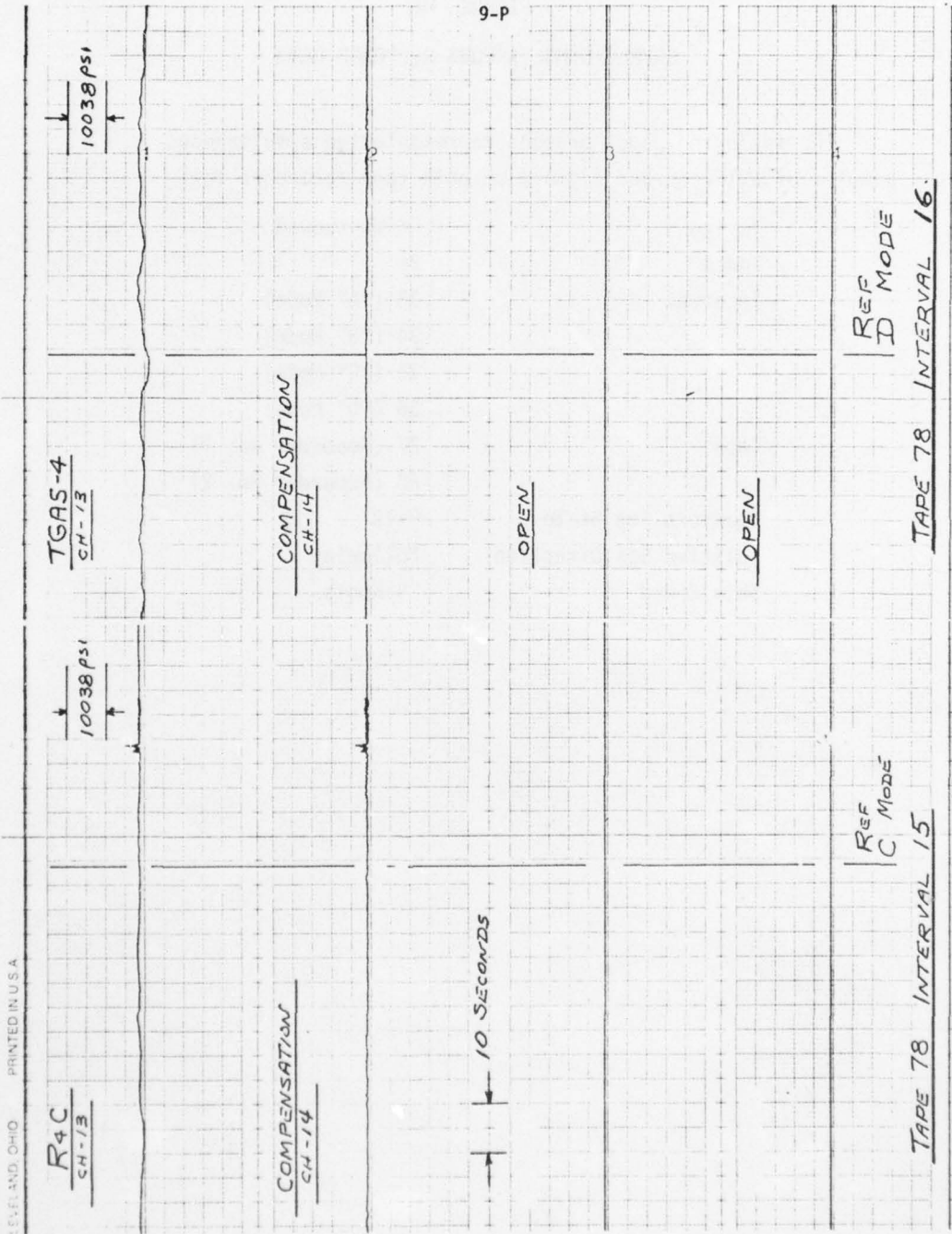


FIGURE 10

SAMPLE SIMULTANEOUS RESPONSE DATA

The following pages present representative simultaneous samples of all recorded signals on both tape recorders for:

Voyage	4 Westbound
Index	26
Interval	33 ("A" Mode)
	34 ("B" Mode)
	35 ("C" Mode)
	36 ("D" Mode)
Tape	27 (Recorder No. 1)
	28 (Recorder No. 2)
Beaufort Sea State	9-10
Relative Sea Direction	Following
Ship Speed	29 Knots

AD-A039 752

TELEDYNE MATERIALS RESEARCH WALTHAM MASS
FIRST SEASON RESULTS FROM SHIP RESPONSE INSTRUMENTATION ABOARD --ETC(U)
SEP 76 R R BOENTGEN, R A FAIN, J W WHEATON
SSC-264

F/G 13/10

N00024-73-C-5059

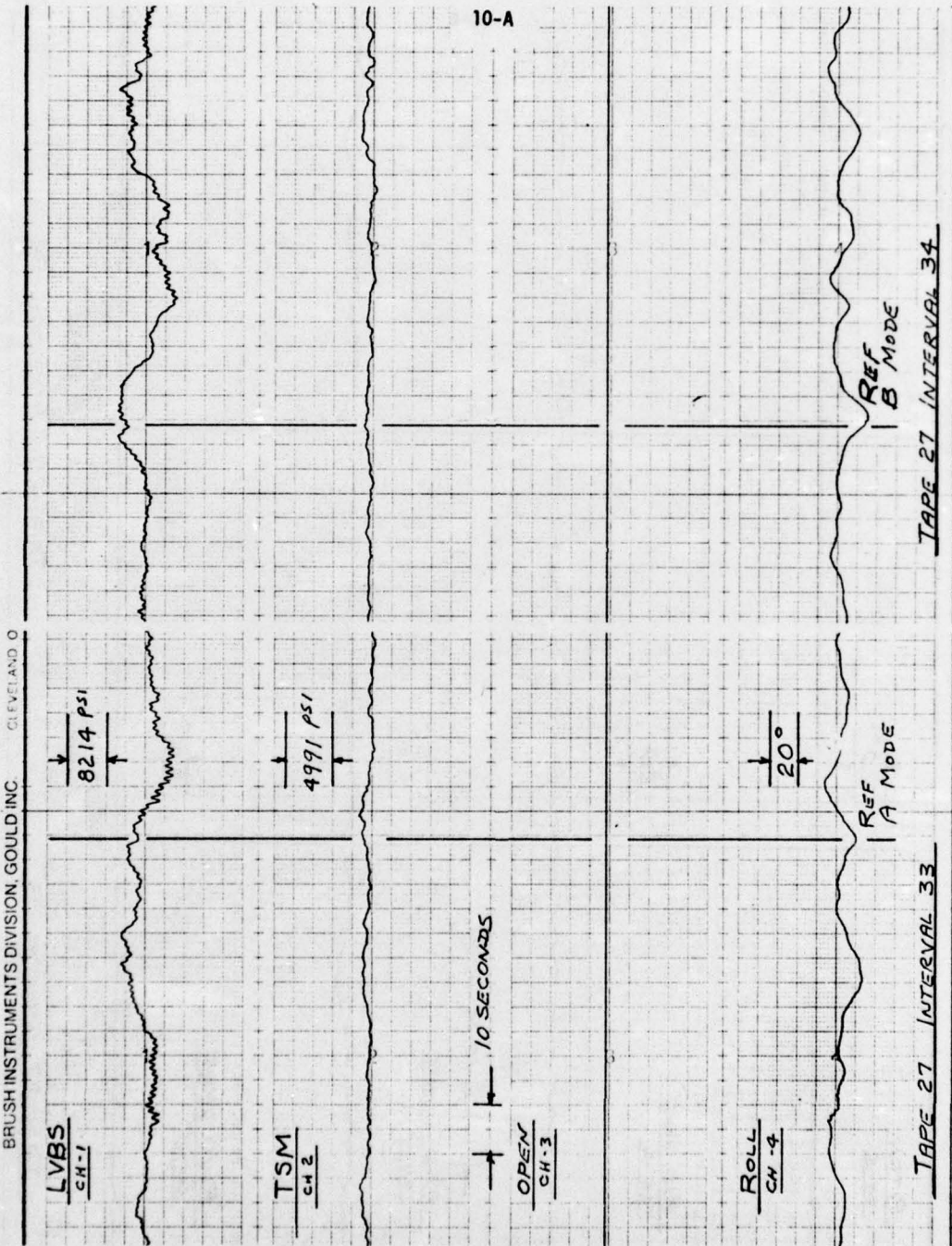
NL

UNCLASSIFIED

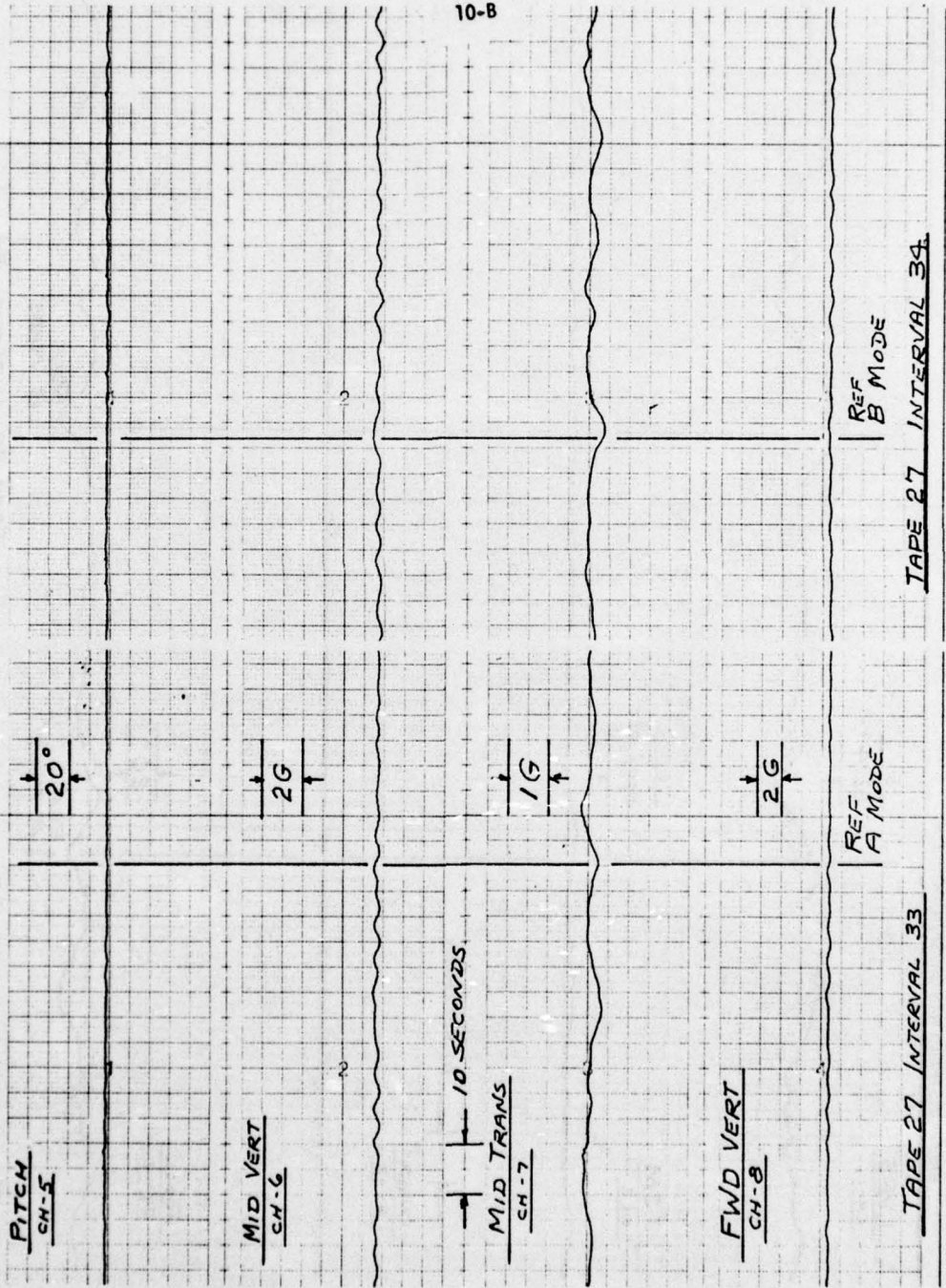
2 of 3
AD
A039752



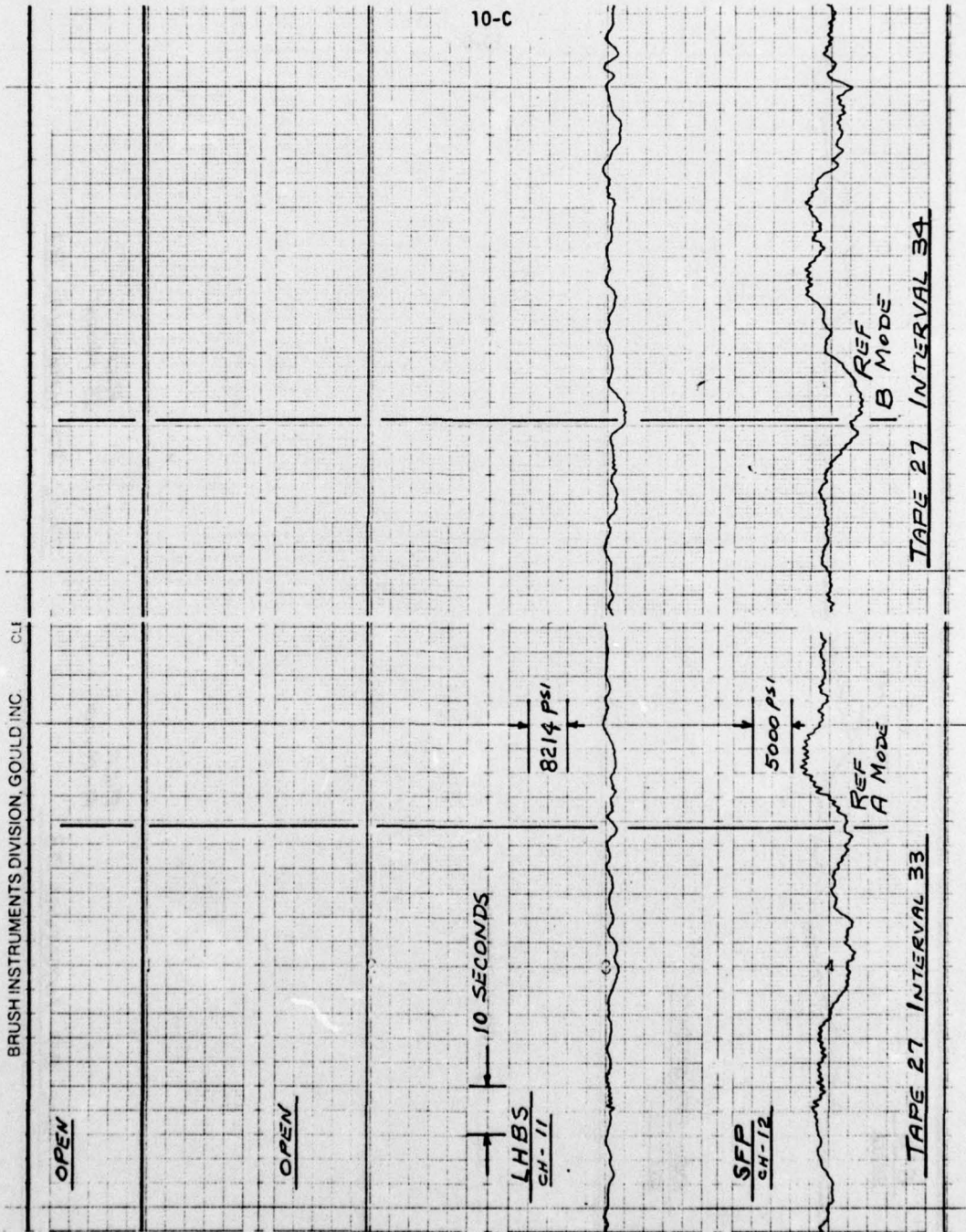
BRUSH INSTRUMENTS DIVISION, GOULD INC. CLEVELAND, O

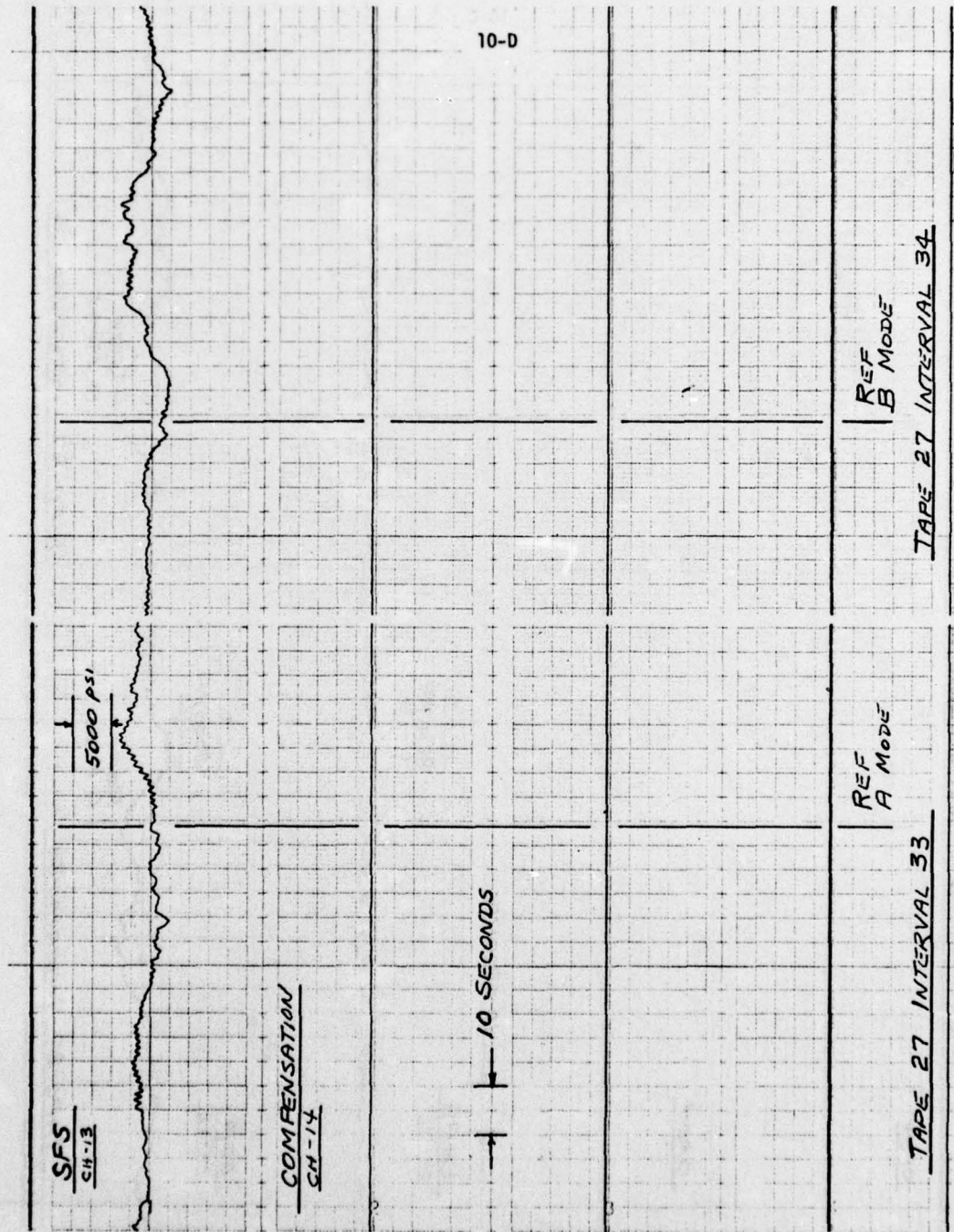


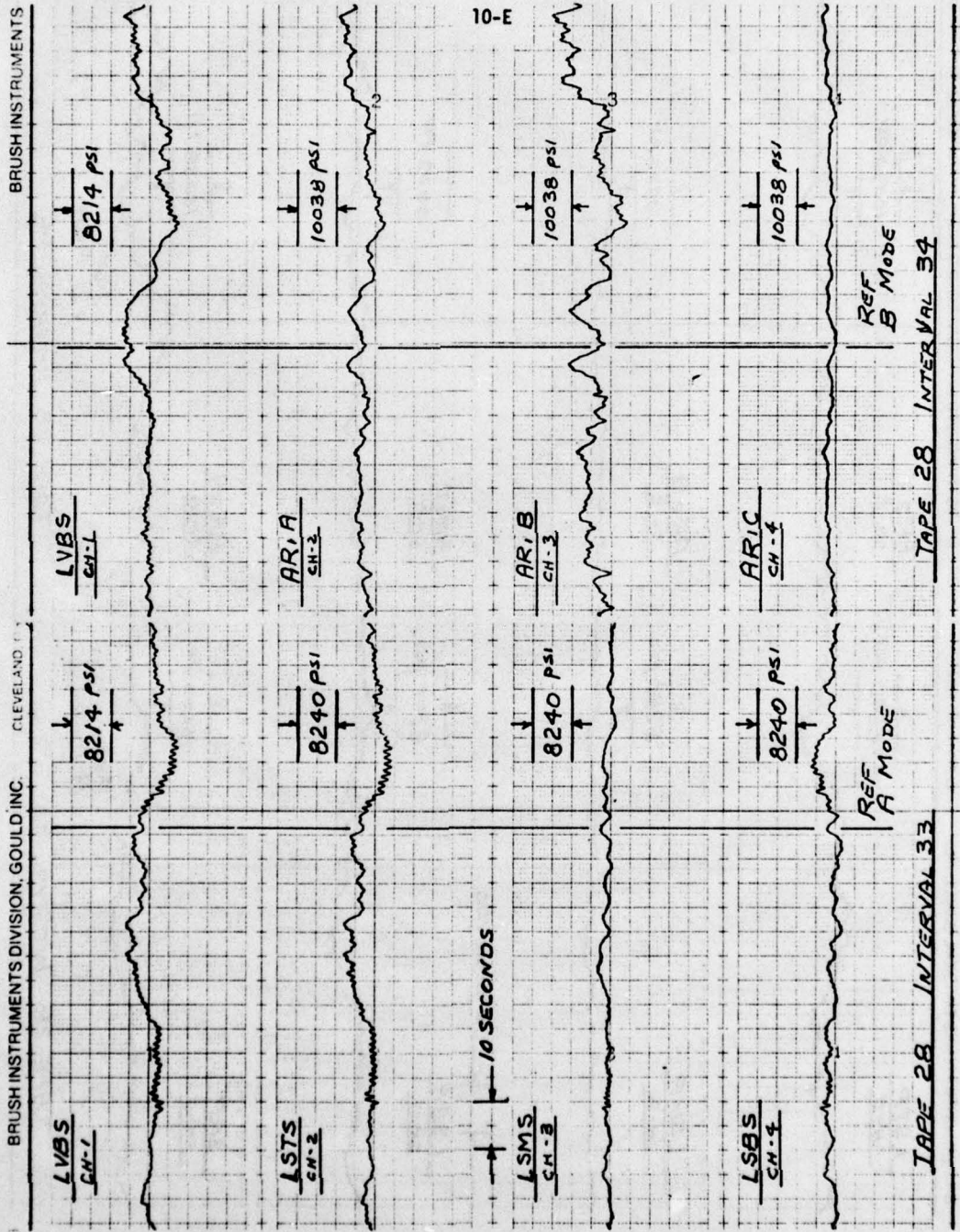
BRUSH INSTRUMENTS DIVISION, GOULD INC. CLEVELAND

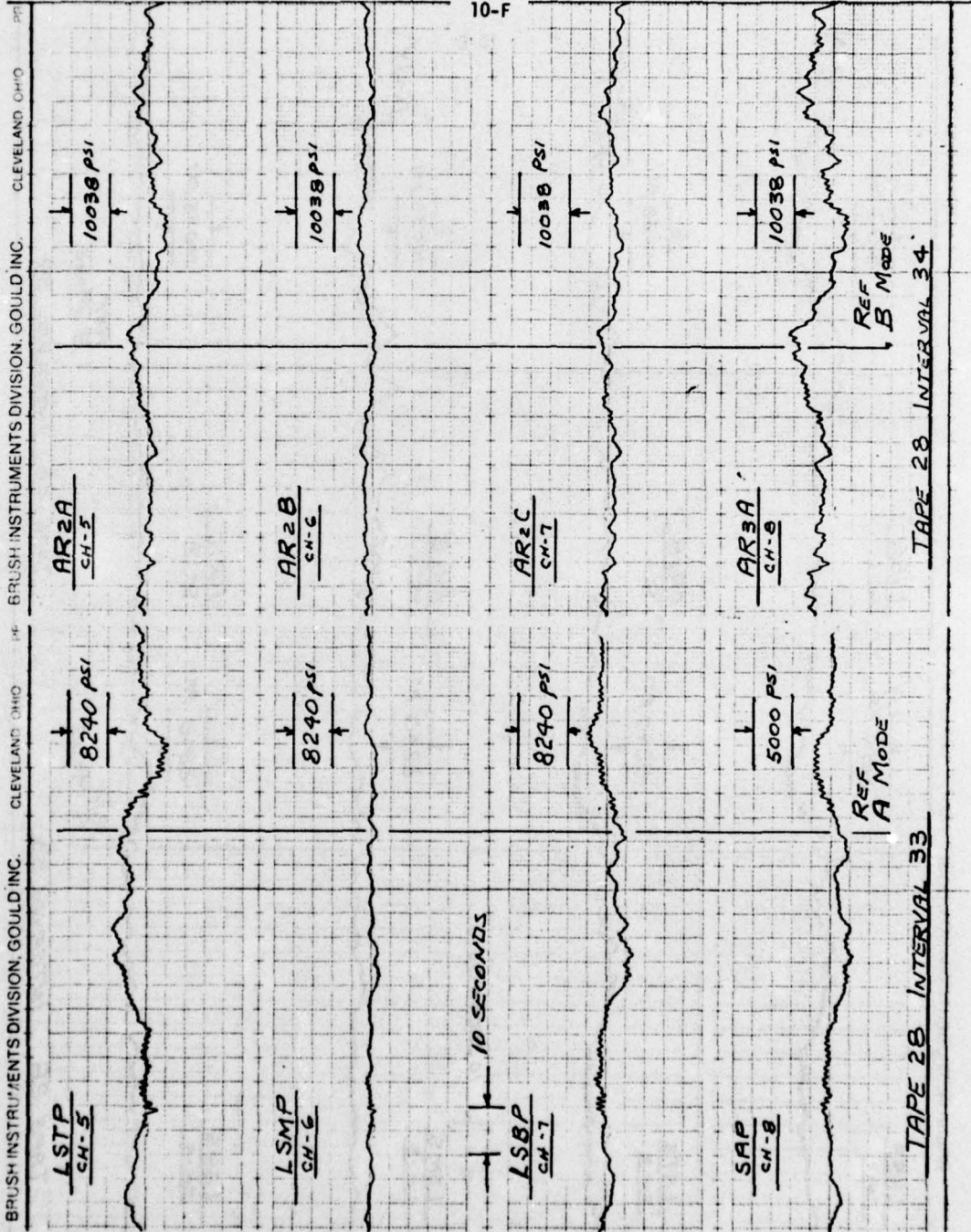


BRUSH INSTRUMENTS DIVISION, GOULD INC. CL1

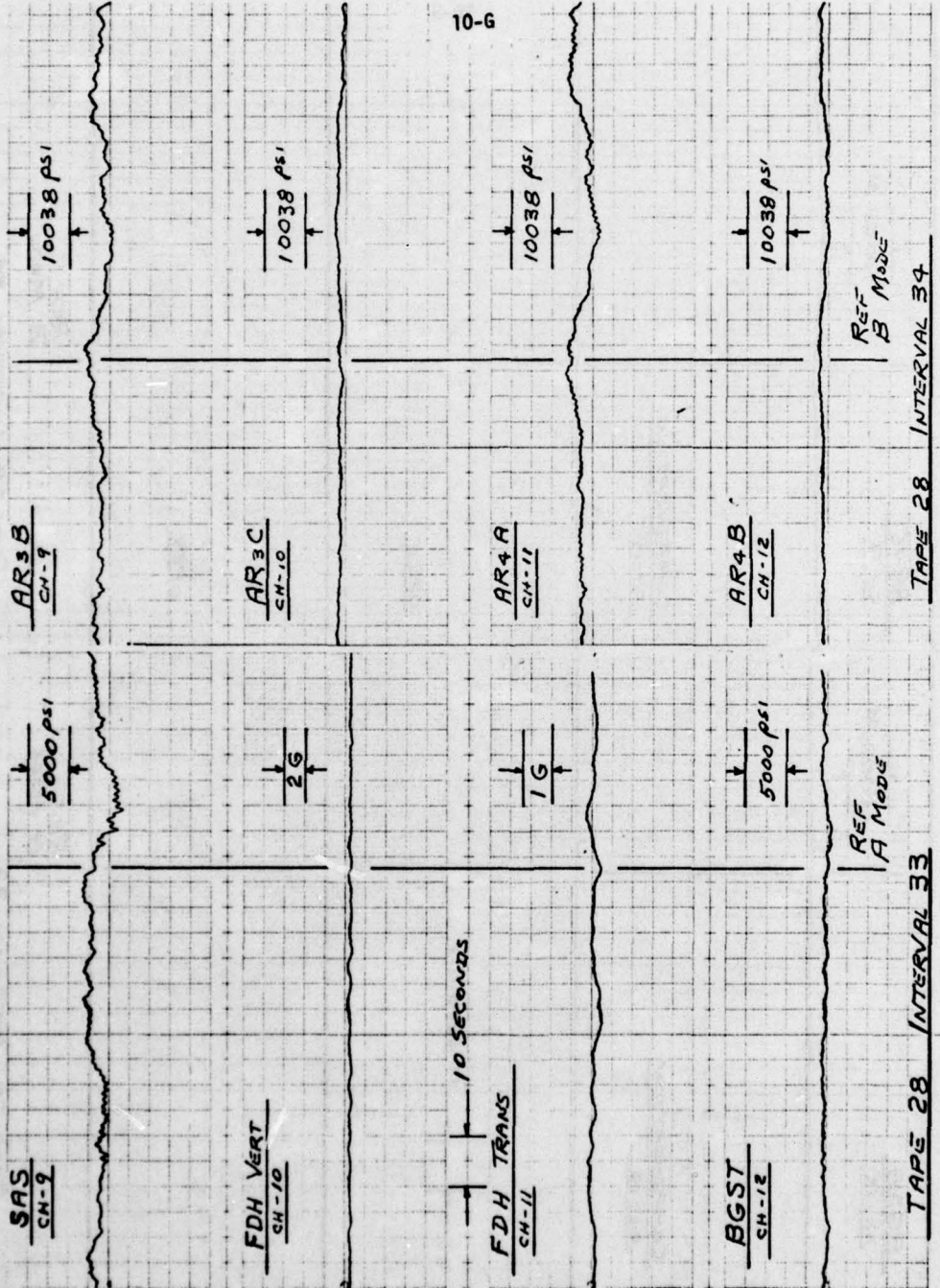


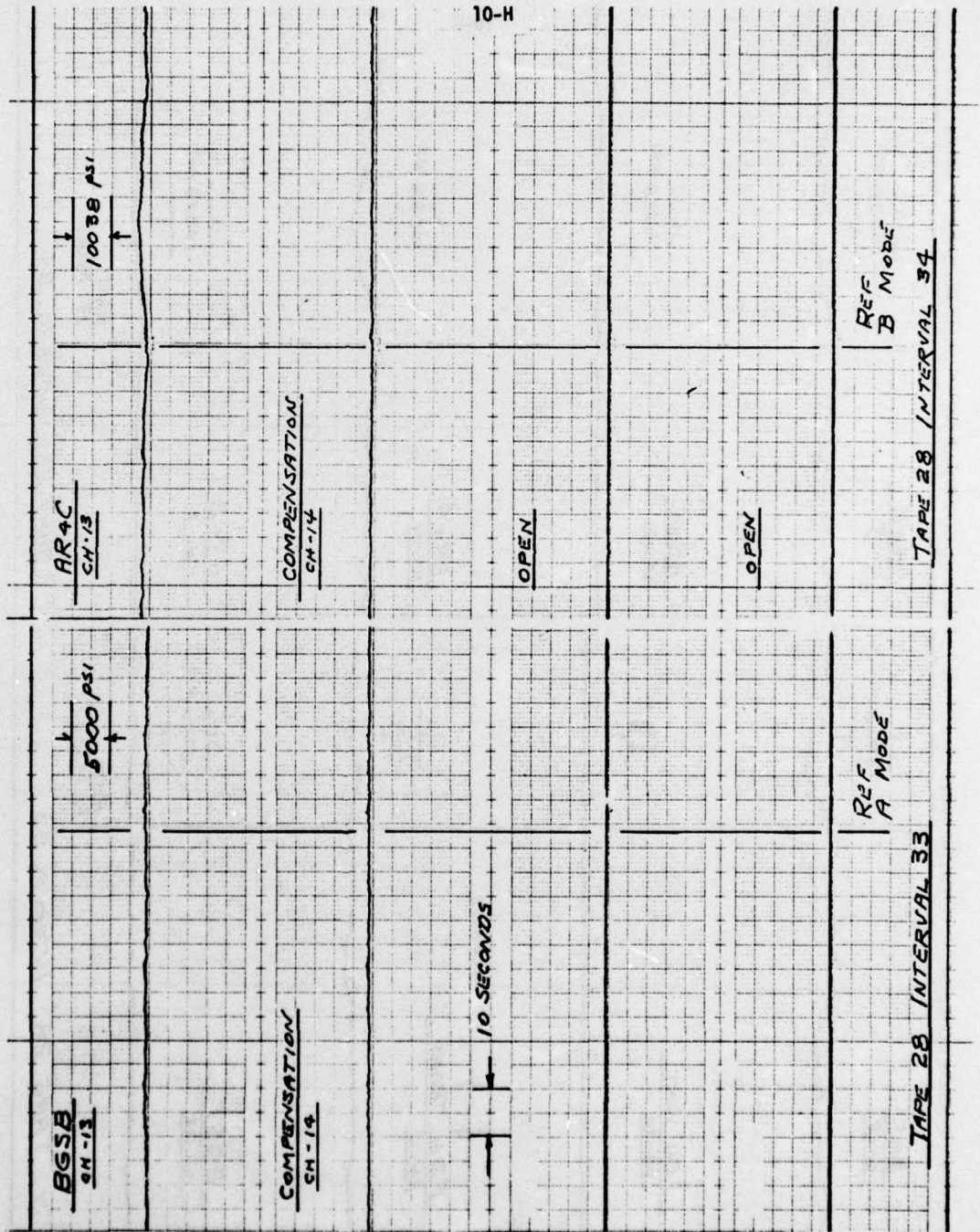






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JON. GOULD INC. CLEVELAND, OHIO PRINTED IN U.S.A.

