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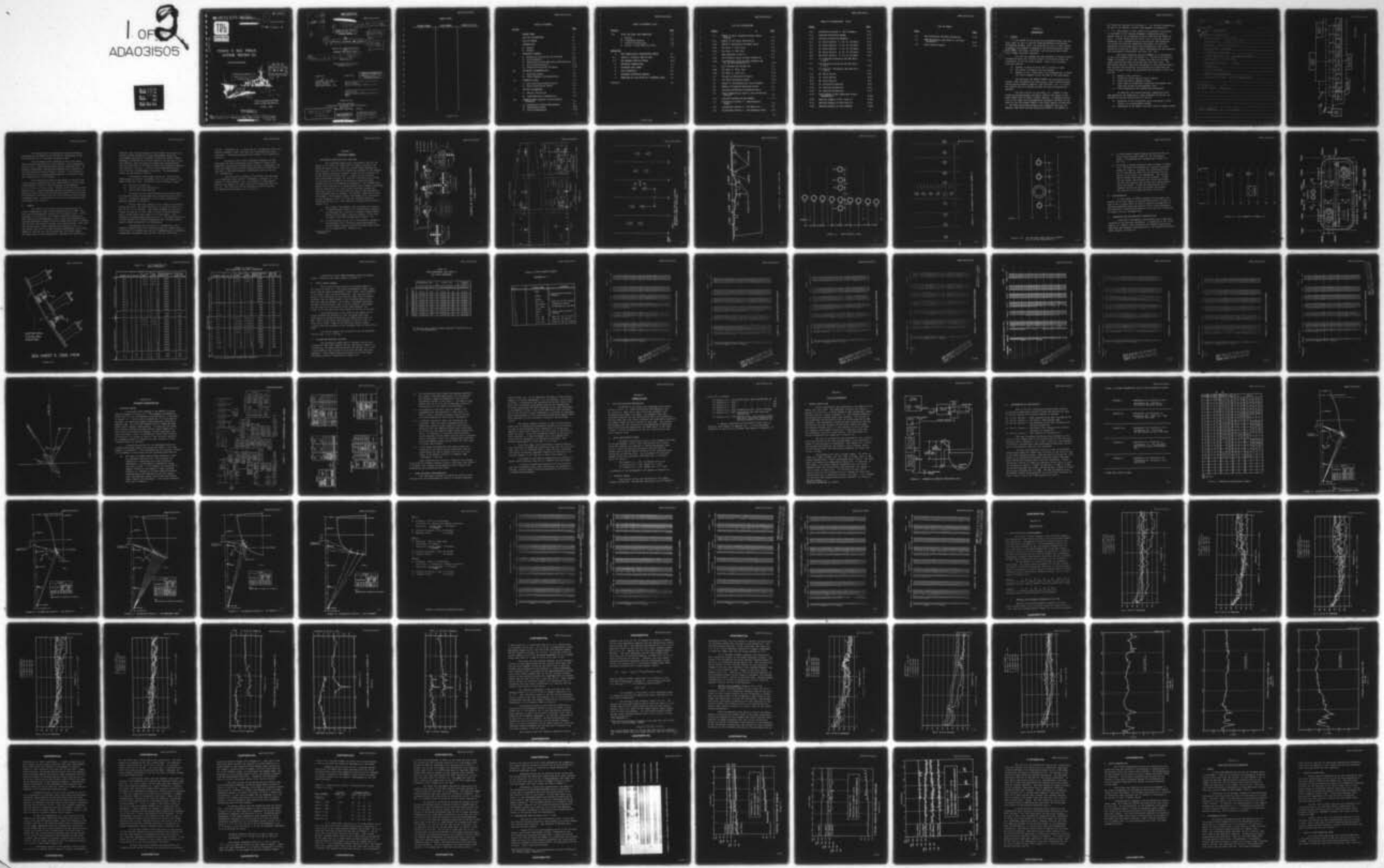

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# PURVIS II SEA TRIALS INTERIM REPORT (U)

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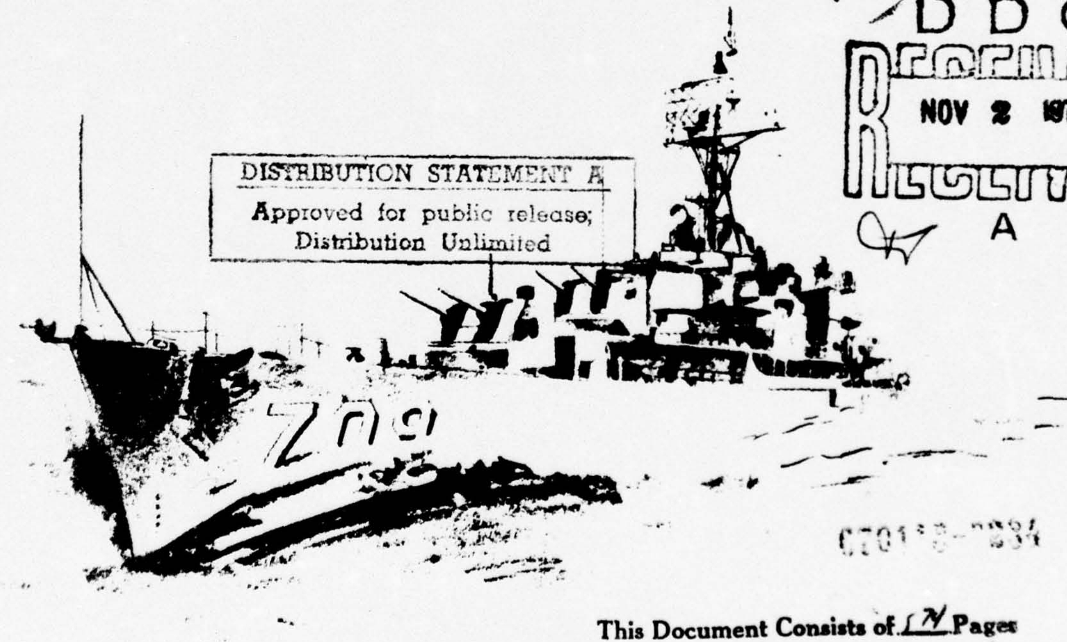

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# PURVIS II SEA TRIALS,

## INTERIM REPORT (U)

(11) Oct 66

~~by~~

(10) N. Nesenoff, R. Newman ~~and~~ D. Chase

(12) 274p.

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# SECTION I

## INTRODUCTION

### A. GENERAL

The PURVIS II Sea Trials were performed during June and July, 1966, as part of the C/P (Conformal/Planar) Array Sonar Development Program, under the direction of the U.S. Navy, Bureau of Ships. The program is managed by the Navy Electronics Laboratory (NEL), San Diego, California, and the David Taylor Model Basin (DTMB) Carderock, Maryland.

next page

The sea test program has been designed to acquire desired information which will provide a basis for critical design considerations on the C/P Array Program. Some of the principal decisions include:

a) Whether to build an array with or without a dome
b) The choice of element size and spacing
c) Whether to use a sonar keel, pod configuration, or mount the array integrally with the ship in the same manner.

The destroyer USS PURVIS (DD709) was instrumented with various sonar hydrophones and electronics, ship's motion sensors, motion picture cameras, magnetic tape recorders, etc., to record the desired data in a medium suitable for data processing and analysis.

The first series of sea trials (i.e., PURVIS I) were conducted during February and March, 1966 in the Tongue of the Ocean (TOTO) area of Andros Island, Bahamas. A complete description of the sonar and instrumentation equipment installed on the ship for the C/P Program PURVIS I Sea Trials appears in Reference 1. The data processing equipment and techniques used for the magnetic tape data recorded during both PURVIS I and PURVIS II

Sea Trials are described in Reference 2. An initial documentation of some of the PURVIS I acoustic data appears in Reference 3.

cont.

The purpose of this report is to provide a description of the PURVIS II C/P Program equipment configuration and to present some of the preliminary acoustic data from the PURVIS II tests. A final report will be issued later containing computed parameters such a normalized cross-correlations and normalized cross-spectral densities (amplitude and phase) for selected hydrophone pairs during passive and transmission tests, noise spectra as a function of ship's speed, hydrophone size and location, strut-hydrophone transmission loss data, etc.

The basic shipboard system of PURVIS II is illustrated in the block diagram shown in Figure 1-1. The Sea Trial Director (DTMB) is located in the ship's bridge from where he can make visual observations while directing each sea trial "run". The TRG Console Operator supervises operations in the Recording Center. This includes the initiation and termination of operations for various equipment during the preparation and duration of each run, such as:

a) Magnetic tape recorders
b) "Fish-eye" stereo motion picture cameras
c) Bubble generators (Masker system)
d) Index lamp (to synchronize underwater photographs with tape data during the photographic runs)
e) Driver-amplifiers and transmitting hydrophones

In addition, the Console-Operator communicates with and supervises the operation of other shipboard facilities (as directed by the Sea Trial Director) such as:

a) Extension of the retractable strut containing a transmitter, to a predetermined length
b) Variations in the bubble flow rate from the masker system.

#2 * Destroyers
OK - 17/1 ~~17/1~~, 13/10

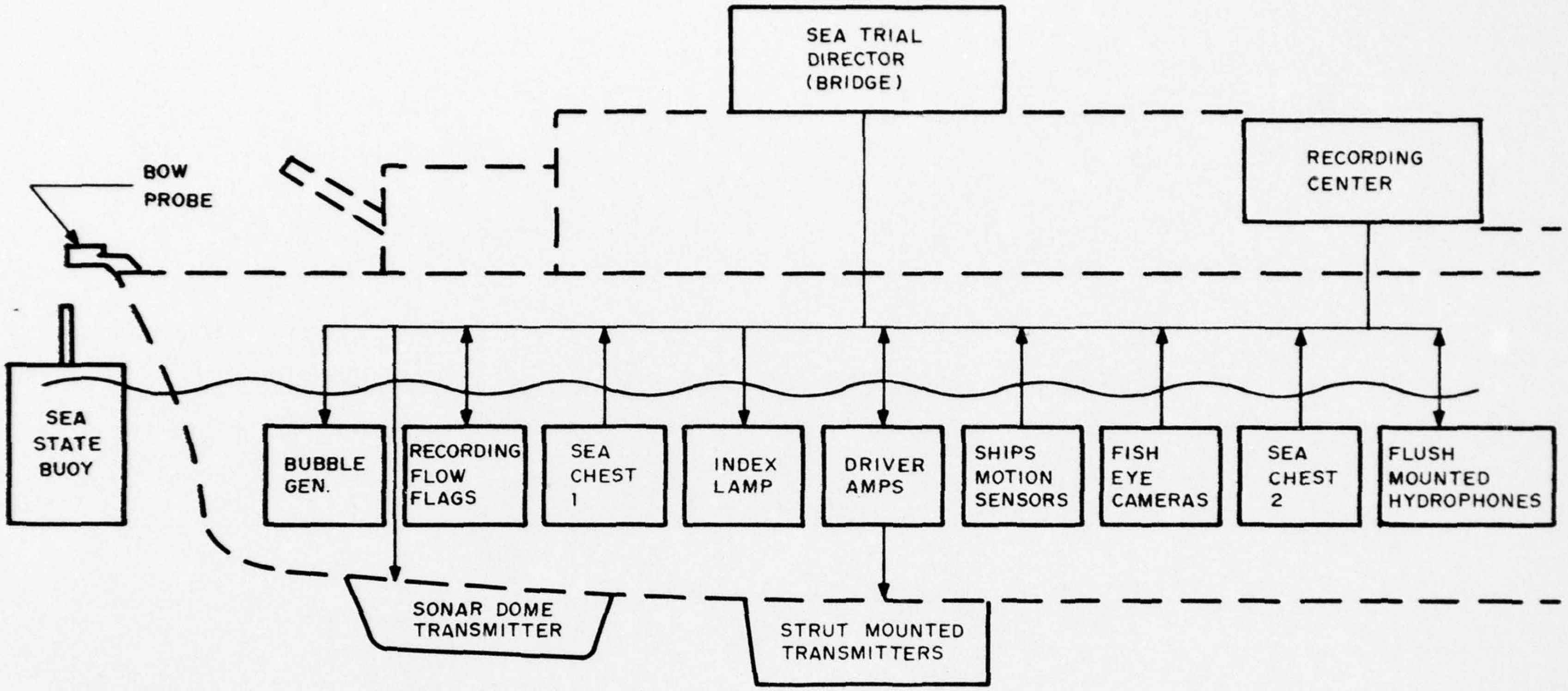
Descriptors [illegible]

* SEA TESTING
* #1 SONAR ARRAYS
DEVELOPMENT TESTS
CONFORMAL STRUCTURES
PLANAR STRUCTURES
ACOUSTIC DATA
HYDROPHONES
CONFIGURATION MANAGEMENT
PASSIVE SYSTEMS
TRANSMISSION LOSS
STRUTS
CAVITATION
RETRACTABLE
UNDERWATER PHOTOGRAPHY

Identifiers

* DD 709 VESSEL

Mod. abstract p. 1-1, 1-2



NOT TO SCALE

FIGURE 1-1 PURVIS II BASIC SHIPBOARD SYSTEM, BLOCK DIAGRAM

The signals from the hydrophones and accelerometers installed for the PURVIS II Sea Trials are transmitted to the Recording Center for recording on magnetic tape.

The hydrophones were installed in two of the three large Sea Chests previously used in PURVIS I, and flush-mounted in two arrays: High Frequency (HF) and Low Frequency (LF). In addition, individual flush-mounted elements were installed at selected locations between frames 42 and 88. A description of the transducers and instrumentation appears in Sections II and III, respectively, of this report.

Five calibration fixtures were added to the port side of the ship at positions which were approximately at the center (longitudinal) of each of the five groups of hydrophones (i.e., HF array, LF array, etc). During in-situ (overside) calibration tests, a boom containing an acoustic projector (J-9) was placed at each fixture, and the received signals from each group of hydrophones associated with the fixture position were recorded on magnetic tape. A description in the in-situ calibration operation appears in Section V.

## B. SUMMARY

The PURVIS II Sea Trials were performed during the period commencing on June 22 and ending on July 20, 1966. The runs were chronologically divided into two major series: Naval Architecture and Acoustic. The Naval Architecture Series was also known as the photographic series, since both shipboard and external underwater cameras were used during this series to obtain data on water and bubble flow over the forward portion of the ship for selected ship's speed, heading with respect to sea, etc. Free-divers were used to obtain external photographic data during PURVIS II, and the test area selected was off Bimini Island. The ocean floor in this location was relatively too shallow for acoustic runs, but was composed of very bright sand, which furnished an ideal background during photographic operations. Photographic operations frequently utilized the masker (bubble generator) system and an air hose placed in the bow wave to produce bubbles. Four recording flow flags and instrumentation were also installed on the ship's motion (low bandwidth) magnetic tape recorder. However, 3 of the 4 flow flags malfunctioned by the 2nd day of photographic operations. The photographic series was concluded on June 25.

The acoustic series began on June 27, when the USS PURVIS departed from Pt. Everglades, Fla. for the Tongue of the Ocean (TOTO) test area. The acoustic tests included 3 types:

a) Overside calibrations
b) Passive runs (No transmission)
c) Active runs (Transmission)

Overside (In-situ) calibrations were performed while the ship was located in the TOTO area, during the period July 6 - July 12. A complete description of the In-Situ calibration operation appears in Section V.

Passive runs were generally 2 or 3 minutes in duration. During these runs, the ship travelled at a speed of either 0, 5, 10, 15, 20, 25, or 30 knots. The ship's heading wrt sea (with respect to sea) was 0°, 90°, 180°, or 270° or was performing a turn by using either full rudder of 1/2 full rudder. Two different recording combinations were used: recording combination 1 which included all forward hydrophones, and recording combination 2, which included all aft hydrophones.

Transmission runs, using 3 or 4 transmitters, also included a passive portion of from 20 seconds to 1 minute prior to the start of transmission, and after transmission was terminated. Transmission frequencies were 1955 Hz, 2125 Hz, 2465 Hz and

2975 Hz. Transmitter No. 2, which was on a retractable strut, was usually extended 5 feet, with some runs occurring with shorter extensions. Transmission periods were usually 2 to 4 minutes in duration.

During the first week's operation, analysis of data indicated that the transmitting strut located at frame 58 was apparently cavitating at speeds above 20 knots. Accordingly, the strut was removed from the ship during the period between July 2 and July 5, limiting subsequent transmission tests to the use of 3 transmitters.

The final week of PURVIS II Sea Trials took the ship on a northbound course from Pt. Everglades to Newport, R.I., in search of "rough weather" (i.e., sea states of 3 and higher). However, the highest sea state encountered during the data run was "2". The last data run was recorded on July 20 and the USS PURVIS entered Newport, R.I. on July 21.

# SECTION II

## TRANSDUCER SUMMARY

### A. HYDROPHONE DESCRIPTION AND LOCATIONS

The Conformal/Planar Sonar installation used for the PURVIS II Sea Trials is illustrated in Figures 2-1a and 2-1b. During the month of May, 1966, in a Boston Naval Shipyard dry dock, the port side of the USS PURVIS was modified by the removal of all PURVIS I acoustic receivers located in the 3 special sea chests and selected hull areas.* As part of the C/P Array Sonar Development Program, the ship was retrofitted with 46 TRG 5" receivers and 10 DTMB FS-13 receivers, along with other special sonar and instrumentation equipments. The 10 DTMB hydrophones were installed in a special window made by GD/EB, containing various thicknesses of a visco elastic material between the fiber glass face of the window and the face of each hydrophone. Each hydrophone had two outputs: an acoustic signal and a vibration signal. The acoustic signal from element D1 is identified in this document as D1H, etc., and the vibration signal is identified as D1A, etc. The window was installed in Sea Chest 1. (Figure 2-2).

The 46 TRG 5" hydrophones were installed in 4 groups:

a) A "high frequency array" of 13 flush-mounted elements, 9 horizontal and 5 vertical (1 common), spaced approximately 10-1/2" apart, center-to-center, in the area of frames 15-20 (HF1 through HF13) (Figure 2-3).

b) A "low-frequency array" of 13 flush-mounted elements, 8 horizontals and 5 verticals spaced approximately 31-1/2" apart, center-to-center, between frames 48-60. (LF-1 through LF-13) (Figure 2-4).

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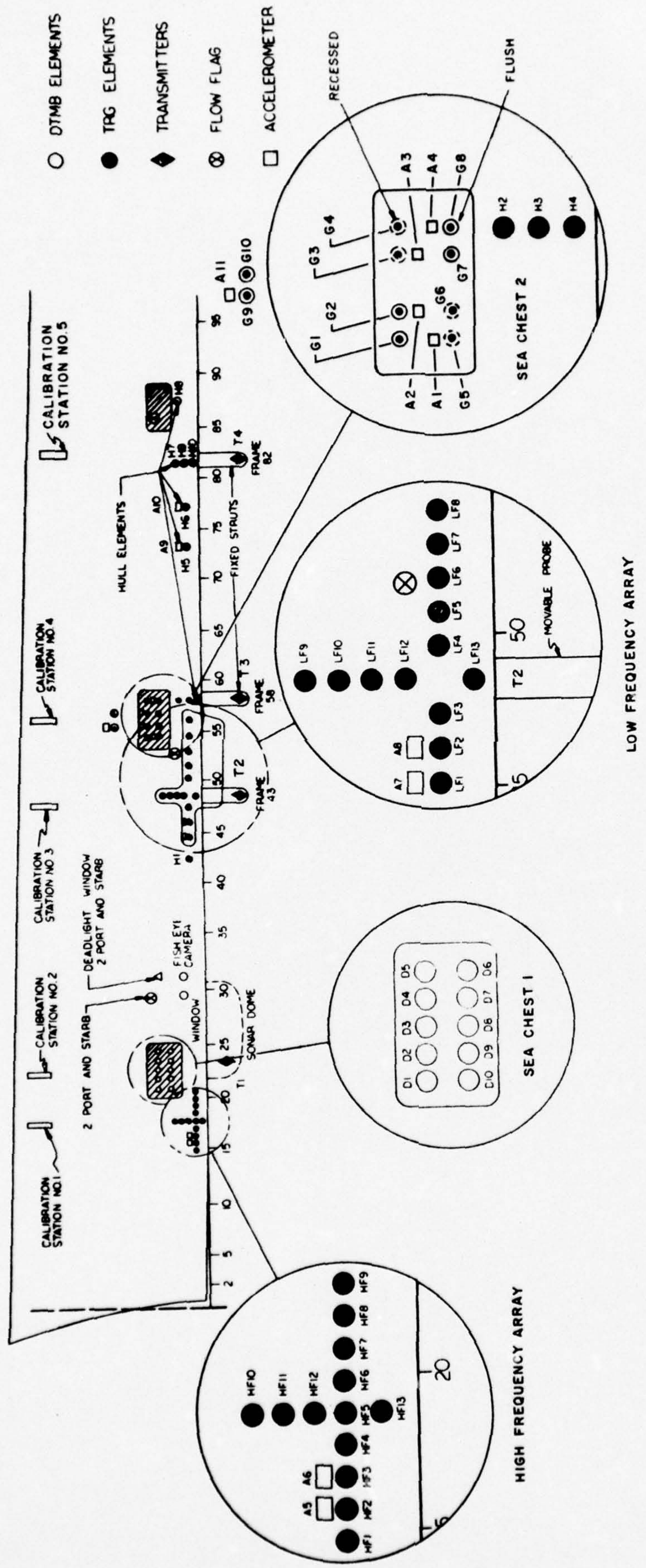
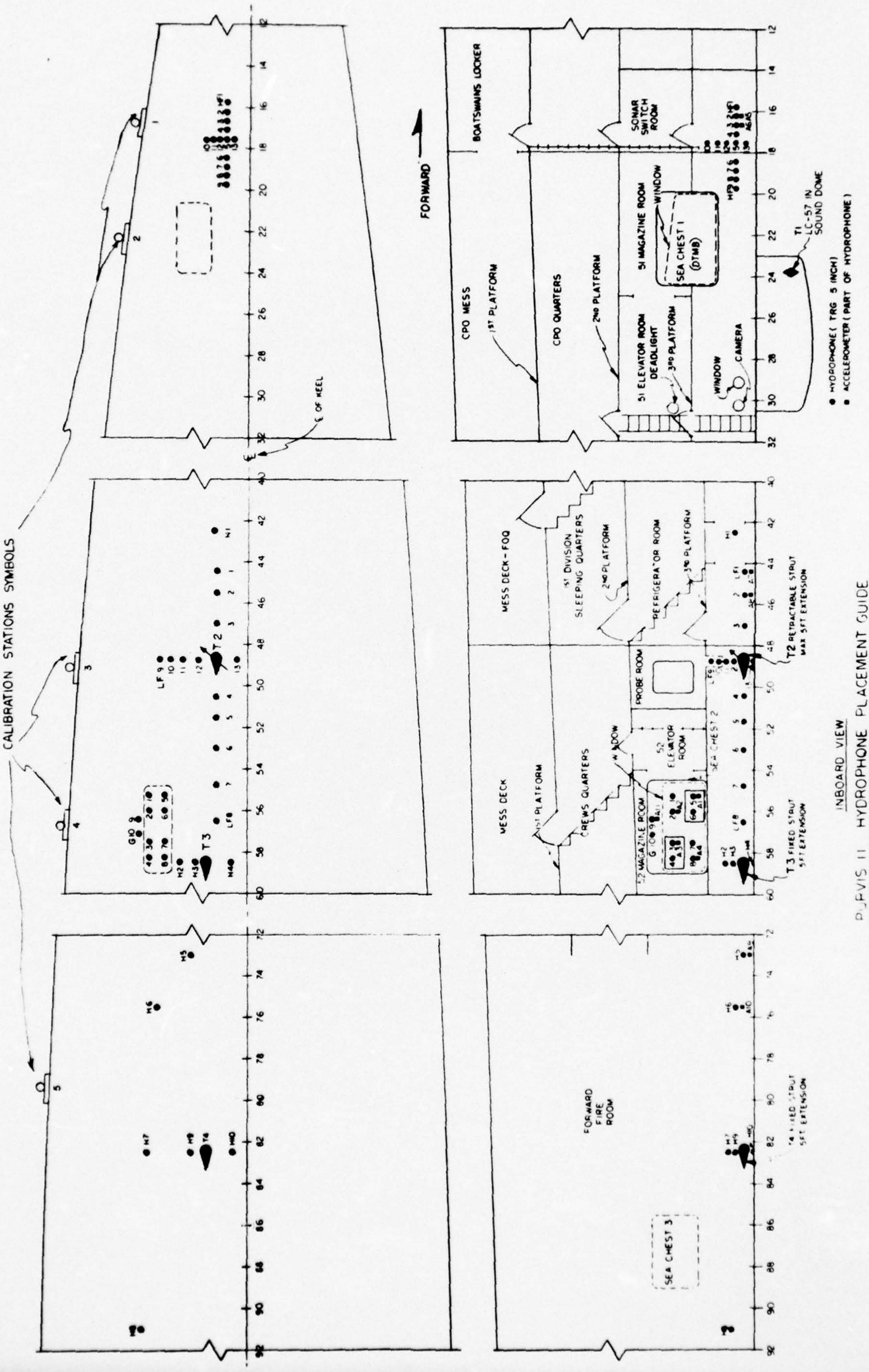
* Reference 1