LVBS
CH-1

8214 PSI

TSM
CH-2

4991 PSI

10 SECONDS

OPEN
CH-3

10-1

ROLL
CH-4

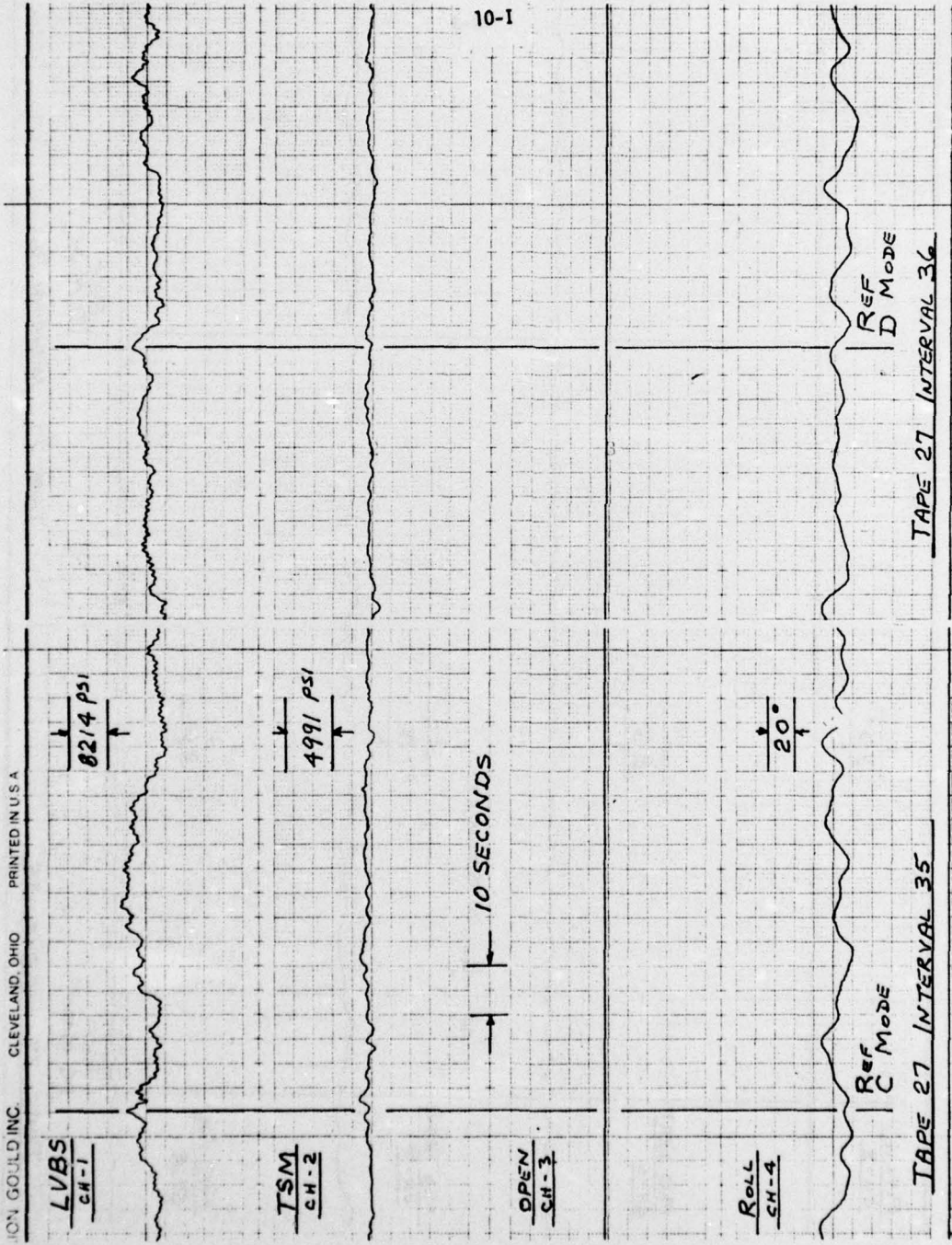
20°

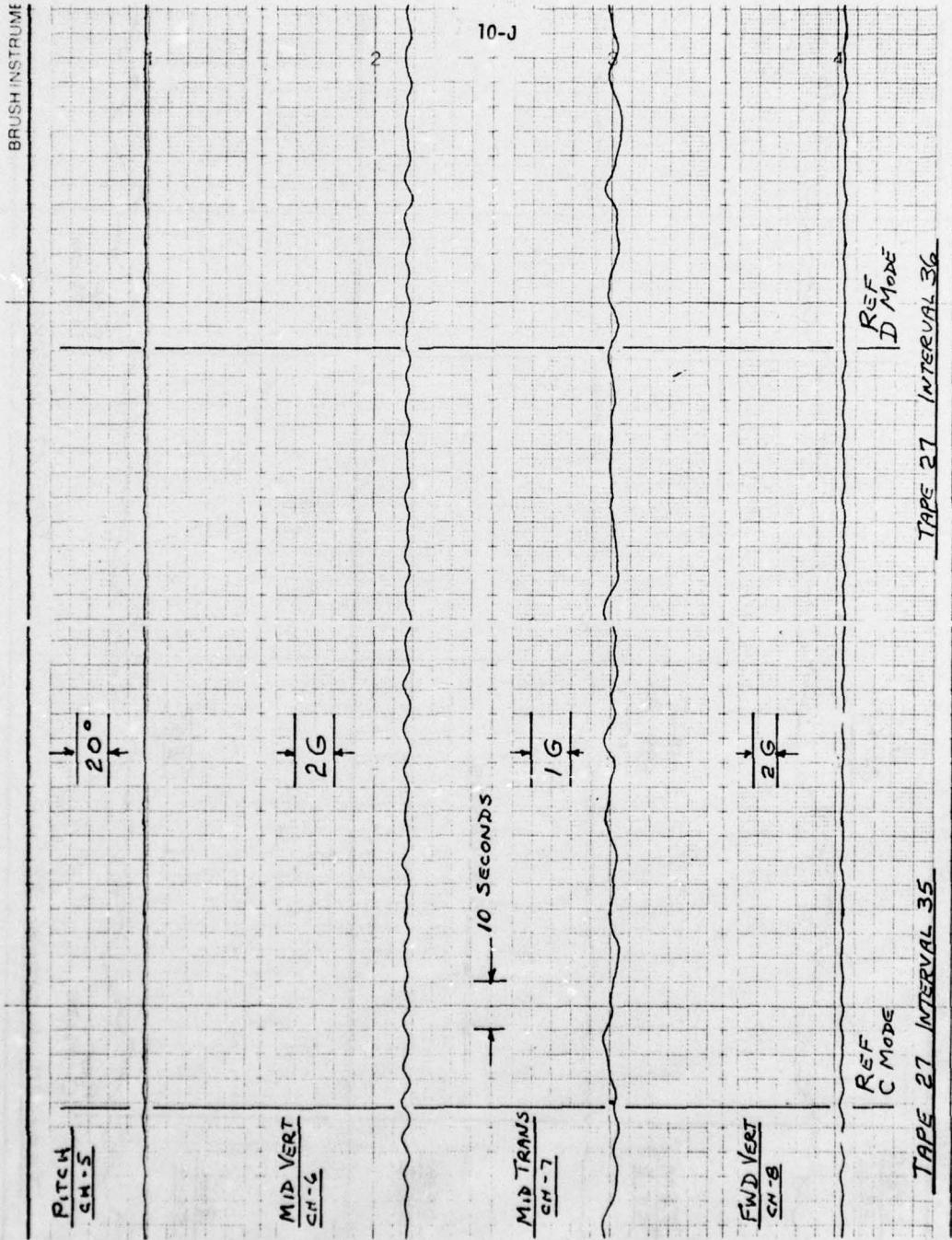
REF
C MODE

TAPE 27 INTERVAL 35

REF
D MODE

TAPE 27 INTERVAL 36





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OPEN
CH-9

OPEN
CH-10

LHBS
CH-11

SFP
CH-12

10-K

10 SECONDS

8214 PSI

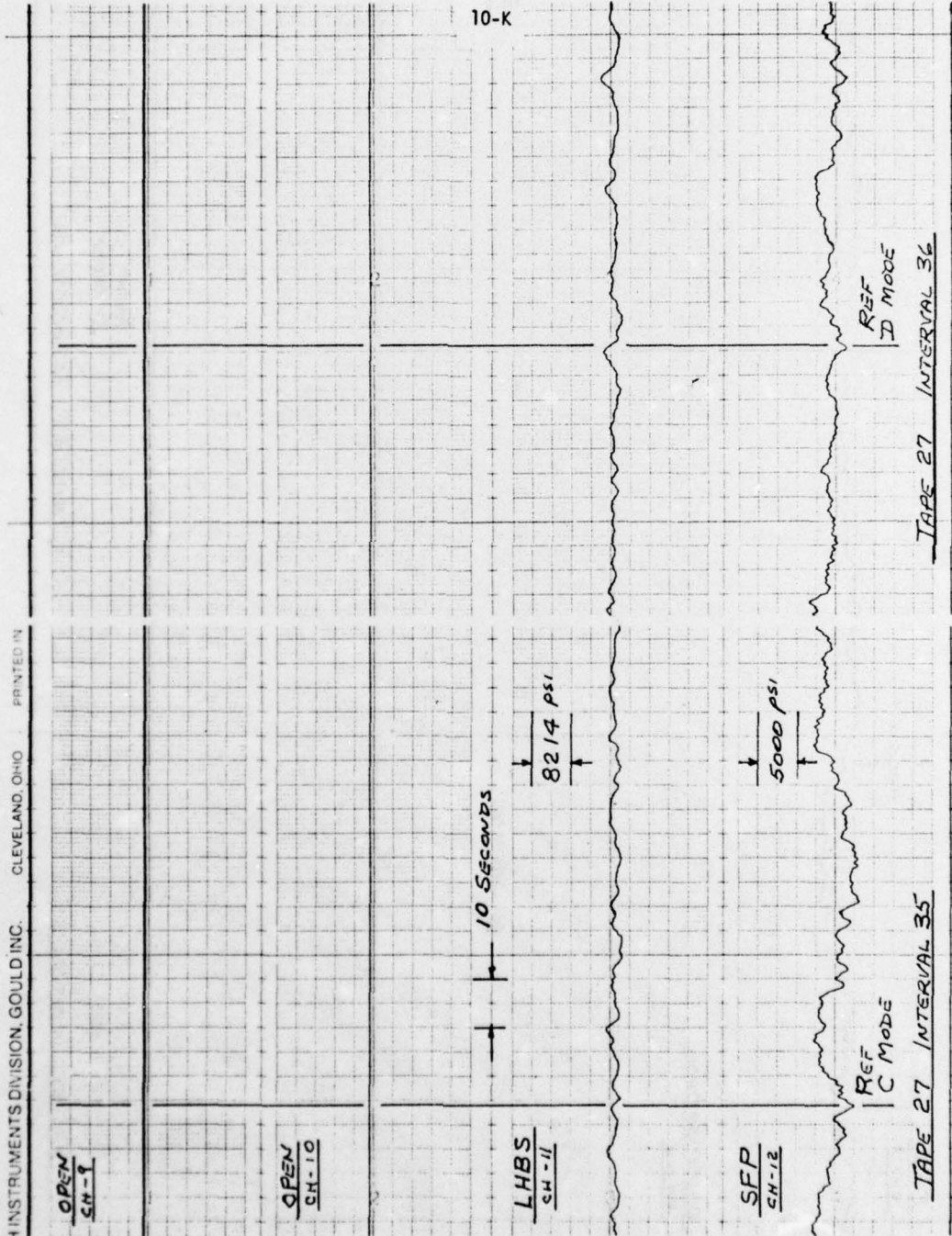
5000 PSI

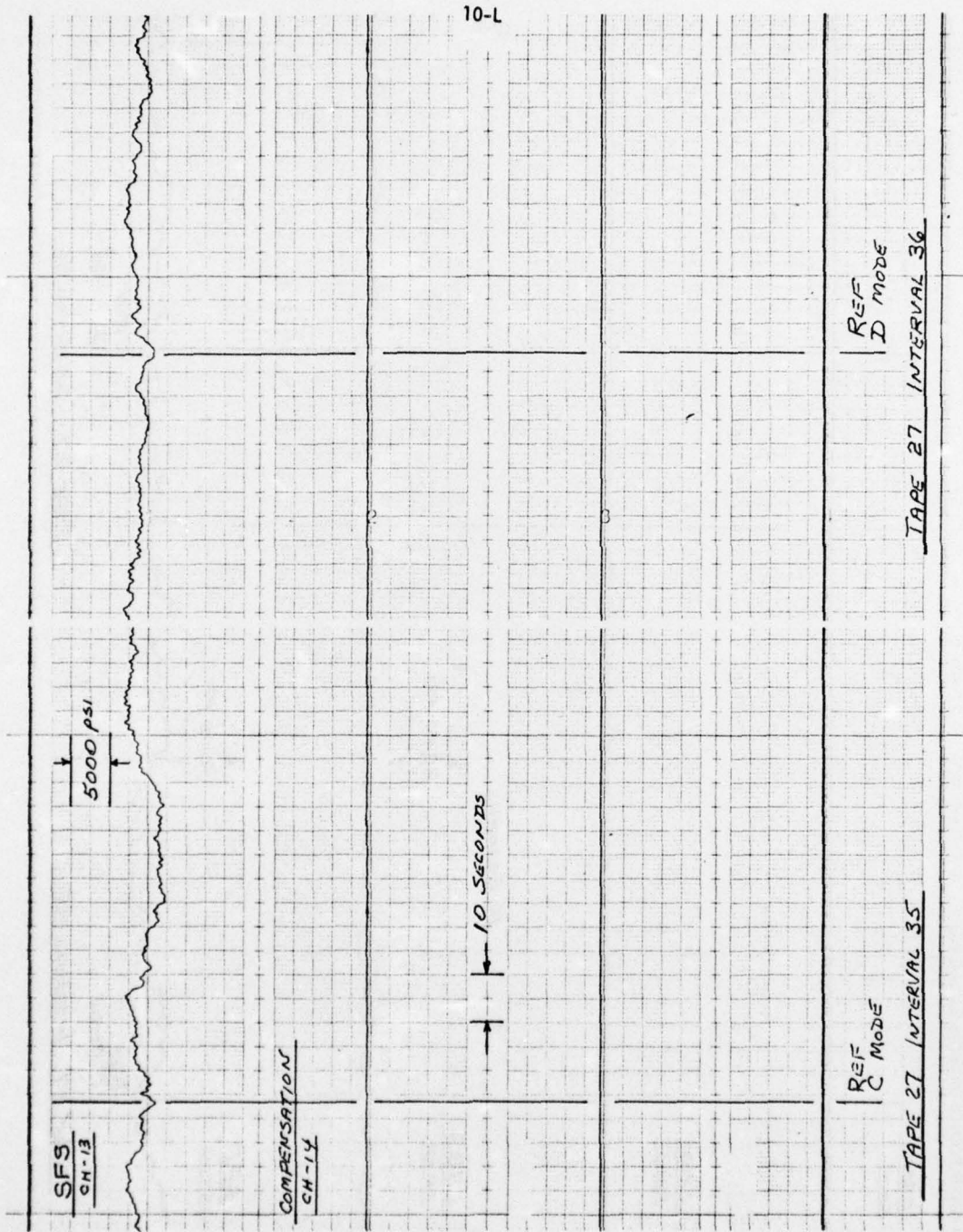
REF
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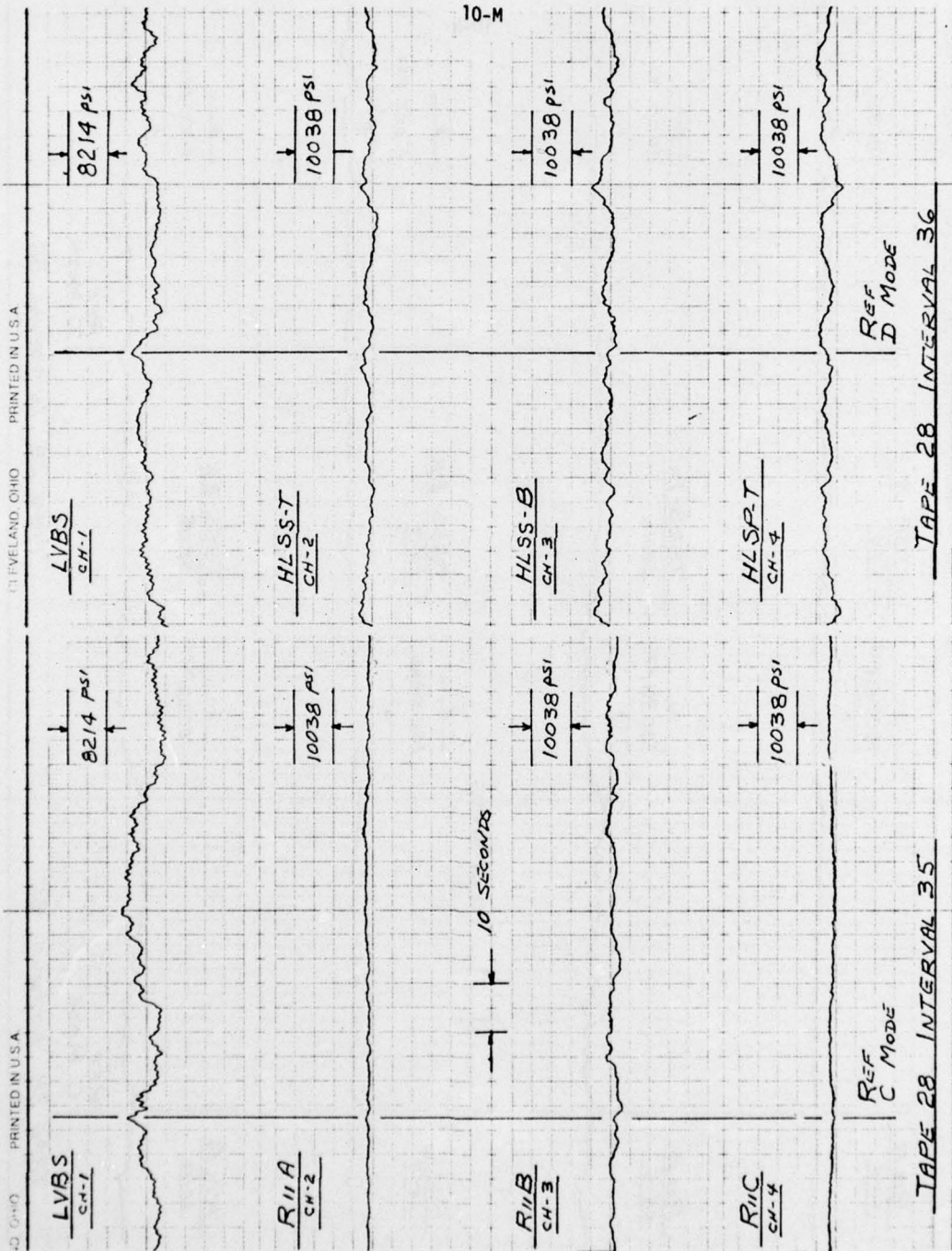
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D MODE

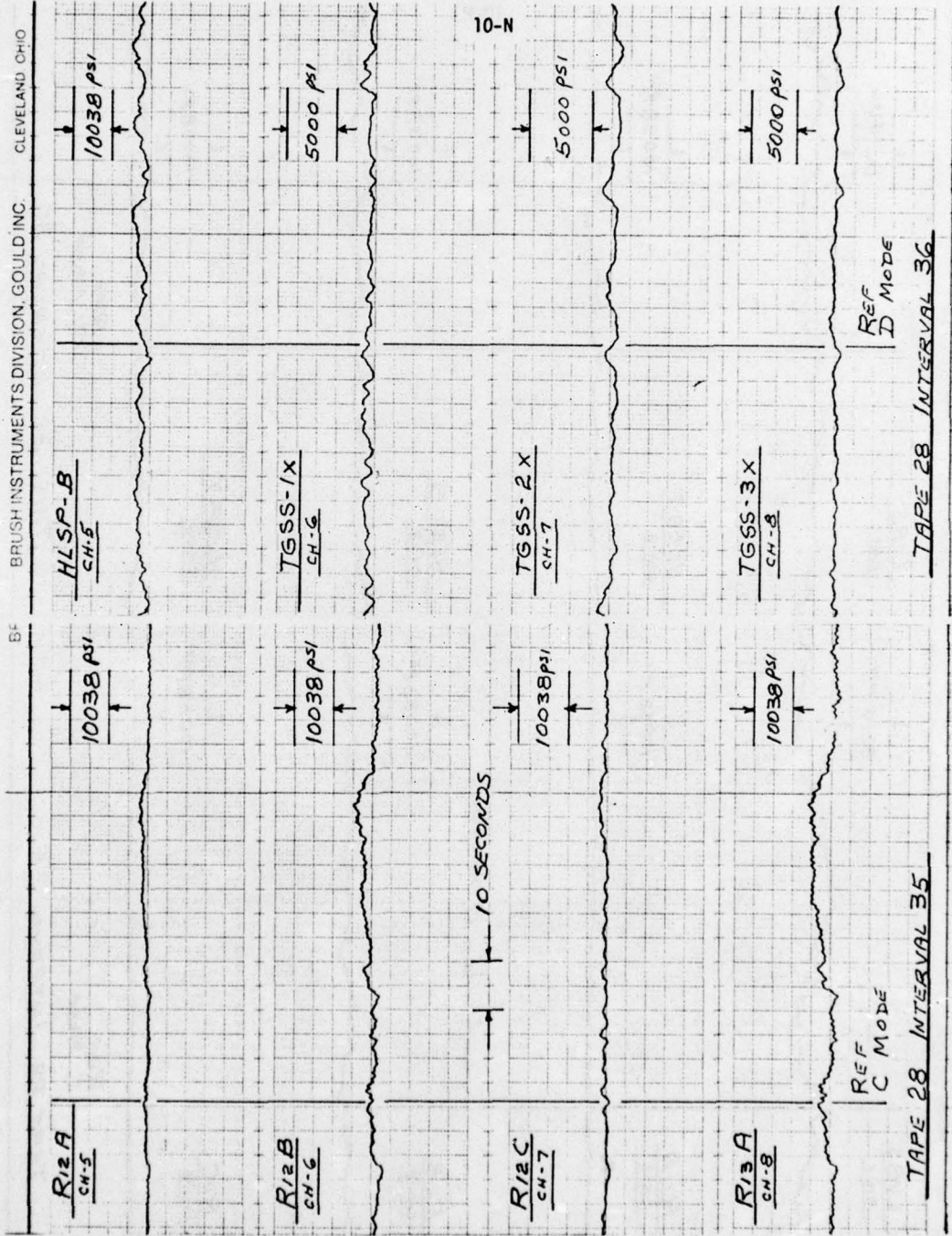
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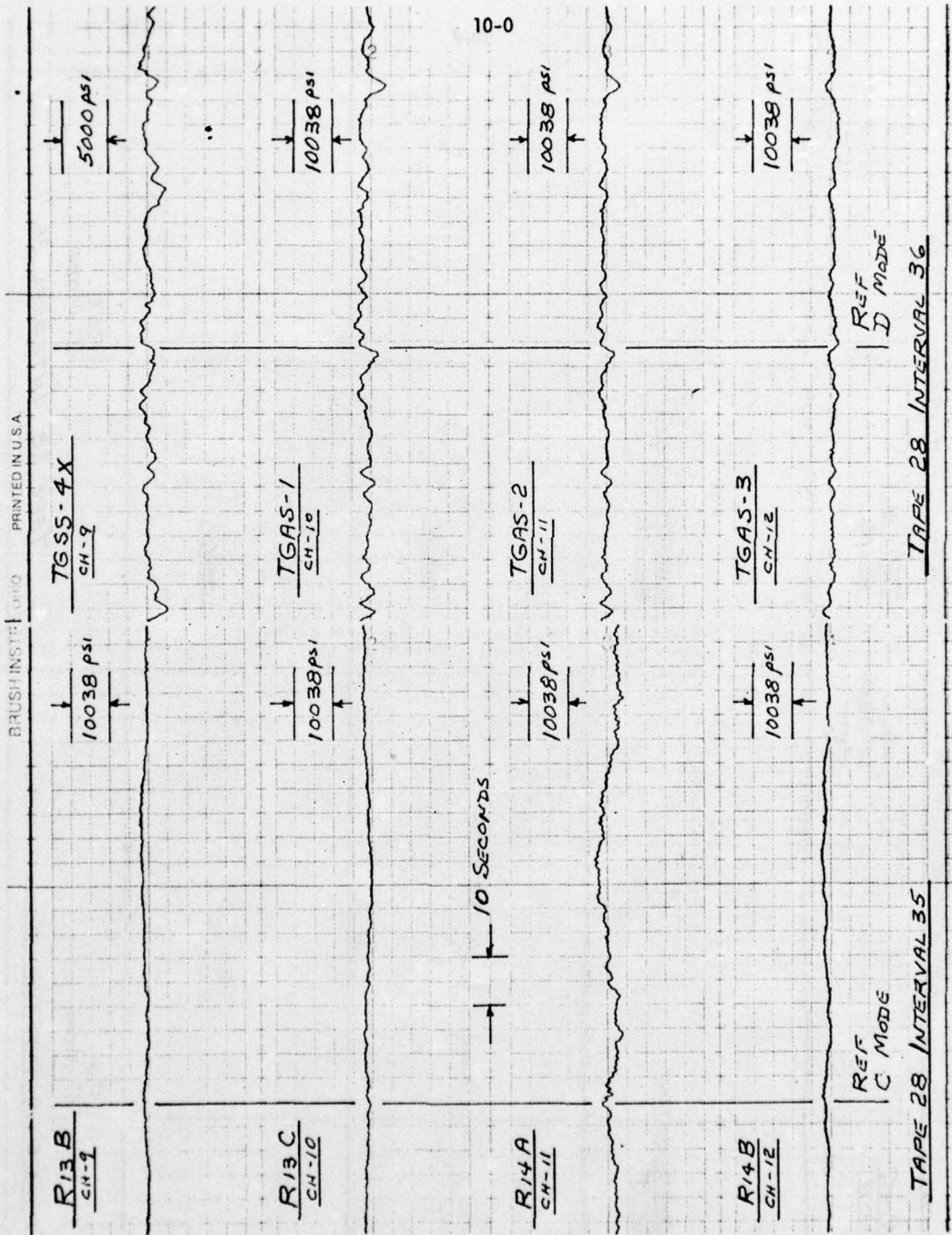
TAPE 27 INTERVAL 36



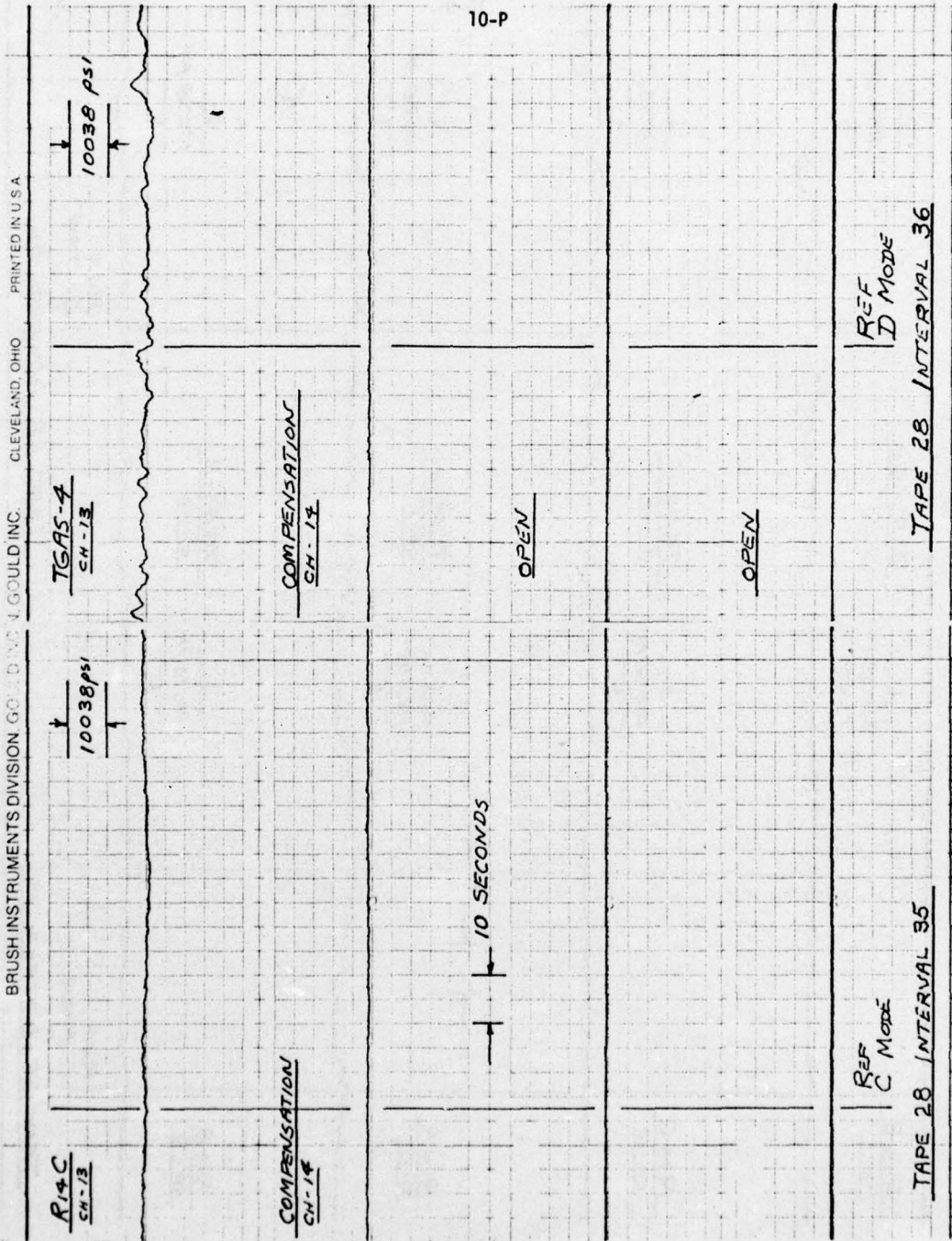








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gages recorded on Recorder No. 2. The maximum peak-to-trough combined values were scaled from oscillograph records for each interval on Voyage 4, separated into sets by Beaufort Number, and the maximas averaged and plotted. Figures 11-A and 11-B present the results from this process. For general comparison, the averaged results from the Longitudinal Vertical Bending (LVB), the Longitudinal Horizontal Bending (LHB), and the Torsional Shear Midship (TSM) stress gages have been plotted against Beaufort Number in Figure 12. These results are from the wave-induced digitized data.

6. Wave Height Radar Data

As part of the continuing effort to obtain accurate information as to the exact nature of the waves incident to the vessel, a wave height radar system was installed aboard the SEA-LAND McLEAN. The output, in the form of a slant range signal, is provided for recording on Channel 3 of Recorder No. 1. The antenna for the device is at the bridge level on the outboard starboard side. The signal, of course, contains components of ship motions. Figure 13 compares the slant range signal with Vertical Bending Stress, Bow Vertical Acceleration, and Roll Sensor outputs.

7. Torsional Response Data

The simultaneous waveforms have been used to develop data plotted in Figure 14, which shows the relationships between strains at the upper corners of the midship transverse girder, and overall midship torsional shear.

8. Simultaneous Comparison of Longitudinal Gages

Figure 15 illustrates the set of instantaneous values from the six longitudinal stress gages as functions of their locations. This figure is designed to be comparable to similar figures presented in the calibration report (Reference 3) for static conditions.

IV. DISCUSSION OF DATA

The following discussion is based on the data presented from the first season. In some cases points are discussed which are the results of observations made during the calibration experiment (Reference 3).

Many relationships can be inferred from the data presented. It is the objective of this discussion to explore some of the more salient features of the ship's response characteristics. No attempt has been made to summarize or correlate all available data. Various forms of data summaries have been used to indicate the behavior of the signals originally recorded on analog tape. Oscillographic display of the magnetic tape data results in time histories from which instantaneous comparisons, waveform analyses, and other manual studies can be performed. The manual studies include a table (IX) of maximum values for Voyage 4. In addition, eight channels of all data from Recorder No. 1 have been digitized, summarized, and parametric studies performed, as mentioned above.

Due to the mass of data collected, it is not possible to publish an all-inclusive summary of results which will not lose some features of the data. Selected analyses have been performed which present some of the more important data comparisons and evaluations. Other areas of interest should be defined by other Investigators (SR-217, for example) or Advisory Committee members. An attempt will be made to include the

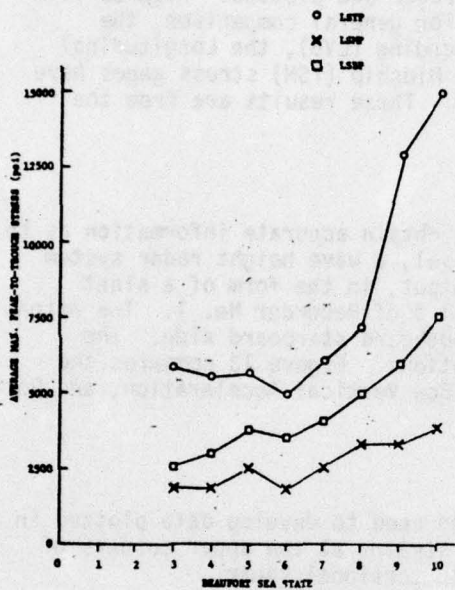


FIGURE 11-A
Port Longitudinal Gages
Average Values - Voyage 4

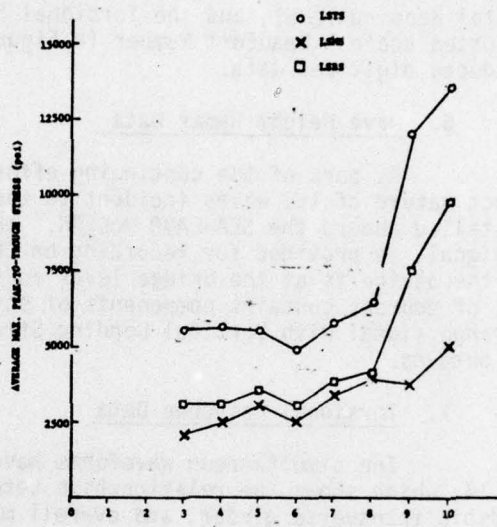


FIGURE 11-B
Starboard Longitudinal Gages
Average Values - Voyage 4

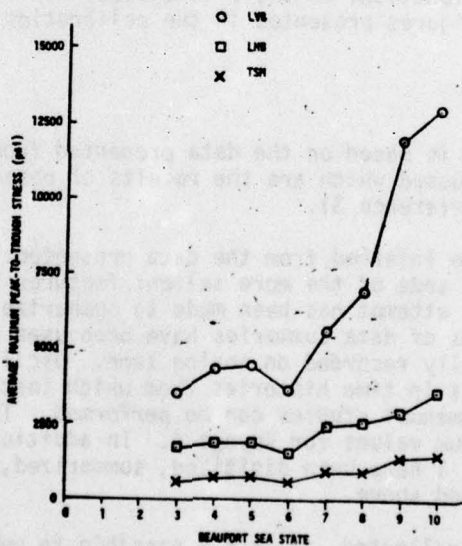
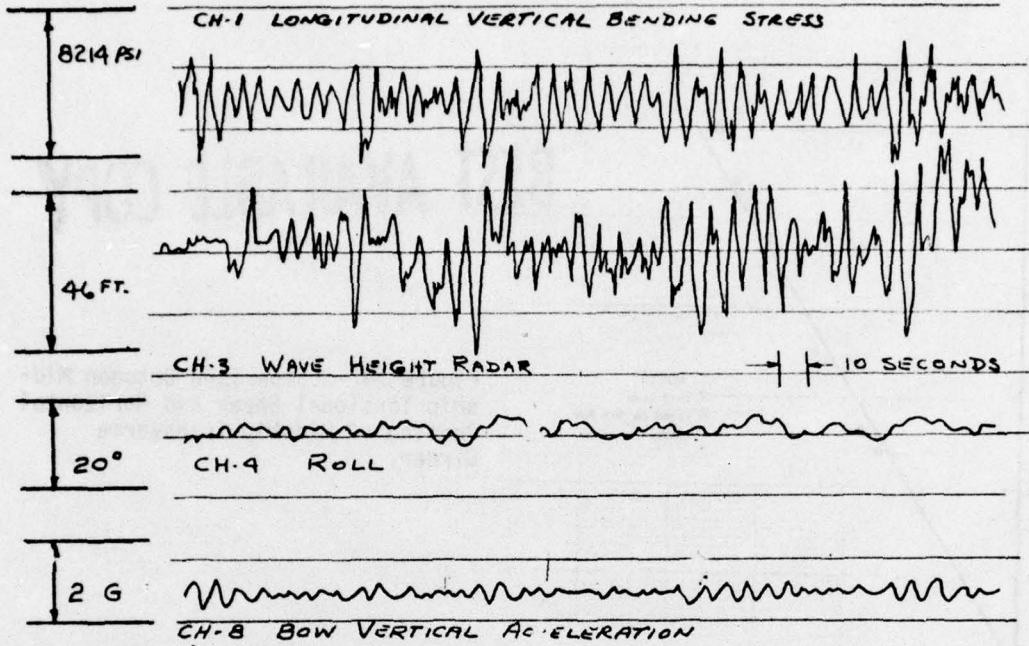
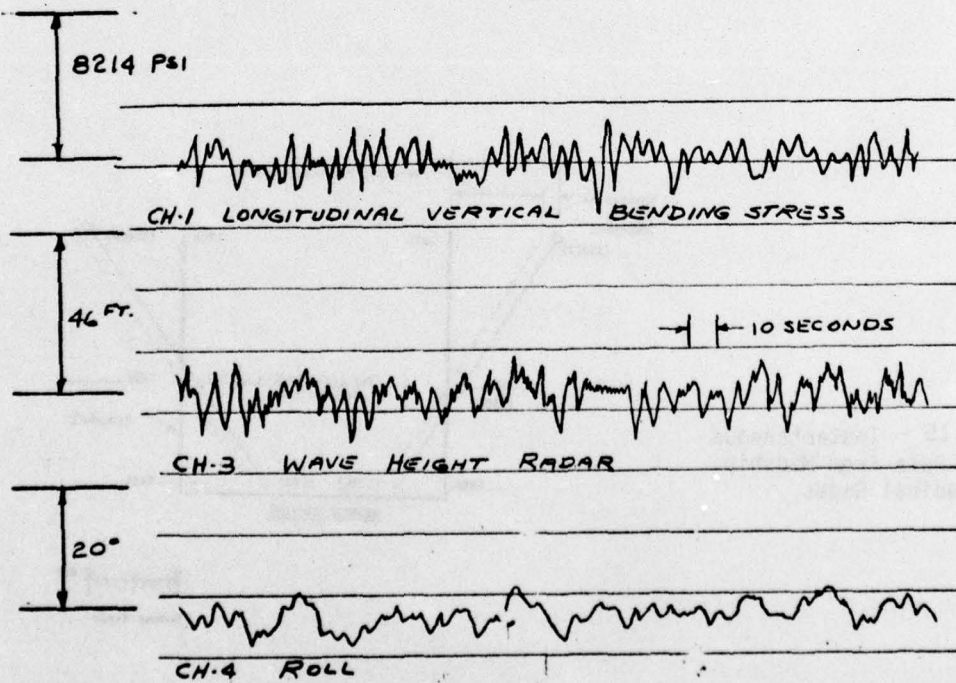


FIGURE 12
AVERAGE MAXIMUM HULL STRESS VALUES
VOYAGE 04



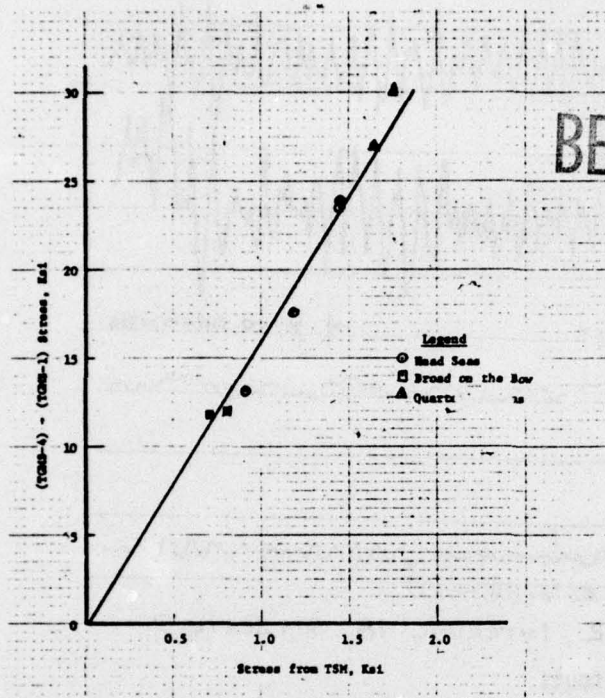
VOYAGE 10 WEST, INDEX 22, INTERVAL 18, SEA STATE 9

Figure 13-A - Sample Wave Height Outputs



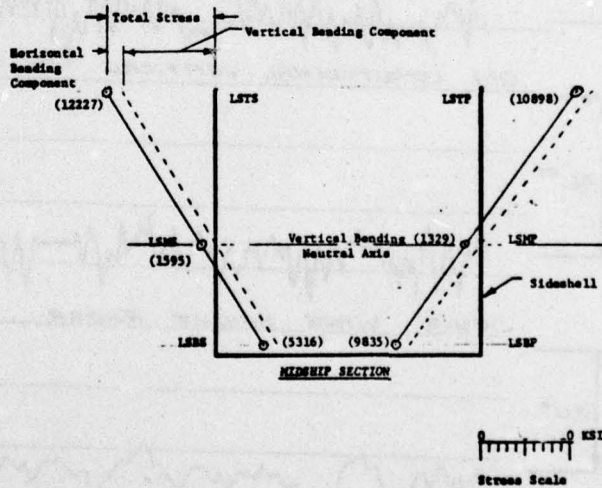
VOYAGE 10 EAST, INDEX 19, INTERVAL 1, SEA STATE 7

Figure 13-B - Sample Wave Height Outputs



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Figure 14 - Comparison Between Midship Torsional Shear and Horizontal Bending of Midship Transverse Girder.



desired data or format in future reports or, if the need is pressing, to issue appropriate supplemental reports.

A. Voyage 4 Simultaneous Response Data

As indicated by Figure 6, no sea conditions in excess of those corresponding to Beaufort 9 were encountered during eastbound voyages, and only two indexes had Beaufort Numbers of 9. In either direction the most commonly reported Beaufort Number was 4, whereas the median value was 5. During westbound voyages Beaufort Numbers of 9 and 10 were reported about equally. Westbound voyages are, therefore, used for high-sea-state, instantaneous data presentations. Voyage 4 had the highest average and peak sea states. It was, therefore, used to provide simultaneous response data for signals assigned to Tape Recorder No. 2 for Figures 7, 8, 9, and 10.

Figures 7, 8, 9, and 10 present recorded high sea state response data for head, broad-on-the-bow, quartering, and following relative sea conditions. Ship speed is reduced from about 30 knots to about 20 knots in the head and broad-on-the-bow cases.

As expected, the most obvious difference between the four sets of data is the period of the wave-induced (long period, low frequency) responses. In the head or broad-on-the-bow data, the 8-9 second wave encounter period is obvious along with the constant 0.8 Hz first-mode structural frequency. For the quartering or following sea cases, a much larger and less well defined wave-induced stress period is present along with the 0.8 Hz first mode response. The magnitude of the peak-to-trough longitudinal vertical bending stress (LVB) is dependent on and approximately equal for similar sea state numbers.

1. Head Seas

An example of slamming is exhibited during Interval 17 (Mode A) of Tape 25 (head sea). A fairly clean hogging stress is followed by sagging and high first mode stresses. The first mode stresses gradually decrease over a period of 40 seconds. Vertical accelerations at the midship and forward deckhouse accelerometers are also evident and closely follow the vertical bending stress curve. At the same instant there are similarly shaped but opposite longitudinal stresses in the top and bottom hull sideshell gages (LSTP, LSBP, LSTS, LSBS, all on Recorder No. 2, both port and starboard) with virtually no stress exhibited at the vertical bending neutral axis (LSMP and LSMS). The bottom stresses are lower than those measured by the top gages because they are closer to the neutral axis.

The small differences, port to starboard, between the respective midship top, neutral axis (mid) and bottom sideshell gage outputs are due to horizontal longitudinal bending components. This component, along with the longitudinal warping stress, also contributes to the nonzero output of the mid sideshell gages. Neutral axis shear gages (SAP and SAS) show similar responses with the opposite polarity (due to the port and starboard wiring convention).

Another example of slamming is shown near the reference lines of the "B" Mode (Interval 18) of the same tape. In this case the aft rosette responses are monitored on Recorder No. 2. Although AR-1 and AR-2 are located in similar positions but opposite sides, they nevertheless exhibit dissimilar responses in magnitude for the longitudinal and transverse gages (elements A and C, respectively).

In comparing the diagonal gage outputs, however, it should be kept in mind that these elements are parallel to each other and are not symmetric about the ship's longitudinal centerline.

It is interesting to note that although the response period of these gages is similar to that of the longitudinal vertical bending stress gages, their peaks are more rounded and the waveform lags the bending sensor output slightly. The largest output for this gage group is exhibited by the longitudinal element of AR-4 which is located in the starboard longitudinal tunnel top. It reflects the longitudinal bending stress at this location.

Intervals 19 and 20 (Modes "C" and "D" of the same index) present similar sea conditions and similar responses on the respective Recorder No. 1 sensors. The longitudinal element of rosette R1 (located aft of the forward house) exhibited the largest stress of the rosettes in this group. Second largest was the longitudinal element of the similarly placed gage on the opposite (starboard) side. Virtually identical stresses were measured by the diagonal element of this gage and the longitudinal element of the gage located in the tunnel top (R3). A still lower stress was present in the longitudinal element of the outboard tunnel top gage (R4). To summarize, the line load seems to be dropping off towards the outboard sides with the forward house a significant factor in the transmission of bending stresses.

Only moderate stresses were recorded in the mid and aft transverse girder corners (in the transverse direction). It is interesting to note that response exhibited by the mid girder gages are predominantly wave-induced, while the aft responses contain obvious first-mode components. The tensile stresses on the forward plate of the transverse girder, coupled with compressive stresses on the aft (bulkhead) plate, indicate a horizontal bending mode. Notice also that the midship torsional shear sensor indicates some small torsional stresses of a similar shape.

2. Broad-on-the-Bow Seas

On the whole, the major characteristics of ship responses to this condition are similar to that for head seas. Vertical bending stress is somewhat reduced while torsional shear, horizontal bending, and roll are slightly increased. The pronounced first-mode slamming stresses are gone from the sample record.

All of the remaining sensor records are at or below the levels for the head sea conditions. Although both sets of intervals were recorded at Sea State 10, the present set is followed by a Sea State 9, and it is possible that the sea state had, in fact, moderated to a small degree. Other studies of the overall Voyage 4 data indicate that the maximum peak-to-trough stresses are very strong functions of sea state for levels of eight, and above. This may well explain the reduction in stress magnitude. Logbook entries of the observer for this Index indicate spray over the ship but no slamming. This is probably the result of the reduction in sea state and not the change in relative sea direction.

3. Quartering Seas

The most obvious characteristic of the quartering and following sea conditions is the long-period wave-induced responses. Another striking difference is the indicated roll ± 13 degrees in Interval 13 ("A" Mode). This is accompanied by virtually no pitch or vertical acceleration, but significant transverse acceleration in phase with the roll. In this case the longitudinal neutral axis stress midships is not negligible, but is composed primarily of horizontal bending. Note

the out-of-phase relationship port and starboard, and the similarity to the longitudinal horizontal bending stress sensor output. It should be noted that although torsional stresses may contribute to this signal, the period of the torsional shear sensor output is different from that exhibited by the neutral axis or horizontal bending sensors.

Of the aft rosettes only the diagonal element of AR-1 (port side, near hatch cutout) showed significant strains, probably due to its being aligned with a stress trajectory from the aft house around the hatch opening.

The measured roll period does not correlate to the vertical or horizontal bending or torsion sensors. Roll does, however, correspond generally to the forward hull longitudinal strain sensors (HLSP/T-T/B).

Only small stresses were recorded for mid and aft transverse girders. The forward and aft signals seem to be uniformly out of phase.

4. Following Seas

The sample record presented for the following sea condition has a higher associated sea state than the preceding quartering condition. Many more instances of first-mode excitation are present on all traces. In general, the peak-to-trough stress levels are higher than for the quartering sea case. This is due, however, to the increased sea state rather than the relative sea direction. (A later section in this discussion will present data to affirm this assertion.)

Another characteristic of this data set is the nonperiodic nature of most output traces. This feature makes comparisons of phase behavior among the responses difficult.