PURVIS II C/P SONAR INSTALLATION

FIGURE 2-1a.

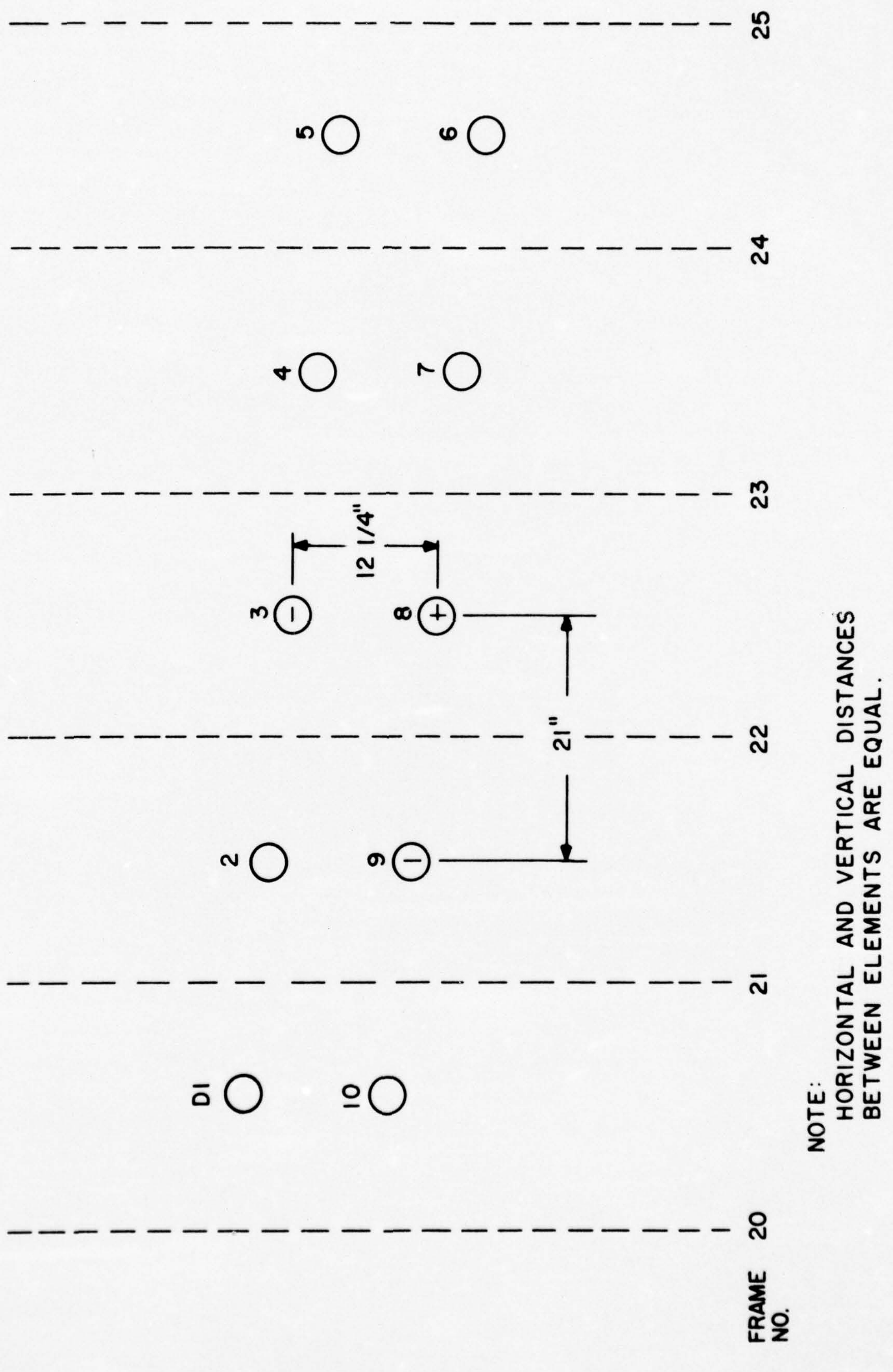


NOTE: T3 REMOVED PRIOR TO START OF IN-SITU CALIBRATION

INBOARD VIEW

PURVIS II HYDROPHONE PLACEMENT GUIDE

FIGURE 2-1b.



NOTE:
HORIZONTAL AND VERTICAL DISTANCES BETWEEN ELEMENTS ARE EQUAL.