The vertical bending sensor shows some evidence of slamming (a relatively clean hogging moment followed by first-mode excitation and an increasing sagging moment.) As would be expected from the following seas, very little torsional shear is present. Roll motions were significant at 20 degrees peak-to-trough. This trace is not a smooth sinusoid as in the case of the quartering sea, but reflects a continuous forcing function application without a steady state or decaying component.

Although virtually no pitch is present, a midship vertical acceleration in excess of 0.1g (peak-to-trough) was present, indicating a heaving translation. A decoupled (i.e., not at the same or harmonic frequency) transverse acceleration component of about 0.4g peak-to-trough was also exhibited. The horizontal bending signal correlates reasonably well with the roll angle. It can also be seen that the forward shear sensors correspond closely to the midship longitudinal stress sensors (available only in the "A" mode) including phase, indicating that these shears are generated mainly by overall vertical bending.

A large (approximately 20 Ksi, peak-to-trough) stress was again present in the diagonal element of the port aft rosette (AR-1). However, there again was no correspondence between the longitudinal and lateral elements of this gage and the symmetrically placed elements on the starboard side. This may be due to the nature of the cargo loading. If the net load in each hold has a port or starboard component the static and dynamic effect of this offset may be to induce these types of stresses.

Gages located in the longitudinal tunnel exhibit the largest stress in the longitudinal direction both forward (gages R-13 and R-14) and aft (gages AR-3 and AR-4). In all cases these stress outputs closely follow the midship vertical bending sensor output.

B. Extreme Variations with Sea State

All maximum peak-to-trough values (combined wave-induced and vibratory) of the six longitudinal stress sensors have been averaged for each Beaufort Number of Voyage 4 and plotted in Figures 11-A and 11-B. In addition, Figure 12 shows similar averages for the LVB, LHB, and TSM transducers taken from the digitized wave-induced records. In all cases, each average contains all ship speeds and relative wave directions.

Average vertical bending and individual midship longitudinal stresses (port and starboard, top and bottom) all increase with increasing sea state. However, at Beaufort Numbers of eight and above, they increase at a faster rate. This situation does not seem to hold for the Torsional Shear Midship or Longitudinal Horizontal Bending sensors. The midship longitudinal neutral axis gages (port and starboard), which see the combined horizontal bending and restraint-of-torsional-warping stresses, similarly do not exhibit the marked stress increase above Beaufort 8. It is therefore probable that the vertical bending stress increases are real and not due to a systematic error in Beaufort Number estimation.

The stresses measured by the six longitudinal gages include components from vertical, horizontal, and torsional loads. The values for the neutral axis pair (X's in Figures 11-A and 11-B) are relatively insensitive to vertical bending, however, so the moderate increase with increasing Beaufort Number must be an indication of increasing horizontal and/or torsional loads. This is confirmed by inspection of Figure 12, which shows an equally moderate increase in those components. The fact that the individual stresses at the bottom on each side are consistently lower than the comparable deck stresses is because of the location of the neutral axis at about 44% of the depth, measured up from the baseline. The significantly higher values for vertical bending at Beaufort Numbers above eight are probably the result of the existence of waves, or combinations of waves and swells, considerably higher and longer than those observed at the lower sea states. Inspection of the logbook data for Voyage 4 in Appendix 4 shows many intervals of reduced speed operation with pitching and slamming noted.

C. Sample Wave Height Signals

Two intervals of wave height radar outputs are presented in Figure 13. This instrument measures the slant range from a position on the forward house to the ocean surface at a constant relative bearing. A minimum of two corrections are required in order to correlate these data to the wave height. Although the angle between the ship's vertical axis and the radar transmission axis is constant, ship's roll alters the angle between the transmission axis and the ocean surface. This, in turn, changes the slant range. In addition, the vertical height above the ocean changes due to pitching and heaving. This also changes the slant range. Some of the required correction signals are available from the instrumentation system. Roll angle can be utilized directly. A double integration of the forward vertical acceleration signal will yield the change in vertical height of the radar from any reference level.

In reviewing the output traces of the wave height radar some correlation can be seen between the roll and radar output. Although this correlation could be due to the waves affecting the ship's roll, it is probable that the reverse is true; the roll is affecting the measured wave height. A lesser correspondence is seen between the vertical acceleration and the radar output. In some instances, however, the periods of these two signals coincide.

(This discussion has ignored the second-order effect on true wave height from changes in angular relationships due to the accelerometers being mounted in the strap-down configuration.)

D. Torsional Stress Indicators

One of the conclusions of the Calibration Report (see Reference 3), is that the midship transverse girder gages (TGMS) are a more sensitive indicator of torsional loading than the midship torsional shear sensor (TSM). Seaway data provide an additional reinforcement of this assertion. Figure 14 presents a plot of the torsional shear sensor output against a measure of the horizontal bending in the midship transverse girder. Each point represents a randomly-selected peak-to-trough stress reading with ordinate and abscissa values taken at the same instant in time. The data from which these points were drawn represent the higher sea states. The difference between the signals from the upper (fore and aft) corner gages in the transverse girder is taken as the measure of horizontal bending in the girder. Since the output of these gages is 180 degrees out of phase, their algebraic difference results in their absolute values being additive. A pure horizontal bending component is thus generated with twice the sensitivity of a single gage. (This bending results in an "S" curved transverse girder with the ends at each longitudinal tunnel acting as fixed.)

It can be seen from Figure 14 that the horizontal bending stress generated in the transverse girder is higher, by a factor of approximately 16, than the corresponding torsional shear stress for all sea directions.

E. Midship Longitudinal Gages

The odd behavior of the six midship longitudinal stress gages during the calibration experiment (see Reference 3) raised some questions as to the correctness of the instrumentation system with regard to these gages. Seaway data can be used to verify their proper operation under the assumed conditions.

Figure 15 presents a plot of the output from these six midship gages for an instant in time. A head-sea condition was chosen so as to minimize the torsional contribution to longitudinal stress which cannot easily be separated from the horizontal contribution. As shown in the figure, the stresses are well behaved and what one would expect of a vertical bending condition with a small horizontal component. This representation is typical of that which was observed in many instances for the seaway data. It thus affirms the proper operation and configuration of these gages.

F. Parametric Studies (Appendix 3)

To aid in the interpretation of the results of the parametric studies (which are, in effect, a presentation of the entire season's data from eight of the most important transducers), the plots and tables from the Longitudinal Vertical Bending (LVB) stress data will be considered in some detail.

Figure B-1 is a "dot-plot" of the RMS stress value from the LVB transducer by Beaufort Number for the entire season. There are 2,078 points shown. The great scatter in each Beaufort Number is caused by the fact that these points are from all relative wave directions and all ship speeds. Figure B-2 has been plotted from these basic data points analyzed into five classifications of ship speed. The classification nomenclature is given in Table B-II, and in all of the Tables B-III through B-XXXIV at the end of Appendix B. Again, the average values given for each ship speed also contain some range of relative wave direction. Figure B-2 shows that the highest mean values of RMS vertical bending stress were measured at Beaufort 10, at ship speeds between 20 and 25 knots. Note that at the next higher speed range the stresses were lower at the highest Beaufort Numbers, which is probably due to predominantly quartering or following seas. There are no reported cases of operation at full speed at Beaufort Numbers higher than 9.

Figure B-3 is a similar classification of the data by relative wave direction. The values for Beaufort 10 (which contain a range of ship speeds as shown in B-2) indicate that the highest stresses were experienced in head seas, the next highest at relative wave directions from 31 to 60 degrees, and the next highest in quartering seas. Beam seas produced the lowest vertical bending stresses at Beaufort Numbers 8 and above.

Figures B-4 through B-6 are organized in the same way except that they present the distributions of the maximum peak-to-trough stress variations. The stress amplitudes scales are doubled, but the general distributions are the same.

The tables following these figures in Appendix B present the basic data for the figures, and, in addition, the standard deviation of the mean values. These provide a measure of the scatter of the data.

Some brief comments can be made concerning the results of these parametric studies:

1. Horizontal bending stress is much lower than vertical bending stress, and is less sensitive to variations in ship speed and relative wave direction, although quartering seas appear to contribute significantly to higher stresses at Beaufort 10.

2. Torsional Shear Midship is even lower, with less scatter at Beaufort 9 and 10. Quartering seas are a factor at Beaufort 10.

3. Forward Shear Port and Starboard results are essentially the same. The largest shearing stress variations occurred at Beaufort 8, in broad-on-the-bow and quartering seas.

4. The Roll results show more rolling at higher Beaufort Numbers with higher speeds. Quartering and beam seas cause the most rolling. A maximum dynamic roll of $\pm 18^\circ$ was recorded at Beaufort 10.

5. The maximum pitching angle was $+ 2.5$ degrees at Beaufort 9. The most pitching occurred at head seas, the least at beam, quartering, and following.

6. The Forward Acceleration (Vertical) showed a maximum of ± 0.45 g. Highest values were recorded in head seas.

V. POSSIBLE DATA FORMATS

This report presents data in a number of forms, those which seemed most appropriate for an overall survey of the data from the first season. Included are expanded time-histories, logbook tabulations, tabulations of maximum values scaled from compressed time-histories, and plots derived from parametric studies of digitized response and logbook data. Also available, but too voluminous for publication, are tabulations of response and logbook data for each interval, all season, for all eight digitized transducers. As a guide for the consideration of possible expansion, modification, or deletion of these data formats, Figure 16 has been prepared to indicate the various possible data presentation formats.

Of the formats illustrated, all but the spectral computations and manual tabulations of logbook data have been used in this report. From the standpoint of relative cost the manual formats shown at the top of the figure are least costly, but are cumbersome where a number of transducers are to be compared. An expanded time-history is essential for the instantaneous comparisons, since the digital data from different transducers have no common time base once a specific interval is defined.

Digitizing the data is relatively expensive, both in man-hours and in computer costs, but this method has great advantages for rapid tabulations and plots of both logbook and response data. At present the data is filtered so that RMS and maximum values are computed from essentially pure wave-induced response, for comparison with design data derived on the same basis. Vibratory components from slamming or other excitations are retained in the basic digitized record of 12,000 data points from 20 minutes of each 30-minute interval. Spectral computations are made from this record.

In considering decisions on data formats, the basic questions concerning the information desired should be formulated in terms of choice of instantaneous vs. statistical data, a few samples under specified conditions vs. the entire season, need for future use of the same data, one transducer or many, and so forth, in order to arrive at a rational decision balancing information desired against cost.

VI. SUMMARY

The first season of data acquisition from the S.S. SEA-LAND McLEAN was a successful one. This report has presented a large amount of data with brief discussions and evaluations. As additional data are acquired during the second season, and the first season data is analyzed more completely, a comprehensive picture of the structural behavior of this unique class of vessel will emerge.

VII. ACKNOWLEDGEMENTS

A program as complex as this can succeed only with the cooperation of many people and organizations. Thanks are due specifically to Mr. John W. Boylston of Sea-Land Service, Inc., and to the officers and crew of the S.S. SEA-LAND McLEAN for all of their efforts to make our part of this work successful. Special thanks also to Teledyne engineers E. T. Booth and H. G. La Montagne for manning the ship and bringing back the data.

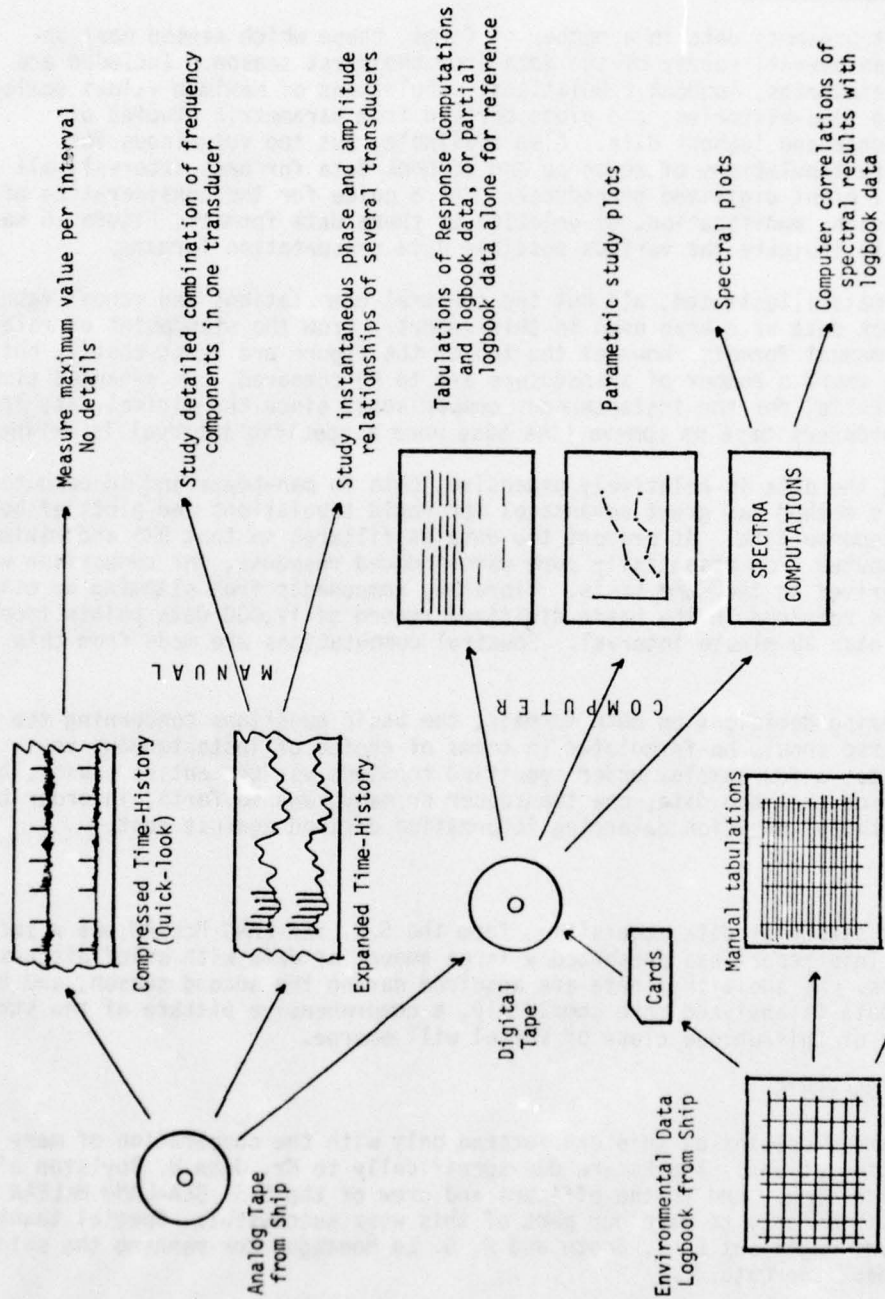


Figure 16
Data Presentation Formats

VIII. REFERENCES

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- 2a. Johnson, A. E., Jr., Flaherty, J. A., and Walters, I. J., A Method for Digitizing, Preparing, and Using Library Tapes of Ship Stress and Environment Data, Ship Structure Committee Report SSC-236, 1973.
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3. Boentgen, R. R., and Wheaton, J. W., Static Structural Calibration of Ship Response Instrumentation System Aboard the S.S. SEA-LAND McLEAN, Ship Structure Committee Report SSC-263 (SL-7-7), 1976.

APPENDIX A

Partial Listing of Logbook Data
First Season
S.S. SEA-LAND McLEAN

Nomenclature

VOY = Voyage number, East or West
TP = Analog magnetic tape number
INT = Data interval number
IDX = Logbook index number
DATE = Month/Day/Year
Time = GMT
SPD = Ship speed, knots
BN = Observed Beaufort Number (appearance of sea)
RWVD = Relative Wave Direction (degrees, Port or Stbd)

VOY TP	INT	IDX	DATE	TIME	SPD	BN	RWVD	A-1	WEATHER	COMMENTS	VOY TP	INT	IDX	DATE	TIME	SPD	BN	RWVD	A-2	WEATHER
01W	01	001	001	10/08/72	2000	02	0523	ICAST		SLOW SPEED	01W	01	051	011	10/10/72	2000	31.8	02	00AP	PTCDY
01W	01	002	001	10/08/72	2000	02	0528	ICAST		SLOW SPEED	01W	01	052	011	10/10/72	2000	31.8	02	00AP	PTCDY
01W	01	003	001	10/08/72	2000	02	0523	ICAST		SLOW SPEED	01W	01	053	014	10/10/72	2000	31.8	04	03SP	PTCDY
01W	01	004	001	10/08/72	2000	02	0523	ICAST		SLOW SPEED	01W	01	054	014	10/10/72	2000	31.8	04	03SP	PTCDY
01W	01	005	002	10/08/72	2400	31.0	02	0653	PTCDY		01W	01	055	014	10/10/72	2000	31.8	04	03SP	PTCDY
01W	01	006	002	10/08/72	2400	31.0	02	0653	PTCDY		01W	01	056	014	10/10/72	2000	31.8	04	03SP	PTCDY
01W	01	007	002	10/08/72	2400	31.0	02	0653	PTCDY		01W	01	057	015	10/11/72	0000	31.8	06	03AP	CLOY RAIN
01W	01	008	002	10/08/72	2400	31.0	02	0653	PTCDY		01W	01	058	015	10/11/72	0000	31.8	06	03AP	CLOY RAIN
01W	01	009	003	10/08/72	0400	31.0	03	075P	PTCDY		01W	01	059	015	10/11/72	0000	31.8	06	03AP	CLOY RAIN
01W	01	010	003	10/08/72	0400	31.0	03	075P	PTCDY		01W	01	060	015	10/11/72	0000	31.8	06	03AP	CLOY RAIN
01W	01	011	003	10/08/72	0400	31.0	03	075P	PTCDY		01W	01	061	016	10/11/72	0000	31.0	07	03SP	CLOY RAIN
01W	01	012	003	10/08/72	0400	31.0	03	075P	PTCDY		01W	01	062	016	10/11/72	0000	31.0	07	03SP	CLOY RAIN
01W	01	013	004	10/08/72	0400	31.0	04	030P	ICAST		01W	01	063	016	10/11/72	0000	31.0	07	03SP	CLOY RAIN
01W	01	014	004	10/08/72	0400	31.0	04	030P	ICAST		01W	01	064	016	10/11/72	0000	31.0	07	03SP	CLOY RAIN
01W	01	015	004	10/08/72	0400	31.0	04	030P	ICAST		01W	01	065	017	10/11/72	1200	31.0	07	05SP	ICAST
01W	01	016	004	10/08/72	0400	31.0	04	030P	ICAST		01W	01	066	017	10/11/72	1200	31.0	07	05SP	ICAST
01W	01	017	005	10/08/72	1200	31.0	04	015S	ICAST	SHIMWMS	01W	01	067	017	10/11/72	1200	31.0	07	05SP	ICAST
01W	01	018	005	10/08/72	1200	31.0	04	015S	ICAST	SHIMWMS	01W	01	068	018	10/11/72	1600	30.8	07	05SP	PTCDY
01W	01	019	005	10/08/72	1200	31.0	04	015S	ICAST	SHIMWMS	01W	01	070	018	10/11/72	1600	30.8	07	05SP	PTCDY
01W	01	020	005	10/08/72	1200	31.0	04	015S	ICAST	SHIMWMS	01W	01	071	018	10/11/72	1600	30.8	07	05SP	PTCDY
01W	01	021	006	10/08/72	1600	31.0	06	037S	RAIN	HIGH SEA	01W	01	072	018	10/11/72	1600	30.8	07	05SP	PTCDY
01W	01	022	006	10/08/72	1600	31.0	06	037S	RAIN	HIGH SEA	01W	01	073	019	10/11/72	2000	30.8	07	05SP	PTCDY
01W	01	023	006	10/08/72	1600	31.0	06	037S	RAIN	HIGH SEA	01W	01	074	019	10/11/72	2000	30.8	07	05SP	PTCDY
01W	01	024	006	10/08/72	1600	31.0	06	037S	RAIN	HIGH SEA	01W	01	075	019	10/11/72	2000	30.8	07	05SP	PTCDY
01W	01	025	007	10/08/72	2000	31.0	07	036S	CLOY	RAIN HUGH SEA	01W	01	076	019	10/11/72	2000	30.8	07	05SP	PTCDY
01W	01	026	007	10/08/72	2000	31.0	07	036S	CLOY	RAIN HUGH SEA	01W	01	077	020	10/11/72	2400	30.8	07	05SP	PTCDY
01W	01	027	007	10/08/72	2000	31.0	07	036S	CLOY	RAIN HUGH SEA	01W	01	078	020	10/11/72	2400	30.8	07	05SP	PTCDY
01W	01	028	007	10/08/72	2000	31.0	07	036S	CLOY	RAIN HUGH SEA	01W	01	079	020	10/11/72	2400	30.8	07	05SP	PTCDY
01W	01	029	008	10/08/72	2400	28.0	07	059S	PTCDY	EASTING	01W	01	080	020	10/11/72	2400	30.8	07	05SP	PTCDY
01W	01	030	008	10/08/72	2400	28.0	07	059S	PTCDY	EASTING	01W	03	005	021	10/12/72	0400	28.9	04	033S	PTCDY
01W	01	031	008	10/08/72	2400	28.0	07	059S	PTCDY	EASTING	01W	03	006	021	10/12/72	0400	28.9	04	033S	PTCDY
01W	01	032	008	10/08/72	2400	28.0	07	059S	PTCDY	EASTING	01W	03	007	021	10/12/72	0400	28.9	04	033S	PTCDY
01W	01	033	009	10/10/72	0400	26.0	05	081S	PTCDY	LWA S.WELL	01W	03	008	021	10/12/72	0400	28.9	04	033S	PTCDY
01W	01	034	009	10/10/72	0400	26.0	05	081S	PTCDY	LWA S.WELL	01W	03	009	022	10/12/72	0400	28.0	03	079P	CLOY
01W	01	035	009	10/10/72	0400	26.0	05	081S	PTCDY	LWA S.WELL	01W	03	010	022	10/12/72	0400	28.0	03	079P	CLOY
01W	01	036	009	10/10/72	0400	26.0	05	081S	PTCDY	LWA S.WELL	01W	03	011	022	10/12/72	0400	28.0	03	079P	CLOY
01W	01	037	010	10/10/72	0800	30.0	03	081S	CLEAR	MUD NNN SEA	01W	03	012	022	10/12/72	0400	28.0	03	079P	CLOY
01W	01	038	010	10/10/72	0800	30.0	03	081S	CLEAR	MUD NNN SEA	01W	03	013	023	10/12/72	1200	30.8	04	124P	PTCDY
01W	01	039	010	10/10/72	0800	30.0	03	081S	CLEAR	MUD NNN SEA	01W	03	014	023	10/12/72	1200	30.8	04	124P	PTCDY
01W	01	040	010	10/10/72	0800	30.0	03	081S	CLEAR	MUD NNN SEA	01W	03	015	023	10/12/72	1200	30.8	04	124P	PTCDY
01W	01	041	011	10/10/72	1200	31.8	04	059S	PTCDY		01W	03	016	023	10/12/72	1200	30.8	04	124P	PTCDY
01W	01	042	011	10/10/72	1200	31.8	04	059S	PTCDY		01W	03	017	025	10/12/72	2000	30.8	04	023P	PTCDY
01W	01	043	011	10/10/72	1200	31.8	04	059S	PTCDY		01W	03	018	025	10/12/72	2000	30.8	04	023P	PTCDY
01W	01	044	011	10/10/72	1200	31.8	04	059S	PTCDY		01W	03	019	025	10/12/72	2000	30.8	04	023P	PTCDY
01W	01	045	012	10/10/72	1600	31.8	02	00AP	PTCDY		01W	03	020	025	10/12/72	2000	30.8	04	023P	PTCDY
01W	01	046	012	10/10/72	1600	31.8	02	00AP	PTCDY		01W	03	021	026	10/12/72	2400	30.8	04	022P	PTCDY
01W	01	047	012	10/10/72	1600	31.8	02	00AP	PTCDY		01W	03	022	026	10/12/72	2400	30.8	04	022P	PTCDY
01W	01	048	012	10/10/72	1600	31.8	02	00AP	PTCDY		01W	03	023	026	10/12/72	2400	30.8	04	022P	PTCDY
01W	01	049	013	10/10/72	2000	31.8	02	00AP	PTCDY		01W	03	024	026	10/12/72	2400	30.8	04	022P	PTCDY
01W	01	050	013	10/10/72	2000	31.8	02	00AP	PTCDY		01W	03	025	027	10/13/72	0400	04	033P	ICAST	
											01W	03	026	027	10/13/72	0400	04	033P	ICAST	

VOY TP	INT	IDX	DATE	TIME	SPD	BN	RWVD	A-3	WEATHER
01W	03	027	027	10/13/72	0400	04	033P	ICAST	
01W	03	028	027	10/13/72	0400	04	033P	ICAST	
01W	03	029	028	10/13/72	0400	04	047S	CLEAR	
01W	03	030	028	10/13/72	0400	04	047S	CLEAR	
01W	03	031	028	10/13/72	0400	04	047S	CLEAR	
01W	03	032	028	10/13/72	0400	04	047S	CLEAR	
01W	03	033	029	10/13/72	1200	04	047S	PTCDY	
01W	03	034	029	10/13/72	1200	04	047S	PTCDY	
01W	03	035	029	10/13/72	1200	04	047S	PTCDY	
01W	03	036	029	10/13/72	1200	04	047S	PTCDY	
02E	05	001	001	10/15/72	0400	28.7	04	00AS	PTCDY
02E	05	002	001	10/15/72	0400	28.7	04	00AS	PTCDY
02E	05	003	001	10/15/72	0400	28.7	04	00AS	PTCDY
02E	05	004	001	10/15/72	0400	28.7	04	00AS	PTCDY
02E	05	005	002	10/15/72	0400	28.7	05	136S	CLOY ICAST
02E	05	006	002	10/15/72	0400	28.7	05	136S	CLOY ICAST
02E	05	007	002	10/15/72	0400	28.7	05	136S	CLOY ICAST
02E	05	008	002	10/15/72	0400	28.7	05	136S	CLOY ICAST
02E	05	009	001	10/15/72	1200	31.4	06	134P	CLOY
02E	05	010	001	10/15/72	1200	31.4	06	134P	CLOY
02E	05	011	001	10/15/72	1200	31.4	06	134P	CLOY
02E	05	012	003	10/15/72	1200	31.4	06	134P	ICAST
02E	05	013	004	10/15/72	1600	30.8	06	134P	ICAST
02E	05	014	004	10/15/72	1600	30.8	06	134P	ICAST
02E	05	015	004	10/15/72	1600	30.8	06	134P	ICAST
02E	05	016	004	10/15/72	1600	30.8	06	134P	ICAST
02E	05	017	005	10/15/72	2000	30.9	06	156P	CLOY ICAST
02E	05	018	005	10/15/72	2000	30.9	06	156P	CLOY ICAST
02E	05	019	005	10/15/72	2000	30.9	06	156P	CLOY ICAST
02E	05	020	005	10/15/72	2000	30.9	06	156P	CLOY ICAST
02E	05	021	006	10/15/72	2400	31.4	06	156P	ICAST
02E	05	022	006	10/15/72	2400	31.4	06</		

VOY	TP	INT	IDX	DATE	TIME	SPD	BN	RWVD	A-4	WEATHER	VOY	TP	INT	IDX	DATE	TIME	SPD	BN	RWVD	A-5	WEATHER	COMMENTS	
02E	05	041	011	10/16/72	2000	32.4	04	078P		CLOUD	02E	07	035	021	10/19/72	2000	05	010P			PCAST		
02E	05	042	011	10/16/72	2000	32.4	04	078P		CLOUD	02E	07	036	021	10/19/72	2000	05	010P			PCAST		
02E	05	043	011	10/16/72	2000	32.4	04	078P		CLOUD	02E	07	037	024	10/19/72	2400	06	007P			PCAST		
02E	05	044	011	10/16/72	2000	32.4	04	078P		CLOUD	02E	07	038	024	10/19/72	2400	06	007P			PCAST		
02E	05	045	012	10/16/72	2400	32.4	03	078M		CLOUD	02E	07	039	024	10/19/72	2400	06	007P			PCAST		
02E	05	046	012	10/16/72	2400	32.4	03	078M		CLOUD	02E	07	040	024	10/19/72	2400	06	007P			PCAST		
02E	05	047	012	10/16/72	2400	32.4	03	078M		CLOUD	02E	07	041	025	10/19/72	2400	06	007P			PCAST		
02E	05	048	012	10/16/72	2400	32.4	03	078M		CLOUD	02E	07	042	025	10/19/72	2400	06	007P			PCAST		
02E	05	049	013	10/17/72	0400	32.3	04	053P		PTCNDY	02E	07	043	025	10/19/72	2400	06	007P			PCAST		
02E	05	050	013	10/17/72	0400	32.3	04	053P		PTCNDY	02E	07	044	025	10/19/72	2400	06	007P			PCAST		
02E	05	051	013	10/17/72	0400	32.3	04	053P		PTCNDY	02E	07	045	026	10/19/72	2400	06	007P			PCAST		
02E	05	052	013	10/17/72	0400	32.3	04	053P		PTCNDY	02E	07	046	026	10/19/72	2400	06	007P			PCAST		
02E	05	053	014	10/17/72	0800	32.0	04	034S		CLOUD	02E	07	047	026	10/19/72	2400	06	007P			PCAST		
02E	05	054	014	10/17/72	0800	32.0	04	034S		CLOUD	02E	07	048	026	10/19/72	2400	06	007P			PCAST		
02E	05	055	014	10/17/72	0800	32.0	04	034S		CLOUD	02E	07	049	027	10/19/72	1200	05	021S			PCAST		
02E	05	056	014	10/17/72	0800	32.0	04	034S		CLOUD	02E	07	050	027	10/19/72	1200	05	021S			PCAST		
02E	07	001	015	10/17/72	1200	32.1	04	034S		PTCNDY	02E	07	051	027	10/19/72	1200	05	021S			PCAST		
02E	07	002	015	10/17/72	1200	32.1	04	034S		PTCNDY	02E	07	052	027	10/19/72	1200	05	021S			PCAST		
02E	07	003	015	10/17/72	1200	32.1	04	034S		PTCNDY	02E	07	053	028	10/19/72	1600	06	016P			PTCNDY		
02E	07	004	015	10/17/72	1200	32.1	04	034S		PTCNDY	02E	07	054	028	10/19/72	1600	06	016P			PTCNDY		
02E	07	005	016	10/17/72	1600	04	034S			PTCNDY	02E	07	055	028	10/19/72	1600	06	016P			PTCNDY		
02E	07	006	016	10/17/72	1600	04	034S			PTCNDY	02E	07	056	028	10/19/72	1600	06	016P			PTCNDY		
02E	07	007	016	10/17/72	1600	04	034S			PTCNDY	02E	09	001	029	10/23/72	0800	30.1	04	052S			PCAST	
02E	07	008	016	10/17/72	1600	04	034S			PTCNDY	02E	09	002	029	10/23/72	0800	30.1	04	052S			PCAST	
02E	07	009	017	10/17/72	2000	04	034S			PTCNDY	02E	09	003	029	10/23/72	0800	30.1	04	052S			PCAST	
02E	07	010	017	10/17/72	2000	04	034S			PTCNDY	02E	09	004	029	10/23/72	0800	30.1	04	052S			PCAST	
02E	07	011	017	10/17/72	2000	04	034S			PTCNDY	02E	09	005	030	10/23/72	1200	27.0	06	010S			PCAST	
02E	07	012	017	10/17/72	2000	04	034S			PTCNDY	02E	09	007	030	10/23/72	1200	27.0	06	010S			PCAST	
02E	07	013	018	10/17/72	2400	04	010P			PTCNDY	02E	09	008	030	10/23/72	1200	27.0	06	010S			PCAST	
02E	07	014	018	10/17/72	2400	04	010P			PTCNDY	02E	09	009	031	10/23/72	1600	32.1	05	026S			PCAST	
02E	07	015	018	10/17/72	2400	04	010P			PTCNDY	02E	09	010	031	10/23/72	1600	32.1	05	026S			PCAST	
02E	07	016	018	10/17/72	2400	04	010P			PTCNDY	02E	09	011	031	10/23/72	1600	32.1	05	026S			PCAST	
02E	07	017	019	10/18/72	0400	04	010P			PTCNDY	02E	09	012	031	10/23/72	1600	32.1	05	026S			PCAST	
02E	07	018	019	10/18/72	0400	04	010P			PTCNDY	02E	09	013	032	10/23/72	2000	32.1	04	059S			PCAST	
02E	07	019	019	10/18/72	0400	04	010P			PTCNDY	02E	09	014	032	10/23/72	2000	32.1	04	059S			PCAST	
02E	07	020	019	10/18/72	0400	04	010P			PTCNDY	02E	09	015	032	10/23/72	2000	32.1	04	059S			PCAST	
02E	07	021	020	10/18/72	0800	04	033P			PTCNDY	02E	09	016	032	10/23/72	2000	32.1	04	059S			PCAST	
02E	07	022	020	10/18/72	0800	04	033P			PTCNDY	02E	09	017	033	10/23/72	2400	31.4	01			PCAST	LONG LOW SHELLS	
02E	07	023	020	10/18/72	0800	04	033P			PTCNDY	02E	09	018	033	10/23/72	2400	31.4	01			PCAST	LONG LOW SHELLS	
02E	07	024	020	10/18/72	0800	04	033P			PTCNDY	02E	09	019	033	10/23/72	2400	31.4	01			PCAST	LONG LOW SHELLS	
02E	07	025	021	10/18/72	1200	03	033P			PCAST	02E	09	020	033	10/23/72	2400	31.4	01			PCAST	LONG LOW SHELLS	
02E	07	026	021	10/18/72	1200	03	033P			PCAST	02E	09	021	034	10/24/72	0400	32.1	02	140P			PCAST	SHIP ROLLING
02E	07	027	021	10/18/72	1200	03	033P			PCAST	02E	09	022	034	10/24/72	0400	32.1	02	140P			PCAST	SHIP ROLLING
02E	07	028	021	10/18/72	1200	03	033P			PCAST	02E	09	023	034	10/24/72	0400	32.1	02	140P			PCAST	SHIP ROLLING
02E	07	029	022	10/18/72	1600	04	033P			PCAST	02E	09	024	034	10/24/72	0400	32.1	02	140P			PCAST	SHIP ROLLING
02E	07	030	022	10/18/72	1600	04	033P			PCAST	02E	09	025	035	10/24/72	0800	32.1	02	140P			PCAST	
02E	07	031	022	10/18/72	1600	04	033P			PCAST	02E	09	026	035	10/24/72	0800	32.1	02	140P			PCAST	
02E	07	032	022	10/18/72	1600	04	033P			PCAST	02E	09	027	035	10/24/72	0800	32.1	02	140P			PCAST	
02E	07	033	023	10/18/72	2000	05	010P			PCAST	02E	09	028	035	10/24/72	0800	32.1	02	140P			PCAST	
02E	07	034	023	10/18/72	2000	05	010P			PCAST	02E	09	029	036	10/24/72	1200	32.1	03	140P			PCAST	

BEST AVAILABLE COPY

VOY	TP	INT	IDX	DATE	TIME	SPD	BN	RWVD	A-6	WEATHER
02E	09	030	036	10/24/72	1200	32.3	03	140P		PCAST
02E	09	031	036	10/24/72	1200	32.3	03	140P		PCAST
02E	09	032	036	10/24/72	1200	32.3	03	140P		PCAST
02E	09	033	037	10/24/72	1600	32.4	04	140P		CLOUD
02E	09	034	037	10/24/72	1600	32.4	04	140P		CLOUD
02E	09	035	037	10/24/72	1600	32.4	04	140P		CLOUD
02E	09	036	037	10/24/72	1600	32.4	04	140P		CLOUD
02E	09	037	038	10/24/72	2000	32.2	03	145P		CLOUD
02E	09	038	038	10/24/72	2000	32.2	03	145P		CLOUD
02E	09	039	038	10/24/72	2000	32.2	03	145P		CLOUD
02E	09	040	038	10/24/72	2000	32.2	03	145P		CLOUD
02E	09	041	039	10/24/72	2400	31.4	06	078P		PCAST
02E	09	042	039	10/24/72	2400	31.4	06	078P		PCAST
02E	09	043	039	10/24/72	2400	31.4	06	078P		PCAST
02E	09	044	039	10/24/72	2400	31.4	06	078P		PCAST
02E	09	045	040	10/25/72	0400	31.7	06	057S		PTCLOUD
02E	09	046	040	10/25/72	0400	31.7	06	057S		PTCLOUD
02E	09	047	040	10/25/72	0400	31.7	06	057S		PTCLOUD
02E	09	048	040	10/25/72	0400	31.7	06	057S		PTCLOUD
02E	09	049	041	10/25/72	0800	31.4	06	079S		PCAST
02E	09	050	041	10/25/72	0800	31.4	06	079S		PCAST
02E	09	051	041	10/25/72	0800	31.4	06	079S		PCAST
02E	09	052	041	10/25/72	0800	31.4	06	079S		PCAST
02E	11	001	042	10/25/72	1100	32.0	05	102S		PTCLOUD
02E	11	002	042	10/25/72	1100	32.0	05	102S		PTCLOUD
02E	11	003	042	10/25/72	1100	32.0	05	102S		PTCLOUD
02E	11	004	042	10/25/72	1100	32.0	05	102S		PTCLOUD
02E	11	005	043	10/25/72	1300	32.0	05	102S		PTCLOUD
02E	11	006	043	10/25/72						

VOY TP	INT	IDX	DATE	TIME	SPD	RH	HWVD	A-7	WEATHER	VOY TP	INT	IDX	DATE	TIME	SPD	RH	HWVD	A-8	WEATHER
02W	11	028	048	10/26/72	0800	52.1	03	043P	CLEAR	03E	13	042	010	10/30/72	1600	31.7	06	0905	PTCLDY
02W	11	029	049	10/26/72	1200	31.9	04	043P	HCST	03E	13	043	010	10/30/72	1600	31.7	06	0905	PTCLDY
02W	11	030	050	10/26/72	1600	31.9	04	043P	HCST	03E	13	044	010	10/30/72	1600	31.7	06	0905	PTCLDY
02W	11	031	049	10/26/72	1200	32.0	04	043P	HCST	03E	13	045	011	10/30/72	2000	31.9	06	0905	PTCLDY
02W	11	032	049	10/26/72	1200	31.9	04	043P	HCST	03E	13	046	011	10/30/72	2000	31.9	06	0905	PTCLDY
02W	11	033	050	10/26/72	1600	04	0715	HCST	SHWFRS	03E	13	047	011	10/30/72	2000	31.9	06	0905	PTCLDY
02W	11	034	050	10/26/72	1600	04	0715	HCST	SHWFRS	03E	13	048	011	10/30/72	2000	31.9	06	0905	PTCLDY
02W	11	035	050	10/26/72	1600	04	0715	HCST	SHWFRS	03E	13	049	012	10/30/72	2400	31.7	06	0905	HCST
02W	11	036	050	10/26/72	1600	04	0715	HCST	SHWFRS	03E	13	050	012	10/30/72	2400	31.7	06	0905	HCST
02W	11	037	051	10/26/72	2000	05	0945	CLDY		03E	13	051	012	10/30/72	2400	31.7	06	0905	HCST
02W	11	038	051	10/26/72	2000	05	0945	CLDY		03E	13	052	012	10/30/72	2400	31.7	06	0905	HCST
02W	11	039	051	10/26/72	2000	05	0945	CLDY		03E	13	053	013	10/31/72	0400	31.7	06	0905	PTCLDY
02W	11	040	051	10/26/72	2000	05	0945	CLDY		03E	13	054	013	10/31/72	0400	31.7	06	0905	PTCLDY
02W	11	041	052	10/26/72	2400	04	0935	CLDY		03E	13	055	013	10/31/72	0400	31.7	06	0905	PTCLDY
02W	11	042	052	10/26/72	2400	04	0935	CLDY		03E	13	056	013	10/31/72	0400	31.7	06	0905	PTCLDY
02W	11	043	052	10/26/72	2400	04	0935	CLDY		03E	13	057	014	10/31/72	0800	31.8	07	1275	CLDY
02W	11	044	052	10/26/72	2400	04	0935	CLDY		03E	13	058	014	10/31/72	0800	31.8	07	1275	CLDY
02W	11	045	053	10/27/72	0400	00	00	CLDY		03E	13	059	014	10/31/72	0800	31.8	07	1275	CLDY
02W	11	046	053	10/27/72	0400	00	00	CLDY		03E	13	060	014	10/31/72	0800	31.8	07	1275	CLDY
02W	11	047	053	10/27/72	0400	00	00	CLDY		03E	15	001	015	10/31/72	1300	31.8	07	1275	HCST
02W	11	048	053	10/27/72	0400	00	00	CLDY		03E	15	002	015	10/31/72	1300	31.8	07	1275	HCST
02W	11	049	054	10/27/72	0800	00	00	CLEAR		03E	15	003	015	10/31/72	1300	31.8	07	1275	HCST
02W	11	050	054	10/27/72	0800	00	00	CLEAR		03E	15	004	015	10/31/72	1300	31.8	07	1275	HCST
02W	11	051	054	10/27/72	0800	00	00	CLEAR		03E	15	005	015	10/31/72	1300	31.8	07	1275	HCST
02W	11	052	054	10/27/72	0800	00	00	CLEAR		03E	15	006	015	10/31/72	1300	31.8	07	1275	HCST
03E	13	017	005	10/29/72	2000	26.4	03	180	DENSE FOG	03E	15	007	016	10/31/72	1600	31.9	05	1055	PTCLDY
03E	13	018	005	10/29/72	2000	26.4	03	180	DENSE FOG	03E	15	008	016	10/31/72	1600	31.9	05	1055	PTCLDY
03E	13	019	005	10/29/72	2000	26.4	03	180	DENSE FOG	03E	15	009	016	10/31/72	1600	31.9	05	1055	PTCLDY
03E	13	020	005	10/29/72	2000	26.4	03	180	DENSE FOG	03E	15	010	016	10/31/72	1600	31.9	05	1055	PTCLDY
03E	13	021	006	10/29/72	2400	28.7	04	0475	HCST	03E	15	011	016	10/31/72	1600	31.9	05	1055	PTCLDY
03E	13	022	006	10/29/72	2400	28.7	04	0475	HCST	03E	15	012	016	10/31/72	1600	31.9	05	1055	PTCLDY
03E	13	023	006	10/29/72	2400	28.7	04	0475	HCST	03E	15	013	016	10/31/72	1600	31.9	05	1055	PTCLDY
03E	13	024	006	10/29/72	2400	28.7	04	0475	HCST	03E	15	014	016	10/31/72	1600	31.9	05	1055	PTCLDY
03E	13	025	007	10/30/72	0400	32.9	07	1395	HCST	03E	15	015	016	10/31/72	1600	31.9	05	1055	PTCLDY
03E	13	026	007	10/30/72	0400	32.9	07	1395	HCST	03E	15	016	016	10/31/72	1600	31.9	05	1055	PTCLDY
03E	13	027	007	10/30/72	0400	32.9	07	1395	HCST	03E	15	017	017	10/31/72	2100	31.1	06	1055	PTCLDY
03E	13	028	007	10/30/72	0400	32.9	07	1395	HCST	03E	15	018	017	10/31/72	2100	31.1	06	1055	PTCLDY
03E	13	029	008	10/30/72	0800	32.0	07	1165	HCST	03E	15	019	017	10/31/72	2100	31.1	06	1055	PTCLDY
03E	13	030	008	10/30/72	0800	32.0	07	1165	HCST	03E	15	020	017	10/31/72	2100	31.1	06	1055	PTCLDY
03E	13	031	008	10/30/72	0800	32.0	07	1165	HCST	03E	15	021	017	10/31/72	2100	31.1	06	1055	PTCLDY
03E	13	032	008	10/30/72	0800	32.0	07	1165	HCST	03E	15	022	018	10/31/72	2100	31.1	06	1055	PTCLDY
03E	13	033	009	10/30/72	1200	32.3	07	0945	CLDY	03E	15	023	018	10/31/72	2400	31.7	05	1505	HCST
03E	13	034	009	10/30/72	1200	32.3	07	0945	CLDY	03E	15	024	018	10/31/72	2400	31.7	05	1505	HCST
03E	13	035	009	10/30/72	1200	32.3	07	0945	CLDY	03E	15	025	018	10/31/72	2400	31.7	05	1505	HCST
03E	13	036	009	10/30/72	1200	32.3	07	0945	CLDY	03E	15	026	018	10/31/72	2400	31.7	05	1505	HCST
03E	13	037	009	10/30/72	1200	32.3	07	0945	CLDY	03E	15	027	018	10/31/72	2400	31.7	05	1505	HCST
03E	13	038	009	10/30/72	1200	32.3	07	0945	CLDY	03E	15	028	018	10/31/72	2400	31.7	05	1505	HCST
03E	13	039	009	10/30/72	1200	32.3	07	0945	CLDY	03E	15	029	018	10/31/72	2400	31.7	05	1505	HCST
03E	13	040	009	10/30/72	1200	32.3	07	0945	CLDY	03E	15	030	018	10/31/72	2400	31.7	05	1505	HCST
03E	13	041	010	10/30/72	1600	31.7	06	0905	PTCLDY	03E	15	031	019	11/01/72	0400	31.5	05	1505	CLDY

VOY TP	INT	IDX	DATE	TIME	SPD	RH	HWVD	A-9	WEATHER
03E	15	032	019	11/01/72	0400	31.5	05	1505	CLDY
03E	15	033	019	11/01/72	0400	31.5	05	1505	CLDY
03E	15	034	019	11/01/72	0400	31.5	05	1505	CLDY
03E	15	035	020	11/01/72	0800	31.9	04	1725	CLDY
03E	15	036	020	11/01/72	0800	31.9	04	1725	CLDY
03E	15	037	020	11/01/72	0800	31.9	04	1725	CLDY
03E	15	038	020	11/01/72	0800	31.9	04	1725	CLDY
03E	15	039	020	11/01/72	0800	31.9	04	1725	CLDY
03E	15	040	020	11/01/72	0800	31.9	04	1725	CLDY
03E	15	041	021	11/01/72	1200	31.9	04	1725	HCST
03E	15	042	021	11/01/72	1200	31.9	04	1725	HCST
03E	15	043	021	11/01/72	1200	31.9	04	1725	HCST
03E	15	044	021	11/01/72	1200	31.9	04	1725	HCST
03E	15	045	022	11/01/72	1600	31.9	04	166P	PTCLDY
03E	15	046	022	11/01/72	1600	31.9	04	166P	PTCLDY
03E	15	047	022	11/01/72	1600	31.9	04	166P	PTCLDY
03E	15	048	022	11/01/72	1600	31.9	04	166P	PTCLDY
03E	15	049	023	11/01/72	2000	31.9	04	145P	CLDY
03E	15	050	023	11/01/72	2000	31.9	04	145P	CLDY
03E	15	051	023	11/01/72	2000	31.9	04	145P	CLDY
03E	15	052	023	11/01/72	2000	31.9	04	145P	CLDY
03E	15	053	024	11/01/72	2400	32.0	02	121P	PTCLDY
03E	15	054	024	11/01/72	2400	32.0	02	121P	PTCLDY
03W	17	001	001	11/06/72	1200	30.0	05	0225	HCST
03W	17	002	001	11/06/72	1200	30.0	05	0225	HCST
03W	17	003	001	11/06/72	1200	30.0	05	0225	HCST
03W	17	004	001	11/06/72	1200	30.0	05	0225	HCST
03W	17	005	002	11/06/72	1600	04	0225	FIG	
03W	17	006	002	11/06/72	1600	04	0225	FIG	
03W	17	007	002	11/06/72	1600	04	0225	FIG	
03W	17	008	002	11/06/72	1600	04	0225	FIG	
03W	17	009	003	11/06/72	2000	31.3	04	0195	HCST
03W	17	010	003	11/06/72	2000	31.3	04	0195	HCST
03W	17	011	003	11/06/72	2000	31.3	04	0195	HCST
03W	17	012	003	11/06/72	2000	31.3	04	0195	HCST
03W	17	013	004	11/06/72	2400	31.9	04	026P	HCST
03W	17	014	004	11/06/72	2400	31.9	04	026P	HCST
03W	17	015	0						

VOY	TP	INT	IDX	DATE	TIME	SPD	BN	RWVD	A-13	WEATHER	COMMENTS
04E	21	050	013	11/14/72	0400	32.0	05	1408		PTCLDY	
04E	21	051	013	11/14/72	0400	32.0	05	1408		PTCLDY	
04E	21	052	013	11/14/72	0400	32.0	05	1408		PTCLDY	
04E	23	001	014	11/14/72	0800	32.0	05	1153		PTCLDY	
04E	23	002	014	11/14/72	0800	32.0	05	1153		PTCLDY	
04E	23	003	014	11/14/72	0800	32.0	05	1153		PTCLDY	
04E	23	004	014	11/14/72	0800	32.0	05	1153		PTCLDY	
04E	23	005	015	11/14/72	1200	32.0	05	1253		PCAST	
04E	23	006	015	11/14/72	1200	32.0	05	1253		PCAST	
04E	23	007	015	11/14/72	1200	32.0	05	1253		PCAST	
04E	23	008	015	11/14/72	1200	32.0	05	1253		PCAST	
04E	23	009	016	11/14/72	1600	32.0	05	1038		PCAST RAIN	
04E	23	010	016	11/14/72	1600	32.0	05	1038		PCAST RAIN	
04E	23	011	016	11/14/72	1600	32.0	05	1038		PCAST RAIN	
04E	23	012	016	11/14/72	1600	32.0	05	1038		PCAST RAIN	
04E	23	013	017	11/14/72	2000	32.0	05	1473		PCAST RAIN	
04E	23	014	017	11/14/72	2000	32.0	05	1473		PCAST RAIN	
04E	23	015	017	11/14/72	2000	32.0	05	1473		PCAST RAIN	
04E	23	016	017	11/14/72	2000	32.0	05	1473		PCAST RAIN	
04E	23	017	018	11/14/72	2400	32.0	04	1473		PCAST RAIN	
04E	23	018	018	11/14/72	2400	32.0	04	1473		PCAST RAIN	
04E	23	019	018	11/14/72	2400	32.0	04	1473		PCAST RAIN	
04E	23	020	018	11/14/72	2400	32.0	04	1473		PCAST RAIN	
04E	23	021	019	11/15/72	0400	32.0	04	1023		PCAST RAIN	
04E	23	022	019	11/15/72	0400	32.0	04	1023		PCAST RAIN	
04E	23	023	019	11/15/72	0400	32.0	04	1023		PCAST RAIN	
04E	23	024	019	11/15/72	0400	32.0	04	1023		PCAST RAIN	
04E	23	025	020	11/15/72	0800	32.0	05	1023		PCAST RAIN	LOW SHELL RIDING
04E	23	026	020	11/15/72	0800	32.0	05	1023		PCAST RAIN	LOW SHELL RIDING
04E	23	027	020	11/15/72	0800	32.0	05	1023		PCAST RAIN	LOW SHELL RIDING
04E	23	028	020	11/15/72	0800	32.0	05	1023		PCAST RAIN	LOW SHELL RIDING
04E	23	029	021	11/15/72	1200	32.0	04	1023		PCAST RAIN	
04E	23	030	021	11/15/72	1200	32.0	04	1023		PCAST RAIN	
04E	23	031	021	11/15/72	1200	32.0	04	1023		PCAST RAIN	
04E	23	032	021	11/15/72	1200	32.0	04	1023		PCAST RAIN	
04E	23	033	022	11/15/72	1600	32.0	04	0573		PCAST RAIN	
04E	23	034	022	11/15/72	1600	32.0	04	0573		PCAST RAIN	
04E	23	035	022	11/15/72	1600	32.0	04	0573		PCAST RAIN	
04E	23	036	022	11/15/72	1600	32.0	04	0573		PCAST RAIN	
04E	23	037	023	11/15/72	2000	32.0	05	1203		PCAST RAIN	
04E	23	038	023	11/15/72	2000	32.0	05	1203		PCAST RAIN	
04E	23	039	023	11/15/72	2000	32.0	05	1203		PCAST RAIN	
04E	23	040	023	11/15/72	2000	32.0	05	1203		PCAST RAIN	
04E	23	041	024	11/15/72	2400	32.0	04	1063		PCAST RAIN	
04E	23	042	024	11/15/72	2400	32.0	04	1063		PCAST RAIN	
04E	23	043	024	11/15/72	2400	32.0	04	1063		PCAST RAIN	
04E	23	044	024	11/15/72	2400	32.0	04	1063		PCAST RAIN	
04E	23	045	025	11/16/72	0400	32.0	04	0783		PCAST RAIN	
04E	23	046	025	11/16/72	0400	32.0	04	0783		PCAST RAIN	
04E	23	047	025	11/16/72	0400	32.0	04	0783		PCAST RAIN	

BEST AVAILABLE COPY

VOY	TP	INT	IDX	DATE	TIME	SPD	BN	RWVD	A-14	WEATHER	COMMENTS
04E	23	048	025	11/16/72	0800	32.0	04	0783		PCAST RAIN	
04E	23	049	025	11/16/72	0800	32.0	04	0783		PCAST RAIN	
04E	23	050	026	11/16/72	0800	32.0	04	1203		PCAST RAIN	
04E	23	051	026	11/16/72	0800	32.0	04	1203		PCAST RAIN	
04E	23	052	026	11/16/72	0800	32.0	04	1203		PCAST RAIN	
04E	23	053	027	11/16/72	1200	32.0	05	1203		PCAST	
04E	23	054	027	11/16/72	1200	32.0	05	1203		PCAST	
04E	23	055	027	11/16/72	1200	32.0	05	1203		PCAST	
04E	23	056	027	11/16/72	1200	32.0	05	1203		PCAST	
04W	25	001	001	11/19/72	2400	24.0	07	050P		PCAST RAIN	
04W	25	002	001	11/19/72	2400	24.0	07	050P		PCAST RAIN	
04W	25	003	001	11/19/72	2400	24.0	07	050P		PCAST RAIN	
04W	25	004	001	11/19/72	2400	24.0	07	050P		PCAST RAIN	
04W	25	005	002	11/20/72	0400	24.0	07	050P		PCAST RAIN	
04W	25	006	002	11/20/72	0400	24.0	07	050P		PCAST RAIN	
04W	25	007	002	11/20/72	0400	24.0	07	050P		PCAST RAIN	
04W	25	008	002	11/20/72	0400	24.0	07	050P		PCAST RAIN	
04W	25	009	003	11/20/72	0800	24.0	08	0		CLDY	SHELLS ON HULL SPR
04W	25	010	003	11/20/72	0800	24.0	08	0		CLDY	SHELLS ON HULL SPR
04W	25	011	003	11/20/72	0800	24.0	08	0		CLDY	SHELLS ON HULL SPR
04W	25	012	003	11/20/72	0800	24.0	08	0		CLDY	SHELLS ON HULL SPR
04W	25	013	004	11/20/72	1200	25.0	09	00MP		PTCLDY	SPEED REDUCED
04W	25	014	004	11/20/72	1200	25.0	09	00MP		PTCLDY	SPEED REDUCED
04W	25	015	004	11/20/72	1200	25.0	09	00MP		PTCLDY	SPEED REDUCED
04W	25	016	004	11/20/72	1200	25.0	09	00MP		PTCLDY	SPEED REDUCED
04W	25	017	005	11/20/72	1600	21.0	10	0205		PTCLDY	PITCHING SLAM HULL
04W	25	018	005	11/20/72	1600	21.0	10	0205		PTCLDY	PITCHING SLAM HULL
04W	25	019	005	11/20/72	1600	21.0	10	0205		PTCLDY	PITCHING SLAM HULL
04W	25	020	005	11/20/72	1600	21.0	10	0205		PTCLDY	PITCHING SLAM HULL
04W	25	021	006	11/20/72	1600	25.0	10	0315		PTCLDY	
04W	25	022	006	11/20/72	1600	25.0	10	0315		PTCLDY	
04W	25	023	006	11/20/72	1600	25.0	10	0315		PTCLDY	
04W	25	024	006	11/20/72	1600	25.0	10	0315		PTCLDY	
04W	25	025	007	11/20/72	16.0	21.0	10	0425		PTCLDY	PITCH HEAVY SPRAY
04W	25	026	007	11/20/72	1600	21.0	10	0425		PTCLDY	PITCH HEAVY SPRAY
04W	25	027	007	11/20/72	1600	21.0	10	0425		PTCLDY	PITCH HEAVY SPRAY
04W	25	028	007	11/20/72	1600	21.0	10	0425		PTCLDY	PITCH HEAVY SPRAY
04W	25	029	008	11/20/72	2000	19.0	10	0425		PTCLDY	PITCH HEAVY SPRAY
04W	25	030	008	11/20/72	2000	19.0	10	0425		PTCLDY	PITCH HEAVY SPRAY
04W	25	031	008	11/20/72	2000	19.0	10	0425		PTCLDY	PITCH HEAVY SPRAY
04W	25	032	008	11/20/72	2000	19.0	10	0425		PTCLDY	PITCH HEAVY SPRAY
04W	25	033	009	11/20/72	2400	26.0	09	0425		PTCLDY	EABING OCCAS, SH
04W	25	034	009	11/20/72	2400	26.0	09	0425		PTCLDY	EABING OCCAS, SH
04W	25	035	009	11/20/72	2400	26.0	09	0425		PTCLDY	EABING OCCAS, SH
04W	25	036	009	11/20/72	2400	26.0	09	0425		PTCLDY	EABING OCCAS, SH
04W	25	037	010	11/21/72	0400	27.0	05	0425		PCAST	
04W	25	038	010	11/21/72	0400	27.0	05	0425		PCAST	
04W	25	039	010	11/21/72	0400	27.0	05	0425		PCAST	
04W	25	040	010	11/21/72	0400	27.0	05	0425		PCAST	
04W	25	041	011	11/21/72	0600	29.0	04	0673		CLDY	ROLLING 5 DEG IN

VOY	TP	INT	IDX	DATE	TIME	SPD	BN	RWVD	A-15	WEATHER	COMMENTS
04W	25	042	011	11/21/72	0800	29.0	04	0678	CLDY		ROLLING S DEG IN
04W	25	043	011	11/21/72	0800	29.0	04	0678	CLDY		ROLLING S DEG IN
04W	25	044	011	11/21/72	0800	29.0	04	0678	CLDY		ROLLING S-DEG IN
04W	25	045	012	11/21/72	1200	30.0	05	1553	OCAST	LT RAIN	
04W	25	046	012	11/21/72	1200	30.0	05	1553	OCAST	LT RAIN	
04W	25	047	012	11/21/72	1200	30.0	05	1553	OCAST	LT RAIN	
04W	25	048	012	11/21/72	1200	30.0	05	1553	OCAST	LT RAIN	
04W	25	049	015	11/21/72	1600	29.0	07	1553	OCAST		
04W	25	050	013	11/21/72	1600	29.0	07	1553	OCAST		
04W	25	051	013	11/21/72	1600	29.0	07	1553	OCAST		
04W	25	052	013	11/21/72	1600	29.0	07	1553	OCAST		
04W	25	053	014	11/21/72	2000	29.0	07	1553	CLDY		ROLLING IN SHELL
04W	25	054	014	11/21/72	2000	29.0	07	1553	CLDY		ROLLING IN SHELL
04W	25	055	014	11/21/72	2000	29.0	07	1553	CLDY		ROLLING IN SHELL
04W	25	056	014	11/21/72	2000	29.0	07	1553	CLDY		ROLLING IN SHELL
04W	25	057	015	11/21/72	2400	29.0	08	1553	OCAST		
04W	25	058	015	11/21/72	2400	29.0	08	1553	OCAST		
04W	25	059	015	11/21/72	2400	29.0	08	1553	OCAST		
04W	25	060	015	11/21/72	2400	29.0	08	1553	OCAST		
04W	25	061	016	11/22/72	0400	29.0	07	1553	OCAST		
04W	25	062	016	11/22/72	0400	29.0	07	1553	OCAST		
04W	25	063	016	11/22/72	0400	29.0	07	1553	OCAST		
04W	25	064	016	11/22/72	0400	29.0	07	1553	OCAST		
04W	25	065	017	11/22/72	0800	29.0	07	1553	PTCDY		
04W	25	066	017	11/22/72	0800	29.0	07	1553	PTCDY		
04W	25	067	017	11/22/72	0800	29.0	07	1553	PTCDY		
04W	25	068	017	11/22/72	0800	29.0	07	1553	PTCDY		
04W	27	001	018	11/22/72	1200	29.0	07	177P	CLEAR		
04W	27	002	018	11/22/72	1200	29.0	07	177P	CLEAR		
04W	27	003	018	11/22/72	1200	29.0	07	177P	CLEAR		
04W	27	004	018	11/22/72	1200	29.0	07	177P	CLEAR		
04W	27	005	019	11/22/72	1600	29.0	07	076P	OCAST		
04W	27	006	020	11/22/72	2000	30.0	07	0253	CLDY		
04W	27	010	020	11/22/72	2000	30.0	07	0253	CLDY		
04W	27	011	020	11/22/72	2000	30.0	07	0253	CLDY		
04W	27	012	020	11/22/72	2000	30.0	07	0253	CLDY		
04W	27	013	021	11/22/72	2400	30.0	05	0703	OCAST		
04W	27	014	021	11/22/72	2400	30.0	05	0703	OCAST		
04W	27	015	021	11/22/72	2400	30.0	05	0703	OCAST		
04W	27	016	021	11/22/72	2400	30.0	05	0703	OCAST		
04W	27	017	022	11/23/72	0400	30.0	04	0253	OCAST		
04W	27	018	022	11/23/72	0400	30.0	04	0253	OCAST		
04W	27	019	022	11/23/72	0400	30.0	04	0253	OCAST		
04W	27	020	022	11/23/72	0400	30.0	04	0253	OCAST		
04W	27	021	023	11/23/72	0800	29.0	03	0253	OCAST		
04W	27	022	023	11/23/72	0800	29.0	03	0253	OCAST		
04W	27	023	023	11/23/72	0800	29.0	03	0253	OCAST		
04W	27	024	023	11/23/72	0800	29.0	03	0253	OCAST		
04W	27	025	024	11/23/72	1200	29.0	07	177P	OCAST		FORCE 7 WEATHER 0
04W	27	026	024	11/23/72	1200	29.0	07	177P	OCAST		FORCE 7 WEATHER 0

VOY	TP	INT	IDX	DATE	TIME	SPD	BN	RWVD	A-15	WEATHER	COMMENTS
04W	27	027	024	11/23/72	1200	29.0	07	177P	OCAST		FORCE 7 WEATHER 0
04W	27	028	024	11/23/72	1200	29.0	07	177P	OCAST		FORCE 7 WEATHER 0
04W	27	029	025	11/23/72	1600	30.0	09	177P	OCAST	RAIN	RIDING EASY WEATH
04W	27	030	025	11/23/72	1600	30.0	09	177P	OCAST	RAIN	RIDING EASY WEATH
04W	27	031	025	11/23/72	1600	30.0	09	177P	OCAST	RAIN	RIDING EASY WEATH
04W	27	032	025	11/23/72	1600	30.0	09	177P	OCAST	RAIN	RIDING EASY WEATH
04W	27	034	026	11/23/72	1800	29.0	09	177P	OCAST	RAIN	ROLLING HEAVY 15-
04W	27	035	026	11/23/72	1800	29.0	09	177P	OCAST	RAIN	ROLLING HEAVY 15-
04W	27	036	026	11/23/72	1800	29.0	09	177P	OCAST	RAIN	ROLLING HEAVY 15-
04W	27	037	027	11/23/72	2000	29.0	10	1383	OCAST	RAIN	ROLLING HEAVY
04W	27	038	027	11/23/72	2000	29.0	10	1383	OCAST	RAIN	ROLLING HEAVY
04W	27	039	027	11/23/72	2000	29.0	10	1383	OCAST	RAIN	ROLLING HEAVY
04W	27	040	027	11/23/72	2000	29.0	10	1383	OCAST	RAIN	ROLLING HEAVY
04W	27	041	028	11/23/72	2200	28.0	10	0933	OCAST	RAIN	ROLLING HEAVY
04W	27	042	028	11/23/72	2200	28.0	10	0933	OCAST	RAIN	ROLLING HEAVY
04W	27	043	028	11/23/72	2200	28.0	10	0933	OCAST	RAIN	ROLLING HEAVY
04W	27	044	028	11/23/72	2200	28.0	10	0933	OCAST	RAIN	ROLLING HEAVY
04W	27	045	029	11/23/72	2400	29.0	10	0733	OCAST	RAIN	MODERATE ROLL
04W	27	046	029	11/23/72	2400	29.0	10	0733	OCAST	RAIN	MODERATE ROLL
04W	27	047	029	11/23/72	2400	29.0	10	0733	OCAST	RAIN	MODERATE ROLL
04W	27	048	029	11/23/72	2400	29.0	10	0733	OCAST	RAIN	MODERATE ROLL
04W	27	049	030	11/24/72	0400	29.0	08	0733	OCAST	RAIN	RIDING EASY
04W	27	050	030	11/24/72	0400	29.0	08	0733	OCAST	RAIN	RIDING EASY
04W	27	051	030	11/24/72	0400	29.0	08	0733	OCAST	RAIN	RIDING EASY
04W	27	052	030	11/24/72	0400	29.0	08	0733	OCAST	RAIN	RIDING EASY
04W	27	053	031	11/24/72	0800	28.0	05	0483	CLDY		
04W	27	054	031	11/24/72	0800	28.0	05	0483	CLDY		
04W	27	055	031	11/24/72	0800	28.0	05	0483	CLDY		
04W	27	056	031	11/24/72	0800	28.0	05	0483	CLDY		
04W	27	057	032	11/24/72	1200	29.0	05	0233	CLDY		
04W	27	058	032	11/24/72	1200	29.0	05	0233	CLDY		
04W	27	059	032	11/24/72	1200	29.0	05	0233	CLDY		
04W	27	060	032	11/24/72	1200	29.0	05	0233	CLDY		
05E	29	001	001	11/26/72	0400			03 180	OCAST	RAIN	
05E	29	002	001	11/26/72	0400			03 180	OCAST	RAIN	
05E	29	003	001	11/26/72	0400			03 180	OCAST	RAIN	
05E	29	004	001	11/26/72	0400			03 180	OCAST	RAIN	
05E	29	005	002	11/26/72	0800	28.0	04	0463	OCAST	RAIN	
05E	29	006	002	11/26/72	0800	28.0	04	0463	OCAST	RAIN	
05E	29	007	002	11/26/72	0800	28.0	04	0463	OCAST	RAIN	
05E	29	008	002	11/26/72	0800	28.0	04	0463	OCAST	RAIN	
05E	29	009	003	11/26/72	1200	30.0	07	0773	OCAST	RAIN	
05E	29	010	003	11/26/72	1200	30.0	07	0773	OCAST	RAIN	
05E	29	011	003	11/26/72	1200	30.0	07	0773	OCAST	RAIN	
05E	29	012	003	11/26/72	1200	30.0	07	0773	OCAST	RAIN	
05E	29	013	004	11/26/72	1600	30.0	07	1003	OCAST	RAIN	
05E	29	014	004	11/26/72	1600	30.0	07	1003	OCAST	RAIN	
05E	29	015	004	11/26/72	1600	30.0	07	1003	OCAST	RAIN	
05E	29	016	004	11/26/72	1600	30.0	07	1003	OCAST	RAIN	
05E	29	017	005	11/26/72	2000	30.0	09	0403	OCAST	RAIN	ROLLING HEAVY

VOY TP	INT	IDX	DATE	TIME	SPD	BN	RWVD	A-17	WEATHER	COMMENTS
05F	29	018	005	11/26/72	2000	30.0	09	0903	OCAST RAIN	ROLLING HEAVY
05E	29	019	005	11/26/72	2000	30.0	09	0903	OCAST RAIN	ROLLING HEAVY
05E	29	020	005	11/26/72	2000	30.0	09	0903	OCAST RAIN	ROLLING HEAVY
05E	29	021	006	11/26/72	2200	30.0	09	0903	OCAST RAIN	ROLLING HEAVY
05F	29	022	006	11/26/72	2200	30.0	09	0903	OCAST RAIN	ROLLING HEAVY
05E	29	023	006	11/26/72	2200	30.0	09	0903	OCAST RAIN	ROLLING HEAVY
05E	29	024	006	11/26/72	2200	30.0	09	0903	OCAST RAIN	ROLLING HEAVY
05F	29	025	007	11/26/72	2400	30.0	08	0755	OCAST RAIN	EASING
05E	29	026	007	11/26/72	2400	30.0	08	0755	OCAST RAIN	EASING
05E	29	027	007	11/26/72	2400	30.0	08	0755	OCAST RAIN	EASING
05E	29	028	007	11/26/72	2400	30.0	08	0755	OCAST RAIN	EASING
05F	29	029	008	11/27/72	0400	30.0	07	0755	OCAST RAIN	
05E	29	030	008	11/27/72	0400	30.0	07	0755	OCAST RAIN	
05E	29	031	008	11/27/72	0400	30.0	07	0755	OCAST RAIN	
05E	29	032	008	11/27/72	0400	30.0	07	0755	OCAST RAIN	
05E	29	033	004	11/27/72	0800	30.0	05	0303	OCAST	
05E	29	034	004	11/27/72	0800	30.0	05	0303	OCAST	
05E	29	035	004	11/27/72	0800	30.0	05	0303	OCAST	
05E	29	036	009	11/27/72	0800	30.0	05	0303	OCAST	
05F	29	037	010	11/27/72	1200	30.0	05	0755	OCAST	
05F	29	038	010	11/27/72	1200	30.0	05	0755	OCAST	
05E	29	040	010	11/27/72	1200	30.0	05	0755	OCAST	
05E	29	041	011	11/27/72	1600		04	0755	PTCLDY	MOVE TO
05E	29	042	011	11/27/72	1600		04	0755	PTCLDY	MOVE TO
05E	29	043	011	11/27/72	1600		04	0755	PTCLDY	MOVE TO
05E	29	044	011	11/27/72	1600		04	0755	PTCLDY	MOVE TO
05E	29	045	012	11/27/72	2000		06	0903	OCAST	MOVE TO
05E	29	046	012	11/27/72	2000		06	0903	OCAST	MOVE TO
05E	29	047	012	11/27/72	2000		06	0903	OCAST	MOVE TO
05E	29	048	012	11/27/72	2000		06	0903	OCAST	MOVE TO
05E	29	049	013	11/27/72	2400		06	0903	OCAST	MOVE TO
05E	29	050	013	11/27/72	2400		06	0903	OCAST	MOVE TO
05E	29	051	013	11/27/72	2400		06	0903	OCAST	MOVE TO
05E	29	052	013	11/27/72	2400		06	0903	OCAST	MOVE TO
05E	29	053	014	11/28/72	0400		05	1433	OCAST	START-STOP
05F	29	054	014	11/28/72	0400		05	1433	OCAST	START-STOP
05E	29	055	014	11/28/72	0400		05	1433	OCAST	START-STOP
05E	29	056	014	11/28/72	0400		05	1433	OCAST	START-STOP
05F	29	057	015	11/28/72	0800		05	1653	OCAST	MOVE TO
05E	29	058	015	11/28/72	0800		05	1653	OCAST	MOVE TO
05E	29	059	015	11/28/72	0800		05	1653	OCAST	MOVE TO
05E	29	060	015	11/28/72	0800		05	1653	OCAST	MOVE TO
05E	29	061	016	11/28/72	1200		04	1653	CLEAR	MOVE TO
05E	29	062	016	11/28/72	1200		04	1653	CLEAR	MOVE TO
05E	29	063	016	11/28/72	1200		04	1653	CLEAR	MOVE TO
05E	29	064	016	11/28/72	1200		04	1653	CLEAR	MOVE TO
05E	31	001	017	11/28/72	1600		04	1433	CLEAR	MOVE TO START 9 K
05E	31	002	017	11/28/72	1600		04	1433	CLEAR	MOVE TO START 9 K
05E	31	003	017	11/28/72	1600		04	1433	CLEAR	MOVE TO START 9 K
05F	31	004	017	11/28/72	1600		04	1433	CLEAR	MOVE TO START 9 K

VOY TP	INT	IDX	DATE	TIME	SPD	BN	RWVD	A-18	WEATHER	COMMENTS
05E	31	005	018	11/28/72	2000	09.0	04	1433	CLEAR	9 KTS STRD ENGIN
05F	31	006	018	11/28/72	2000	09.0	04	1433	CLEAR	9 KTS STRD ENGIN
05F	31	007	018	11/28/72	2000	09.0	04	1433	CLEAR	9 KTS STRD ENGIN
05E	31	008	018	11/28/72	2000	09.0	04	1433	CLEAR	9 KTS STRD ENGIN
05F	31	009	019	11/28/72	2400	13.0	03	1653	CLEAR	13 KTS STRD ENGIN
05F	31	010	019	11/28/72	2400	13.0	03	1653	CLEAR	13 KTS STRD ENGIN
05F	31	011	019	11/28/72	2400	13.0	03	1653	CLEAR	13 KTS STRD ENGIN
05E	31	012	019	11/28/72	2400	13.0	03	1653	CLEAR	13 KTS STRD ENGIN
05E	31	013	020	11/29/72	0400	13.0	03	170P	CLEAR	STRD ENGIN ONLY
05E	31	014	020	11/29/72	0400	13.0	03	170P	CLEAR	STRD ENGIN ONLY
05E	31	015	020	11/29/72	0400	13.0	03	170P	CLEAR	STRD ENGIN ONLY
05E	31	016	020	11/29/72	0400	13.0	03	170P	CLEAR	STRD ENGIN ONLY
05F	31	017	021	11/29/72	0800	13.0	04	147P	CLEAR	STRD ENGIN ONLY
05E	31	018	021	11/29/72	0800	13.0	04	147P	CLEAR	STRD ENGIN ONLY
05E	31	019	021	11/29/72	0800	13.0	04	147P	CLEAR	STRD ENGIN ONLY
05E	31	020	021	11/29/72	0800	13.0	04	147P	CLEAR	STRD ENGIN ONLY
05F	31	021	022	11/29/72	1200	13.0	04	147P	CLEAR	STRD ENGIN ONLY
05E	31	022	022	11/29/72	1200	13.0	04	147P	CLEAR	STRD ENGIN ONLY
05E	31	023	022	11/29/72	1200	13.0	04	147P	CLEAR	STRD ENGIN ONLY
05E	31	024	022	11/29/72	1200	13.0	04	147P	CLEAR	STRD ENGIN ONLY
05E	31	025	023	11/29/72	1600	13.0	04	147P	CLEAR	STRD ENGIN ONLY
05E	31	026	023	11/29/72	1600	13.0	04	147P	CLEAR	STRD ENGIN ONLY
05F	31	027	023	11/29/72	1600	13.0	04	147P	CLEAR	STRD ENGIN ONLY
05E	31	028	023	11/29/72	1600	13.0	04	147P	CLEAR	STRD ENGIN ONLY
05E	31	029	024	11/29/72	2000	13.0	04	167S	PTCLDY	STRD ENGIN ONLY
05E	31	030	024	11/29/72	2000	13.0	04	167S	PTCLDY	STRD ENGIN ONLY
05E	31	031	024	11/29/72	2000	13.0	04	167S	PTCLDY	STRD ENGIN ONLY
05E	31	032	024	11/29/72	2000	13.0	04	167S	PTCLDY	STRD ENGIN ONLY
05E	31	033	025	11/29/72	2400	13.0	05	145S	PTCLDY	STRD ENGIN ONLY
05E	31	034	025	11/29/72	2400	13.0	05	145S	PTCLDY	STRD ENGIN ONLY
05E	31	035	025	11/29/72	2400	13.0	05	145S	PTCLDY	STRD ENGIN ONLY
05E	31	036	025	11/29/72	2400	13.0	05	145S	PTCLDY	STRD ENGIN ONLY
05E	31	037	026	11/30/72	0400	13.0	06	111S	OCAST RAIN	STRD ENGIN ONLY
05E	31	038	026	11/30/72	0400	13.0	06	111S	OCAST RAIN	STRD ENGIN ONLY
05E	31	039	026	11/30/72	0400	13.0	06	111S	OCAST RAIN	STRD ENGIN ONLY
05F	31	040	026	11/30/72	0400	13.0	06	111S	OCAST RAIN	STRD ENGIN ONLY
05E	31	041	027	11/30/72	0800	13.0	06	167S	OCAST RAIN	STRD ENGIN ONLY
05E	31	042	027	11/30/72	0800	13.0	06	167S	OCAST RAIN	STRD ENGIN ONLY
05E	31	043	027	11/30/72	0800	13.0	06	167S	OCAST RAIN	STRD ENGIN ONLY
05E	31	044	027	11/30/72	0800	13.0	06	167S	OCAST RAIN	STRD ENGIN ONLY
05E	31	045	028	11/30/72	1200	13.0	06	167S	OCAST	STRD ENGIN ONLY
05E	31	046	028	11/30/72	1200	13.0	06	167S	OCAST	STRD ENGIN ONLY
05E	31	047	028	11/30/72	1200	13.0	06	167S	OCAST	STRD ENGIN ONLY
05E	31	048	028	11/30/72	1200	13.0	06	167S	OCAST	STRD ENGIN ONLY
05E	33	001	034	12/01/72	1200	13.0	07	121P	PTCLDY	STRD ENGIN ONLY
05E	33	002	034	12/01/72	1200	13.0	07	121P	PTCLDY	STRD ENGIN ONLY
05E	33	003	034	12/01/72	1200	13.0	07	121P	PTCLDY	STRD ENGIN ONLY
05E	33	004	034	12/01/72	1200	13.0	07	121P	PTCLDY	STRD ENGIN ONLY
05E	33	005	035	12/01/72	1600	13.0	07	107P	OCAST	STRD ENGIN ONLY
05E	33	006	035	12/01/72	1600	13.0	07	107P	OCAST	STRD ENGIN ONLY

VOY TP INT IDX DATE TIME SPD BN RWYD A-22 WEATHER

ORW 51 059 045 02/10/73 1600 25.0 04 0R2P CLDY
ORW 51 060 045 02/10/73 1600 25.0 04 0R2P CLDY
ORW 51 061 046 02/10/73 2000 25.0 06 037P CLDY
ORW 51 062 046 02/10/73 2000 25.0 06 037P CLDY
ORW 51 063 046 02/10/73 2000 25.0 06 037P CLDY
ORW 51 064 046 02/10/73 2000 25.0 06 037P CLDY
ORW 51 065 047 02/10/73 2400 25.0 05 037P CLDY
ORW 51 066 047 02/10/73 2400 25.0 05 037P CLDY
ORW 51 067 047 02/10/73 2400 25.0 05 037P CLDY
ORW 51 068 047 02/10/73 2400 25.0 05 037P CLDY
ORW 53 001 048 02/11/73 0400 25.0 04 0R2P CLDY
ORW 53 002 048 02/11/73 0400 25.0 04 0R2P CLDY
ORW 53 003 048 02/11/73 0800 25.0 04 0R2P CLDY
ORW 53 004 048 02/11/73 0400 25.0 04 0R2P CLDY
ORW 53 005 049 02/11/73 0800 25.0 04 0R2P CLDY
ORW 53 006 049 02/11/73 0800 25.0 04 0R2P CLDY
ORW 53 007 049 02/11/73 0800 25.0 04 0R2P CLDY
ORW 53 008 049 02/11/73 0800 25.0 04 0R2P CLDY
ORW 53 009 050 02/11/73 1200 25.0 02 0R2P CLDY
ORW 53 010 050 02/11/73 1200 25.0 02 0R2P CLDY
ORW 53 011 050 02/11/73 1200 25.0 02 0R2P CLDY
ORW 53 012 050 02/11/73 1200 25.0 02 0R2P CLDY
ORW 53 013 051 02/11/73 1600 20.0 04 0R2P FOG DENSE
ORW 53 014 051 02/11/73 1600 20.0 04 0R2P FOG DENSE
ORW 53 015 051 02/11/73 1600 20.0 04 0R2P FOG DENSE
ORW 53 016 051 02/11/73 1600 20.0 04 0R2P FOG DENSE
ORW 53 017 052 02/11/73 2000 20.0 03 104P FOG
ORW 53 018 052 02/11/73 2000 20.0 03 104P FOG
ORW 53 019 052 02/11/73 2000 20.0 03 104P FOG
ORW 53 020 052 02/11/73 2000 20.0 03 104P FOG
ORW 53 021 053 02/11/73 2400 20.0 03 127P FOG
ORW 53 022 053 02/11/73 2400 20.0 03 127P FOG
ORW 53 023 053 02/11/73 2400 20.0 03 127P FOG
ORW 53 024 053 02/11/73 2400 20.0 03 127P FOG
ORW 53 025 054 02/12/73 0400 24.9 03 127P FOG LIFTING
ORW 53 026 054 02/12/73 0400 24.9 03 127P FOG LIFTING
ORW 53 027 054 02/12/73 0400 24.9 03 127P FOG LIFTING
ORW 53 028 054 02/12/73 0400 24.9 03 127P FOG LIFTING
ORW 53 029 055 02/12/73 0800 24.9 04 0R2P PT CLDY
ORW 53 030 055 02/12/73 0800 24.9 04 0R2P PT CLDY
ORW 53 031 055 02/12/73 0800 24.9 04 0R2P PT CLDY
ORW 53 032 055 02/12/73 0800 24.9 04 0R2P PT CLDY
ORW 53 033 056 02/12/73 1200 24.9 06 150P PT CLDY
ORW 53 034 056 02/12/73 1200 24.9 06 150P PT CLDY
ORW 53 035 056 02/12/73 1200 24.9 06 150P PT CLDY
ORW 53 036 056 02/12/73 1200 24.9 06 150P PT CLDY
ORW 53 037 057 02/12/73 1600 24.9 06 150P PT CLDY
ORW 53 038 057 02/12/73 1600 24.9 06 150P PT CLDY
ORW 53 039 057 02/12/73 1600 24.9 06 150P PT CLDY
ORW 53 040 057 02/12/73 1600 24.9 06 150P PT CLDY