FIGURE 2-2a. SEA CHEST 1 FRONT VIEW

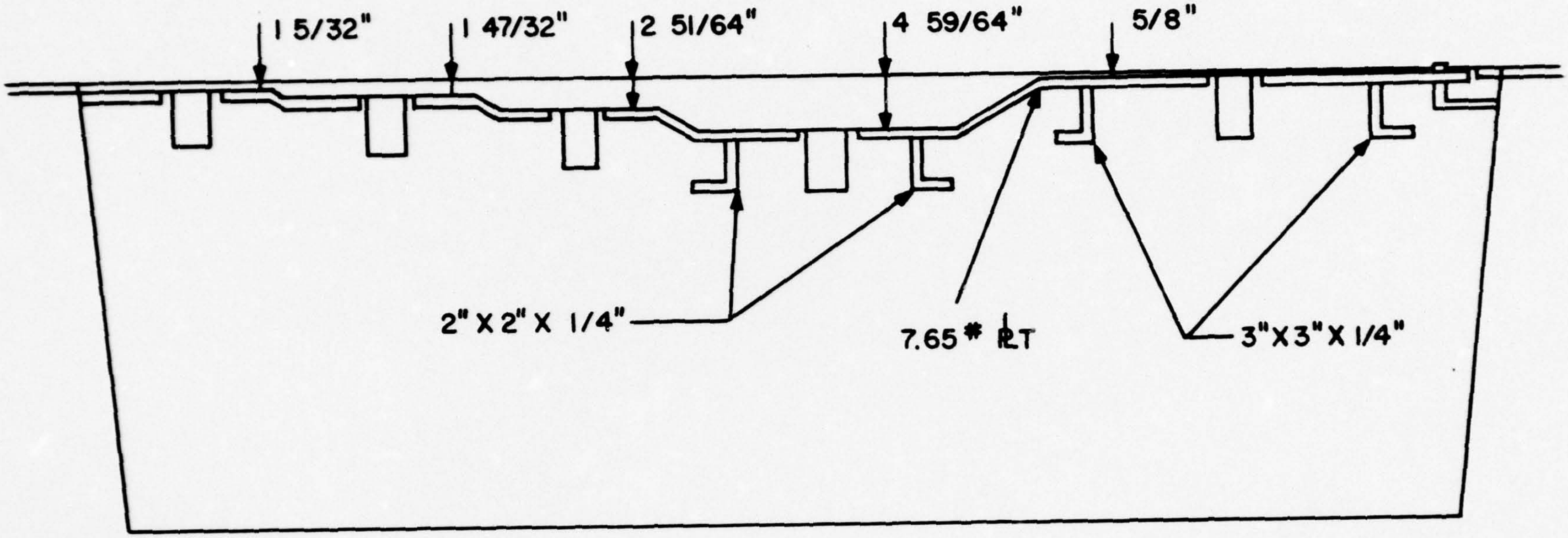


FIGURE 2-2b.   SEA CHEST 1, SIDE VIEW

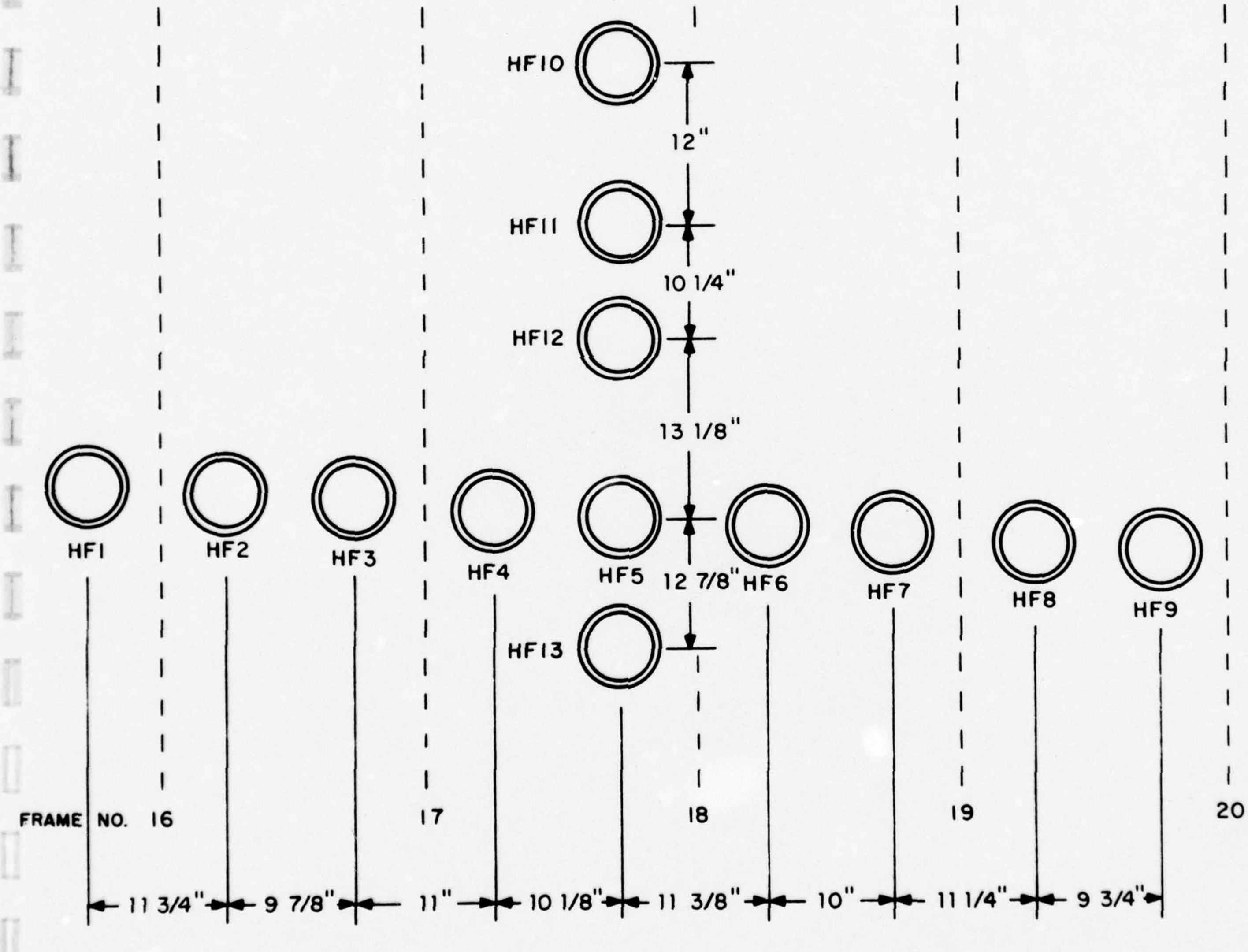


FIGURE 2-3. HIGH FREQUENCY ARRAY

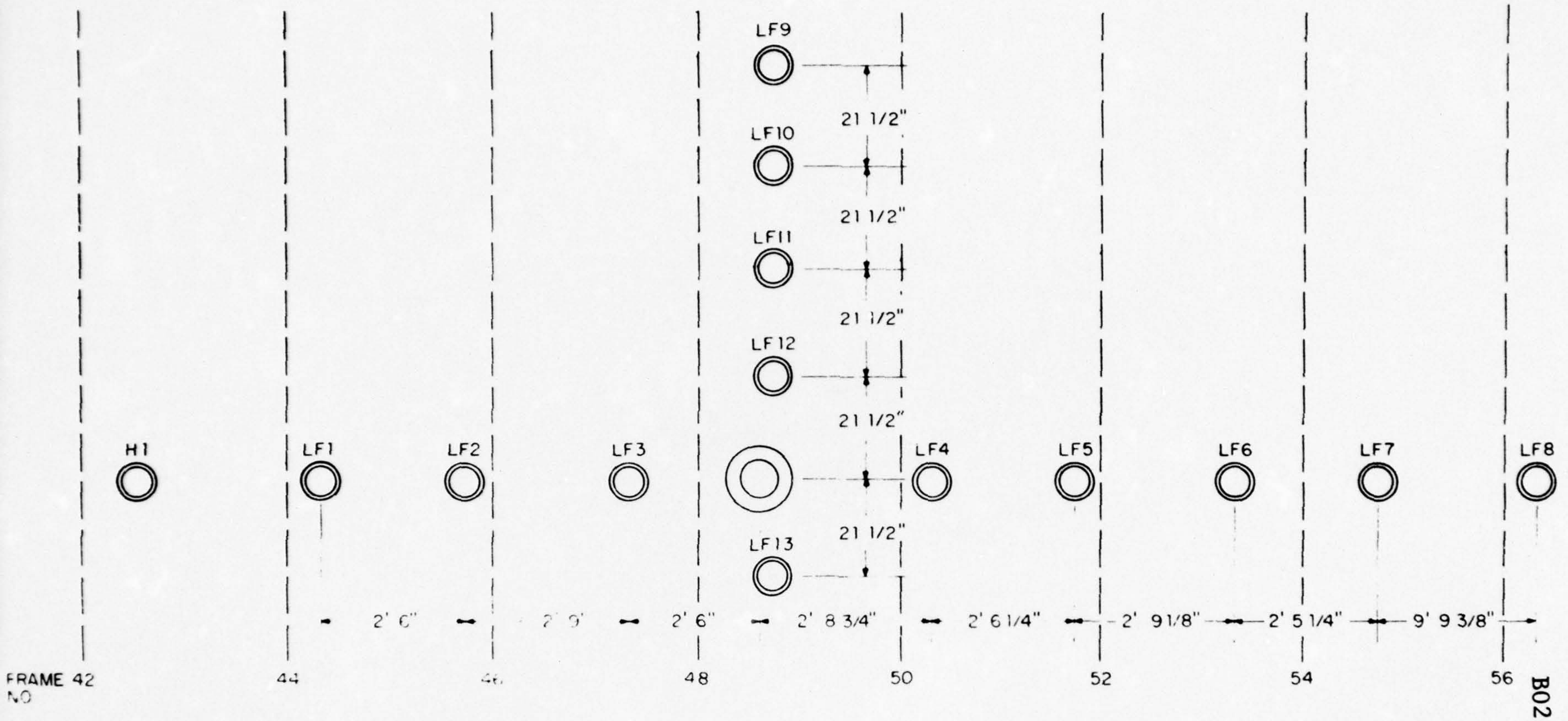


FIGURE 2-4a. LOW FREQUENCY ARRAY AND HULL ELEMENT H1

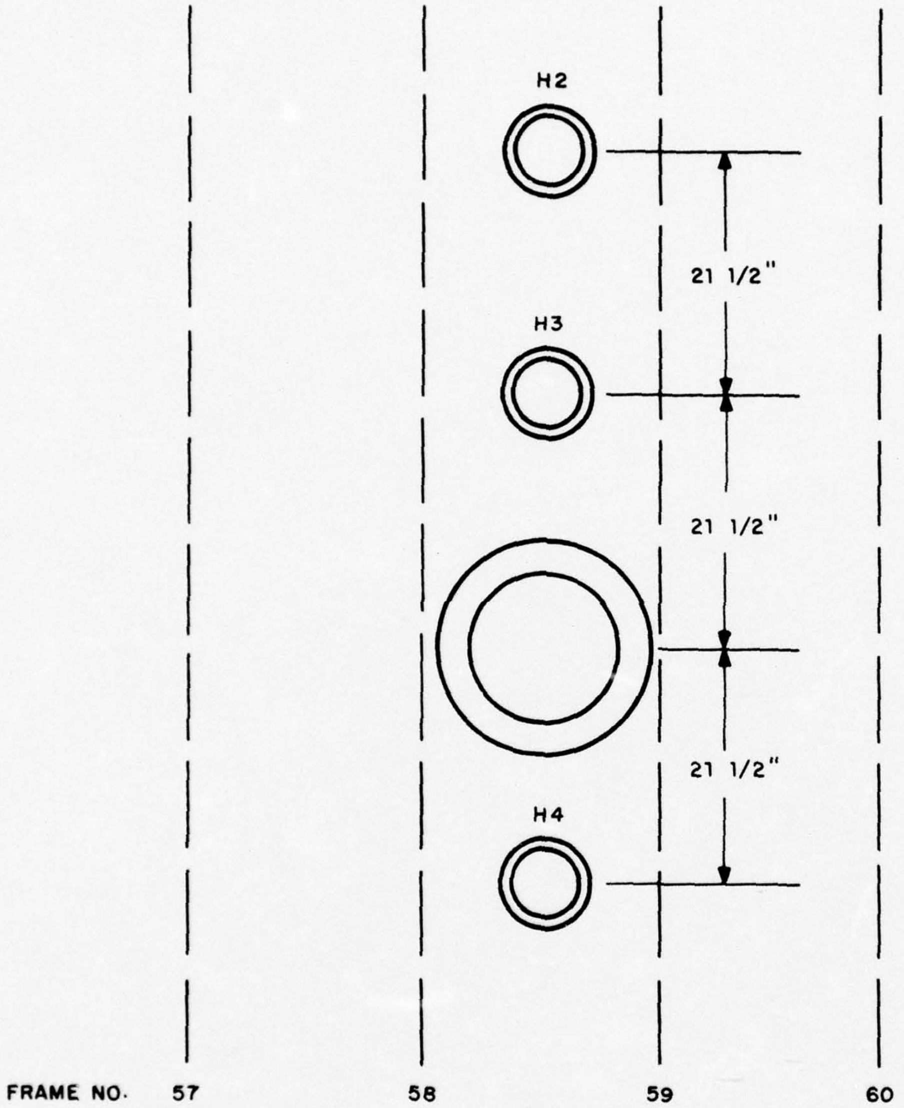


FIGURE 2-4b. LOW FREQUENCY ARRAY AND HULL ELEMENTS H2, H3, H4 AND TRANSMITTER T3

c) 10 flush-mounted single elements located near the two fixed struts and near frames 42, 58, and between frames 72 through 88 (H-1 through H-10) (Figure 2-4 and 2-5).

d) 10 elements located within and near Sea Chest 2 (Figure 2-6). Of these 8 are mounted on a special fiberglass window in 4 pairs: two pairs are flush-mounted (G1, G2, G7, G8) and the other two are recessed from the water by a 6" cavity, (G3 through G6). The cavities can be flooded with water and also drained. During the sea trials, the cavities were filled with water. The last two elements (G9 and G10) were flush-mounted above the window A dome was placed around all 10 elements which also could be flooded and drained. The dome was not flooded during the sea trials.

## B. ACCELEROMETERS

At the request of DTMB a miniature accelerometer was mounted on the rear masses of selected TRG receivers located in each of the 4 groups above in order to measure the magnitude of vibration appearing along the sensitive axis of the hydrophone. The locations of these accelerometers (11 in all) are illustrated in Figure 2-1a (A-1 through A-11).

## C. TRANSDUCER AND PRE-AMPLIFIER IDENTIFICATION

Each TRG 5" hydrophone, accelerometer and preamplifier installed on the ship was serialized. A tabulation of the serial numbers vs. element, their associated SCA (Signal Conditioning Amplifier) and connector identification in the Shipboard Recording Center appears in Table 2-1.