VOY TP INT IDX DATE TIME SPD BN RWYD A-23 WEATHER

COMMENTS

ORW 53 041 058 02/12/73 2000 24.9 05 120S FOG MIST
ORW 53 042 058 02/12/73 2000 24.9 05 120S FOG MIST
ORW 53 043 058 02/12/73 2000 24.9 05 120S FOG MIST
ORW 53 044 058 02/12/73 2000 24.9 05 120S FOG MIST
ORW 53 045 059 02/12/73 2400 24.9 05 097S FOG MIST
ORW 53 046 059 02/12/73 2400 24.9 05 097S FOG MIST
ORW 53 047 059 02/12/73 2400 24.9 05 097S FOG MIST
ORW 53 048 059 02/12/73 2400 24.9 05 097S FOG MIST
ORW 53 049 060 02/13/73 0400 24.9 05 097S PT CLDY
ORW 53 050 060 02/13/73 0400 24.9 05 097S PT CLDY
ORW 53 051 060 02/13/73 0400 24.9 05 097S PT CLDY
ORW 53 052 060 02/13/73 0400 24.9 05 097S PT CLDY
ORW 53 053 061 02/13/73 0800 24.9 04 075S PT CLDY
ORW 53 054 061 02/13/73 0800 24.9 04 075S PT CLDY
ORW 53 055 061 02/13/73 0800 24.9 04 075S PT CLDY
ORW 53 056 061 02/13/73 0800 24.9 04 075S PT CLDY
ORW 53 057 062 02/13/73 1200 24.9 04 046S PT CLDY
ORW 53 058 062 02/13/73 1200 24.9 04 046S PT CLDY
ORW 53 059 062 02/13/73 1200 24.9 04 046S PT CLDY
ORW 53 060 062 02/13/73 1200 24.9 04 046S PT CLDY
ORW 53 061 061 02/15/73 1600 25.0 07 102S OCAST
ORW 53 062 061 02/15/73 1600 25.0 07 102S OCAST
ORW 53 063 061 02/15/73 1600 25.0 07 102S OCAST
ORW 53 064 061 02/15/73 1600 25.0 07 102S OCAST
ORW 53 065 062 02/15/73 2000 24.0 07 113S OCAST
ORW 53 066 062 02/15/73 2000 24.0 07 113S OCAST
ORW 53 067 062 02/15/73 2000 24.0 07 113S OCAST
ORW 53 068 062 02/15/73 2000 24.0 07 113S OCAST
ORW 53 069 063 02/15/73 2400 24.0 07 124S OCAST
ORW 53 070 063 02/15/73 2400 24.0 07 124S OCAST
ORW 53 071 063 02/15/73 2400 24.0 07 124S OCAST
ORW 53 072 063 02/15/73 2400 24.0 07 124S OCAST
ORW 53 073 064 02/16/73 0400 25.0 07 124S OCAST
ORW 53 074 064 02/16/73 0400 25.0 07 124S OCAST
ORW 53 075 064 02/16/73 0400 25.0 07 124S OCAST
ORW 53 076 064 02/16/73 0400 25.0 07 124S OCAST
ORW 53 077 065 02/16/73 0800 25.0 07 074S OCAST
ORW 53 078 065 02/16/73 0800 25.0 07 074S OCAST
ORW 53 079 065 02/16/73 0800 25.0 07 074S OCAST
ORW 53 080 065 02/16/73 0800 25.0 07 074S OCAST
ORW 53 081 065 02/16/73 0800 25.0 07 074S OCAST
ORW 53 082 065 02/16/73 0800 25.0 07 074S OCAST
ORW 53 083 066 02/16/73 1200 25.0 07 102S OCAST
ORW 53 084 066 02/16/73 1200 25.0 07 102S OCAST
ORW 53 085 066 02/16/73 1200 25.0 07 102S OCAST
ORW 53 086 067 02/16/73 1600 24.0 07 102S OCAST
ORW 53 087 067 02/16/73 1600 24.0 07 102S OCAST
ORW 53 088 067 02/16/73 1600 24.0 07 102S OCAST
ORW 53 089 068 02/16/73 2000 24.0 07 102S OCAST
ORW 53 090 068 02/16/73 2000 24.0 07 102S OCAST

SPRAY OVEN STBD. B
SPRAY OVEN STBD. B

VOY	TP	INT	IDX	DATE	TIME	SPD	RN	RWVD	A-24	WEATHER	COMMENTS
09E	55	031	008	02/16/73	2000	24.0	07	1025	NCAST		SPRAY OVER STD R
09E	55	032	008	02/16/73	2000	24.0	07	1025	NCAST		SPRAY OVER STD R
09E	55	033	009	02/16/73	2400	24.0	05	1025	NCAST	FIG	
09E	55	034	009	02/16/73	2400	24.0	05	1025	NCAST	FIG	
09E	55	035	009	02/16/73	2400	24.0	05	1025	NCAST	FIG	
09E	55	036	009	02/16/73	2400	24.0	05	1025	NCAST	FIG	
09E	55	037	010	02/17/73	0400	23.0	05	1025	NCAST		
09E	55	038	010	02/17/73	0400	23.0	05	1025	NCAST		
09E	55	039	010	02/17/73	0400	23.0	05	1025	NCAST		
09E	55	040	010	02/17/73	0400	23.0	05	1025	NCAST		
09E	55	041	011	02/17/73	0800	23.0	04	0575	CLEAR		ROLLING EASILY
09E	55	042	011	02/17/73	0800	23.0	04	0575	CLEAR		ROLLING EASILY
09E	55	043	011	02/17/73	0800	23.0	04	0575	CLEAR		ROLLING EASILY
09E	55	044	011	02/17/73	0800	23.0	04	0575	CLEAR		ROLLING EASILY
09E	55	045	012	02/17/73	1200	23.0	04	1025	PT CLDY		
09E	55	046	012	02/17/73	1200	23.0	04	1025	PT CLDY		
09E	55	047	012	02/17/73	1200	23.0	04	1025	PT CLDY		
09E	55	048	012	02/17/73	1200	23.0	04	1025	PT CLDY		
09E	55	049	013	02/17/73	1600	24.0	06	1025	NCAST		
09E	55	050	013	02/17/73	1600	24.0	06	1025	NCAST		
09E	55	051	013	02/17/73	1600	24.0	06	1025	NCAST		
09E	55	052	013	02/17/73	1600	24.0	06	1025	NCAST		
09E	55	053	014	02/17/73	2000	24.0	06	1103	CLDY		
09E	55	054	014	02/17/73	2000	24.0	06	1103	CLDY		
09E	57	001	015	02/17/73	2000	24.0	06	1275	NCAST		
09E	57	002	015	02/17/73	2000	24.0	06	1275	NCAST		
09E	57	003	015	02/17/73	2000	24.0	06	1275	NCAST		
09E	57	004	015	02/17/73	2000	24.0	06	1275	NCAST		
09E	57	005	016	02/18/73	0400	24.0	04	1275	PT CLDY		
09E	57	006	016	02/18/73	0400	24.0	04	1275	PT CLDY		
09E	57	007	016	02/18/73	0400	24.0	04	1275	PT CLDY		
09E	57	008	016	02/18/73	0400	24.0	04	1275	PT CLDY		
09E	57	009	017	02/18/73	0800	24.0	04	0945	CLDY		
09E	57	010	017	02/18/73	0800	24.0	04	0945	CLDY		
09E	57	011	017	02/18/73	0800	24.0	04	0945	CLDY		
09E	57	012	017	02/18/73	0800	24.0	04	0945	CLDY		
09E	57	013	018	02/18/73	1200	24.0	05	0945	PT CLDY		
09E	57	014	018	02/18/73	1200	24.0	05	0945	PT CLDY		
09E	57	015	018	02/18/73	1200	24.0	05	0945	PT CLDY		
09E	57	016	018	02/18/73	1200	24.0	05	0945	PT CLDY		
09E	57	017	019	02/18/73	1600	23.0	04	0945	CLDY		
09E	57	018	019	02/18/73	1600	23.0	04	0945	CLDY		
09E	57	019	019	02/18/73	1600	23.0	04	0945	CLDY		
09E	57	020	019	02/18/73	1600	23.0	04	0945	CLDY		
09E	57	021	020	02/18/73	2000	23.0	04	0945	CLDY		
09E	57	022	020	02/18/73	2000	23.0	04	0945	CLDY		
09E	57	023	020	02/18/73	2000	23.0	04	0945	CLDY		
09E	57	024	020	02/18/73	2000	23.0	04	0945	CLDY		
09E	57	025	021	02/18/73	2400	23.0	03	1445	NCAST		
09E	57	026	021	02/18/73	2400	23.0	03	1445	NCAST		

VOY	TP	INT	IDX	DATE	TIME	SPD	RN	RWVD	A-25	WEATHER	VOY	TP	INT	IDX	DATE	TIME	SPD	RN	RWVD	A-26	WEATHER
09E	57	027	021	02/18/73	2400	23.0	03	1445	NCAST		09W	59	017	034	02/25/73	0800	24.0	06	0215	NCAST	
09E	57	028	021	02/18/73	2400	23.0	03	1445	NCAST		09W	59	018	034	02/25/73	0800	24.0	06	0215	NCAST	
09E	57	029	022	02/19/73	0400	23.0	05	1345	NCAST		09W	59	019	034	02/25/73	0800	24.0	06	0215	NCAST	
09E	57	030	022	02/19/73	0400	23.0	05	1345	NCAST		09W	59	020	034	02/25/73	0800	24.0	06	0215	NCAST	
09E	57	031	022	02/19/73	0400	23.0	05	1345	NCAST		09W	59	021	035	02/25/73	1200	24.0	07	043P	PT CLDY	
09E	57	032	022	02/19/73	0400	23.0	05	1345	NCAST		09W	59	022	035	02/25/73	1200	24.0	07	043P	PT CLDY	
09E	57	033	023	02/19/73	0800	23.0	02	175P	NCAST		09W	59	023	035	02/25/73	1200	24.0	07	043P	PT CLDY	
09E	57	034	023	02/19/73	0800	23.0	02	175P	NCAST		09W	59	024	035	02/25/73	1200	24.0	07	043P	PT CLDY	
09E	57	035	023	02/19/73	0800	23.0	02	175P	NCAST		09W	59	025	036	02/25/73	1600	25.0	07	0215	PT CLDY	
09E	57	036	023	02/19/73	0800	23.0	02	175P	NCAST		09W	59	026	036	02/25/73	1600	25.0	07	0215	PT CLDY	
09E	57	037	024	02/19/73	1200	23.0	04	155P	NCAST		09W	59	027	036	02/25/73	1600	25.0	07	0215	PT CLDY	
09E	57	038	024	02/19/73	1200	23.0	04	155P	NCAST		09W	59	028	036	02/25/73	1600	25.0	07	0215	PT CLDY	
09E	57	039	024	02/19/73	1200	23.0	04	155P	NCAST		09W	59	029	037	02/25/73	2000	25.0	07	0215	NCAST	
09E	57	040	024	02/19/73	1200	23.0	04	155P	NCAST		09W	59	030	037	02/25/73	2000	25.0	07	0215	NCAST	
09E	57	041	025	02/19/73	1600	23.0	04	135P	PT CLDY		09W	59	031	037	02/25/73	2000	25.0	07	0215	NCAST	
09E	57	042	025	02/19/73	1600	23.0	04	135P	PT CLDY		09W	59	032	037	02/25/73	2000	25.0	07	0215	NCAST	
09E	57	043	025	02/19/73	1600	23.0	04	135P	PT CLDY		09W	59	033	038	02/25/73	2400	25.0	05	001P	PT CLDY	
09E	57	044	025	02/19/73	1600	23.0	04	135P	PT CLDY		09W	59	034	038	02/25/73	2400	25.0	05	001P	PT CLDY	
09E	57	045	026	02/19/73	2000	25.0	04	124P	PT CLDY		09W	59	035	038	02/25/73	2400	25.0	05	001P	PT CLDY	
09E	57	046	026	02/19/73	2000	25.0	04	124P	PT CLDY		09W	59	036	038	02/25/73	2400	25.0	05	001P	PT CLDY	
09E	57	047	026	02/19/73	2000	25.0	04	124P	PT CLDY		09W	59	037	039	02/26/73	0400	25.0	05	024P	PT CLDY	
09E	57	048	026	02/19/73	2000	25.0	04	124P	PT CLDY		09W	59	038	039	02/26/73	0400	25.0	05	024P	PT CLDY	
09E	57	049	027	02/19/73	2400	24.0	04	124P	NCAST		09W	59	039	039	02/26/73	0400	25.0	05	024P	PT CLDY	
09E	57	050	027	02/19/73	2400	24.0	04	124P	NCAST		09W	59	040	039	02/26/73	0400	25.0	05	024P	PT CLDY	
09E	57	051	027	02/19/73	2400	24.0	04	124P	NCAST		09W	59	041	040	02/26/73	0800	25.0	05	024P	NCAST	
09E	57	052	027	02/19/73	2400	24.0	04	124P	NCAST		09W	59	042	040	02/26/73	0800	25.0	05	024P	NCAST	
09E	57	053	028	02/20/73	0800	24.0	04	096P	CLDY		09W	59	043	040	02/26/73	0800	25.0	05	024P	NCAST	
09E	57	054	028	02/20/73	0800	24.0	04	096P	CLDY		09W	59	044	040	02/26/73	0800	25.0	05	024P	NCAST	
09E	57	055	028	02/20/73	0800	24.0	04	096P	CLDY		09W	59	045	041	02/26/73	1200	25.0	06	024P	NCAST	
09E	57	056	028	02/20/73	0800	24.0	04	096P	CLDY		09W	59	046	041	02/26/73	1200	25.0	06	024P	NCAST	
09E	57	057	029	02/20/73	0800	24.0	04	096P	CLDY		09W	59	047	041	02/26/73	1200	25.0	06	024P	NCAST	
09E	57	058	029	02/20/73	0800	24.0	04	096P	CLDY		09W	59	048	041	02/26/73	1600	25.0	06	024P	NCAST	
09E	57	059	029	02/20/73	0800	24.0	04	096P	CLDY		09W	59	049	042	02/26/73	1600	25.0	06	024P	NCAST	
09E	57	060	029	02/20/73	0800	24.0	04	096P	CLDY		09W	59	050	042	02/26/73	1600	25.0	06	024P	NCAST	
09W	59	001	031	02/24/73	1600	22.0	04	1335	CLDY		09W	59	051	042	02/26/73	1600	25.0	06	024P	NCAST	
09W	59	002	030	02/24/73	1600	22.0	04	1335	CLDY		09W	59	052	042	02/26/73	1600	25.0	06	024P	NCAST	
09W	59	003	030	02/24/73	1600	22.0	04	1335	CLDY		09W	61	001	043	02/26/73	2000	25.0	06	0053	NCAST	
09W	59	004	030	02/24/73	1600	22.0	04	1335	CLDY		09W	61	002	043	02/26/73	2000	25.0	06	0053	NCAST	
09W	59	005	031	02/24/7																	

VOY TP	INT	IDX	DATE	TIME	SPD	RN	RWVD	A-30	WEATHER	COMMENTS	VOY TP	INT	IDX	DATE	TIME	SPD	RN	RWVD	A-31	WEATHER
10E 65 021 024	03/07/73	1400							PCAST	PORT LIST	10W 67 027 003	03/12/73	1600	28.6	05	119P	PT	CLDY		
10E 65 022 024	03/07/73	1400							PCAST	PORT LIST	10W 67 029 004	03/12/73	2000	28.6	05	066P	PT	CLDY		
10E 65 023 024	03/07/73	1400							PCAST	PORT LIST	10W 67 030 008	03/12/73	2000	28.6	05	066P	PT	CLDY		
10E 65 024 024	03/07/73	1400							PCAST	PORT LIST	10W 67 031 008	03/12/73	2000	28.6	05	066P	PT	CLDY		
10E 65 025 025	03/07/73	1600	28.5	06	077S				PCAST		10W 67 032 008	03/12/73	2000	28.6	05	066P	PT	CLDY		
10E 65 026 025	03/07/73	1600	28.5	06	077S				PCAST		10W 67 033 009	03/12/73	2400	28.5	05	029P	PT	CLDY		
10E 65 027 025	03/07/73	1600	28.5	06	077S				PCAST		10W 67 034 009	03/12/73	2400	28.5	05	029P	PT	CLDY		
10E 65 028 025	03/07/73	1600	28.5	06	077S				PCAST		10W 67 035 009	03/12/73	2400	28.5	05	029P	PT	CLDY		
10E 65 029 024	03/07/73	2000	28.6	06	077S	LDY			LDY		10W 67 036 009	03/12/73	2400	28.5	05	029P	PT	CLDY		
10E 65 030 026	03/07/73	2000	28.6	06	077S	LDY			LDY		10W 67 037 010	03/13/73	0400	28.5	05	029P	RAIN			
10E 65 031 026	03/07/73	2000	28.6	06	077S	LDY			LDY		10W 67 038 010	03/13/73	0400	28.5	05	029P	RAIN			
10E 65 032 026	03/07/73	2000	28.6	06	077S	LDY			LDY		10W 67 039 010	03/13/73	0400	28.5	05	029P	RAIN			
10E 65 033 027	03/07/73	2400	28.8	05	055S	PT	CLDY		PT	CLDY	10W 67 040 010	03/13/73	0400	28.5	05	029P	RAIN			
10E 65 034 027	03/07/73	2400	28.8	05	055S	PT	CLDY		PT	CLDY	10W 67 041 011	03/13/73	0800	28.5	04	026P	PCAST			
10E 65 035 027	03/07/73	2400	28.8	05	055S	PT	CLDY		PT	CLDY	10W 67 042 011	03/13/73	0800	28.5	04	026P	PCAST			
10E 65 036 027	03/07/73	2400	28.8	05	055S	PT	CLDY		PT	CLDY	10W 67 043 011	03/13/73	0800	28.5	04	026P	PCAST			
10E 65 037 028	03/08/73	0400	28.8	04	033S	CLEAR			CLEAR		10W 67 044 011	03/13/73	0800	28.5	04	026P	PCAST			
10E 65 038 028	03/08/73	0400	28.8	04	033S	CLEAR			CLEAR		10W 67 045 012	03/13/73	1200	28.7	04	064S	PT	CLDY		
10E 65 039 028	03/08/73	0400	28.8	04	033S	CLEAR			CLEAR		10W 67 046 012	03/13/73	1200	28.7	04	064S	PT	CLDY		
10E 65 040 028	03/08/73	0400	28.8	04	033S	CLEAR			CLEAR		10W 67 047 012	03/13/73	1200	28.7	04	064S	PT	CLDY		
10E 65 041 029	03/08/73	0800	28.9	02	030S	CLEAR			CLEAR		10W 67 048 012	03/13/73	1200	28.7	04	064S	PT	CLDY		
10E 65 042 029	03/08/73	0800	28.9	02	030S	CLEAR			CLEAR		10W 67 049 013	03/13/73	1600	28.6	04	068S	PT	CLDY		
10E 65 043 029	03/08/73	0800	28.9	02	030S	CLEAR			CLEAR		10W 67 050 013	03/13/73	1600	28.6	04	068S	PT	CLDY		
10E 65 044 029	03/08/73	0800	28.9	02	030S	CLEAR			CLEAR		10W 67 051 013	03/13/73	1600	28.6	04	068S	PT	CLDY		
10W 67 001 001	03/11/73	1600							PCAST		10W 67 052 013	03/13/73	1600	28.6	04	068S	PT	CLDY		
10W 67 002 001	03/11/73	1600							PCAST		10W 67 053 016	03/13/73	2000	28.8	07	041P	PCAST			
10W 67 003 001	03/11/73	1600							PCAST		10W 67 054 016	03/13/73	2000	28.8	07	041P	PCAST			
10W 67 004 001	03/11/73	1600							PCAST		10W 67 055 014	03/13/73	2000	28.8	07	041P	PCAST			
10W 67 005 002	03/11/73	2000	28.3	03	164P	PCAST			PCAST		10W 67 056 014	03/13/73	2000	28.8	07	041P	PCAST			
10W 67 006 002	03/11/73	2000	28.3	03	164P	PCAST			PCAST		10W 67 057 015	03/13/73	2400	28.5	08	041P	PCAST			
10W 67 007 002	03/11/73	2000	28.3	03	164P	PCAST			PCAST		10W 67 058 015	03/13/73	2400	28.5	08	041P	PCAST			
10W 67 008 002	03/11/73	2000	28.3	03	164P	PCAST			PCAST		10W 67 059 015	03/13/73	2400	28.5	08	041P	PCAST			
10W 67 009 003	03/11/73	2400	28.9	04	141P	CLEAR			CLEAR		10W 67 060 015	03/13/73	2400	28.5	08	041P	PCAST			
10W 67 010 003	03/11/73	2400	28.9	04	141P	CLEAR			CLEAR		10W 67 061 016	03/14/73	0400	25.1	09	019P				
10W 67 011 003	03/11/73	2400	28.9	04	141P	CLEAR			CLEAR		10W 67 062 016	03/14/73	0400	25.1	09	019P				
10W 67 012 003	03/11/73	2400	28.9	04	141P	CLEAR			CLEAR		10W 67 063 016	03/14/73	0400	25.1	09	019P				
10W 67 013 004	03/12/73	0400	28.6	05	074P	PT	LDY		PT	LDY	10W 67 064 016	03/14/73	0400	25.1	09	019P				
10W 67 014 004	03/12/73	0400	28.6	05	074P	PT	LDY		PT	LDY	10W 67 065 017	03/14/73	0800	21.4	08	019P	RAIN			
10W 67 015 004	03/12/73	0400	28.6	05	074P	PT	LDY		PT	LDY	10W 67 066 017	03/14/73	0800	21.4	08	019P	RAIN			
10W 67 016 004	03/12/73	0400	28.6	05	074P	PT	LDY		PT	LDY	10W 67 067 017	03/14/73	0800	21.4	08	019P	RAIN			
10W 67 017 005	03/12/73	0800	28.6	06	119P	PT	LDY		PT	LDY	10W 67 068 017	03/14/73	0800	21.4	08	019P	RAIN			
10W 67 018 005	03/12/73	0800	28.6	06	119P	PT	LDY		PT	LDY	10W 69 001 018	03/14/73	1200	23.4	07	021S	PT	CLDY		
10W 67 019 005	03/12/73	0800	28.6	06	119P	PT	LDY		PT	LDY	10W 69 002 018	03/14/73	1200	23.4	07	021S	PT	CLDY		
10W 67 020 005	03/12/73	0800	28.6	06	119P	PT	LDY		PT	LDY	10W 69 003 018	03/14/73	1200	23.4	07	021S	PT	CLDY		
10W 67 021 006	03/12/73	1200	28.7	06	096P	PT	CLDY		PT	CLDY	10W 69 004 016	03/14/73	1600	23.4	07	021S	PT	CLDY		
10W 67 022 006	03/12/73	1200	28.7	06	096P	PT	CLDY		PT	CLDY	10W 69 005 019	03/14/73	1400	23.4	07	021S	PT	CLDY		
10W 67 023 006	03/12/73	1200	28.7	06	096P	PT	CLDY		PT	CLDY	10W 69 006 019	03/14/73	1400	23.4	07	021S	PT	CLDY		
10W 67 024 006	03/12/73	1200	28.7	06	096P	PT	CLDY		PT	CLDY	10W 69 007 019	03/14/73	1400	23.4	07	021S	PT	CLDY		
10W 67 025 007	03/12/73	1600	28.6	05	119P	PT	CLDY		PT	CLDY	10W 69 008 019	03/14/73	1400	23.4	07	021S	PT	CLDY		
10W 67 026 007	03/12/73	1600	28.6	05	119P	PT	CLDY		PT	CLDY										

VOY TP	INT	IDX	DATE	TIME	SPD	RN	RWVD	A-32	WEATHER	COMMENTS
10W 69 009 020	03/14/73	1600	29.4	10	001P	PCAST				
10W 69 010 020	03/14/73	1600	29.4	10	001P	PCAST				
10W 69 011 020	03/14/73	1600	29.4	10	001P	PCAST				
10W 69 012 020	03/14/73	1600	29.4	10	001P	PCAST				
10W 69 013 021	03/14/73	1600	29.4	10	001P	PCAST				
10W 69 014 021	03/14/73	1600	29.4	10	001P	PCAST				
10W 69 015 021	03/14/73	1600	29.4	10	001P	PCAST				
10W 69 016 021	03/14/73	1600	29.4	10	001P	PCAST				
10W 69 017 022	03/14/73	2000	29.4	09	001P	CLDY				
10W 69 018 022	03/14/73	2000	29.4	09	001P	CLDY				
10W 69 019 022	03/14/73	2000	29.4	09	001P	CLDY				
10W 69 020 022	03/14/73	2000	29.4	09	001P	CLDY				
10W 69 021 023	03/14/73	2200	29.4	09	001P	CLDY				
10W 69 022 023	03/14/73	2200	29.4	09	001P	CLDY				
10W 69 023 023	03/14/73	2200	29.4	09	001P	CLDY				
10W 69 024 023	03/14/73	2200	29.4	09	001P	CLDY				
10W 69 025 024	03/14/73	2400	22.2	09	044S	CLDY				PITCHING
10W 69 026 024	03/14/73	2400	22.2	09	044S	CLDY				PITCHING
10W 69 027 024	03/14/73	2400	22.2	09	044S	CLDY				PITCHING
10W 69 028 024	03/14/73	2400	22.2	09	044S	CLDY				PITCHING
10W 69 029 024	03/14/73	2400	22.2	09	044S	CLDY				PITCHING
10W 69 030 024	03/14/73	2400	22.2	09	044S	CLDY				PITCHING
10W 69 031 024	03/14/73	2400	22.2	09	044S	CLDY				PITCHING
10W 69 032 024	03/14/73	2400	22.2	09	044S	CLDY				PITCHING
10W 69 033 025	03/15/73	0400	19.8	08	044S	PT	CLDY			
10W 69 034 025	03/15/73	0400	19.8	08	044S	PT	CLDY			
10W 69 035 025	03/15/73	0400	19.8	08	044S	PT	CLDY			
10W 69 036 025	03/15/73	0400	19.8	08	044S	PT	CLDY			
10W 69 037 025	03/15/73	0400	19.8	08	044S	PT	CLDY			
10W 69 038 025	03/15/73	0400	19.8	08	044S	PT	CLDY			
10W 69 039 025	03/15/73	0400	19.8	08	044S	PT	CLDY			
10W 69 040 025	03									

A-33										A-34									
VOY	TP	INT	IDX	DATE	TIME	SPD	RN	RWVD	WEATHER	VOY	TP	INT	IDX	DATE	TIME	SPD	RN	RWVD	WEATHER
10W	69	059	029	03/15/73	2000	29.4	02	136P	OCAST	11F	71	049	013	03/21/73	0400	29.7	04	128S	PT CLDY
10W	69	060	029	03/15/73	2000	29.4	02	136P	OCAST	11F	71	050	013	03/21/73	0400	29.7	04	128S	PT CLDY
11E	71	001	001	03/19/73	1200	28.9	07	124P	OCAST	11E	71	051	013	03/21/73	0400	29.7	04	128S	PT CLDY
11E	71	002	001	03/19/73	1200	28.9	07	124P	OCAST	11E	71	052	013	03/21/73	0400	29.7	04	128S	PT CLDY
11E	71	003	001	03/19/73	1200	28.9	07	124P	OCAST	11E	71	053	014	03/21/73	0400	28.5	05	128S	CLDY
11E	71	004	001	03/19/73	1200	28.9	07	124P	OCAST	11E	71	054	014	03/21/73	0400	28.5	05	128S	CLDY
11E	71	005	002	03/19/73	1400				OCAST	11E	71	055	014	03/21/73	0400	28.5	05	128S	CLDY
11E	71	006	002	03/19/73	1400				OCAST	11E	71	056	014	03/21/73	0400	28.5	05	128S	CLDY
11E	71	007	002	03/19/73	1400				OCAST	11E	71	057	015	03/21/73	1200	28.7	06	128S	CLEAR
11E	71	008	002	03/19/73	1400				OCAST	11E	71	058	015	03/21/73	1200	28.7	06	128S	CLEAR
11E	71	009	003	03/19/73	1600	29.3	04	146P	OCAST	11E	71	059	015	03/21/73	1200	28.7	06	128S	CLEAR
11E	71	010	003	03/19/73	1600	29.3	04	146P	OCAST	11E	71	060	015	03/21/73	1200	28.7	06	128S	CLEAR
11E	71	011	003	03/19/73	1600	29.3	04	146P	OCAST	11E	71	061	016	03/21/73	1600	28.9	05	151S	PTCLDY
11E	71	012	003	03/19/73	1600	29.3	04	146P	OCAST	11E	71	062	016	03/21/73	1600	28.9	05	151S	PTCLDY
11E	71	013	004	03/19/73	1600				OCAST	11E	71	063	016	03/21/73	1600	28.9	05	151S	PTCLDY
11E	71	014	004	03/19/73	1600				OCAST	11E	71	064	016	03/21/73	1600	28.9	05	151S	PTCLDY
11E	71	015	004	03/19/73	1600				OCAST	11E	71	065	017	03/21/73	2000	29.0	06	151S	CLDY
11E	71	016	004	03/19/73	1600				OCAST	11E	71	066	017	03/21/73	2000	29.0	06	151S	CLDY
11E	71	017	005	03/19/73	2000	29.6	08	166P	OCAST	11E	71	067	017	03/21/73	2000	29.0	06	151S	CLDY
11E	71	018	005	03/19/73	2000	29.6	08	166P	OCAST	11E	71	068	017	03/21/73	2000	29.0	06	151S	CLDY
11E	71	019	005	03/19/73	2000	29.6	08	166P	OCAST	11E	71	069	018	03/21/73	2400	28.8	04	151S	OCAST
11E	71	020	005	03/19/73	2000	29.6	08	166P	OCAST	11E	71	070	018	03/21/73	2400	28.8	04	151S	OCAST
11E	71	021	006	03/19/73	2400	29.4	08	135P	OCAST	11E	71	071	018	03/21/73	2400	28.8	04	151S	OCAST
11E	71	022	006	03/19/73	2400	29.4	08	135P	OCAST	11E	71	072	018	03/21/73	2400	28.8	04	151S	OCAST
11E	71	023	006	03/19/73	2400	29.4	08	135P	OCAST	11E	71	073	019	03/22/73	0400	28.9	03	151S	OCAST
11E	71	024	006	03/19/73	2400	29.4	08	135P	OCAST	11E	71	074	019	03/22/73	0400	28.9	03	151S	OCAST
11E	71	025	007	03/20/73	0400	28.4	05	135S	OCAST	11E	71	075	019	03/22/73	0400	28.9	03	151S	OCAST
11E	71	026	007	03/20/73	0400	28.4	05	135S	OCAST	11E	71	076	019	03/22/73	0400	28.9	03	151S	OCAST
11E	71	027	007	03/20/73	0800	28.4	05	135S	OCAST	11E	73	002	020	03/22/73	0400	28.9	04	151S	OCAST
11E	71	028	007	03/20/73	0800	28.4	05	135S	OCAST	11E	73	003	020	03/22/73	0400	28.9	04	151S	OCAST
11E	71	029	008	03/20/73	0800	28.4	04	157P	CLDY	11E	73	004	020	03/22/73	0400	28.9	04	151S	OCAST
11E	71	030	008	03/20/73	0800	28.4	04	157P	CLDY	11E	73	005	021	03/22/73	1200	28.9	04	151S	FOG
11E	71	031	008	03/20/73	0800	28.4	04	157P	CLDY	11E	73	006	021	03/22/73	1200	28.9	04	151S	FOG
11E	71	032	008	03/20/73	0800	28.4	04	157P	CLDY	11E	73	007	021	03/22/73	1200	28.9	04	151S	FOG
11E	71	033	009	03/20/73	1200	28.8	04	135P	CLDY	11E	73	008	021	03/22/73	1200	28.9	04	151S	FOG
11E	71	034	009	03/20/73	1200	28.8	04	135P	CLDY	11E	73	009	022	03/22/73	1600	28.8	04	166S	FOG
11E	71	035	009	03/20/73	1200	28.8	04	135P	CLDY	11E	73	010	022	03/22/73	1600	28.8	04	166S	FOG
11E	71	036	009	03/20/73	1200	28.8	04	135P	CLDY	11E	73	011	022	03/22/73	1600	28.8	04	166S	FOG
11E	71	037	010	03/20/73	1600	28.7	05	157S	PT CLDY	11E	73	012	022	03/22/73	1600	28.8	04	166S	FOG
11E	71	038	010	03/20/73	1600	28.7	05	157S	PT CLDY	11E	73	013	023	03/22/73	2000	28.8	04	166S	OCAST
11E	71	039	010	03/20/73	1600	28.7	05	157S	PT CLDY	11E	73	014	023	03/22/73	2000	28.8	04	166S	OCAST
11E	71	040	010	03/20/73	1600	28.7	05	157S	PT CLDY	11E	73	015	023	03/22/73	2000	28.8	04	166S	OCAST
11E	71	041	011	03/20/73	2000	28.7	05	135S	PT CLDY	11E	73	016	023	03/22/73	2000	28.8	04	166S	OCAST
11E	71	042	011	03/20/73	2000	28.7	05	135S	PT CLDY	11E	73	017	024	03/22/73	2400	28.8	04	166S	OCAST
11E	71	043	011	03/20/73	2000	28.7	05	135S	PT CLDY	11E	73	018	024	03/22/73	2400	28.8	04	166S	OCAST
11E	71	044	011	03/20/73	2000	28.7	05	135S	PT CLDY	11E	73	019	024	03/22/73	2400	28.8	04	166S	OCAST
11E	71	045	012	03/20/73	2400	28.6	04	135S	PT CLDY	11E	73	020	024	03/22/73	2400	28.8	04	166S	OCAST
11E	71	046	012	03/20/73	2400	28.6	04	135S	PT CLDY	11E	73	021	025	03/23/73	0400	28.8	03	166S	PT CLDY
11E	71	047	012	03/20/73	2400	28.6	04	135S	PT CLDY	11E	73	022	025	03/23/73	0400	28.8	03	166S	PT CLDY
11E	71	048	012	03/20/73	2400	28.6	04	135S	PT CLDY	11E	73	023	025	03/23/73	0400	28.8	03	166S	PT CLDY

A-35									
VOY	TP	INT	IDX	DATE	TIME	SPD	RN	RWVD	WEATHER
11E	73	024	025	03/23/73	0400	28.4	03	106S	PT CLDY
11E	73	025	026	03/23/73	0800	28.4	04	061S	PT CLDY
11E	73	026	026	03/23/73	0800	28.4	04	061S	PT CLDY
11E	73	027	026	03/23/73	0800	28.4	04	061S	PT CLDY
11E	73	028	026	03/23/73	0800	28.4	04	061S	PT CLDY
11E	73	029	027	03/23/73	1200	28.4	05	106S	PT CLDY
11E	73	030	027	03/23/73	1200	28.4	05	106S	PT CLDY
11E	73	031	027	03/23/73	1200	28.4	05	106S	PT CLDY
11E	73	032	027	03/23/73	1200	28.4	05	106S	PT CLDY
11E	73	033	028	03/23/73	1600	28.4	05	106S	PT CLDY
11E	73	034	028	03/23/73	1600	28.4	05	106S	PT CLDY
11E	73	035	028	03/23/73	1600	28.4	05	106S	PT CLDY
11E	73	036	028	03/23/73	1600	28.4	05	106S	PT CLDY
11E	73	037	029	03/23/73	2000	28.4	05	106S	PT CLDY
11E	73	038	029	03/23/73	2000	28.4	05	106S	PT CLDY
11E	73	039	029	03/23/73	2000	28.4	05	106S	PT CLDY
11E	73	040	029	03/23/73	2000	28.4	05	106S	PT CLDY
11E	73	041	030	03/23/73	2400	28.5	03		PT CLDY
11E	73	042	030	03/23/73	2400	28.5	03		PT CLDY
11E	73	043	030	03/23/73	2400	28.5	03		PT CLDY
11E	73	044	030	03/23/73	2400	28.5	03		PT CLDY
11E	73	045	031	03/24/73	0400	26.0	02		CLEAR
11E	73	046	031	03/24/73	0400	26.0	02		CLEAR
11E	73	047	031	03/24/73	0400	26.0	02		CLEAR
11E	73	048	031	03/24/73	0400	26.0	02		CLEAR
11W	75	001	001	03/26/73	1200	26.4	03		PT CLDY
11W	75	002	001	03/26/73	1200	26.4	03		PT CLDY
11W	75	003	001	03/26/73	1200	26.4	03		PT CLDY
11W	75	004	001	03/26/73	1200	26.4	03		PT CLDY
11W	75	005	002	03/26/73	1600	26.7	03	025P	PT CLDY
11W	75	006	002	03/26/73	1600	26.7	03	025P	PT CLDY
11W	75	007	002	03/26/73	1600	26.7	03	025P	PT CLDY
11W	75	008	002	03/26/73	1600	26.7	03	025P	PT CLDY
11W	75	009	003	03/26/73	2000	26.5	05	044P	OCAST
11W	75	010	003	03/26/73	2000	26.5	05	044P	OCAST
11W	75	011	003	03/26/73	2000	26.5	05	044P	OCAST
11W	75	012	003	03/26/73	2000	26.5	05	044P	OCAST
11W	75	013	004	03/26/73	2400	28.5	05		

VOY TP INT IDX DATE TIME SPD BN RWVD A-36 WEATHER VOY TP INT IDX DATE TIME SPD BN RWVD A-37 WEATHER

Table with columns: VOY TP INT IDX, DATE, TIME, SPD, BN, RWVD, WEATHER. Rows include data for stations 11W 75 026 007 through 11W 75 008 020.

Table with columns: VOY TP INT IDX, DATE, TIME, SPD, BN, RWVD, WEATHER. Rows include data for stations 11W 77 009 021 through 12E 79 006 020.

VOY TP INT IDX DATE TIME SPD BN RWVD A-38 WEATHER

Table with columns: VOY TP INT IDX, DATE, TIME, SPD, BN, RWVD, WEATHER. Rows include data for stations 12E 79 007 002 through 12E 79 056 014.

VOY TP INT IDX DATE TIME SPD BN RWVD A-39 WEATHER

Table with columns: VOY TP INT IDX, DATE, TIME, SPD, BN, RWVD, WEATHER. Rows include data for stations 12E 79 057 015 through 12E 79 072 018.

APPENDIX B

PARAMETRIC STUDIES

This appendix contains the plots and tabulated summaries resulting from the parametric studies program, designated "SPLOT". Each plot presents either a five-curve family of various ship speeds or a five-curve family of relative wave direction groups for a transducer output against Beaufort Number. Within each Beaufort Number, the magnitude of a particular point is determined by calculating the mean of the appropriate data. A superscribed note on each plot designates which value is applicable. The measured data set is composed of the maximum wave-induced peak-to-trough value within each 30-minute data interval, or the RMS value determined for that interval. The graph title notes which characterization is applicable. Eight measurements, all from Recorder No. 1, were selected for study:

1. Longitudinal Vertical Bending Stress
2. Longitudinal Horizontal Bending Stress
3. Torsional Shear Midship Stress
4. Forward Shearing Stress-Port
5. Forward Shearing Stress-Starboard
6. Roll Angle
7. Pitch Angle
8. Forward Hull Vertical Acceleration

Each tabulated summary (Tables III-XXXIV) presents a listing of all plotted points along with the number of data points comprising each plotted mean point and its standard deviation.

Table B-I provides an index for all parametric plots and summaries.

Table B-II gives the code for the ship speed or relative sea direction curve families as used in the plots.

TABLE B-I

Figure and Table Index for Parametric Studies

For value within each 30-minute interval of: For values within each Beaufort No. Set		For Sensor*															
		LVB		LHB		TSM		SFP		SFS		ROLL		PITCH		FAV	
		RMS	Max	RMS	Max	RMS	Max	RMS	Max	RMS	Max	RMS	Max	RMS	Max	RMS	Max
All Data Points		1	4	7	10	13	16	19	22	25	28	31	34	37	40	43	46
Mean of All Data Points	by Ship Speed	2	5	8	11	14	17	20	23	26	29	32	35	38	41	44	47
	by Relative Wave Direction	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48
Summary Listing	by Ship Speed	III	V	VII	IX	XI	XIII	XV	XVII	XIX	XXI	XXIII	XXV	XXVII	XXIX	XXXI	XXXIII
	by Relative Wave Direction	IV	VI	VIII	X	XII	XIV	XVI	XVIII	XX	XXII	XXIV	XXVI	XXVIII	XXX	XXXII	XXXIV

Note: Arabic numbers are Figure Numbers B-1, etc.

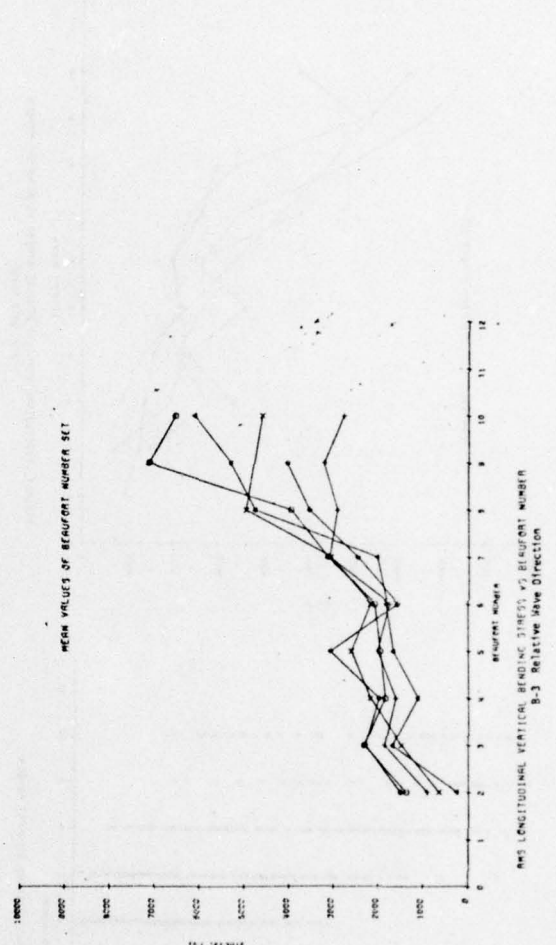
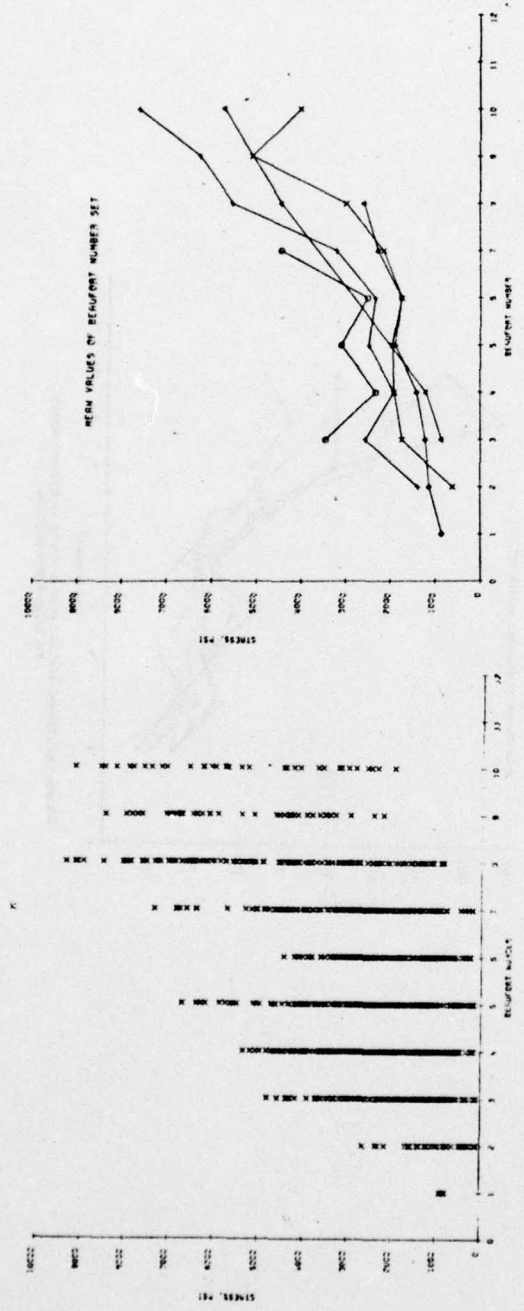
Roman numerals are Table Numbers B-III, etc.

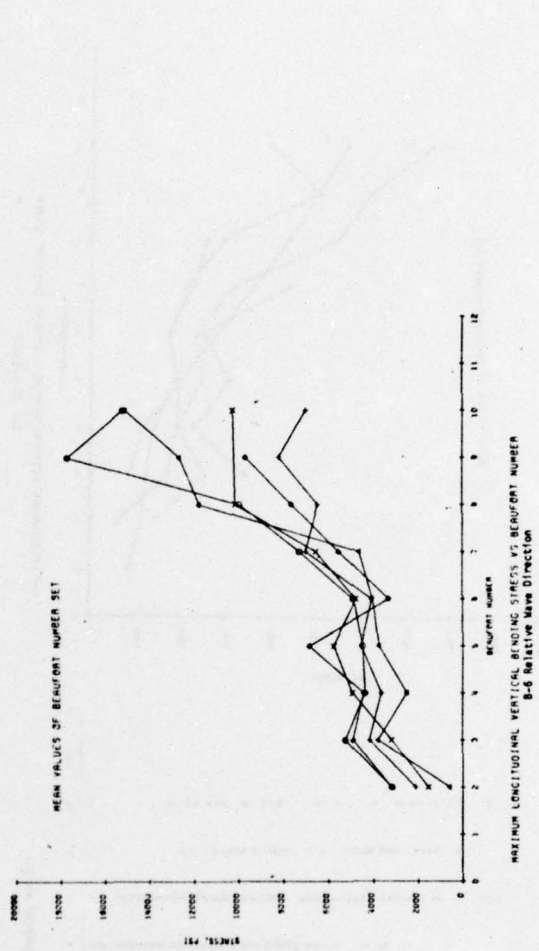
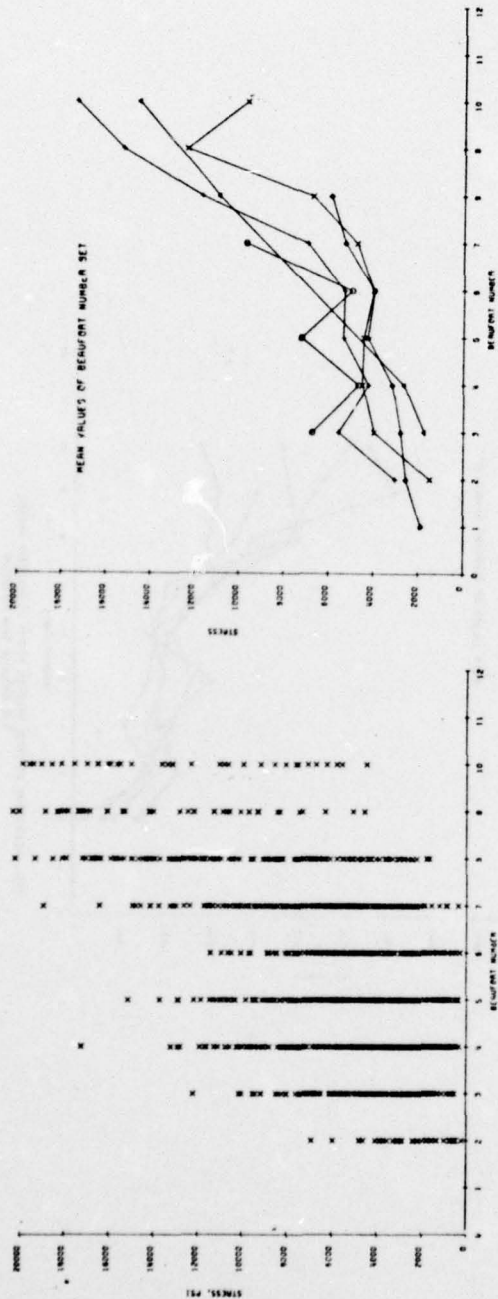
*See Table III for definition of Sensor Abbreviations

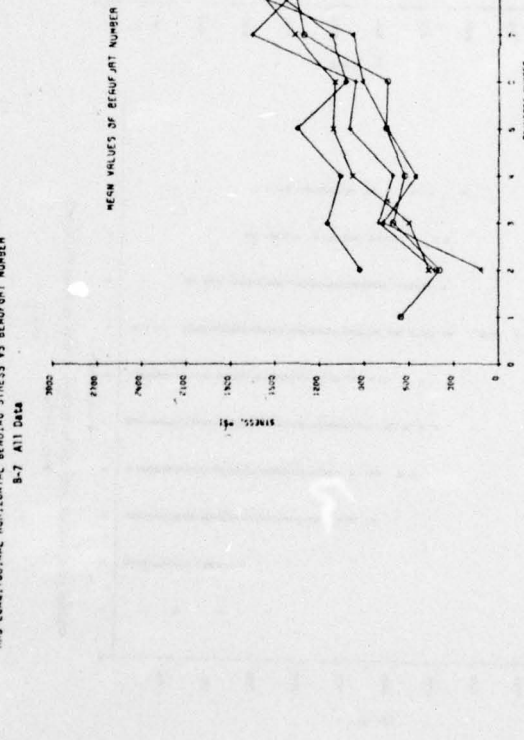
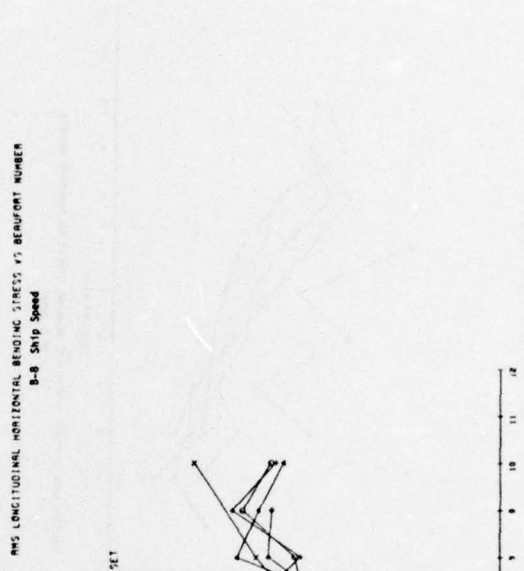
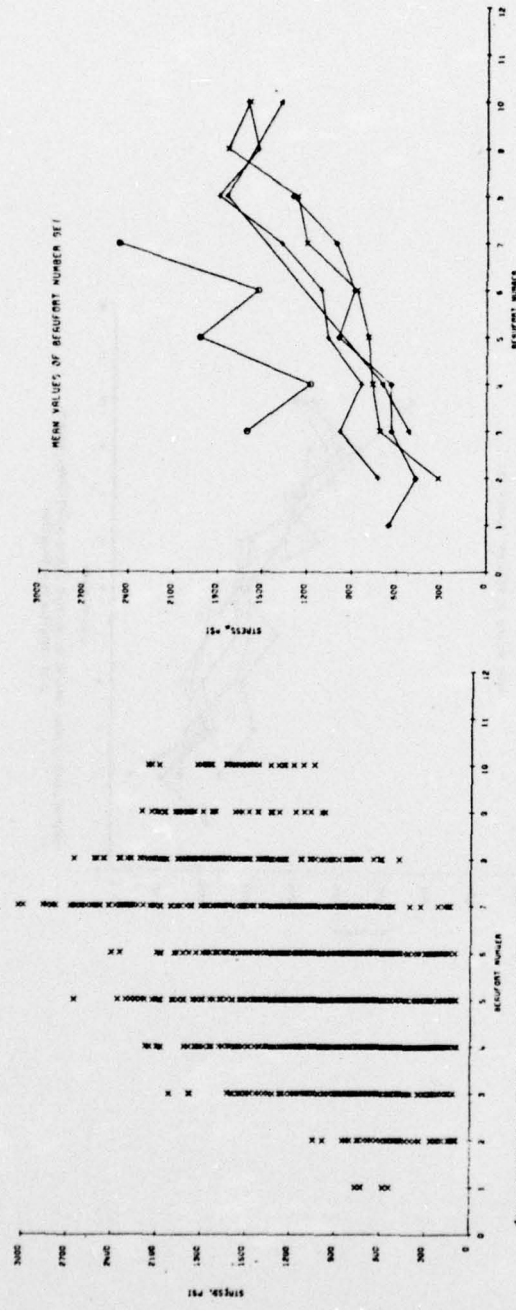
TABLE B-II

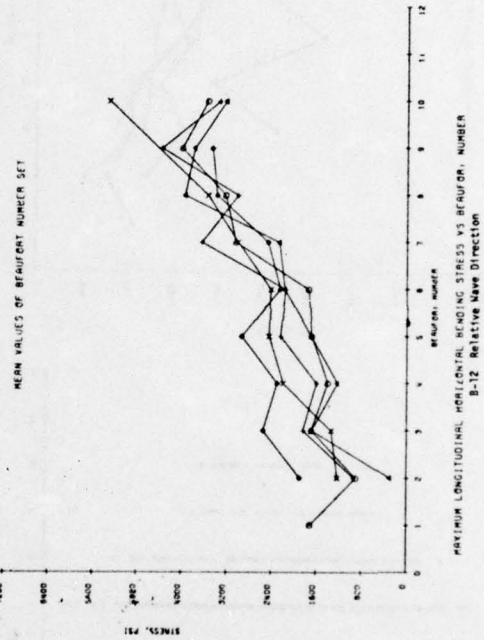
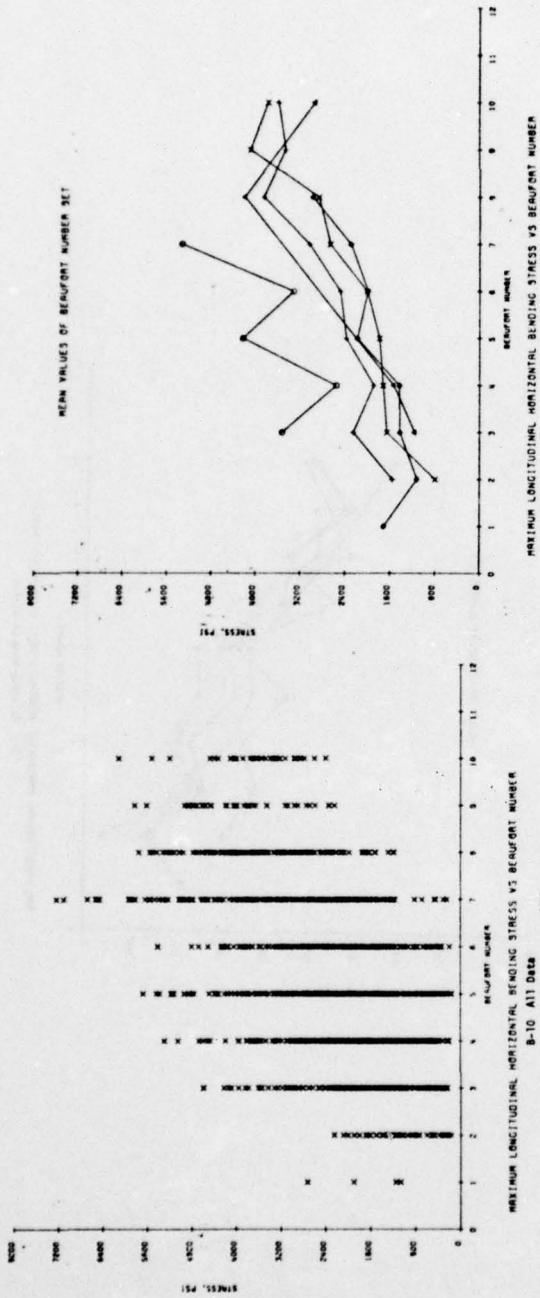
LEGEND FOR PARAMETRIC STUDIES

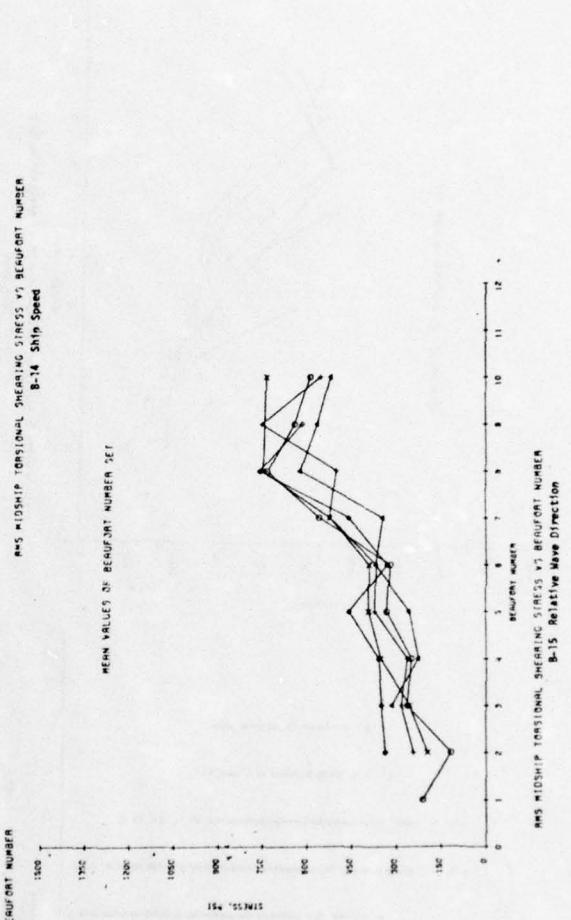
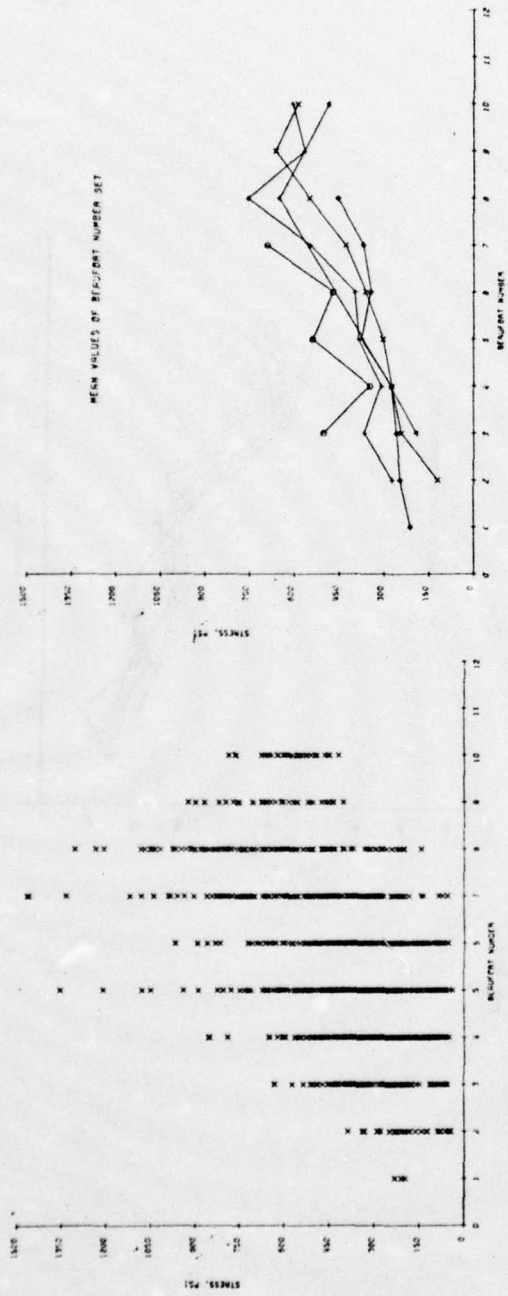
SYMBOL	Ship's Speed, Knots	Relative Sea Direction, Deg. P or S
○	1-15	0-30
△	15-20	31-60
+	20-25	61-120
×	25-30	121-150
◇	30-35	151-180

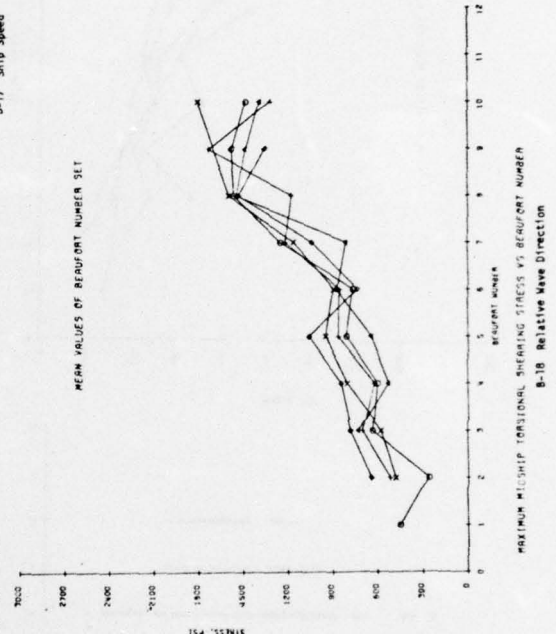
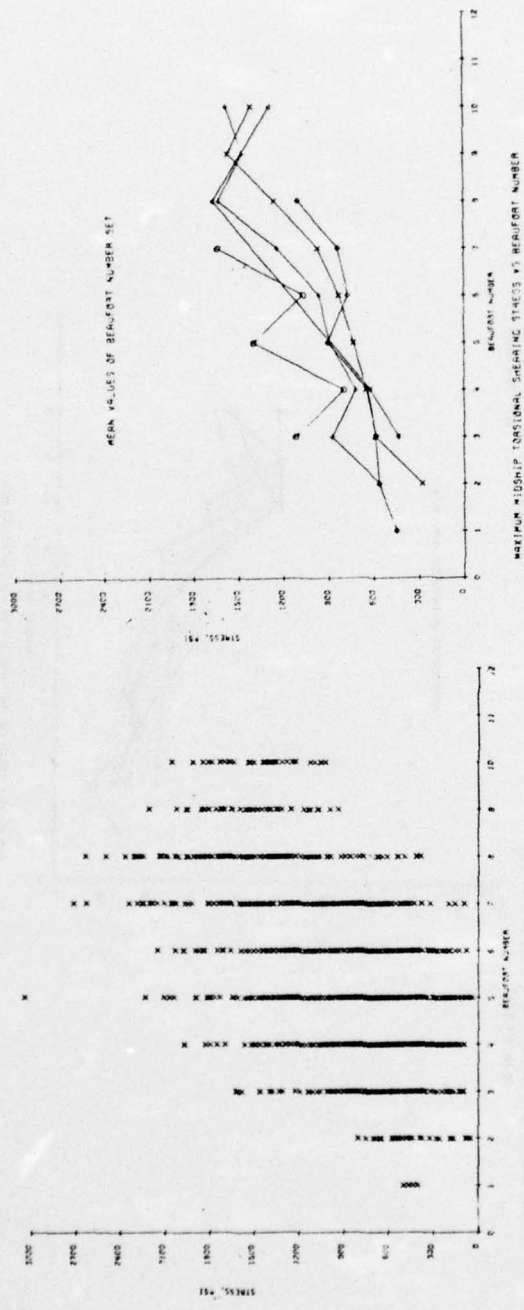


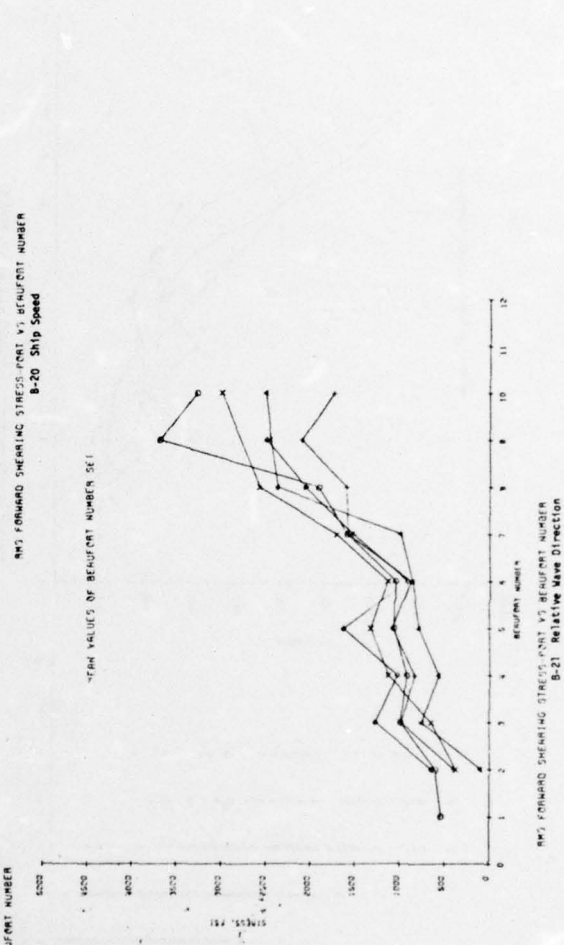
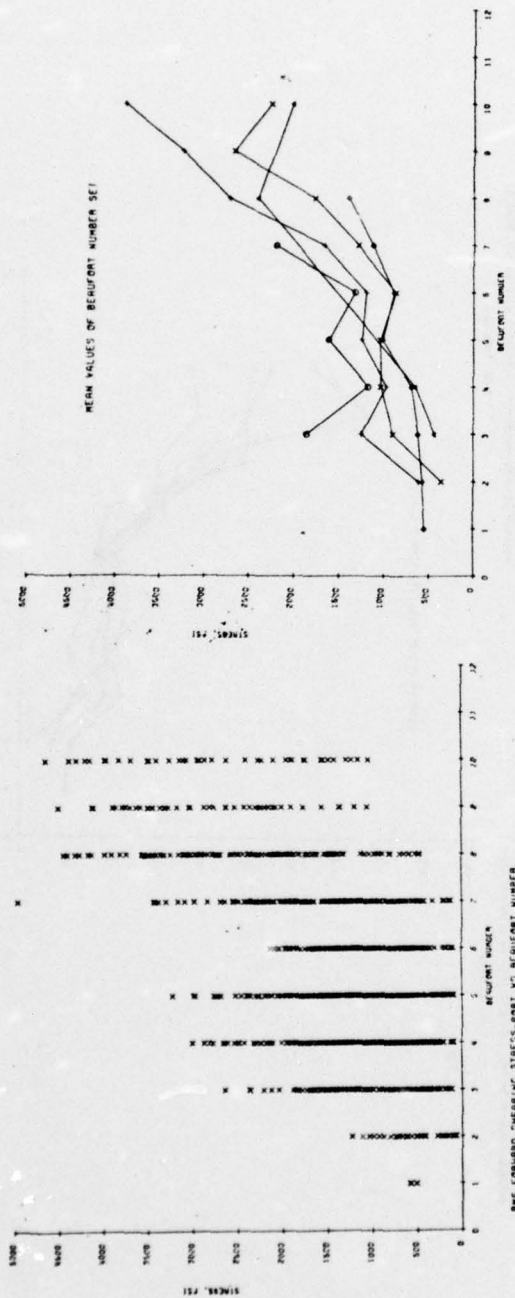


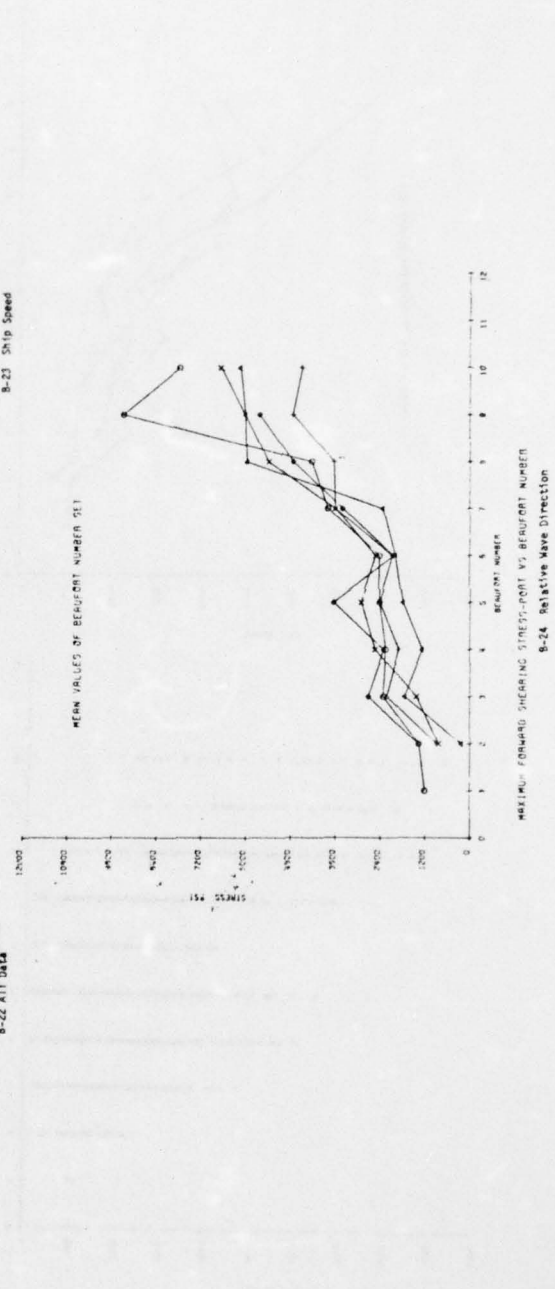
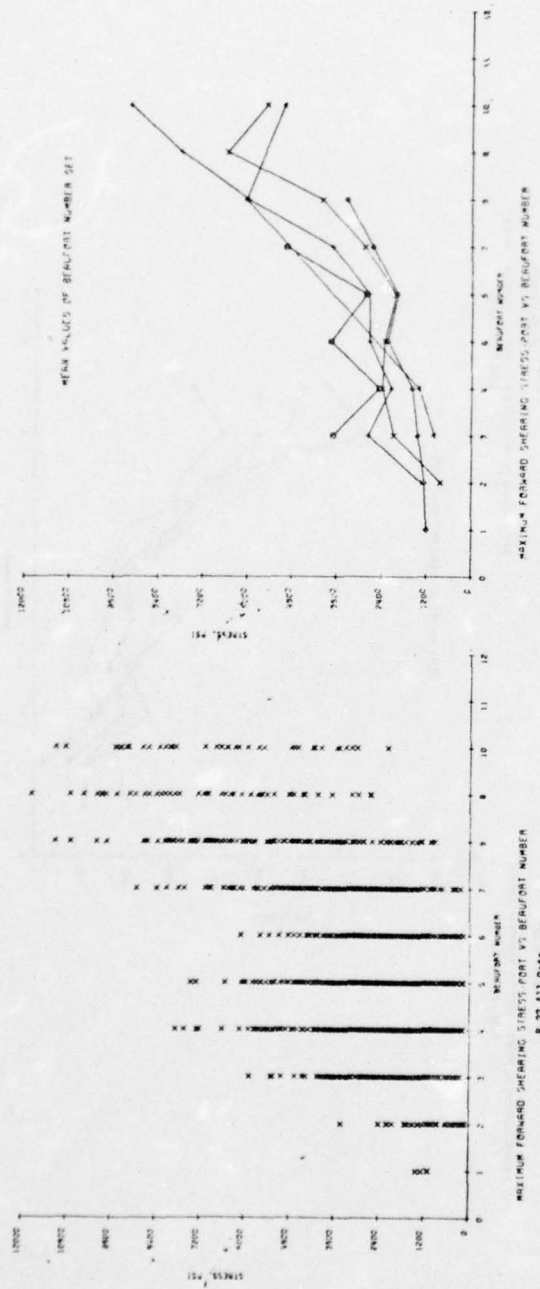


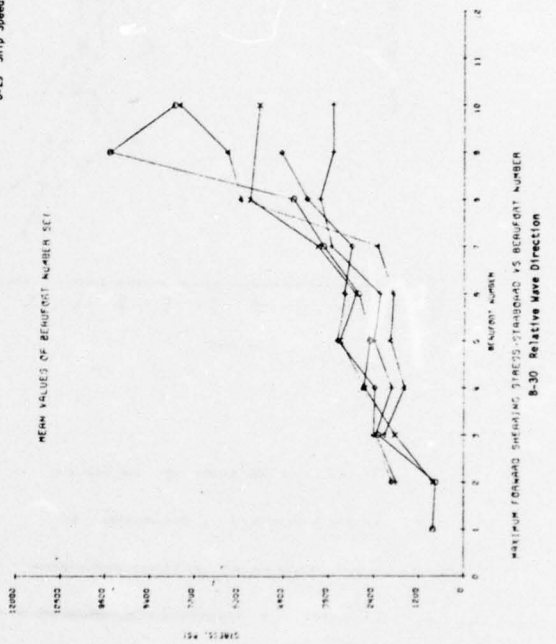
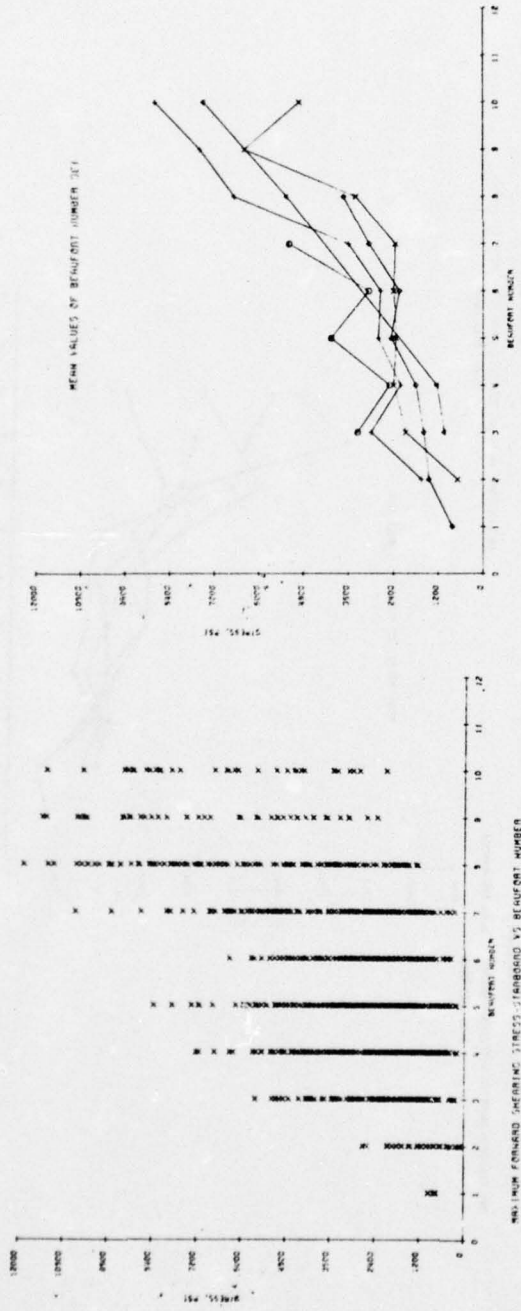


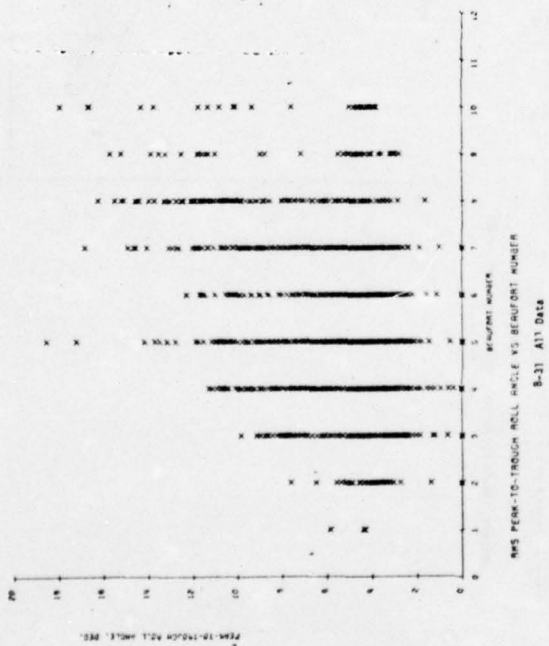
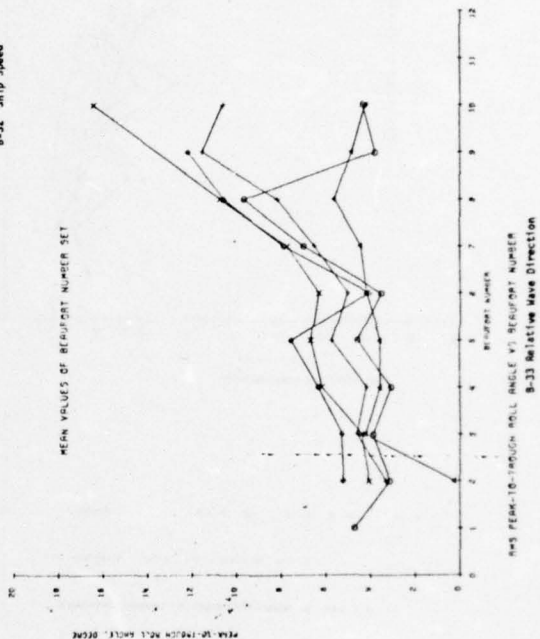
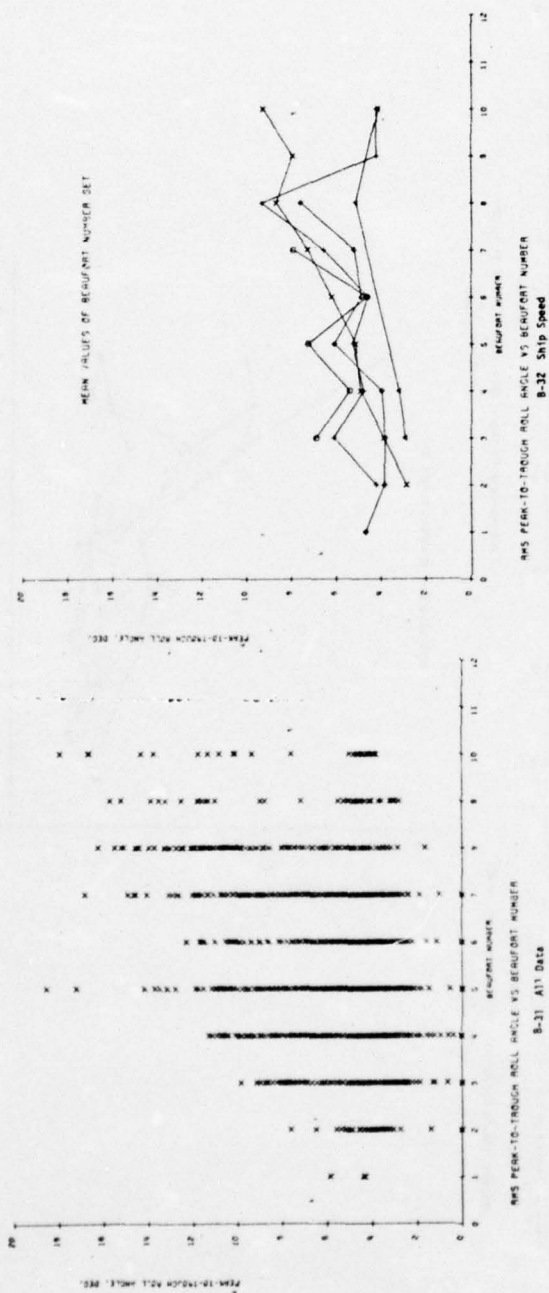


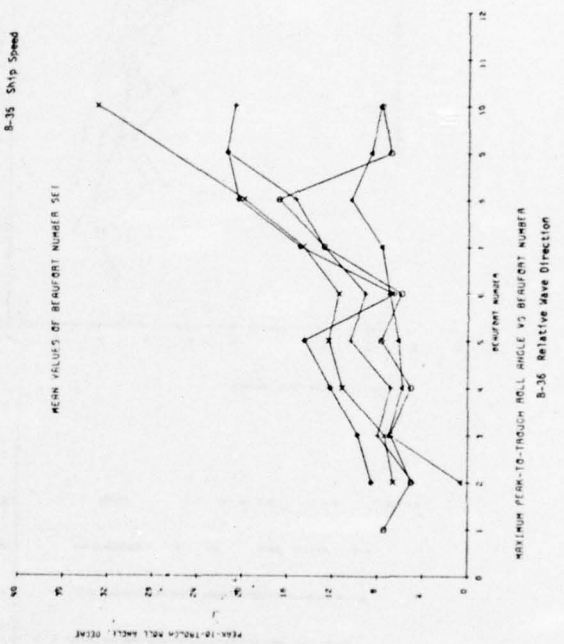
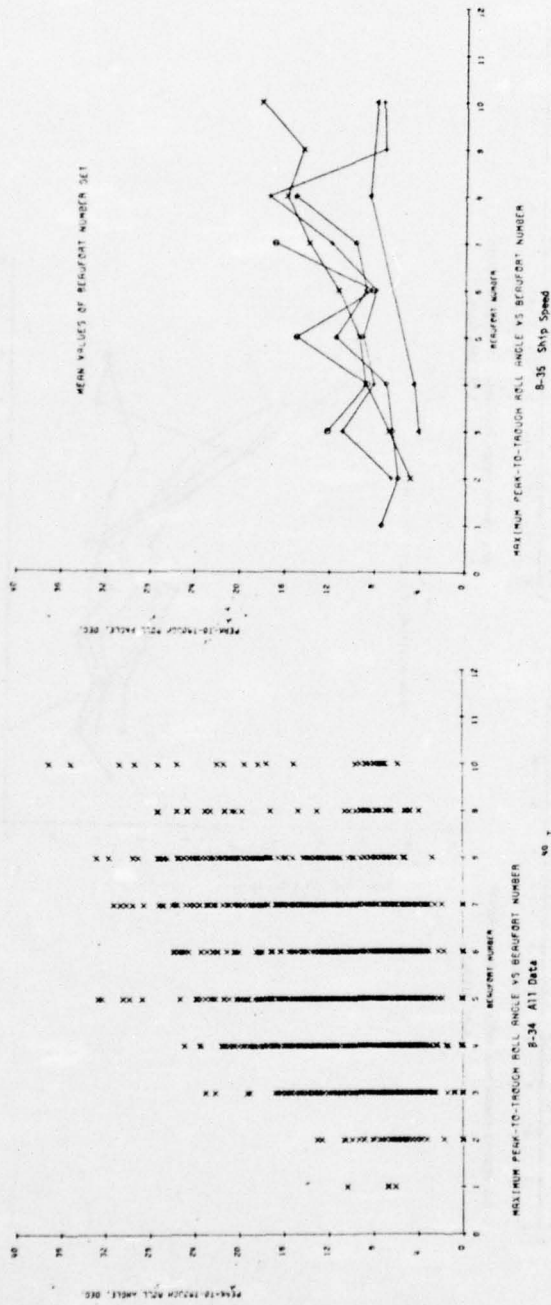


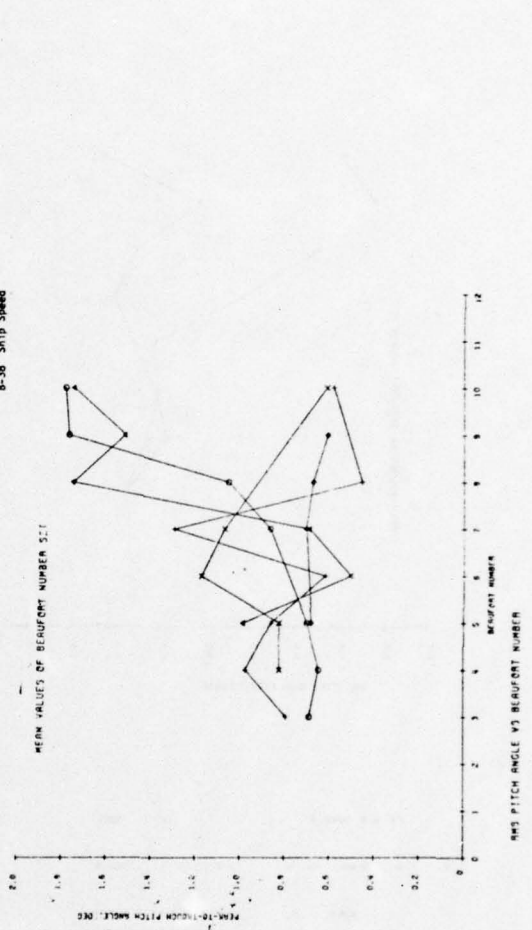
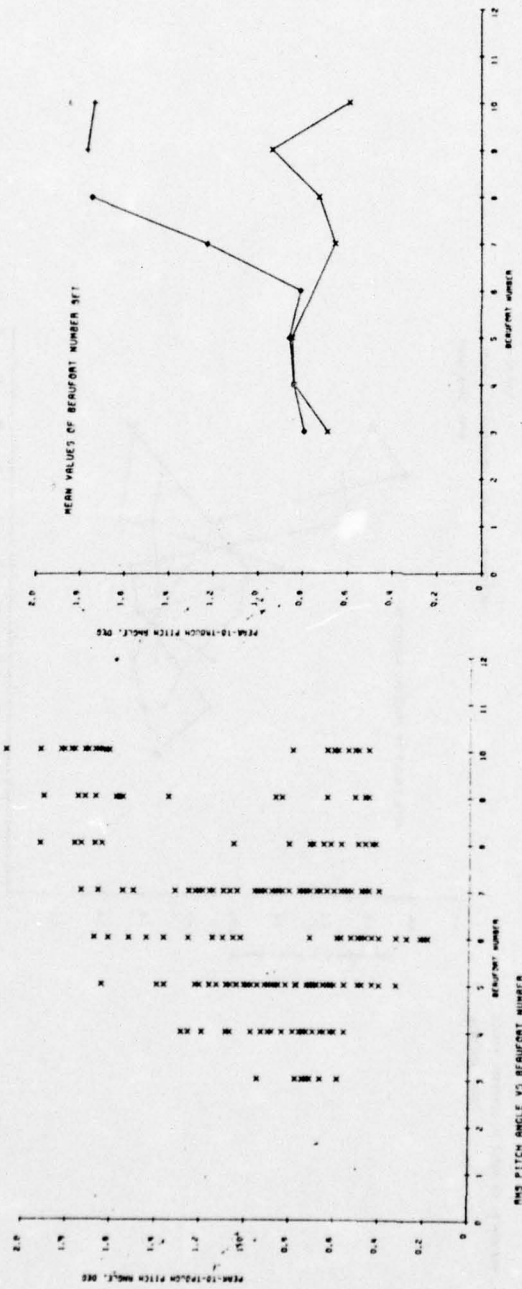