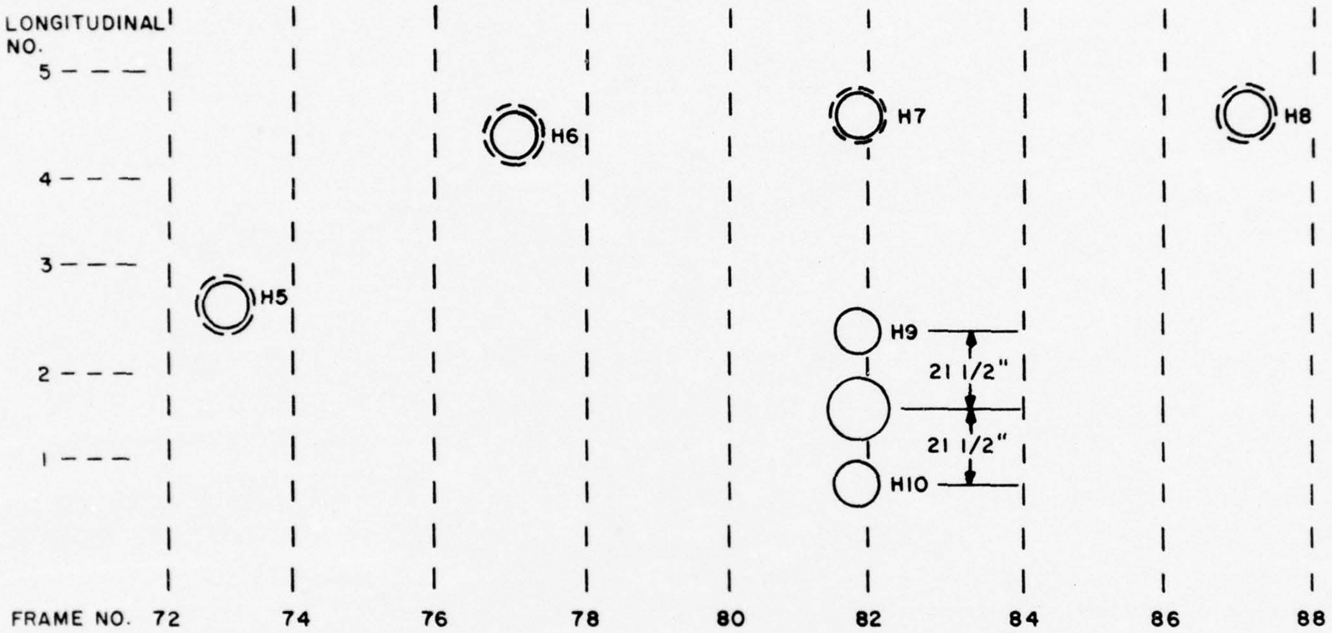
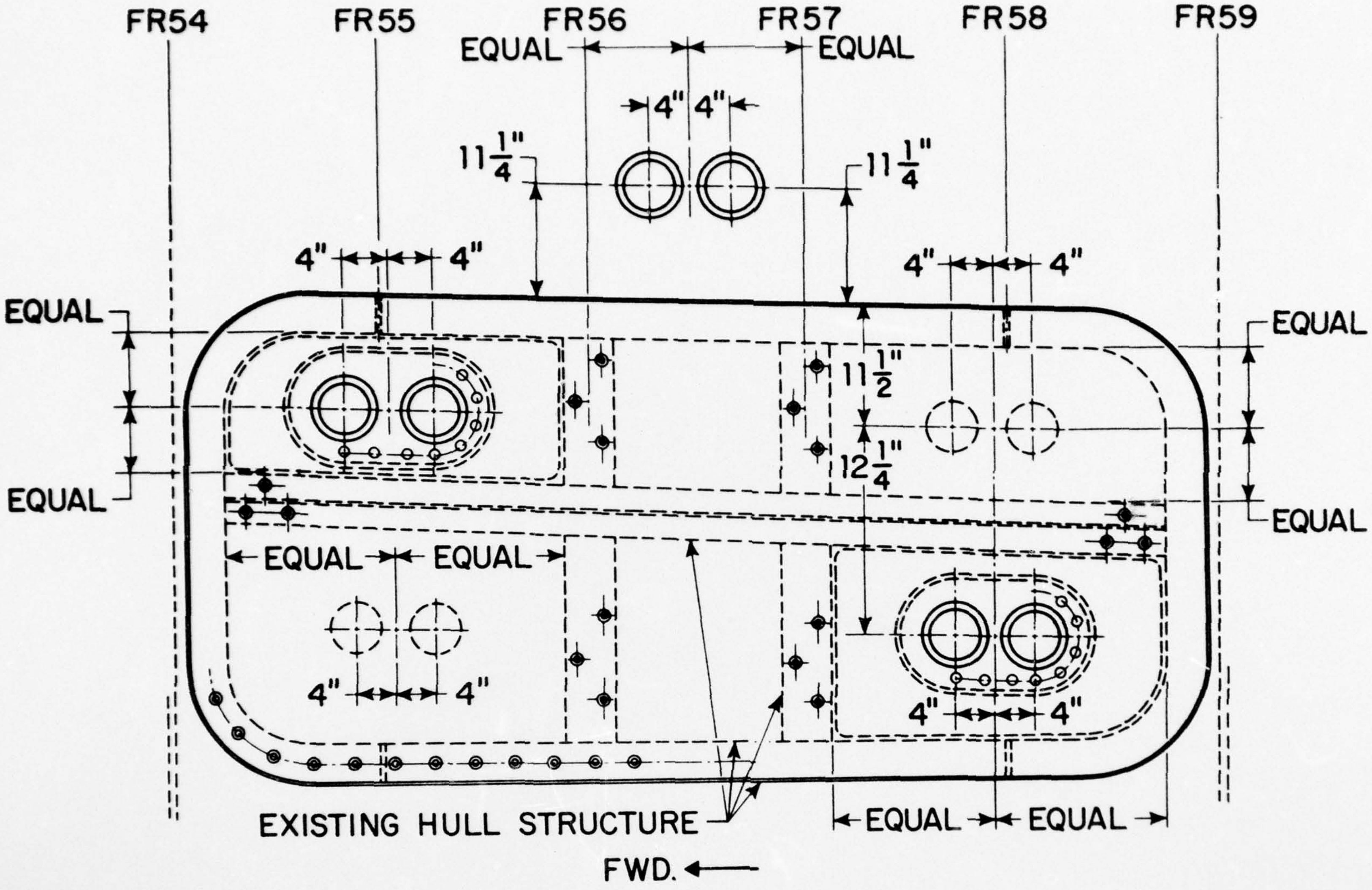
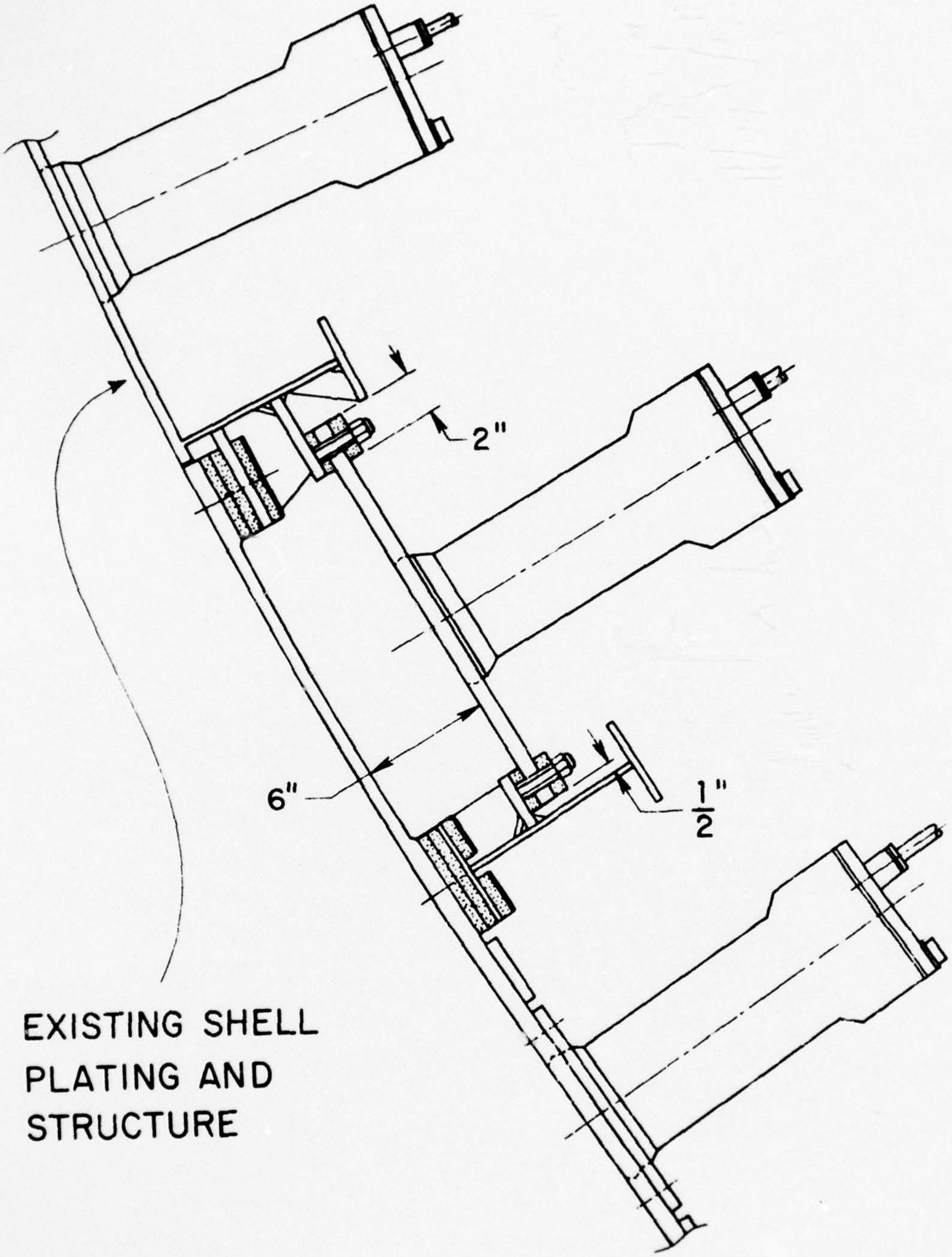


FIGURE 2-5. HULL ELEMENTS H5 THROUGH H10



SEA CHEST 2 - FRONT VIEW

FIGURE 2-6a



SEA CHEST 2 - SIDE VIEW

FIGURE 2-6b

## TABLE 2-1. TRG TRANSDUCERS AND CABLE CONNECTORS

| | ELEMENT NO. | SCA NO. | B + CAL. CONN. | SIG. CONN. | HYDROPHONE/ACC. SERIAL NO. | PRE-AMP. SER. NO. |
|---|---|---|---|---|---|---|
| CALIBRATION STATION 1 | HF 1 | 1 | 1-1-1 | 1-2-1 | P1007 | 110 |
| | HF 2 | 2 | 1-1-2 | 1-2-2 | P1011 | 117 |
| | HF 3 | 3 | 1-1-3 | 1-2-3 | P1076 | 253 |
| | HF 4 | 4 | " 4 | " 4 | P1036 | 121 |
| | HF 5 | 5 | " 5 | " 5 | P1027 | 146 |
| | HF 6 | 6 | " 6 | " 6 | P1019 | 125 |
| | HF 7 | 7 | " 7 | " 7 | P1030 | 136 |
| | HF 8 | 8 | " 8 | " 8 | P1002 | 112 |
| | HF 9 | 9 | " 9 | " 9 | P1014 | 130 |
| | HF 10 | 10 | " 10 | " 10 | P1060 | 137 |
| | HF 11 | 11 | " 11 | " 11 | P1031 | 149 |
| | HF 12 | 12 | " 12 | " 12 | P1004 | 103 |
| | HF 13 | 13 | " 13 | " 13 | P1008 | 122 |
| | A 5 | 14 | " 14 | " 14 | 1001 | 256 |
| | A 6 | 15 | " 15 | " 15 | 1002 | 160 |
| CALIBRATION STATION 3 | LF 1 | 16 | 2-1-1 | 2-2-1 | P1015 | 111 |
| | LF 2 | 17 | 2-1-2 | 2-2-2 | P1034 | 259 |
| | LF 3 | 18 | 2-1-3 | 2-2-3 | P1010 | 120 |
| | LF 4 | 19 | " 4 | " 4 | P1001 | 127 |
| | LF 5 | 20 | " 5 | " 5 | P1043 | 113 |
| | LF 6 | 21 | " 6 | " 6 | P1063 | 106 |
| | LF 7 | 22 | " 7 | " 7 | P1029 | 150 |
| | LF 8 | 23 | " 8 | " 8 | P1059 | 118 |
| | LF 9 | 24 | " 9 | " 9 | P1068 | 142 |
| | LF 10 | 25 | " 10 | " 10 | P1012 | 123 |
| | LF 11 | 26 | " 11 | " 11 | P1062 | 107 |
| | LF 12 | 27 | " 12 | " 12 | P1050 | 102 |
| | LF 13 | 12 | " 12 | " 12 | P1065 | 134 |
| | A 7 | 29 | " 14 | " 14 | 996 | 116 |
| | A 8 | 30 | " 15 | " 15 | 1003 | 258 |

## TABLE 2-1 (cont'd)
## TRG TRANSDUCERS AND CABLE CONNECTORS

| | ELEMENT NO. | SCA NO. | B + CAL. CONN. | SIG. CONN. | HYDROPHONE/ACC. SERIAL NO. | PRE-AMP. SER. NO. |
|---|---|---|---|---|---|---|
| CALIBRATION STATION 4 | G 1 | 31 | 2-3-1 | 2-4-1 | P1095 | 144 |
| | G 2 | 32 | 2-3-2 | 2-4-2 | P1073 | 135 |
| | G 3 | 33 | " 3 | " 3 | P1021 | 131 |
| | G 4 | 34 | " 4 | " 4 | P1098 | 152 |
| | G 5 | 35 | " 5 | " 5 | P1020 | 141 |
| | G 6 | 36 | " 6 | " 6 | P1042 | 145 |
| | G 7 | 37 | " 7 | " 7 | P1045 | 156 |
| | G 8 | 38 | " 8 | " 8 | P1071 | 143 |
| | G 9 | 39 | " 9 | " 9 | P1079 | 155 |
| | G 10 | 40 | " 10 | " 10 | P1052 | 133 |
| | A 2 | 41 | " 11 | " 11 | 994 | 153 |
| | A 3 | 42 | " 12 | " 12 | 993 | 132 |
| | A 1 | 43 | " 13 | " 13 | 999 | 151 |
| | A 4 | 44 | " 14 | " 14 | 995 | 164 |
| | A 11 | 45 | " 15 | " 15 | 992 | 140 |
| CALIBRATION STATION 3 | *H 1 | 46 | 2-5-9 | 2-6-9 | P1075 | 105 |
| | H 2 | 47 | 2-5-10 | 2-6-10 | P1051 | 148 |
| | H 3 | 48 | 2-5-11 | 2-6-11 | P1078 | 126 |
| | H 4 | 49 | 2-5-12 | 2-6-12 | P1057 | 159 |
| CALIBRATION STATION 5 | H 5 | 50 | 3-1-5 | 3-2-5 | P1046 | 158 |
| | H 6 | 51 | 3-1-6 | 3-2-6 | P1061 | 255 |
| | H 7 | 52 | " 7 | " 7 | P1056 | 251 |
| | H 8 | 53 | " 8 | " 8 | P1016 | 139 |
| | H 9 | 54 | " 9 | " 9 | P1009 | 114 |
| | H 10 | 55 | " 10 | " 10 | P1049 | 129 |
| | A 9 | 56 | " 11 | " 11 | 997 | 147 |
| | A 11 | 57 | " 12 | " 12 | 1000 | 168 |

* H 1 is located near calibration Station 3

A tabulation of the DTMB hydrophone and accelerometer outputs, connectors and SCAs, appears in Table 2-2.

## D. SHIP'S MOTION SENSORS

The 12 ship's motion sensors used during PURVIS II are listed in Table 2-3. The three accelerometers (Sway, Surge, Heave) and the three potentiometers (Yaw, Pitch, Roll) originate at the Stable Table (inertial platform). The sea state buoy, which is cast overboard on days when sea state data is desired, transmits the sea state signal to the recording center via a UHF radio link at 138 MHz. This device, nicknamed "Splashnik" contains an accelerometer that is used to measure wave height. The bow probe is an ultrasonic device which measures the height of the bow above the water during the course of the runs.

The modifications to the ship for the PURVIS II Sea Trials included the addition of four recording flow flags manufactured by GD/EB and modified, per DTMB instructions, by TRG. Three of the flags were installed on the port side at frame 29-1/2 (FFA), frame 52-1/2 (FFB) and frame 86 (FFC). A fourth flag was installed on the starboard side at frame 29-1/2 (FFD).

All twelve signals were recorded on the low bandwidth recorder (No. 5) at 1-7/8 ips.

## E. TRANSMITTER-RECEIVER DISTANCES

The distances between each 5" receiver and the four transmitters have been computed and are tabulated in Figure 2-7. In addition, the angles associated with the distance R to T and a line normal to the transducer front fare (N) have also been tabulated. These angles have been measured in the C/P Sonar Coordinate System as illustrated in Figure 2-8.

## TABLE 2-2
## DTMB HYDROPHONES (SEA CHEST 1) AND CABLE CONNECTORS

| | | Hydrophone (H) | | Accel. (A) | | Vibrator Input |
|---|---|---|---|---|---|---|
| | | Connector | SCA No.* | Connector | SCA No. | Connector |
| Calibration Station 2 | D1 | 1-4-1 | 60 | 1-3-1 | 75 | 1-5-1 |
| | D2 | 1-4-2 | 61 | 1-3-2 | 76 | 1-5-2 |
| | D3 | 1-4-3 | 62 | 1-3-3 | 77 | 1-5-3 |
| | D4 | 1-4-4 | 63 | 1-3-4 | 78 | 1-5-4 |
| | D5 | 1-4-5 | 64 | 1-3-5 | 79 | 1-5-5 |
| | D6 | 1-4-6 | 65 | 1-3-6 | 80 | 1-5-6 |
| | D7 | 1-4-7 | 66 | 1-3-7 | 81 | 1-5-7 |
| | D8 | 1-4-8 | 67 | 1-3-8 | 82 | 1-5-8 |
| | D9 | 1-4-9 | 68 | 1-3-9 | 83 | 1-5-9 |
| | D10 | 1-4-10 | 69 | 1-3-10 | 84 | 1-5-10 |

*To SCA via dual channel summing amplifier modified for use as a 20 DB preamplifier