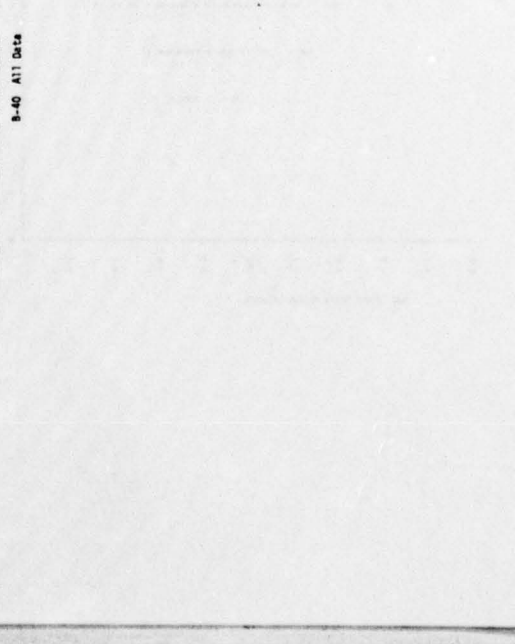
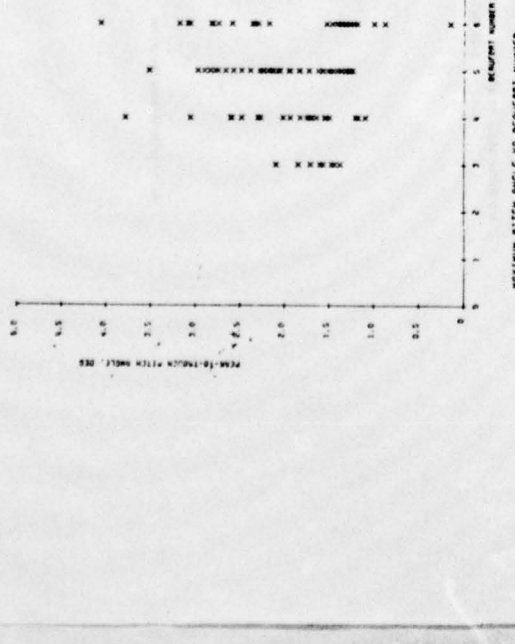
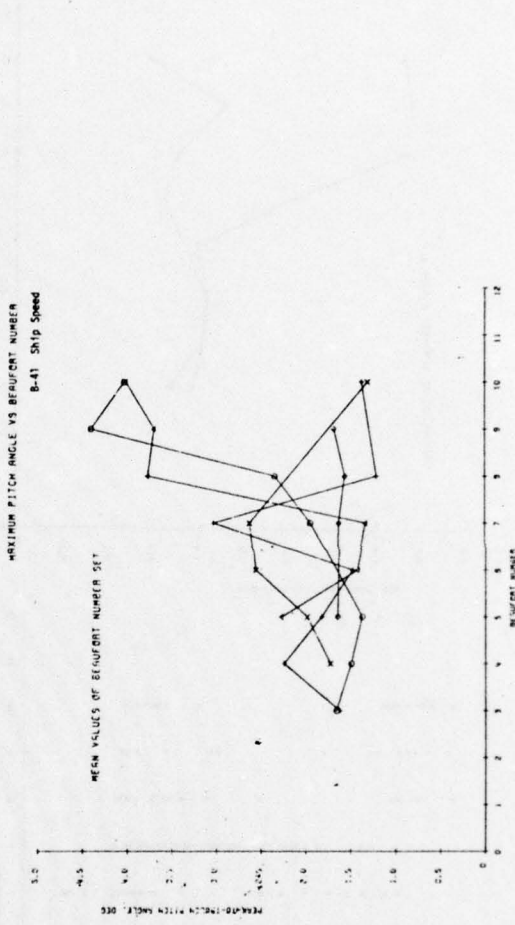
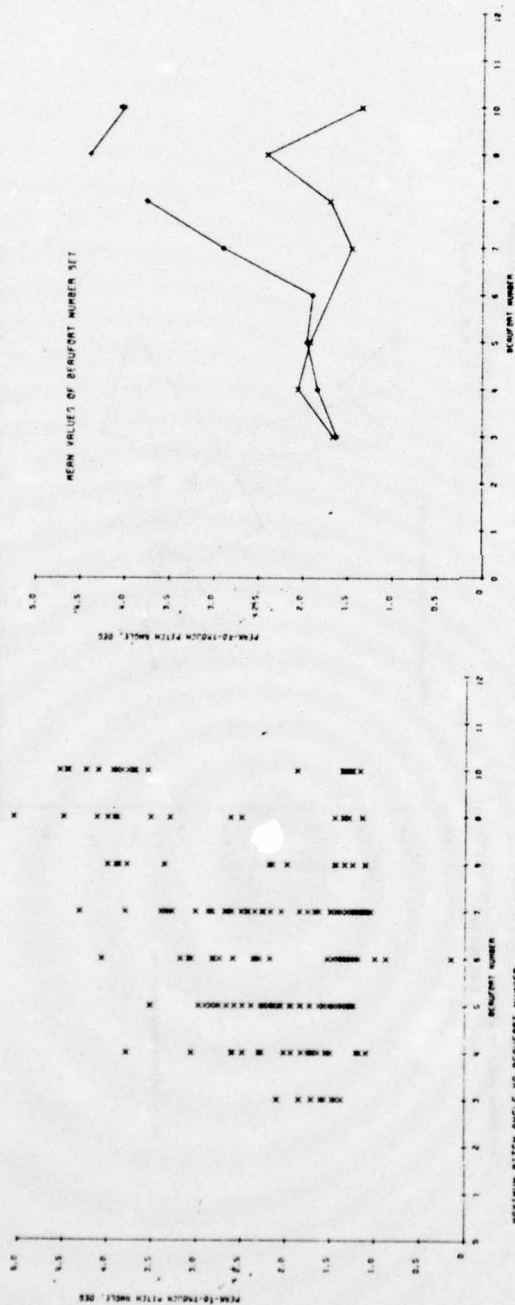


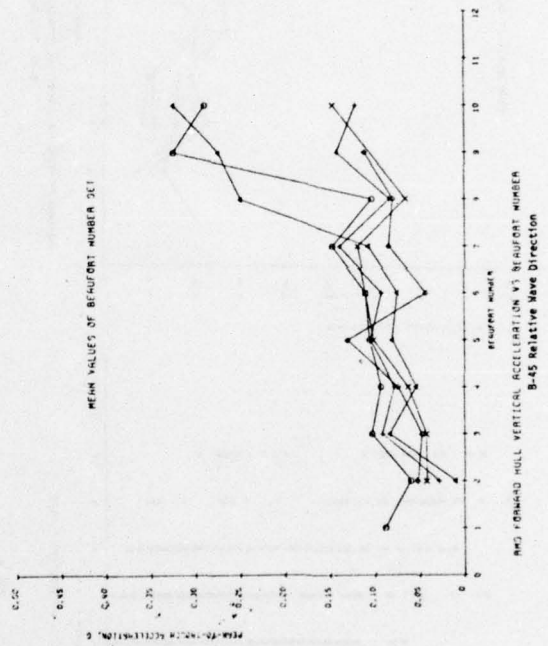
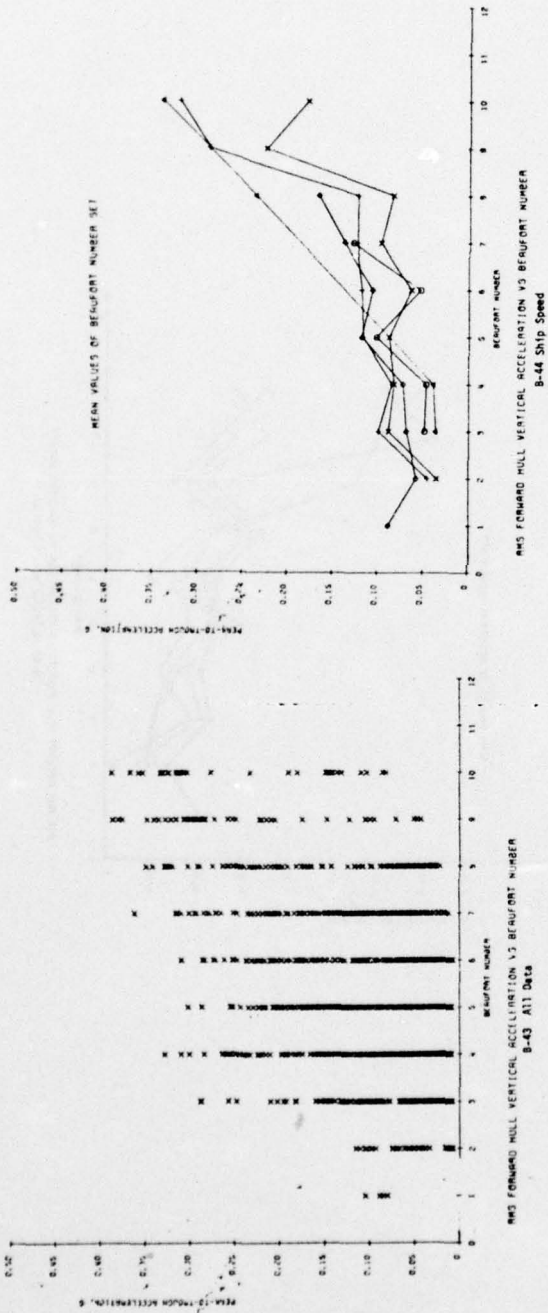


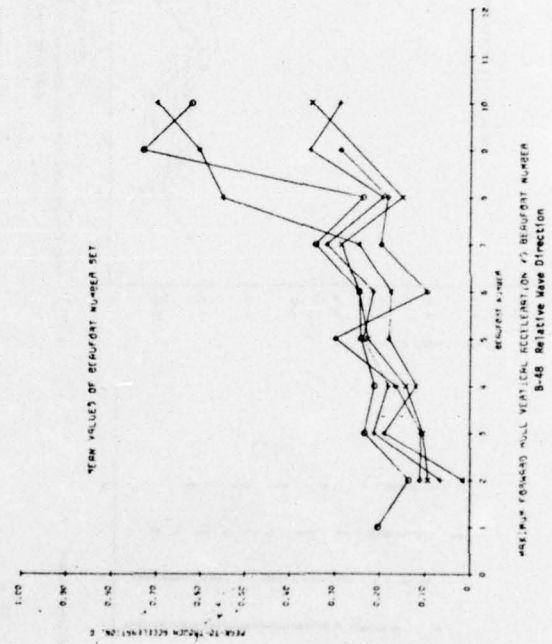
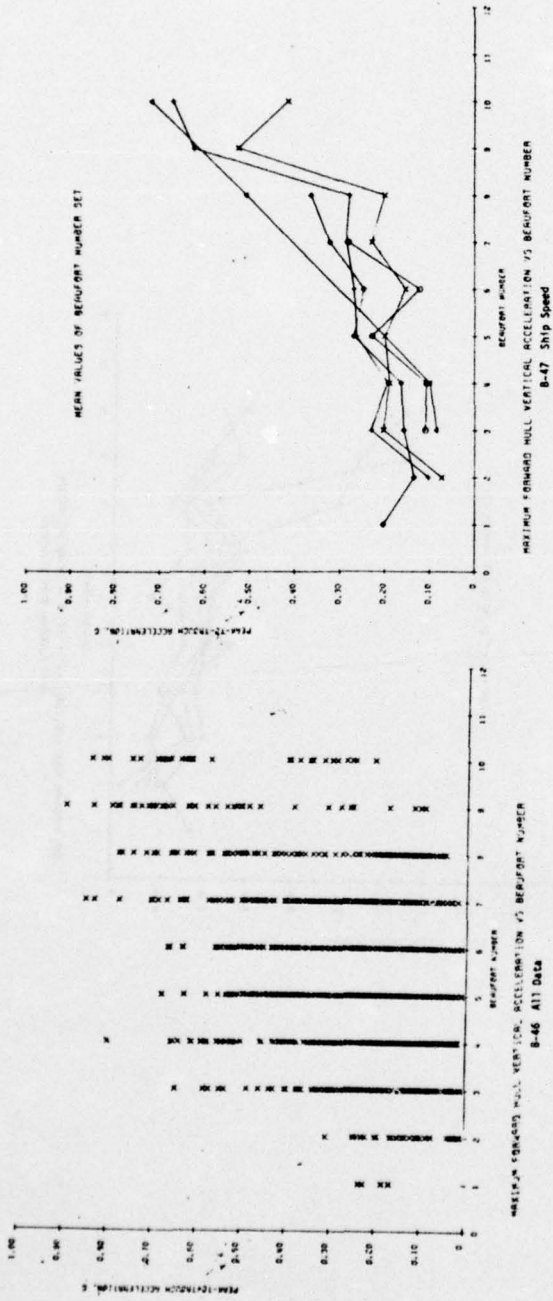




B-39 Relative Wave Direction







RMS LONGITUDINAL VERTICAL BENDING STRESS VS BEAUFORT NUMBER

SHIP SPEED BETWEEN 1.0 AND 15.0		PLOT SYMBOL OCTAGONAL		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	23	3455.	3488.	477.
5	10	2211.	2371.	856.
6	12	3216.	3355.	957.
7	36	2478.	2496.	300.
8	0			
9	0			
10	0			
11	0			
12	0			

III

SHIP SPEED BETWEEN 15.0 AND 20.0		PLOT SYMBOL TRIANGLE		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	4	856.	856.	35.
5	0	1192.	1193.	64.
6	0			
7	0			
8	8	4420.	4432.	130.
9	0			
10	4	5689.	5695.	266.
11	0			
12	0			

SHIP SPEED BETWEEN 20.0 AND 25.0		PLOT SYMBOL PLUS		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	56	1372.	1389.	216.
4	155	2560.	2768.	1051.
5	139	1919.	2182.	1039.
6	77	2473.	2781.	1272.
7	40	2332.	2494.	884.
8	78	3189.	3605.	1681.
9	12	5508.	5847.	1962.
10	12	6213.	6279.	903.
11	0	7575.	7636.	964.
12	0			

SHIP SPEED BETWEEN 25.0 AND 30.0		PLOT SYMBOL X		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	16	604.	832.	572.
3	80	1744.	1929.	823.
4	162	1907.	2263.	1220.
5	176	1947.	2288.	1200.
6	83	1741.	1889.	712.
7	74	2142.	2268.	744.
8	52	2969.	3319.	1484.
9	31	5064.	5363.	1766.
10	20	4002.	4249.	1427.
11	0			
12	0			

SHIP SPEED BETWEEN 30.0 AND 35.0		PLOT SYMBOL DIAMOND		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4	851.	852.	40.
2	22	1121.	1319.	684.
3	48	1713.	1289.	456.
4	84	1397.	1518.	594.
5	90	1887.	1972.	572.
6	126	1750.	1997.	963.
7	87	2265.	2504.	1068.
8	16	2572.	2872.	1278.
9	0			
10	0			
11	0			
12	0			

RMS LONGITUDINAL VERTICAL BENDING STRESS VS BEAUFORT NUMBER

RELATIVE WAVE DIRECTION BETWEEN 0,0 AND 31,0 PLOT SYMBOL OCTAGONAL

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	16	1372,	1551,	723,
3	48	2312,	2370,	519,
4	87	1839,	2209,	1215,
5	68	1951,	2286,	1113,
6	57	2069,	2406,	1227,
7	20	3131,	3165,	561,
8	8	3958,	4306,	1694,
9	16	7115,	7181,	606,
10	16	6522,	6805,	1981,
11	0			
12	0			

IV

RELATIVE WAVE DIRECTION BETWEEN 31,0 AND 61,0 PLOT SYMBOL TRIANGLE

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	3	253,	257,	43,
3	24	1673,	1907,	916,
4	110	1111,	1321,	715,
5	75	1857,	1835,	786,
6	32	1810,	1937,	689,
7	50	2027,	2231,	932,
8	32	4755,	4886,	1124,
9	12	5301,	5377,	902,
10	8	6098,	6130,	620,
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 61,0 AND 121,0 PLOT SYMBOL PLUS

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	10	912,	1001,	543,
3	72	1849,	2158,	1112,
4	179	1612,	1933,	1067,
5	190	2010,	2241,	992,
6	128	1733,	1939,	870,
7	108	3090,	3170,	1346,
8	35	2915,	3621,	2470,
9	8	3215,	3263,	563,
10	8	2771,	2818,	510,
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 121,0 AND 151,0 PLOT SYMBOL X

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	12	653,	686,	215,
3	45	1476,	1716,	876,
4	96	2176,	2406,	1025,
5	92	2598,	2980,	1460,
6	52	2161,	2341,	902,
7	47	3068,	3726,	2114,
8	67	4959,	5386,	2109,
9	0			
10	4	4597,	4623,	493,
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 151,0 AND 180,0 PLOT SYMBOL DIAMOND

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	1499,	1502,	102,
3	20	2283,	2551,	1139,
4	42	1985,	2199,	947,
5	28	3064,	3315,	1266,
6	20	1555,	1786,	803,
7	52	2668,	2589,	777,
8	12	3559,	3676,	932,
9	7	4052,	4081,	686,
10	0			
11	0			
12	0			

MAXIMUM LONGITUDINAL VERTICAL BENDING STRESS VS BEAUFORT NUMBER

SHIP SPEED BETWEEN 1.0 AND 15.0		PLOT SYMBOL OCTAGONAL		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	23	4763.	6801.	722.
5	16	4692.	5001.	1899.
6	12	7255.	7582.	2204.
7	36	5003.	5039.	402.
8	0	9722.	9844.	1543.
9	0			
10	0			
11	0			
12	0			

SHIP SPEED BETWEEN 15.0 AND 20.0		PLOT SYMBOL TRIANGLE		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	4	1757.	1760.	116.
5	0	2640.	2691.	925.
6	0			
7	0			
8	0			
9	0	10950.	11045.	1587.
10	4	14559.	14617.	1303.
11	0			
12	0			

SHIP SPEED BETWEEN 20.0 AND 25.0		PLOT SYMBOL PLUS		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	56	3034.	3074.	495.
4	155	5589.	4062.	2340.
5	155	4236.	4871.	2405.
6	139	5386.	5991.	2623.
7	77	5345.	5782.	2204.
8	80	6975.	7758.	3396.
9	76	11730.	12405.	4036.
10	12	15244.	15587.	3140.
11	12	17374.	17507.	2150.
12	0			

SHIP SPEED BETWEEN 25.0 AND 30.0		PLOT SYMBOL X		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	16	1488.	2016.	1364.
3	80	3979.	4463.	2021.
4	162	4518.	5500.	3136.
5	174	4473.	5275.	2795.
6	43	4036.	4426.	1823.
7	74	4798.	5645.	1848.
8	52	4746.	7754.	3788.
9	31	12404.	13162.	4400.
10	20	9697.	10323.	3540.
11	0			
12	0			

SHIP SPEED BETWEEN 30.0 AND 35.0		PLOT SYMBOL DIAMOND		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4	1903.	1905.	91.
2	22	2553.	3040.	1686.
3	48	2808.	2966.	955.
4	99	3169.	3471.	1417.
5	99	4287.	4501.	1372.
6	124	3493.	4587.	2258.
7	87	3304.	4015.	2029.
8	16	5946.	6720.	3132.
9	0			
10	0			
11	0			
12	0			

MAXIMUM LONGITUDINAL VERTICAL BENDING STRESS VS BEAUFORT NUMBER

RELATIVE WAVE DIRECTION BETWEEN 0,0 AND 31,0 PLOT SYMBOL OCTAGONAL

VI

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	10	3101.	3050.	1025.
3	40	5231.	5420.	1451.
4	87	4353.	5332.	3080.
5	40	4477.	5140.	2525.
6	57	4861.	5697.	2972.
7	20	7271.	7555.	1976.
8	0	9940.	10611.	4253.
9	14	17477.	17730.	1377.
10	14	15190.	15792.	4149.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 31,0 AND 61,0 PLOT SYMBOL TRIANGLE

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	3	505.	587.	56.
3	24	3770.	4200.	1997.
4	110	2403.	2961.	1612.
5	79	3747.	4220.	1959.
6	32	4020.	4308.	1543.
7	50	4609.	5092.	2106.
8	32	11755.	12210.	3302.
9	12	12692.	12802.	2422.
10	0	15081.	15229.	2116.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 61,0 AND 121,0 PLOT SYMBOL PLUS

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	10	2110.	2405.	1261.
3	72	4154.	4841.	2526.
4	179	3630.	4428.	2550.
5	190	4543.	5094.	2303.
6	120	4053.	4820.	2210.
7	108	4906.	7699.	3256.
8	35	6400.	6550.	5319.
9	4	8172.	8599.	2678.
10	0	6907.	7211.	1784.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 121,0 AND 151,0 PLOT SYMBOL X

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	12	1545.	1601.	420.
3	45	3173.	3594.	1080.
4	96	4910.	5510.	2504.
5	92	5760.	6395.	2993.
6	52	4745.	5109.	1694.
7	47	6529.	7699.	4081.
8	47	10109.	10690.	4071.
9	0			
10	4	10240.	10272.	736.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 151,0 AND 180,0 PLOT SYMBOL DIAMOND

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	3207.	3220.	391.
3	20	4801.	5356.	2201.
4	42	4410.	4979.	2303.
5	24	6042.	7410.	2845.
6	20	3203.	3698.	1010.
7	52	5520.	5766.	1666.
8	12	7598.	7790.	1743.
9	7	9667.	9605.	1658.
10	0			
11	0			
12	0			

RMS LONGITUDINAL HORIZONTAL BENDING STRESS VS BEAUFORT NUMBER

VII

SHIP SPEED BETWEEN 1,0 AND 15,0		PLOT SYMBOL OCTAGONAL		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	23	1006.	1620.	215.
5	16	1177.	1281.	507.
6	12	1926.	2000.	542.
7	36	1526.	1536.	174.
8	0			
9	0			
10	0			
11	0			
12	0			

SHIP SPEED BETWEEN 15,0 AND 20,0		PLOT SYMBOL TRIANGLE		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	4	520.	521.	29.
5	0	695.	696.	22.
6	0			
7	0			
8	0			
9	0	1740.	1750.	224.
10	4	1374.	1375.	63.
11	0			
12	0			

SHIP SPEED BETWEEN 20,0 AND 25,0		PLOT SYMBOL PLUS		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	8	729.	759.	211.
3	54	981.	1028.	309.
4	157	859.	910.	360.
5	138	1062.	1127.	370.
6	75	1103.	1200.	473.
7	79	1375.	1440.	546.
8	78	1796.	1833.	364.
9	12	1531.	1575.	366.
10	12	1600.	1603.	101.
11	0			
12	0			

SHIP SPEED BETWEEN 25,0 AND 30,0		PLOT SYMBOL X		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	16	325.	401.	235.
3	79	714.	808.	377.
4	90	765.	861.	395.
5	171	793.	899.	403.
6	42	866.	932.	308.
7	74	1204.	1286.	450.
8	92	1265.	1316.	360.
9	31	1736.	1766.	321.
10	20	1566.	1617.	316.
11	0			
12	0			

SHIP SPEED BETWEEN 30,0 AND 35,0		PLOT SYMBOL DIAMOND		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4	653.	660.	95.
2	22	475.	504.	160.
3	47	637.	665.	190.
4	100	640.	702.	268.
5	90	991.	1019.	240.
6	125	863.	936.	367.
7	87	1008.	1036.	237.
8	14	1297.	1366.	489.
9	0			
10	0			
11	0			
12	0			

RMS LONGITUDINAL HORIZONTAL BENDING STRESS VS BEAUFORT NUMBER

VIII

RELATIVE WAVE DIRECTION BETWEEN 0.0 AND 31.0 PLOT SYMBOL OCTAGO

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4	653.	660.	95.
2	20	595.	450.	216.
3	48	708.	787.	344.
4	88	629.	705.	319.
5	71	758.	846.	378.
6	58	786.	859.	428.
7	23	1314.	1380.	425.
8	20	1376.	1450.	457.
9	16	1730.	1775.	399.
10	16	1537.	1550.	200.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 31.0 AND 61.0 PLOT SYMBOL TRIANGLE

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	113.	114.	15.
3	23	773.	815.	260.
4	108	554.	685.	403.
5	72	750.	798.	271.
6	32	911.	970.	334.
7	88	980.	1067.	422.
8	32	1765.	1801.	362.
9	12	1618.	1639.	259.
10	8	1450.	1453.	94.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 61.0 AND 121.0 PLOT SYMBOL PLUS

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	10	427.	480.	219.
3	70	805.	904.	410.
4	179	708.	786.	340.
5	189	1003.	1110.	477.
6	128	956.	1045.	420.
7	108	1663.	1808.	709.
8	55	1335.	1450.	564.
9	8	1799.	1818.	262.
10	8	1502.	1520.	229.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 121.0 AND 151.0 PLOT SYMBOL X

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	12	467.	495.	162.
3	47	600.	640.	223.
4	96	977.	1045.	422.
5	91	1111.	1214.	489.
6	52	1097.	1212.	516.
7	49	1372.	1469.	520.
8	67	1437.	1678.	371.
9	0			
10	4	2054.	2058.	131.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 151.0 AND 180.0 PLOT SYMBOL DIAMOND

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0	927.	931.	91.
3	20	1147.	1245.	533.
4	45	1058.	1150.	451.
5	24	1352.	1371.	229.
6	20	1023.	1132.	485.
7	52	1124.	1162.	293.
8	12	1553.	1565.	194.
9	7	1530.	1572.	361.
10	0			
11	0			
12	0			

MAXIMUM LONGITUDINAL HORIZONTAL BENDING STRESS VS BEAUFORT NUMBER

IX

SHIP SPEED BETWEEN 1,0 AND 15,0		PLOT SYMBOL OCTAGONAL		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	8	3520.	3552.	478.
4	23	2548.	2738.	1001.
5	16	4221.	4403.	1253.
6	12	3318.	3554.	510.
7	36	5324.	5393.	858.
8	0			
9	0			
10	0			
11	0			
12	0			

SHIP SPEED BETWEEN 15,0 AND 20,0		PLOT SYMBOL TRIANGLE		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	8	1154.	1155.	62.
4	4	1530.	1533.	93.
5	0			
6	0			
7	0			
8	0	4193.	4297.	943.
9	0			
10	4	2932.	2933.	43.
11	0			
12	0			

SHIP SPEED BETWEEN 20,0 AND 25,0		PLOT SYMBOL PLUS		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	8	1554.	1598.	370.
3	54	2248.	2378.	773.
4	157	1481.	2044.	800.
5	138	2371.	2536.	900.
6	75	2479.	2686.	1033.
7	79	3033.	3252.	1173.
8	78	3853.	3927.	780.
9	12	3061.	3579.	913.
10	12	3584.	3599.	326.
11	0			
12	0			

SHIP SPEED BETWEEN 25,0 AND 30,0		PLOT SYMBOL X		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	16	792.	921.	471.
3	79	1645.	1873.	895.
4	161	1715.	1933.	891.
5	171	1781.	1999.	908.
6	42	2000.	2157.	808.
7	74	2641.	2849.	1018.
8	52	2866.	2977.	805.
9	31	4087.	4170.	829.
10	20	3771.	3892.	964.
11	0			
12	0			

SHIP SPEED BETWEEN 30,0 AND 35,0		PLOT SYMBOL DIAMOND		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4	1709.	1835.	670.
2	22	1116.	1213.	475.
3	47	1417.	1480.	426.
4	100	1429.	1569.	648.
5	90	2175.	2265.	634.
6	125	1986.	2139.	848.
7	87	2298.	2376.	612.
8	16	2978.	3239.	1278.
9	0			
10	0			
11	0			
12	0			

MAXIMUM LONGITUDINAL HORIZONTAL BENDING STRESS VS BEAUFORT NUMBER

RELATIVE WAVE DIRECTION BETWEEN 0.0 AND 31.0 PLOT SYMBOL OCTAGONAL X

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4	1709.	1835.	670.
2	70	903.	1006.	443.
3	48	1687.	1888.	847.
4	88	1402.	1579.	776.
5	71	1685.	1894.	865.
6	58	1737.	1989.	969.
7	23	3043.	3275.	1070.
8	20	3218.	3342.	1059.
9	16	3997.	4119.	999.
10	16	3540.	3575.	496.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 31.0 AND 61.0 PLOT SYMBOL TRIANGLE

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	293.	312.	107.
3	23	1681.	1768.	588.
4	108	1220.	1524.	902.
5	72	1697.	1820.	659.
6	32	2106.	2315.	817.
7	48	2267.	2477.	989.
8	32	3937.	4016.	806.
9	12	3769.	3823.	650.
10	8	3212.	3233.	370.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 61.0 AND 121.0 PLOT SYMBOL PLUS

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	10	932.	1046.	474.
3	70	1831.	2040.	987.
4	179	1599.	1759.	731.
5	189	2241.	2487.	1077.
6	128	2155.	2359.	960.
7	108	3640.	3950.	1532.
8	35	2997.	3255.	1219.
9	8	4355.	4414.	725.
10	8	3328.	3370.	527.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 121.0 AND 151.0 PLOT SYMBOL X

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	12	1225.	1315.	475.
3	47	1343.	1443.	528.
4	96	2195.	2411.	997.
5	91	2809.	2693.	1121.
6	52	2412.	2675.	1158.
7	49	3001.	3229.	1193.
8	47	3534.	3676.	811.
9	0			
10	4	5300.	5336.	622.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 151.0 AND 180.0 PLOT SYMBOL DIAMOND

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	1899.	1902.	162.
3	20	2547.	2806.	1177.
4	45	2302.	2480.	922.
5	24	2936.	2998.	608.
6	20	2244.	2300.	1101.
7	52	2469.	2541.	679.
8	12	3372.	3423.	589.
9	7	3460.	3544.	935.
10	0			
11	0			
12	0			

RMS MIDSHIP TORSIONAL SHEARING STRESS VS REAUFORT NUMBER

XI

SHIP SPEED BETWEEN 1.0 AND 15.0 PLOT SYMBOL OCTAGONAL

REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	22	503.	507.	68.
5	0	348.	372.	133.
6	12	471.	474.	60.
7	15	600.	600.	83.
8	0			
9	0			
10	0			
11	0			
12	0			

SHIP SPEED BETWEEN 15.0 AND 20.0 PLOT SYMBOL TRIANGLE

REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	8	192.	193.	17.
4	8	277.	277.	5.
5	0			
6	0			
7	0			
8	0	440.	455.	81.
9	0			
10	4	483.	480.	30.
11	0			
12	0			

SHIP SPEED BETWEEN 20.0 AND 25.0 PLOT SYMBOL PLUS

REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	8	275.	282.	70.
3	53	364.	370.	86.
4	156	410.	414.	122.
5	133	488.	489.	137.
6	75	508.	520.	151.
7	77	505.	508.	221.
8	78	753.	773.	172.
9	12	565.	570.	97.
10	12	603.	605.	51.
11	0			
12	0			

SHIP SPEED BETWEEN 25.0 AND 30.0 PLOT SYMBOL X

REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	16	120.	138.	67.
3	73	202.	205.	108.
4	159	270.	317.	159.
5	160	302.	363.	202.
6	45	361.	437.	207.
7	75	427.	477.	213.
8	52	509.	590.	250.
9	31	661.	675.	136.
10	20	980.	993.	98.
11	0			
12	0			

SHIP SPEED BETWEEN 30.0 AND 35.0 PLOT SYMBOL DIAMOND

REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4	211.	212.	13.
2	10	266.	280.	40.
3	88	250.	267.	69.
4	85	275.	297.	112.
5	90	378.	380.	80.
6	118	300.	370.	150.
7	78	360.	377.	78.
8	16	450.	482.	141.
9	0			
10	0			
11	0			
12	0			

UHS MIDSHIP TORSIONAL SHEARING STRESS VS BEAUFORT NUMBER

XII

RELATIVE WAVE DIRECTION BETWEEN 0,0 AND 31,0		0,0	31,0	PLOT SYMBOL OCTAGONAL	
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION	
1	4	211.	212.	13.	
2	12	117.	139.	76.	
3	45	204.	201.	96.	
4	79	250.	270.	104.	
5	70	311.	375.	176.	
6	61	321.	359.	162.	
7	23	597.	645.	329.	
8	26	729.	797.	321.	
9	16	639.	651.	125.	
10	16	586.	589.	64.	
11	0				
12	0				

RELATIVE WAVE DIRECTION BETWEEN 31,0 AND 61,0		31,0	61,0	PLOT SYMBOL TRIANGLE	
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION	
1	0				
2	0				
3	24	315.	321.	60.	
4	97	226.	250.	109.	
5	71	257.	275.	99.	
6	24	370.	405.	165.	
7	31	384.	378.	197.	
8	32	621.	629.	101.	
9	12	563.	571.	94.	
10	6	517.	519.	42.	
11	0				
12	0				

RELATIVE WAVE DIRECTION BETWEEN 61,0 AND 121,0		61,0	121,0	PLOT SYMBOL PLUS	
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION	
1	0				
2	4	245.	249.	52.	
3	61	283.	313.	133.	
4	177	263.	297.	137.	
5	178	372.	422.	200.	
6	127	369.	412.	183.	
7	110	522.	560.	202.	
8	35	500.	566.	266.	
9	8	749.	763.	148.	
10	8	552.	556.	74.	
11	0				
12	0				

RELATIVE WAVE DIRECTION BETWEEN 121,0 AND 151,0		121,0	151,0	PLOT SYMBOL X	
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION	
1	0				
2	12	197.	204.	53.	
3	45	257.	273.	92.	
4	96	353.	387.	158.	
5	91	392.	419.	148.	
6	52	392.	433.	182.	
7	48	523.	591.	276.	
8	67	745.	769.	188.	
9	0				
10	4	732.	755.	69.	
11	0				
12	0				

RELATIVE WAVE DIRECTION BETWEEN 151,0 AND 180,0		151,0	180,0	PLOT SYMBOL DIAMOND	
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION	
1	0				
2	4	337.	339.	35.	
3	20	349.	388.	149.	
4	48	358.	375.	111.	
5	24	458.	470.	108.	
6	20	331.	382.	147.	
7	41	459.	475.	120.	
8	12	756.	774.	165.	
9	7	618.	622.	97.	
10	0				
11	0				
12	0				

MAXIMUM MIDSHIP TORSIONAL SHEARING STRESS VS BEAUFORT NUMBER

XIII

SHIP SPEED BETWEEN 10.0 AND 15.0		PLOT SYMBOL OCTAGONAL		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	22	1110.	1130.	191.
5	16	1399.	1600.	450.
6	12	1665.	1881.	187.
7	39	1635.	1605.	313.
8	0			
9	0			
10	0			
11	0			
12	0			

SHIP SPEED BETWEEN 15.0 AND 20.0		PLOT SYMBOL TRIANGLE		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	0	436.	489.	107.
5	0	625.	624.	41.
6	0			
7	0			
8	0	1000.	1002.	296.
9	0			
10	4	1287.	1295.	108.
11	0			
12	0			

SHIP SPEED BETWEEN 20.0 AND 25.0		PLOT SYMBOL PLUS		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	53	562.	572.	105.
4	156	876.	922.	287.
5	113	718.	762.	309.
6	75	803.	852.	129.
7	77	960.	1001.	402.
8	78	1237.	1332.	492.
9	78	1631.	1672.	369.
10	12	1440.	1487.	238.
11	12	1581.	1598.	231.
12	0			

SHIP SPEED BETWEEN 25.0 AND 30.0		PLOT SYMBOL X		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	10	282.	339.	108.
3	73	584.	651.	208.
4	190	667.	749.	377.
5	169	735.	871.	468.
6	85	831.	986.	350.
7	73	970.	1073.	490.
8	92	1258.	1351.	690.
9	31	1565.	1597.	321.
10	20	1813.	1835.	251.
11	0			
12	0			

SHIP SPEED BETWEEN 30.0 AND 35.0		PLOT SYMBOL DIAMOND		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4	450.	651.	30.
2	10	560.	582.	130.
3	88	565.	697.	159.
4	85	601.	707.	200.
5	90	608.	900.	259.
6	118	770.	852.	350.
7	76	817.	867.	225.
8	16	1101.	1100.	420.
9	0			
10	0			
11	0			
12	0			

MAXIMUM MINSHIP TORSIONAL SHEARING STRESS VS BEAUFORT NUMBER

RELATIVE WAVE DIRECTION BETWEEN 0.0 AND 31.0 PLOT SYMBOL OCTAGONAL XIV

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4	450.	451.	34.
2	12	264.	330.	109.
3	45	631.	677.	240.
4	70	599.	665.	291.
5	70	809.	921.	439.
6	61	763.	850.	395.
7	21	1205.	1011.	605.
8	20	1558.	1672.	607.
9	16	1572.	1597.	282.
10	16	1474.	1490.	250.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 31.0 AND 61.0 PLOT SYMBOL TRIANGLE

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	24	725.	741.	152.
4	97	525.	597.	284.
5	71	642.	711.	305.
6	24	872.	955.	359.
7	31	808.	891.	375.
8	32	1559.	1571.	518.
9	12	1870.	1501.	240.
10	8	1362.	1396.	194.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 61.0 AND 121.0 PLOT SYMBOL PLUS

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	520.	526.	81.
3	63	694.	797.	387.
4	177	621.	711.	305.
5	174	865.	973.	445.
6	127	852.	955.	432.
7	110	1213.	1311.	499.
8	35	1172.	1301.	565.
9	8	1725.	1751.	299.
10	8	1313.	1326.	183.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 121.0 AND 151.0 PLOT SYMBOL X

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	12	488.	515.	177.
3	45	574.	621.	256.
4	96	803.	879.	358.
5	91	947.	1028.	400.
6	52	892.	999.	450.
7	48	1158.	1307.	606.
8	47	1592.	1644.	410.
9	0			
10	0			
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 151.0 AND 180.0 PLOT SYMBOL DIAMOND

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	646.	689.	81.
3	20	780.	847.	379.
4	48	842.	890.	289.
5	20	1058.	1091.	264.
6	20	734.	819.	348.
7	51	1034.	1070.	286.
8	12	1524.	1559.	327.
9	7	1348.	1378.	286.
10	0			
11	0			
12	0			

RMS EDWARD SHELLING STRESS-POINT VS REAUFORT NUMBER

XV

SHIP SPEED BETWEEN 1.0 AND 15.0 PLOT SYMBOL OCTAGONAL

REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	21	1852.	1864.	205.
5	16	1170.	1249.	437.
6	12	1609.	1663.	422.
7	36	1317.	1324.	133.
8	0			
9	0			
10	0			
11	0			
12	0			

SHIP SPEED BETWEEN 15.0 AND 20.0 PLOT SYMBOL TRIANGLE

REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	0	415.	436.	29.
5	0	603.	603.	23.
6	0			
7	0			
8	8	2398.	2403.	149.
9	0			
10	7	2015.	2150.	775.
11	0			
12	0			

SHIP SPEED BETWEEN 20.0 AND 25.0 PLOT SYMBOL PLUS

REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	56	619.	624.	85.
4	161	1245.	1302.	500.
5	180	968.	1092.	506.
6	180	1240.	1370.	578.
7	77	1141.	1267.	430.
8	77	1668.	1845.	784.
9	74	2719.	2850.	856.
10	12	3248.	3272.	395.
11	12	3868.	3917.	474.
12	0			

SHIP SPEED BETWEEN 25.0 AND 30.0 PLOT SYMBOL X

REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	16	363.	485.	322.
3	20	895.	994.	437.
4	167	1030.	1205.	608.
5	182	1037.	1224.	652.
6	83	841.	931.	358.
7	83	1269.	1384.	509.
8	51	1768.	1955.	815.
9	35	2472.	2822.	910.
10	20	2252.	2360.	704.
11	0			
12	0			

SHIP SPEED BETWEEN 30.0 AND 35.0 PLOT SYMBOL DIAMOND

REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	22	545.	586.	34.
3	48	578.	652.	310.
4	88	617.	652.	210.
5	102	687.	761.	327.
6	86	1011.	1084.	334.
7	117	852.	988.	446.
8	70	1124.	1249.	537.
9	15	1393.	1508.	578.
10	0			
11	0			
12	0			

RMS FORCE AND QUANTILE STRESS-POINT VS REAUPORT NUMBER

XVI

RELATIVE WAVE DIRECTION BETWEEN 0.0 AND 31.0 PLOT SYMBOL OCTAGONAL

REAUPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0	505.	500.	30.
2	20	609.	720.	392.
3	88	990.	1063.	379.
4	88	928.	1159.	660.
5	71	1060.	1216.	585.
6	61	1050.	1210.	598.
7	73	1500.	1627.	350.
8	20	1911.	2007.	592.
9	16	3080.	3702.	323.
10	16	1271.	3031.	1030.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 31.0 AND 61.0 PLOT SYMBOL TRIANGLE

REAUPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0	102.	104.	10.
3	20	753.	833.	357.
4	111	572.	470.	360.
5	80	780.	861.	347.
6	32	865.	896.	234.
7	51	903.	1105.	485.
8	32	2377.	2430.	500.
9	16	2452.	2502.	811.
10	11	2504.	2667.	917.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 61.0 AND 121.0 PLOT SYMBOL PLUS

REAUPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	10	401.	461.	229.
3	72	901.	1130.	570.
4	183	842.	1002.	504.
5	190	1082.	1199.	510.
6	127	805.	904.	429.
7	150	1500.	1702.	632.
8	33	1403.	1497.	1191.
9	8	2090.	2100.	421.
10	8	1741.	1760.	309.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 121.0 AND 151.0 PLOT SYMBOL X

REAUPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	12	382.	401.	122.
3	40	452.	706.	362.
4	97	1130.	1277.	587.
5	87	1324.	1525.	750.
6	44	1101.	1233.	400.
7	81	1710.	2013.	1001.
8	67	2501.	2720.	882.
9	0			
10	0	2090.	3010.	365.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 151.0 AND 180.0 PLOT SYMBOL DIAMOND

REAUPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0	652.	653.	37.
3	20	1270.	1420.	615.
4	49	1430.	1209.	620.
5	28	1411.	1609.	440.
6	20	922.	997.	380.
7	52	1521.	1570.	425.
8	12	2062.	2077.	206.
9	7	2405.	2525.	392.
10	0			
11	0			
12	0			

MAXIMUM FORWARD SHEARING STRESS-PART VS BEAUFORT NUMBER

XVII

SHIP SPEED BETWEEN 1.0 AND 15.0		PLOT SYMBOL OCTAGONAL		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	23	3701.	3721.	388.
5	16	2485.	2649.	918.
6	12	3769.	3913.	1050.
7	36	2816.	2836.	329.
8	0	4964.	5028.	800.
9	0			
10	0			
11	0			
12	0			

SHIP SPEED BETWEEN 15.0 AND 20.0		PLOT SYMBOL TRIANGLE		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	4	996.	1001.	118.
5	0	1415.	1425.	164.
6	0			
7	0			
8	0			
9	0	6037.	6105.	910.
10	7	5023.	5003.	1991.
11	0			
12	0			

SHIP SPEED BETWEEN 20.0 AND 25.0		PLOT SYMBOL PLUS		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	56	1353.	1372.	230.
4	0	2768.	2980.	1113.
5	141	2158.	2471.	1205.
6	140	2705.	3002.	1217.
7	77	2750.	2968.	1117.
8	77	3724.	4045.	1631.
9	78	5977.	6261.	1866.
10	12	7785.	7877.	1205.
11	12	9159.	9211.	1150.
12	0			

SHIP SPEED BETWEEN 25.0 AND 30.0		PLOT SYMBOL X		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	16	827.	1132.	776.
3	80	2081.	2345.	1081.
4	167	2308.	2624.	1676.
5	182	2333.	2774.	1900.
6	43	2042.	2240.	922.
7	43	2845.	3087.	1151.
8	51	3928.	4514.	2118.
9	35	6536.	7003.	2515.
10	20	5805.	5723.	1599.
11	0			
12	0			

SHIP SPEED BETWEEN 30.0 AND 35.0		PLOT SYMBOL DIAMOND		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4	1205.	1213.	133.
2	22	1271.	1479.	756.
3	88	1409.	1560.	584.
4	102	1500.	1759.	752.
5	86	2254.	2390.	795.
6	117	1949.	2270.	1000.
7	77	2454.	2684.	1365.
8	15	3369.	3670.	1516.
9	0			
10	0			
11	0			
12	0			

MAXIMUM FORWARD SHEARING STRESS-PORT VS BEAUFORT NUMBER

RELATIVE WAVE DIRECTION BETWEEN 0.0 AND 31.0 PLOT SYMBOL OCTAGONAL

XVIII

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4	1205.	1213.	133.
2	20	1372.	1674.	959.
3	48	2317.	2898.	922.
4	88	2251.	2790.	1647.
5	71	2430.	2758.	1308.
6	61	2821.	3008.	1881.
7	23	1802.	2797.	881.
8	20	4239.	4518.	1551.
9	16	9281.	9350.	1137.
10	16	7762.	8138.	2379.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 31.0 AND 61.0 PLOT SYMBOL TRIANGLE

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	233.	233.	13.
3	24	1742.	1924.	817.
4	111	1270.	1504.	806.
5	40	1800.	1986.	838.
6	32	1907.	2066.	528.
7	51	2330.	2588.	1126.
8	32	5078.	6218.	1710.
9	16	6071.	6318.	1916.
10	11	6161.	6571.	2285.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 61.0 AND 121.0 PLOT SYMBOL PLUS

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	10	841.	1026.	509.
3	72	2225.	2592.	1331.
4	183	1902.	2306.	1304.
5	190	2915.	2713.	1236.
6	127	2064.	2307.	1114.
7	118	3603.	3913.	1427.
8	31	3651.	4570.	2748.
9	11	4701.	4880.	1140.
10	8	4448.	4592.	935.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 121.0 AND 151.0 PLOT SYMBOL X

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	12	845.	883.	257.
3	48	1931.	1615.	740.
4	97	2529.	2847.	1307.
5	87	2922.	3341.	1621.
6	44	2516.	2708.	1001.
7	81	3601.	4225.	2210.
8	67	5387.	5692.	1838.
9	0			
10	0			
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 151.0 AND 180.0 PLOT SYMBOL DIAMOND

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	1578.	1390.	180.
3	20	2712.	3000.	1283.
4	49	2502.	2681.	1375.
5	28	3600.	3814.	1072.
6	28	2043.	2192.	795.
7	42	3805.	3537.	958.
8	12	4728.	4807.	871.
9	7	5631.	5767.	1267.
10	0			
11	0			
12	0			

RMS FORWARD SHEARING STRESS-STANDBARD VS BEAUFORT NUMBER

XIX

SHIP SPEED BETWEEN 1.0 AND 19.0		PLOT SYMBOL OCTAGONAL		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	23	1061.	1074.	208.
5	14	1101.	1245.	451.
6	12	1014.	1005.	504.
7	36	1473.	1474.	137.
8	0			
9	0			
10	0			
11	0			
12	0			

SHIP SPEED BETWEEN 19.0 AND 20.0		PLOT SYMBOL TRIANGLE		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	4	499.	491.	30.
5	0			
6	0			
7	0			
8	0			
9	0			
10	0			
11	0			
12	0			

SHIP SPEED BETWEEN 20.0 AND 25.0		PLOT SYMBOL PLUS		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	54	805.	827.	193.
4	158	1391.	1553.	603.
5	138	1012.	1173.	592.
6	76	1276.	1284.	760.
7	77	1189.	1247.	637.
8	78	1451.	1442.	1020.
9	78	3095.	3314.	1170.
10	12	3154.	3185.	426.
11	0			
12	0			

SHIP SPEED BETWEEN 25.0 AND 30.0		PLOT SYMBOL X		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	16	303.	380.	240.
3	70	887.	971.	390.
4	155	907.	1152.	577.
5	146	1914.	1176.	596.
6	43	1020.	1197.	505.
7	75	1021.	1080.	350.
8	52	1405.	1443.	702.
9	31	2522.	2727.	1039.
10	20	1899.	2037.	738.
11	0			
12	0			

SHIP SPEED BETWEEN 30.0 AND 35.0		PLOT SYMBOL DIAMOND		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	19	427.	470.	12.
4	19	648.	719.	311.
5	39	696.	728.	207.
6	68	815.	902.	380.
7	80	1004.	1125.	300.
8	96	1001.	1121.	504.
9	65	1305.	1461.	971.
10	12	1566.	1700.	661.
11	0			
12	0			

RMS FORWARD HEADING STRESS-STANDARD VS BEAUFORT NUMBER

RELATIVE WAVE DIRECTION BETWEEN 0.0 AND 31.0 PLOT SYMBOL OCTAGONAL

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0	827.	828.	32.
2	12	336.	850.	269.
3	47	935.	1069.	432.
4	84	1075.	1206.	347.
5	63	1048.	1215.	578.
6	85	1246.	1382.	530.
7	23	1594.	1642.	386.
8	20	2012.	2110.	637.
9	16	3711.	3726.	340.
10	16	3178.	3308.	919.
11	0			
12	0			

XX

RELATIVE WAVE DIRECTION BETWEEN 31.0 AND 61.0 PLOT SYMBOL TRIANGLE

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	10	1810.	1205.	653.
4	58	701.	885.	539.
5	71	850.	926.	366.
6	10	867.	920.	304.
7	32	987.	1149.	589.
8	32	2436.	2535.	700.
9	12	2608.	2663.	575.
10	8	2884.	2905.	336.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 61.0 AND 121.0 PLOT SYMBOL PLUS

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	814.	858.	249.
3	55	1046.	1213.	615.
4	169	855.	1030.	572.
5	182	1067.	1194.	536.
6	127	985.	1082.	400.
7	110	1577.	1740.	782.
8	31	1696.	2273.	1519.
9	8	1416.	1455.	251.
10	8	1249.	1270.	230.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 121.0 AND 151.0 PLOT SYMBOL X

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	10	360.	391.	143.
3	46	847.	1003.	537.
4	91	1206.	1305.	500.
5	88	1498.	1688.	779.
6	46	1299.	1368.	628.
7	34	1867.	2258.	1254.
8	67	2760.	3026.	1241.
9	0			
10	4	2110.	2136.	337.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 151.0 AND 180.0 PLOT SYMBOL DIAMOND

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	973.	978.	93.
3	20	1113.	1232.	530.
4	47	1068.	1136.	386.
5	26	1509.	1727.	800.
6	8	1528.	1529.	129.
7	52	1345.	1403.	346.
8	12	1868.	1942.	658.
9	7	2018.	2024.	163.
10	0			
11	0			
12	0			

MAXIMUM SHEAR STRESS-STANDARD VS REAUFORT NUMBER

XXI

SHIP SPEED BETWEEN 1.0 AND 15.0		PLOT SYMBOL OCTAGONAL		
REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	21	3352.	3371.	355.
5	10	2804.	2859.	910.
6	16	4062.	4241.	1210.
7	12	5052.	5074.	367.
8	16	5169.	5230.	713.
9	0			
10	0			
11	0			
12	0			

SHIP SPEED BETWEEN 15.0 AND 20.0		PLOT SYMBOL TRIANGLE		
REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	0	1007.	1044.	60.
5	0	1257.	1239.	77.
6	0			
7	0			
8	0			
9	0	5251.	5311.	705.
10	0			
11	0	7508.	7577.	1047.
12	0			

SHIP SPEED BETWEEN 20.0 AND 25.0		PLOT SYMBOL PLUS		
REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	50	1052.	1090.	357.
4	150	2040.	2044.	1263.
5	150	2214.	2560.	1285.
6	130	2801.	3174.	1092.
7	70	2735.	2906.	1107.
8	77	3505.	4150.	2080.
9	70	6050.	7090.	2040.
10	12	7507.	7730.	1095.
11	12	8009.	8095.	1220.
12	0			

SHIP SPEED BETWEEN 25.0 AND 30.0		PLOT SYMBOL X		
REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	10	002.	000.	500.
3	70	2070.	2296.	902.
4	155	2300.	2812.	1000.
5	100	2331.	2710.	1300.
6	00	2300.	2600.	1250.
7	70	2357.	2607.	000.
8	52	3300.	3000.	1005.
9	31	6300.	6000.	2000.
10	20	4020.	4201.	1005.
11	0			
12	0			

SHIP SPEED BETWEEN 30.0 AND 35.0		PLOT SYMBOL DIAMOND		
REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	10	021.	020.	01.
4	00	1051.	1015.	709.
5	00	1502.	1000.	500.
6	00	1000.	2012.	091.
7	00	2050.	2550.	709.
8	00	2215.	2522.	1109.
9	00	3050.	3005.	1000.
10	00	3721.	4005.	1500.
11	0			
12	0			

MAXIMUM FORWARD SHEARING STRESS-STARBOARD VS REAPORT NUMBER

XXII

RELATIVE WAVE DIRECTION BETWEEN 0.0 AND 31.0 PLOT SYMBOL OCTAGONAL

REAPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4	821.	828.	81.
2	12	789.	984.	839.
3	47	2287.	2517.	1063.
4	60	2661.	3049.	1489.
5	63	2499.	2835.	1336.
6	45	2818.	3065.	1213.
7	21	1727.	1910.	1183.
8	20	4531.	4778.	1519.
9	16	9883.	9547.	1102.
10	16	7754.	8650.	2231.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 31.0 AND 61.0 PLOT SYMBOL TRIANGLE

REAPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	10	2110.	2070.	1184.
4	54	1542.	2074.	1265.
5	71	1946.	2165.	908.
6	10	1891.	1987.	608.
7	32	2292.	2645.	1360.
8	32	5954.	6256.	1921.
9	12	6308.	6874.	1866.
10	8	7581.	7651.	1032.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 61.0 AND 121.0 PLOT SYMBOL PLUS

REAPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	1808.	1921.	608.
3	54	2119.	2465.	1339.
4	149	1918.	2324.	1412.
5	142	2394.	2642.	1210.
6	127	2238.	2584.	1254.
7	110	3523.	3948.	1742.
8	31	5827.	6054.	3311.
9	8	5847.	5584.	841.
10	8	3401.	3588.	829.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 121.0 AND 151.0 PLOT SYMBOL X

REAPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	14	821.	877.	308.
3	86	1839.	2113.	1056.
4	91	2437.	2804.	1075.
5	88	1284.	1621.	1522.
6	44	2842.	3000.	966.
7	38	3879.	4539.	2157.
8	47	5690.	6224.	2521.
9	0			
10	4	3855.	4284.	601.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 151.0 AND 180.0 PLOT SYMBOL DIAMOND

REAPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	1921.	1927.	157.
3	20	2197.	2610.	1053.
4	47	2327.	2450.	456.
5	24	3364.	3783.	1730.
6	8	3177.	3408.	385.
7	42	2977.	3114.	915.
8	12	4167.	4430.	1505.
9	7	4862.	4942.	901.
10	0			
11	0			
12	0			

RMSE PEAK-TO-TROUGH ROLL ANGLE VS RAUFBORT NUMBER

XXIII

SHIP SPEED BETWEEN 1.0 AND 15.0		PLOT SYMBOL OCTAGONAL		
RAUFBORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	25	6898.	6805.	610.
5	16	9025.	8725.	1828.
6	16	7271.	7605.	2221.
7	19	4619.	4855.	385.
8	1A	7910.	8006.	1237.
9	0			
10	0			
11	0			
12	0			

SHIP SPEED BETWEEN 15.0 AND 20.0		PLOT SYMBOL TRIANGLE		
RAUFBORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	0			
5	0			
6	0			
7	0			
8	0			
9	0			
10	0			
11	0			
12	0			

SHIP SPEED BETWEEN 20.0 AND 25.0		PLOT SYMBOL PLUS		
RAUFBORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	54	2931.	2961.	429.
5	15A	3215.	3220.	181.
6	100			
7	77	5100.	5230.	950.
8	78			
9	7A	4101.	4100.	168.
10	0			
11	0			
12	0			

SHIP SPEED BETWEEN 25.0 AND 30.0		PLOT SYMBOL X		
RAUFBORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	1A	4210.	4331.	1016.
3	0			
4	54	6111.	6175.	1815.
5	15A	4001.	4200.	2233.
6	100	4281.	4770.	2365.
7	77	4500.	5200.	2550.
8	78	6567.	7256.	3091.
9	7A	9530.	9700.	2933.
10	12	4200.	4302.	928.
11	0			
12	0			

SHIP SPEED BETWEEN 30.0 AND 35.0		PLOT SYMBOL DIAMOND		
RAUFBORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	22	4722.	4767.	652.
3	0			
4	4A	3805.	4196.	1600.
5	0			
6	1A2	381A.	4191.	1606.
7	176	3083.	4690.	2080.
8	0			
9	90	6090.	6370.	1711.
10	126	4870.	5298.	2067.
11	0			
12	0			

RMS PEAK-TO-TROUGH ROLL ANGLE VS REPORT NUMBER

XXIV

RELATIVE WAVE DIRECTION BETWEEN 0.0 AND 31.0 PLOT SYMBOL OCTAGONAL

REPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4	4722.	4767.	692.
2	20	3110.	3523.	1654.
3	47	3004.	4050.	2151.
4	87	3064.	3662.	2003.
5	72	4552.	5370.	2644.
6	62	3510.	4902.	2951.
7	22	6974.	8161.	4235.
8	20	9404.	10807.	4960.
9	14	3705.	3805.	677.
10	14	4330.	4360.	344.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 31.0 AND 61.0 PLOT SYMBOL TRIANGLE

REPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	220.	450.	397.
3	24	4223.	4600.	1626.
4	111	3557.	4192.	2142.
5	74	3535.	3970.	1826.
6	32	4182.	4040.	1504.
7	41	4052.	4777.	1782.
8	17	5620.	5997.	1975.
9	12	4810.	4884.	390.
10	4	4195.	4196.	150.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 61.0 AND 121.0 PLOT SYMBOL PLUS

REPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4			
2	10	3280.	4080.	2361.
3	72	4410.	4284.	2405.
4	177	4140.	4750.	2204.
5	190	5711.	6361.	2800.
6	124	5034.	5502.	2219.
7	109	6504.	4856.	2154.
8	34	8175.	4934.	3408.
9	4	11540.	11797.	2450.
10	4	10500.	10753.	1695.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 121.0 AND 181.0 PLOT SYMBOL X

REPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	12	4049.	4086.	550.
3	48	4595.	4724.	1743.
4	98	6140.	4608.	2582.
5	92	6657.	7125.	2539.
6	52	6312.	6824.	2644.
7	49	7715.	4540.	3689.
8	67	10741.	10910.	1914.
9	0			
10	0	16397.	16440.	1500.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 181.0 AND 180.0 PLOT SYMBOL DIAMOND

REPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4			
2	4	5209.	9214.	257.
3	20	5502.	5824.	2412.
4	44	6327.	6605.	1880.
5	24	7532.	7750.	1854.
6	20	4071.	4121.	643.
7	52	7872.	8246.	2585.
8	12	10543.	10610.	2193.
9	7	12180.	12334.	1972.
10	0			
11	0			
12	0			

MAXIMUM PEAK-TO-TROUGH HULL ANGLE VS BEAUFORT NUMBER

SHIP SPEED BETWEEN 1.0 AND 15.0 PLOT SYMBOL OCTAGONAL XXV

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0	12273.	12456.	2132.
4	23	8738.	9617.	8016.
5	16	15032.	16138.	5870.
6	12	8242.	8340.	1271.
7	36	16922.	17463.	4313.
8	0			
9	0			
10	0			
11	0			
12	0			

SHIP SPEED BETWEEN 15.0 AND 20.0 PLOT SYMBOL TRIANGLE

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	8	4163.	4212.	646.
4	4	4552.	4639.	894.
5	0			
6	0			
7	0			
8	4	8521.	8762.	2043.
9	0			
10	4	7947.	8001.	923.
11	0			
12	0			

SHIP SPEED BETWEEN 20.0 AND 25.0 PLOT SYMBOL PLUS

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	6564.	6888.	2086.
3	55	10944.	11681.	4083.
4	156	8148.	9502.	4889.
5	100	9100.	10399.	5034.
6	77	7981.	9614.	5360.
7	78	11943.	13723.	6760.
8	78	17478.	18474.	5985.
9	12	7223.	7525.	2110.
10	12	7383.	7422.	754.
11	0			
12	0			

SHIP SPEED BETWEEN 25.0 AND 30.0 PLOT SYMBOL X

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	16	4872.	8010.	3520.
3	80	6790.	8276.	4731.
4	162	8873.	10548.	5703.
5	176	9461.	11516.	6566.
6	43	11107.	13244.	6896.
7	76	13938.	15535.	6862.
8	51	15880.	17359.	6998.
9	31	14507.	16273.	7373.
10	20	18117.	20588.	9781.
11	0			
12	0			

SHIP SPEED BETWEEN 30.0 AND 35.0 PLOT SYMBOL DIAMOND

BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	22	7438.	7627.	1689.
3	48	5970.	6706.	3053.
4	48	4512.	7143.	3194.
5	162	7527.	8764.	5237.
6	90	11523.	12148.	3848.
7	126	8802.	10000.	4747.
8	89	9771.	10681.	4314.
9	16	15133.	17309.	8401.
10	0			
11	0			
12	0			

MAXIMUM PEAK-TO-TROUGH ROLL ANGLE VS BEAUFORT NUMBER

XXVI

RELATIVE WAVE DIRECTION BETWEEN 0.0 AND 31.0		PLOT SYMBOL OCTAGONAL		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4	7458.	7627.	1649.
2	20	5011.	5908.	3122.
3	47	6870.	8079.	4071.
4	87	9026.	10804.	4026.
5	72	7701.	9518.	5593.
6	62	5893.	8361.	5931.
7	22	12227.	15009.	7703.
8	20	16801.	19096.	9077.
9	16	6916.	7114.	1669.
10	16	7670.	7722.	902.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 31.0 AND 61.0		PLOT SYMBOL TRIANGLE		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0	568.	1137.	988.
3	20	6978.	8022.	3058.
4	111	5771.	7311.	4449.
5	76	6128.	7228.	3819.
6	32	8079.	7678.	3201.
7	51	7690.	8602.	3035.
8	32	10413.	11187.	4034.
9	12	8626.	8702.	1148.
10	8	7760.	7810.	855.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 61.0 AND 121.0		PLOT SYMBOL PLUS		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	10	4824.	4286.	3047.
3	72	8003.	9502.	5123.
4	177	6821.	8120.	4738.
5	190	10440.	12037.	5090.
6	178	9134.	10558.	5295.
7	109	12854.	14035.	5635.
8	30	15318.	17251.	7050.
9	8	21510.	21950.	8377.
10	8	20782.	21003.	3827.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 121.0 AND 151.0		PLOT SYMBOL X		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	12	6870.	6883.	1068.
3	84	7408.	8208.	3536.
4	98	11119.	12207.	4133.
5	92	12380.	13470.	6133.
6	52	11516.	12810.	5611.
7	40	14702.	16507.	7507.
8	47	19935.	20350.	8133.
9	0			
10	8	32491.	33141.	3163.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 151.0 AND 180.0		PLOT SYMBOL DIAMOND		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	8	8527.	8570.	900.
2	8	9788.	10925.	4853.
3	20	12191.	13009.	4502.
4	44	14504.	15022.	3001.
5	20	6558.	6830.	1920.
6	20	15007.	16090.	8814.
7	12	20418.	20816.	8009.
8	7	21445.	21760.	3686.
9	0			
10	0			
11	0			
12	0			

RMS PITCH ANGLE VS BEAUFORT NUMBER

SHIP SPEED BETWEEN 10.0 AND 15.0		PLOT SYMBOL OCTAGONAL			XXVII
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION	
NO DATA POINTS					

SHIP SPEED BETWEEN 15.0 AND 20.0		PLOT SYMBOL TRIANGLE		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	0			
5	0			
6	0			
7	0			
8	0			
9	0			
10	4	1846.	1851.	142.
11	0			
12	0			

SHIP SPEED BETWEEN 20.0 AND 25.0		PLOT SYMBOL PLUS		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	0			
5	0			
6	0			
7	0			
8	0			
9	0	1765.	1767.	87.
10	12	1732.	1735.	108.
11	0			
12	0			

SHIP SPEED BETWEEN 25.0 AND 30.0		PLOT SYMBOL X		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	4	667.	690.	65.
4	8	837.	851.	149.
5	20	800.	809.	310.
6	0			
7	16	651.	671.	155.
8	12	725.	809.	358.
9	11	935.	1042.	480.
10	11	588.	594.	86.
11	0			
12	0			

SHIP SPEED BETWEEN 30.0 AND 35.0		PLOT SYMBOL DIAMOND		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	4	791.	797.	92.
4	16	839.	872.	237.
5	28	855.	890.	247.
6	28	808.	924.	448.
7	20	1225.	1285.	222.
8	8	1746.	1749.	108.
9	0			
10	0			
11	0			
12	0			

RMS PITCH ANGLE VS BEAUFORT NUMBER

RELATIVE WAVE DIRECTION BETWEEN 0.0 AND 31.0		PLOT SYMBOL OCTAGONAL		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	0	687.	690.	85.
5	0	648.	680.	84.
6	0	690.	701.	58.
7	0			
8	4	861.	884.	73.
9	4	1051.	1102.	448.
10	4	1765.	1767.	87.
11	0			
12	0			

XXVIII

RELATIVE WAVE DIRECTION BETWEEN 31.0 AND 61.0		PLOT SYMBOL TRIANGLE		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	0			
5	0			
6	0			
7	0	983.	1076.	439.
8	0	503.	507.	67.
9	0	680.	692.	86.
10	4	1746.	1749.	108.
11	4	1512.	1515.	95.
12	0			

RELATIVE WAVE DIRECTION BETWEEN 61.0 AND 121.0		PLOT SYMBOL PLUS		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	4	791.	797.	92.
5	12	973.	994.	203.
6	20	859.	877.	185.
7	20	617.	775.	469.
8	9	1293.	1385.	370.
9	0	450.	456.	30.
10	0			
11	0	580.	588.	99.
12	0			

RELATIVE WAVE DIRECTION BETWEEN 121.0 AND 151.0		PLOT SYMBOL X		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	0			
5	4	820.	825.	92.
6	16	821.	862.	243.
7	4	1172.	1186.	182.
8	0	1047.	1072.	101.
9	0			
10	3	610.	610.	20.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 151.0 AND 180.0		PLOT SYMBOL DIAMOND		
BEAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	0			
5	0			
6	0			
7	0	678.	679.	28.
8	0			
9	27	701.	748.	251.
10	4	671.	672.	37.
11	7	605.	628.	168.
12	0			

MAXIMUM PITCH ANGLE VS BEAUFORT NUMBER

SHIP SPEED BETWEEN 1.0 AND 15.0 PLOT SYMBOL OCTAGONAL
 BEAUFORT NO. OF DATA MEAN RMS ST. DEVIATION
 NUMBER POINTS

XIX

NO DATA POINTS

SHIP SPEED BETWEEN 15.0 AND 20.0 PLOT SYMBOL TRIANGLE
 BEAUFORT NO. OF DATA MEAN RMS ST. DEVIATION
 NUMBER POINTS

1	0			
2	0			
3	0			
4	0			
5	0			
6	0			
7	0			
8	0			
9	0			
10	4	4049.	4058.	270.
11	0			
12	0			

SHIP SPEED BETWEEN 20.0 AND 25.0 PLOT SYMBOL PLUS
 BEAUFORT NO. OF DATA MEAN RMS ST. DEVIATION
 NUMBER POINTS

1	0			
2	0			
3	0			
4	0			
5	0			
6	0			
7	0			
8	0			
9	4	4395.	4414.	440.
10	12	4005.	4018.	324.
11	0			
12	0			

SHIP SPEED BETWEEN 25.0 AND 30.0 PLOT SYMBOL X
 BEAUFORT NO. OF DATA MEAN RMS ST. DEVIATION
 NUMBER POINTS

1	0			
2	0			
3	4	1657.	1680.	281.
4	8	2050.	2084.	377.
5	2	1917.	2018.	631.
6	0			
7	16	1458.	1493.	321.
8	12	1704.	1867.	763.
9	11	2479.	2641.	1081.
10	11	1351.	1343.	176.
11	0			
12	0			

SHIP SPEED BETWEEN 30.0 AND 35.0 PLOT SYMBOL DIAMOND
 BEAUFORT NO. OF DATA MEAN RMS ST. DEVIATION
 NUMBER POINTS

1	0			
2	0			
3	4	1422.	1427.	138.
4	16	1833.	1907.	714.
5	28	1954.	2016.	494.
6	28	1893.	2057.	880.
7	20	2489.	2446.	521.
8	8	3760.	3768.	234.
9	0			
10	0			
11	0			
12	0			

MAXIMUM PITCH ANGLE VS REAUFORT NUMBER

RELATIVE WAVE DIRECTION BETWEEN 0.0 AND 31.0 PLOT SYMBOL OCTAGONAL XXX

REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	4	1457.	1680.	281.
4	8	1490.	1516.	376.
5	4	1370.	1371.	49.
6	0			
7	4	1944.	1971.	326.
8	4	2102.	2508.	1002.
9	4	4395.	4016.	400.
10	8	4026.	4038.	320.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 31.0 AND 61.0 PLOT SYMBOL TRIANGLE

REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	0			
5	8	2267.	2394.	768.
6	4	1824.	1426.	81.
7	4	1328.	1335.	137.
8	4	3760.	3768.	239.
9	4	3680.	3700.	287.
10	4	4006.	4018.	303.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 61.0 AND 121.0 PLOT SYMBOL PLUS

REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	4	1622.	1627.	138.
4	12	2202.	2303.	679.
5	20	1819.	1870.	433.
6	20	1481.	1774.	977.
7	9	3023.	3127.	800.
8	9	1210.	1214.	99.
9	0			
10	8	1370.	1383.	193.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 121.0 AND 151.0 PLOT SYMBOL X

REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	4	1726.	1727.	70.
5	14	1982.	2054.	439.
6	8	2561.	2580.	316.
7	4	2621.	2640.	310.
8	0			
9	0			
10	3	1303.	1306.	89.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 151.0 AND 180.0 PLOT SYMBOL DIAMOND

REAUFORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4			
2	0			
3	0			
4	0			
5	4	1480.	1480.	363.
6	0			
7	27	1626.	1724.	571.
8	6	1558.	1579.	280.
9	7	1478.	1771.	566.
10	0			
11	0			
12	0			

RMS FORWARD HULL VERTICAL ACCELERATION VS HEADPOST NUMBER

SHIP SPEED BETWEEN 10.0 AND 15.0 PLOT SYMBOL OCTAGONAL

HEADPOST NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	7	494.	496.	42.
4	22	471.	506.	186.
5	15	1023.	1071.	314.
6	12	533.	534.	37.
7	35	1291.	1323.	287.
8	0			
9	0			
10	0			
11	0			
12	0			

XXXI

SHIP SPEED BETWEEN 15.0 AND 20.0 PLOT SYMBOL TRIANGLE

HEADPOST NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	8	308.	371.	50.
4	0	391.	391.	25.
5	0			
6	0			
7	0			
8	8	2365.	2371.	169.
9	0			
10	4	3404.	3407.	152.
11	0			
12	0			

SHIP SPEED BETWEEN 20.0 AND 25.0 PLOT SYMBOL PLUS

HEADPOST NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	8	457.	464.	77.
3	40	999.	1276.	676.
4	138	850.	1051.	620.
5	119	1189.	1298.	565.
6	72	1168.	1351.	643.
7	67	1265.	1367.	564.
8	67	1238.	1506.	658.
9	12	2865.	2910.	382.
10	12	3217.	3221.	171.
11	0			
12	0			

SHIP SPEED BETWEEN 25.0 AND 30.0 PLOT SYMBOL X

HEADPOST NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	16	355.	547.	417.
3	78	886.	1032.	530.
4	157	824.	1076.	692.
5	144	882.	1087.	637.
6	83	654.	704.	296.
7	33	902.	1093.	480.
8	51	847.	1091.	688.
9	31	2248.	2488.	1064.
10	20	1740.	1974.	631.
11	0			
12	0			

SHIP SPEED BETWEEN 30.0 AND 35.0 PLOT SYMBOL DIAMOND

HEADPOST NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0	880.	890.	90.
2	22	479.	645.	280.
3	47	692.	802.	406.
4	100	724.	865.	474.
5	89	1187.	1335.	610.
6	121	1069.	1317.	769.
7	87	1386.	1652.	662.
8	15	1670.	1949.	1042.
9	0			
10	0			
11	0			
12	0			

RMS FORWARD HULL VERTICAL ACCELERATION VS HEADPORT NUMBER

RELATIVE WAVE DIRECTION BETWEEN 0.0 AND 31.0 PLOT SYMBOL OCTAGONAL

HEADPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4	889.	890.	40.
2	20	600.	735.	625.
3	46	1037.	1133.	656.
4	83	933.	1202.	758.
5	67	1062.	1233.	676.
6	57	1101.	1376.	828.
7	22	1481.	1559.	667.
8	20	1039.	1429.	881.
9	16	1257.	1268.	517.
10	16	2902.	2989.	717.
11	0			
12	0			

XXXII

RELATIVE WAVE DIRECTION BETWEEN 31.0 AND 61.0 PLOT SYMBOL TRIANGLE

HEADPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	98.	101.	24.
3	20	836.	931.	410.
4	109	539.	732.	496.
5	74	808.	1000.	590.
6	32	748.	787.	249.
7	48	1079.	1278.	684.
8	32	2498.	2559.	562.
9	12	2751.	2767.	299.
10	6	1247.	1253.	190.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 61.0 AND 121.0 PLOT SYMBOL PLUS

HEADPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	10	284.	304.	122.
3	64	920.	1151.	692.
4	144	783.	1015.	646.
5	183	1050.	1231.	682.
6	125	926.	1098.	590.
7	108	1400.	1543.	649.
8	30	838.	928.	402.
9	8	1428.	1517.	510.
10	8	1219.	1254.	368.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 121.0 AND 151.0 PLOT SYMBOL X

HEADPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	12	424.	476.	211.
3	43	430.	440.	163.
4	91	629.	736.	382.
5	78	1016.	1159.	557.
6	50	1102.	1393.	653.
7	38	1197.	1323.	563.
8	59	660.	783.	342.
9	0			
10	4	1470.	1470.	21.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 151.0 AND 180.0 PLOT SYMBOL DIAMOND

HEADPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	924.	525.	43.
3	19	480.	505.	159.
4	45	741.	863.	442.
5	16	1306.	1365.	397.
6	20	829.	437.	78.
7	50	850.	1017.	556.
8	12	802.	808.	276.
9	7	1119.	1327.	714.
10	0			
11	0			
12	0			

MAXIMUM FORWARD HULL VERTICAL ACCELERATION VS REAPORT NUMBER

XXXIII

SHIP SPEED BETWEEN 1.0 AND 15.0 PLOT SYMBOL OCTAGONAL

REAPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	7	1101.	1123.	219.
4	22	1067.	1159.	451.
5	15	2281.	2403.	755.
6	12	1215.	1222.	134.
7	15	2809.	2876.	614.
8	0			
9	0			
10	0			
11	0			
12	0			

SHIP SPEED BETWEEN 15.0 AND 20.0 PLOT SYMBOL TRIANGLE

REAPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	0			
5	0			
6	0			
7	0			
8	0			
9	0			
10	0			
11	0			
12	0			

SHIP SPEED BETWEEN 20.0 AND 25.0 PLOT SYMBOL PLUS

REAPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0			
3	0			
4	138	1032.	1046.	171.
5	119	2309.	2705.	1485.
6	72	1932.	2397.	1418.
7	67	2632.	2919.	1262.
8	72	2887.	3062.	1070.
9	67	2849.	3130.	1308.
10	67	2777.	3350.	1875.
11	12	6241.	4303.	881.
12	12	6717.	6741.	567.

SHIP SPEED BETWEEN 25.0 AND 30.0 PLOT SYMBOL X

REAPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	14	750.	1188.	937.
3	78	2038.	2403.	1277.
4	157	1801.	2085.	1615.
5	180	2001.	2080.	1468.
6	84	1536.	1702.	821.
7	73	2288.	2561.	1158.
8	61	1904.	2036.	1724.
9	31	5254.	5709.	2333.
10	20	4105.	4531.	1830.
11	0			
12	0			

SHIP SPEED BETWEEN 30.0 AND 35.0 PLOT SYMBOL DIAMOND

REAPORT NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	22	2051.	2050.	279.
3	47	1384.	1535.	723.
4	47	1583.	1816.	889.
5	100	1431.	1950.	1069.
6	89	2491.	3015.	1340.
7	121	2454.	3012.	1781.
8	87	3215.	3819.	2061.
9	15	3627.	4153.	2021.
10	0			
11	0			
12	0			

MAXIMUM FORWARD HULL VERTICAL ACCELERATION VS HEADPOST NUMBER

XXXIV

RELATIVE WAVE DIRECTION BETWEEN 0.0 AND 31.0 PLOT SYMBOL OCTAGONAL

HEADPOST NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	4	2031.	2090.	279.
2	20	1364.	1717.	1044.
3	46	2335.	2555.	1016.
4	83	2128.	2734.	1723.
5	67	2429.	2649.	1489.
6	57	2478.	3106.	1877.
7	22	3414.	3621.	1256.
8	20	2378.	4242.	2184.
9	14	7296.	7337.	756.
10	16	6201.	6307.	1531.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 31.0 AND 61.0 PLOT SYMBOL TRIANGLE

HEADPOST NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	4	165.	179.	71.
3	20	1891.	2104.	925.
4	109	1701.	1641.	1118.
5	74	1812.	2230.	1300.
6	32	1767.	1899.	695.
7	28	2454.	2903.	1545.
8	32	4501.	4637.	1232.
9	12	6031.	6078.	755.
10	8	6986.	6997.	623.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 61.0 AND 121.0 PLOT SYMBOL PLUS

HEADPOST NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	16	468.	733.	302.
3	60	2123.	2638.	1565.
4	160	1815.	2363.	1513.
5	183	2375.	2747.	1457.
6	124	2160.	2545.	1383.
7	104	3174.	3436.	1540.
8	30	1933.	2140.	919.
9	8	3557.	3713.	1064.
10	8	2893.	2937.	508.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 121.0 AND 151.0 PLOT SYMBOL X

HEADPOST NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	12	942.	1067.	502.
3	43	1050.	1204.	668.
4	91	1430.	1694.	908.
5	74	2275.	2575.	1205.
6	50	2482.	3114.	1883.
7	34	2450.	3179.	1410.
8	50	1504.	1718.	822.
9	6			
10	6	3507.	3523.	333.
11	0			
12	0			

RELATIVE WAVE DIRECTION BETWEEN 151.0 AND 180.0 PLOT SYMBOL DIAMOND

HEADPOST NUMBER	NO. OF DATA POINTS	MEAN	RMS	ST. DEVIATION
1	0			
2	0	1117.	1132.	181.
3	10	1079.	1153.	406.
4	45	1649.	1923.	948.
5	14	2094.	3109.	966.
6	24	964.	993.	217.
7	40	1965.	2348.	1318.
8	12	1424.	1926.	615.
9	7	2881.	3516.	2005.
10	6			
11	0			
12	0			

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) #		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report contains data, with appropriate evaluation and discussions, collected during the first season on board the S.S. SEA-LAND McLEAN. Data collection began with westbound Voyage 1 on October 8, 1972 and terminated with the eastbound passage of Voyage 12 on April 5, 1973. A total of 80 data tapes were recorded containing in excess of 50,000 separate data intervals from more than 100 transducers. → next page		

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20. ABSTRACT (Cont'd).

→ Discussions include a description of the digitized data, comparisons of stresses with sea state, simultaneous response data from all transducers during selected portions of a rough voyage, and a consideration of torsional responses.



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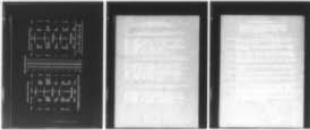
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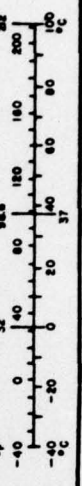
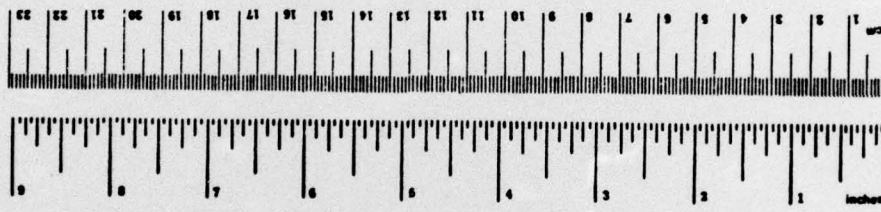


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METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures			Approximate Conversions from Metric Measures			
Symbol	When You Know	Multiply by	To Find	Symbol	When You Know	
LENGTH						
in	inches	2.5	centimeters	cm	centimeters	
ft	feet	30	centimeters	cm	centimeters	
yd	yards	0.9	meters	m	meters	
mi	miles	1.6	kilometers	km	kilometers	
AREA						
sq ft	square feet	0.09	square centimeters	cm ²	square centimeters	
sq yd	square yards	0.8	square meters	m ²	square meters	
sq mi	square miles	2.6	square kilometers	km ²	square kilometers	
ac	acres	0.4	hectares	ha	hectares (10,000 m ²)	
MASS (weight)						
oz	ounces	28	grams	g	grams	
lb	pounds	0.45	kilograms	kg	kilograms	
sh	short tons (2000 lb)	0.9	tonnes	t	tonnes (1000 kg)	
VOLUME						
teaspoon	teaspoons	5	milliliters	ml	milliliters	
fluid ounce	fluid ounces	30	milliliters	ml	milliliters	
cup	cups	0.24	liters	l	liters	
quart	quarts	0.95	liters	l	liters	
gallon	gallons	3.8	liters	l	liters	
cu ft	cubic feet	0.03	cubic meters	m ³	cubic meters	
cu yd	cubic yards	0.76	cubic meters	m ³	cubic meters	
TEMPERATURE (exact)						
Fahrenheit temperature	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C	Celsius temperature	
Celsius temperature	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F	Fahrenheit temperature	



* 1 m = 2.54 (exactly). For other exact conversions and more detailed tables, see NIST Mon. Publ. 285, Unit of Weight and Measure, Price \$2.25, SD Catalog No. C13.10-286.