## TABLE 2-3 SHIP'S MOTION SENSORS

### RECORDER NO. 5

| Track | Signal Name | Comments |
|---|---|---|
| 1 | Sway | Stable Table Accelerometers. |
| 2 | Surge | |
| 3 | Heave | |
| 4 | F.F. "A" | Near Fr. 29 1/2 (port) |
| 5 | Bow Probe | Ultrasonic device |
| 6 | S.S. Buoy | Transmitted at 138 MHz |
| 9 | Pitch | Stable Table Potentiometers |
| 10 | Roll | |
| 11 | Yaw | |
| 12 | F.F. "B" | Near Fr. 52 1/2 (port) |
| 13 | F.F. "C" | Near Fr. 86 (port) |
| 14 | F.F. "D" | Near Fr. 29 1/2 (stbd.) |

```
X1   TRANSMITTER IN SONAR DOME                                                      8/15/66       PAGE   1

TRANSMITTER    RECEIVER    R TO T LENGTH    THETA-RT    PHI-RT    THETA-R    PHI-R    ANGLE-R TO RT

   X1            HF1        14'  6.222''    -22.974    178.928    -32.000   273.007      81.258
                 HF2        13'  7.470''    -24.581    178.644    -33.000   272.733      79.931
                 HF3        12'  9.542''    -26.287    178.647    -33.000   272.733      79.185
                 HF4        11' 11.771''    -28.228    178.417    -34.000   272.733      77.906
                 HF5        11'  3.054''    -30.232    178.158    -35.000   272.733      76.565
                 HF6        10'  5.702''    -32.749    177.560    -35.000   273.007      75.825
                 HF7         9'  9.444''    -35.380    177.007    -36.000   273.007      74.294
                 HF8         9'  0.713''    -38.719    176.113    -37.000   273.007      72.444
                 HF9         8'  5.878''    -41.872    175.464    -38.500   273.007      70.184
                 HF10       12' 10.618''    -40.115    170.508    -19.500   275.333      88.245
                 HF11       12'  3.094''    -36.928    172.671    -25.000   274.517      83.962
                 HF12       11'  9.287''    -34.058    175.099    -28.000   273.750      81.206
                 HF13       10'  9.871''    -26.034    181.964    -40.000   272.013      73.648
                 LF1        36' 11.811''     -6.972      1.512    -65.500   272.267      83.345
                 LF2        39'  5.573''     -6.487      1.522    -65.500   272.267      83.751
                 LF3        41' 11.462''     -6.172      1.488    -68.000   271.983      84.054
                 LF4        47'  4.892''     -5.219      1.353    -69.500   272.005      84.864
                 LF5        49' 10.880''     -5.077      1.309    -70.500   272.005      84.982
                 LF6        52'  7.763''     -4.812      1.297    -71.500   272.300      85.119
                 LF7        55'  1.665''     -4.605      1.238    -72.500   272.300      85.289
                 LF8        57' 10.487''     -4.294      1.241    -72.500   272.005      85.675
                 LF9        45'  7.174''    -11.063      9.013    -39.500   272.267      88.103
                 LF10       45'  2.412''     -9.551      7.452    -47.000   274.867      84.778
                 LF11       44' 10.230''     -8.010      5.666    -55.000   274.983      83.836
                 LF12       44'  7.087''     -6.708      3.601    -62.500   273.750      83.984
                 LF13       44'  4.451''     -4.997    359.190    -72.000   270.767      84.761
                 G1         57'  6.024''    -11.134      9.436    -28.500   276.450      87.253
                 G2         58'  1.770''    -11.009      9.327    -28.500   276.450      87.258
                 G3         62'  5.750''    -10.247      9.164    -28.500   276.450      87.482
                 G4         63'  1.524''    -10.141      9.066    -28.500   276.450      87.448
                 G5         56'  5.646''     -9.460      2.336    -38.000   276.333      81.062
                 G6         57'  1.532''     -9.350      2.309    -38.000   276.333      81.107
                 G7         62'  1.589''     -6.581      8.895    -38.500   276.400      86.606
                 G8         62'  9.406''     -8.492      8.400    -39.000   276.400      86.518
                 G9         60'  4.736''    -12.208     11.399    -24.000   276.450      89.486
                 G10        61'  0.404''    -12.078     11.273    -23.500   276.450      85.539
                 H1         33' 11.173''     -8.047      2.168    -63.500   272.850      82.499
                 H2         42'  3.973''   [illegible]   4.450    -64.000   275.933      83.185
                 H3         62'  0.325''     -5.097      2.986    -69.000   274.567      84.676
                 H4         61'  9.924''     -3.545  [illegible]  -78.000   270.600      86.301
                 H5         87'  1.732''     -2.574      2.442    -76.500   273.350      86.857
                 H6         95'  1.198''     -3.215      4.177    -69.000   270.717      86.237
                 H7        103'  8.106''     -3.323      4.387    -71.000   274.767      86.734
                 H8        114'  7.557''     -2.677      4.194    -73.000   274.333      87.399
                 H9   [illegible] [illegible] [illegible] 1.896   -78.500   272.817      87.501
                 H10       103'  3.192''   [illegible] [illegible] -80.000  270.417      87.845
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FIGURE 2-7. TRANSMITTER-RECEIVER DISTANCES

X3 FIXED STRUT AT FRAME 58 8/19/66 PAGE 2

| TRANSMITTER | RECEIVER | R TO T LENGTH | THETA-RT | PHI-RT | THETA-R | PHI-R | ANGLE-R TO RT |
|---|---|---|---|---|---|---|---|
| X3 | HF1 | 75' 4.969'' | -5.231 | 181.612 | -32.000 | 273.007 | 88.241 |
| | HF2 | 74' 5.275'' | -5.299 | 181.836 | -33.000 | 272.733 | 87.866 |
| | HF3 | 73' 6.320'' | -5.365 | 181.843 | -33.000 | 272.733 | 87.825 |
| | HF4 | 72' 7.366'' | -5.433 | 181.850 | -34.000 | 272.733 | 87.695 |
| | HF5 | 71' 9.409'' | -5.496 | 181.855 | -35.000 | 272.733 | 87.568 |
| | HF6 | 70' 10.442'' | -5.567 | 181.828 | -35.000 | 273.007 | 87.773 |
| | HF7 | 70' 0.479'' | -5.633 | 181.816 | -36.000 | 273.007 | 87.653 |
| | HF8 | 69' 1.515'' | -5.708 | 181.788 | -37.000 | 273.007 | 87.539 |
| | HF9 | 68' 4.556'' | -5.770 | 181.790 | -38.500 | 273.007 | 87.361 |
| | HF10 | 72' 0.649'' | -7.565 | 180.802 | -19.500 | 275.333 | 91.705 |
| | HF11 | 71' 11.310'' | -6.844 | 181.103 | -25.000 | 274.517 | 90.185 |
| | HF12 | 71' 10.367'' | -6.233 | 181.437 | -28.000 | 273.750 | 89.109 |
| | HF13 | 71' 8.710'' | -4.765 | 182.372 | -40.000 | 272.013 | 86.665 |
| | LF1 | 25' 8.334'' | -12.812 | 183.790 | -65.500 | 272.267 | 77.729 |
| | LF2 | 23' 3.079'' | -14.103 | 184.025 | -65.500 | 272.267 | 76.464 |
| | LF3 | 20' 10.303'' | -15.912 | 184.408 | -68.000 | 271.983 | 74.369 |
| | LF4 | 15' 7.066'' | -20.742 | 185.947 | -69.500 | 272.005 | 69.253 |
| | LF5 | 13' 4.037'' | -24.947 | 187.076 | -70.500 | 272.005 | 64.891 |
| | LF6 | 10' 11.053'' | -31.001 | 188.833 | -71.500 | 272.300 | 58.709 |
| | LF7 | 8' 10.919'' | -39.734 | 192.022 | -72.500 | 272.300 | 50.018 |
| | LF8 | 6' 11.657'' | -52.647 | 198.970 | -72.500 | 272.005 | 35.771 |
| | LF9 | 20' 7.285'' | -28.898 | 165.932 | -39.500 | 272.267 | 83.259 |
| | LF10 | 19' 9.602'' | -26.092 | 169.776 | -47.000 | 274.867 | 80.666 |
| | LF11 | 19' 1.257'' | -22.979 | 174.256 | -55.000 | 274.983 | 77.203 |
| | LF12 | 18' 7.679'' | -20.136 | 179.468 | -62.500 | 273.750 | 74.149 |
| | LF13 | 18' 6.096'' | -15.908 | 190.521 | -72.000 | 270.767 | 71.875 |
| | G1 | 15' 2.775'' | -53.937 | 132.363 | -29.500 | 276.450 | 91.907 |
| | G2 | 14' 11.751'' | -55.282 | 129.053 | -28.500 | 276.450 | 91.687 |
| | G3 | 14' 3.489'' | -59.578 | 97.943 | -28.500 | 276.450 | 91.913 |
| | G4 | 14' 3.111'' | -59.792 | 92.663 | -28.500 | 276.450 | 91.653 |
| | G5 | 12' 1.323'' | -60.017 | 183.355 | -38.000 | 276.333 | 59.149 |
| | G6 | 11' 9.507'' | -62.818 | 183.770 | -38.000 | 276.333 | 57.888 |
| | G7 | 12' 4.875'' | -56.457 | 98.276 | -38.500 | 276.400 | 85.030 |
| | G8 | 12' 6.626'' | -56.702 | 92.776 | -39.000 | 276.400 | 84.249 |
| | G9 | 17' 1.008'' | -54.911 | 112.975 | -24.000 | 276.450 | 99.825 |
| | G10 | 16' 11.363'' | -55.576 | 109.302 | -23.500 | 276.450 | 100.167 |
| | H1 | 28' 9.373'' | -11.948 | 182.757 | -63.500 | 272.850 | 79.365 |
| | H2 | 6' 11.110'' | -75.883 | 90.000 | -64.000 | 275.933 | 40.066 |
| | H3 | 6' 8.939'' | -84.950 | 90.000 | -69.000 | 274.567 | 26.037 |
| | H4 | 5' 11.405'' | -57.729 | 270.000 | -78.000 | 270.600 | 20.272 |
| | H5 | 25' 10.974'' | -12.772 | 2.457 | -76.500 | 273.350 | 77.378 |
| | H6 | 33' 10.977'' | -11.121 | 7.410 | -69.000 | 270.717 | 83.005 |
| | H7 | 42' 9.451'' | -9.790 | 7.267 | -71.000 | 274.767 | 81.560 |
| | H8 | 53' 2.641'' | -7.043 | 6.250 | -73.000 | 274.333 | 83.788 |
| | H9 | 41' 10.395'' | -7.906 | 1.093 | -78.500 | 272.817 | 82.302 |
| | H10 | 41' 10.875'' | -6.752 | 355.722 | -80.000 | 270.417 | 82.536 |

FIGURE 2-7a. TRANSMITTER-RECEIVER DISTANCES

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X2A  RETRACTABLE STRUT EXTENDED 1 FOOT                                          8/15/66          PAGE  [illegible]

TRANSMITTER      RECEIVER     R TO T LENGTH      THETA-RT       PHI-RT      THETA-N      PHI-N       ANGLE-N TO RT

X2A              HF1         57'   7.383''       -2.114        181.244      -32.000      273.007         90.374
                 HF2         56'   7.644''       -2.150        181.266      -33.000      272.733         90.059
                 HF3         55'   8.649''       -2.186        181.265      -33.000      272.733         90.040
                 HF4         54'   9.655''       -2.222        181.264      -34.000      272.733         89.974
                 HF5         53'  11.659''       -2.256        181.262      -35.000      272.733         89.910
                 HF6         53'   0.654''       -2.295        181.216      -35.000      273.007         90.149
                 HF7         52'   2.654''       -2.332        181.190      -36.000      273.007         90.098
                 HF8         51'   3.650''       -2.374        181.141      -37.000      273.007         90.060
                 HF9         50'   6.655''       -2.409        181.134      -38.500      273.007         89.565
                 HF10        54'   1.512''       -5.046        179.867      -19.500      275.333         93.445
                 HF11        54'   0.631''       -4.056        180.266      -25.000      274.517         92.128
                 HF12        54'   0.085''       -3.240        180.708      -28.000      273.750         91.160
                 HF13        53'  11.536''       -1.283        181.947      -40.000      272.013         89.225
                 LF1          7'   6.940''       -7.186        184.052      -65.500      272.267         82.725
                 LF2          5'   1.247''      -10.346        185.237      -65.500      272.267         79.384
                 LF3          2'   8.560''      -20.918        189.462      -68.000      271.983         67.878
                 LF4          3'   1.456''      -14.297        352.679      -69.500      272.005         73.363
                 LF5          5'   6.573''       -9.020        356.207      -70.500      272.005         75.567
                 LF6   [illegible]  3.626''      -6.050        357.831      -71.500      272.300         82.848
                 LF7         10'   9.491''       -4.707        358.335      -72.500      272.300         84.220
                 LF8         13'   6.306''       -3.356        358.939      -72.900      272.005         85.878
                 LF9          7'   6.988''      -43.388         90.000      -39.500      272.267         57.089
                 LF10         5'   9.96[illegible]'' -42.756    90.000      -47.000      274.867         90.141
                 LF11         3'  11.46[illegible]'' -43.187    90.000      -55.000      274.983         81.722
                 LF12         2'   1.227''      -52.449         90.000      -62.500      273.750         65.013
                 LF13         2'   1.79[illegible]''  -8.841    270.000      -78.000      270.767         63.361
                 G1          15'   5.185''      -28.665         34.073      -28.500      276.450         97.351
                 G2          16'   3.076''      -27.723         32.586      -28.500      276.450         96.533
                 G3          15'  11.505''      -22.298         26.681      -28.500      276.450         95.746
                 G4          20'   6.160''      -21.665         25.781      -28.500      276.450         95.406
                 G5          12'  10.064''      -26.555          3.849      -38.000      276.333         72.194
                 G6          13'   5.244''      -25.297          3.638      -38.000      276.333         72.753
                 G7          19'   2.535''      -17.351         25.866      -38.500      276.400         93.629
                 G8          19'   9.447''      -10.031         24.988      -39.000      276.400         93.146
                 G9          19'   4.477''      -28.450         36.646      -24.000      276.450        102.135
                 G10         15'  10.188''      -27.708         35.348      -23.500      276.450        101.943
                 F1          10'   8.951''       -6.487        181.236      -63.500      272.850         84.916
                 F2          16'   2.786''      -12.372         10.680      -64.000      275.933         80.982
                 F3          17'   8.229''       -6.288          5.009      -69.000      274.567         84.411
                 F4          17'   7.466''       -0.914        353.312      -78.000      270.600         87.994
                 F5    [illegible]  [illegible]  -1.310          2.957      -76.500      273.350         88.634
                 F6          50'   9.255''       -2.020          6.122      -69.000      270.711         90.047
                 F7    [illegible]  4.791''      -2.382          6.207      -71.000      274.767         88.216
                 F8    [illegible]  4.322''      -1.476          5.609      -73.000      274.333         88.561
                 F9          53'  [illegible]   [illegible]      1.861      -78.000      272.817         85.126
                 F10   [illegible]  [illegible] [illegible]   [illegible]   -80.000      270.417         89.425
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FIGURE 2-7b. TRANSMITTER-RECEIVER DISTANCES

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X2B  RETRACTABLE STRUT EXTENDED 2 FEET                                          6/19/66        PAGE   4

TRANSMITTER    RECEIVER      R TO T LENGTH      THETA-RT      PHI-RT      THETA-N      PHI-N       ANGLE-N TO RT

   X2B           HF1        57'  9.001''       -3.[illegible]     181.576     -32.000     273.007        85.585
                 HF2        56'  9.273''       -2.118      181.603     -33.000     272.733        89.245
                 HF3        55'  9.287''       -3.169      181.600     -33.000     272.733        89.217
                 HF4        54' 10.301''       -3.272      181.613     -34.000     272.733        89.126
                 HF5        54'  0.314''       -3.272      181.616     -35.000     272.733        89.030
                 HF6        53'  1.316''       -3.[illegible]     181.576     -35.000     273.007        89.263
                 HF7        52'  4.723''       -3.301      181.556     -36.000     273.003        89.188
                 HF8        51'  4.326''       -3.462      181.514     -37.000     273.007        89.120
                 HF9        50'  7.359''       -3.493      181.512     -38.500     273.007        88.994
                 HF10       54'  2.638''       -6.054      180.221     -19.500     275.331        92.769
                 HF11       54'  1.577''       [illegible]      180.626     -25.000     274.517        91.377
                 HF12       54'  0.899''       -4.253      181.063     -28.000     273.750        90.371
                 HF13       54'  0.044''       -2.299      182.301     -40.000     272.013        88.307
                 LF1         7'  5.430''      -14.1[illegible]     186.576     -65.500     272.267        75.346
                 LF2         4'  4.785''      -20.394      188.997     -65.500     272.267        68.800
                 LF3         2'  2.933''      -36.439      156.695     -68.000     271.983        51.150
                 LF4         3'  6.438''      -29.272      346.527     -69.500     272.005        57.349
                 LF5         5' 10.072''      -18.2[illegible]     352.768     -70.500     272.005        64.703
                 LF6         6'  5.711''      -12.4[illegible]     355.524     -71.500     272.300        70.015
                 LF7        10' 11.113''       -9.715      356.562     -72.500     272.300        75.014
                 LF8        13'  7.505''       -7.379      357.5[illegible]    -72.500     272.005        81.617
                 LF9         6'  0.620''      -49.946       50.000     -39.501     272.267        90.452
                 LF10        6'  3.666''      -51.737       51.000     -47.000     274.867        81.674
                 LF11        4'  5.004''      -55.161       40.000     -55.000     274.983        65.763
                 LF12        2'  5.491''      -70.145       90.000     -62.500     273.750        47.329
                 LF13        2'  9.266''      -27.979       70.000     -72.000     270.717        44.419
                 G1         14'  1.00[illegible]''      -31.775       21.914     -27.500     277.450        94.561
                 G2         14'  [illegible]       -32.9[illegible]      31.4[illegible]     -24.500     276.450        94.200
                 G3         20'  [illegible].497''      -24.472       25.745     -28.500     276.450        93.546
                 G4         20'  9.072''      -24.765       24.872     -28.500     276.450        93.271
                 G5         13'  4.355''      -30.250        2.187     -38.000     276.333        68.517
                 G6         13' 10.367''      -28.401        2.066     -38.000     276.333        65.582
                 G7         19'  4.611''      -20.152       14.922     -18.500     270.400        91.065
                 G8         17' 11.495''      -19.561       34.166     -35.000     276.400        90.647
                 G9         14'  [illegible].146''      -31.377       35.735     -24.000     276.450        95.551
                 G10        20'  1.771''      -20.376       34.432     -23.500     276.450        95.778
                 H1         10' 10.398''      -11.510      183.240     -73.500     272.850        75.633
                 H2         16'  4.455''      -15.[illegible]      [illegible]      -74.000     275.933        77.859
                 H3         17'  9.961''       -9.4[illegible]        4.026     -69.000     274.567        81.153
                 H4         17'  2.403''       -4.[illegible]      152.[illegible]     -75.000     270.600        84.339
                 H5         42' 10.01[illegible]''       -3.[illegible]        2.511     -76.500     [illegible]        87.283
                 H6         56'  [illegible]        -3.1[illegible]        2.749     -69.000     [illegible]        85.506
                 H7         [illegible]         [illegible]      [illegible]     -71.000     274.767        87.238
                 H8         70'  [illegible]        [illegible]      [illegible].349     -71.000     274.221        88.136
                 H9         60'  [illegible]        -1.[illegible]        1.937     -76.[illegible]     272.817        87.150
                 H10        [illegible]         [illegible]      [illegible]      [illegible]      [illegible]        89.4[illegible]
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FIGURE 2-7c.   TRANSMITTER-RECEIVER DISTANCES

XMC RETRACTABLE STRUT EXTENDED 3 FEET    8/19/66    PAGE [illegible]

| TRANSMITTER | RECEIVER | R TC T LENGTH | THETA-AT | PHI-AT | THETA-N | PHI-N | ANGLE-N TC RT |
|---|---|---|---|---|---|---|---|
| XMC | HF1 | 57' 8.814'' | -3.973 | 181.948 | -32.000 | 273.007 | 88.792 |
| | HF2 | 56' 9.100'' | -4.041 | 181.982 | -33.000 | 272.733 | 88.429 |
| | HF3 | 55' 10.126'' | -4.108 | 181.993 | -33.000 | 272.733 | 88.383 |
| | HF4 | 54' 11.152'' | -4.176 | 182.005 | -34.000 | 272.733 | 88.249 |
| | HF5 | 54' 1.177'' | -4.240 | 182.014 | -35.000 | 272.733 | 88.157 |
| | HF6 | 53' 2.188'' | -4.313 | 181.981 | -35.000 | 273.007 | 88.346 |
| | HF7 | 52' 4.206'' | -4.382 | 181.967 | -36.000 | 273.007 | 88.265 |
| | HF8 | 51' 5.219'' | -4.460 | 181.932 | -37.000 | 273.007 | 88.174 |
| | HF9 | 50' 8.244'' | -4.526 | 181.937 | -38.500 | 273.007 | 88.019 |
| | HF10 | 54' 3.919'' | -7.016 | 180.620 | -19.500 | 275.333 | 92.049 |
| | HF11 | 54' 2.705'' | -6.032 | 181.018 | -25.000 | 274.517 | 90.467 |
| | HF12 | 54' 1.905'' | -5.220 | 181.461 | -28.000 | 273.750 | 89.565 |
| | HF13 | 54' 0.774'' | -3.269 | 182.699 | -40.000 | 272.013 | 87.374 |
| | LF1 | 8' 1.308'' | -20.373 | 189.385 | -65.500 | 272.267 | 68.596 |
| | LF2 | 5' 10.130'' | -28.534 | 193.134 | -65.500 | 272.267 | 59.778 |
| | LF3 | 3' 11.400'' | -46.049 | 204.224 | -68.000 | 271.983 | 40.010 |
| | LF4 | 4' 1.763'' | -39.645 | 339.969 | -69.500 | 272.005 | 45.669 |
| | LF5 | 6' 2.905'' | -26.139 | 348.962 | -70.500 | 272.005 | 61.124 |
| | LF6 | 8' 9.072'' | -18.305 | 352.946 | -71.500 | 272.300 | 69.708 |
| | LF7 | 11' 1.747'' | -14.340 | 354.575 | -72.500 | 272.300 | 74.016 |
| | LF8 | 13' 9.530'' | -11.146 | 355.939 | -72.500 | 272.005 | 77.552 |
| | LF9 | 8' 6.692'' | -55.865 | 90.000 | -39.500 | 272.267 | 84.615 |
| | LF10 | 6' 10.087'' | -58.513 | 90.000 | -47.000 | 274.867 | 74.411 |
| | LF11 | 5' 0.889'' | -64.592 | 90.000 | -55.000 | 274.983 | 60.346 |
| | LF12 | 3' 7.052'' | -80.811 | 90.000 | -62.500 | 273.750 | 36.674 |
| | LF13 | 3' 7.031'' | -37.802 | 270.000 | -72.000 | 270.767 | 34.200 |
| | G1 | 16' 5.160'' | -35.058 | 31.573 | -28.500 | 276.450 | 91.795 |
| | G2 | 16' 10.820'' | -33.944 | 30.146 | -28.500 | 276.450 | 91.522 |
| | G3 | 20' 5.640'' | -27.487 | 24.683 | -28.500 | 276.450 | 91.358 |
| | G4 | 21' 0.133'' | -24.722 | 23.833 | -28.500 | 276.450 | 91.143 |
| | G5 | 13' 9.095'' | -33.605 | 0.313 | -38.000 | 276.333 | 65.821 |
| | G6 | 14' 3.814'' | -32.129 | 0.295 | -38.000 | 276.333 | 66.571 |
| | G7 | 19' 6.919'' | -22.857 | 23.842 | -38.500 | 276.400 | 88.530 |
| | G8 | 20' 1.700'' | -22.181 | 23.016 | -39.000 | 276.400 | 88.176 |
| | G9 | 19' 11.862'' | -33.747 | 34.686 | -24.000 | 276.450 | 97.667 |
| | G10 | 20' 5.401'' | -32.887 | 33.420 | -23.500 | 276.450 | 97.628 |
| | H1 | 11' 1.236'' | -16.123 | 185.042 | -63.500 | 272.850 | 74.638 |
| | H2 | 18' 7.342'' | -18.097 | 8.431 | -64.000 | 275.933 | 74.869 |
| | H3 | 17' 11.347'' | -12.368 | 3.304 | -69.000 | 274.567 | 78.014 |
| | H4 | 17' 10.165'' | -6.929 | 351.036 | -78.000 | 270.600 | 81.230 |
| | H5 | 42' 10.457'' | -3.817 | 2.010 | -76.500 | 273.350 | 85.975 |
| | H6 | 50' 10.217'' | -4.135 | 5.327 | -69.000 | 270.717 | 87.788 |
| | H7 | 59' 5.213'' | -4.191 | 5.526 | -71.000 | 274.767 | 86.285 |
| | H8 | 70' 4.413'' | -3.004 | 5.034 | -73.000 | 274.333 | 87.333 |
| | H9 | 59' 0.832'' | -2.517 | 1.173 | -78.500 | 272.817 | 87.206 |
| | H10 | 59' 1.162'' | -1.990 | 357.392 | -80.000 | 270.417 | 87.915 |

FIGURE 2-7d. TRANSMITTER-RECEIVER DISTANCES

X2C RETRACTABLE STRUT EXTENDED 4 FEET 8/15/78 PAGE

| TRANSMITTER | RECEIVER | R TO T LENGTH | THETA-RT | PHI-RT | THETA-R | PHI-R | ANGLE-R TO RT |
|---|---|---|---|---|---|---|---|
| X2C | HF1 | 57' 9.830'' | -4.876 | 182.321 | -32.000 | 273.007 | 87.557 |
| | HF2 | 56' 10.133'' | -4.962 | 182.361 | -33.000 | 272.733 | 87.611 |
| | HF3 | 55' 11.174'' | -5.043 | 182.379 | -33.000 | 272.733 | 87.552 |
| | HF4 | 55' 0.217'' | -5.127 | 182.297 | -34.000 | 272.733 | 87.414 |
| | HF5 | 54' 2.256'' | -5.206 | 182.412 | -35.000 | 272.733 | 87.275 |
| | HF6 | 53' 3.280'' | -5.295 | 182.386 | -35.000 | 273.007 | 87.473 |
| | HF7 | 52' 5.312'' | -5.380 | 182.378 | -36.000 | 273.007 | 87.348 |
| | HF8 | 51' 6.339'' | -5.475 | 182.351 | -37.000 | 273.007 | 87.220 |
| | HF9 | 50' 9.378'' | -5.556 | 182.362 | -38.500 | 273.007 | 87.044 |
| | HF10 | 54' 5.417'' | -7.972 | 181.018 | -19.500 | 275.333 | 91.372 |
| | HF11 | 54' 4.047'' | -6.992 | 181.417 | -25.000 | 274.517 | 89.640 |
| | HF12 | 54' 3.128'' | -6.183 | 181.859 | -28.000 | 273.750 | 88.763 |
| | HF13 | 54' 1.721'' | -4.237 | 183.096 | -40.000 | 272.013 | 86.449 |
| | LF1 | 8' 6.417'' | -25.987 | 192.149 | -65.500 | 272.267 | 62.440 |
| | LF2 | 6' 4.958'' | -35.327 | 197.136 | -65.500 | 272.267 | 52.194 |
| | LF3 | 4' 9.099'' | -52.213 | 210.964 | -68.000 | 271.983 | 32.435 |
| | LF4 | 4' 10.602'' | -46.844 | 333.914 | -69.500 | 272.005 | 37.242 |
| | LF5 | 6' 9.203'' | -32.810 | 345.251 | -70.500 | 272.005 | 53.726 |
| | LF6 | 9' 1.625'' | -23.664 | 350.397 | -71.500 | 272.300 | 63.860 |
| | LF7 | 11' 5.363'' | -18.737 | 352.602 | -72.500 | 272.300 | 69.247 |
| | LF8 | 14' 0.372'' | -14.797 | 354.359 | -72.500 | 272.005 | 73.606 |
| | LF9 | 9' 1.719'' | -61.040 | 90.000 | -39.500 | 272.267 | 79.442 |
| | LF10 | 7' 5.631'' | -64.650 | 90.000 | -47.000 | 274.867 | 68.285 |
| | LF11 | 5' 9.452'' | -71.859 | 90.000 | -55.000 | 274.983 | 53.058 |
| | LF12 | 4' 5.553'' | -57.458 | 90.000 | -62.500 | 273.750 | 30.037 |
| | LF13 | 4' 5.658'' | -44.151 | 270.000 | -72.000 | 270.767 | 27.852 |
| | G1 | 16' 9.852'' | -37.332 | 30.192 | -28.500 | 276.450 | 89.148 |
| | G2 | 17' 2.384'' | -36.402 | 28.803 | -28.500 | 276.450 | 88.553 |
| | G3 | 20' 9.310'' | -29.926 | 23.599 | -28.000 | 276.450 | 89.228 |
| | G4 | 21' 3.710'' | -29.104 | 22.778 | -28.000 | 276.450 | 89.071 |
| | G5 | 14' 3.467'' | -26.659 | 358.436 | -38.000 | 276.333 | 62.973 |
| | G6 | 14' 9.946'' | -35.122 | 358.524 | -38.000 | 276.333 | 63.783 |
| | G7 | 19' 9.798'' | -25.467 | 22.743 | -38.000 | 276.400 | 86.052 |
| | G8 | 20' 4.500'' | -24.721 | 21.945 | -39.000 | 276.400 | 85.756 |
| | G9 | 20' 4.101'' | -36.274 | 33.609 | -24.000 | 276.450 | 95.511 |
| | G10 | 20' 9.546'' | -35.314 | 32.363 | -23.000 | 276.450 | 95.539 |
| | H1 | 11' 5.143'' | -20.487 | 187.042 | -63.500 | 272.850 | 69.893 |
| | H2 | 18' 10.427'' | -20.797 | 7.226 | -64.000 | 275.933 | 71.953 |
| | H3 | 18' 1.765'' | -15.208 | 2.079 | -65.000 | 274.567 | 74.535 |
| | H4 | 18' 0.507'' | -9.906 | 349.842 | -75.000 | 270.600 | 78.180 |
| | H5 | 42' 11.169'' | -5.039 | 1.507 | -76.500 | 273.350 | 84.670 |
| | H6 | 50' 10.709'' | -5.147 | 6.904 | -69.000 | 270.717 | 86.674 |
| | H7 | 59' 5.684'' | -5.074 | 5.165 | -73.000 | 274.767 | 85.332 |
| | H8 | 70' 4.679'' | -3.750 | 4.730 | [illegible] | 274.333 | 86.530 |
| | H9 | 59' 1.323'' | -3.605 | 0.809 | [illegible] | 272.917 | 86.283 |
| | H10 | [illegible] 1.443'' | [illegible] | 357.029 | [illegible] | 270.417 | 88.579 |

FIGURE 2-7e. TRANSMITTER-RECEIVER DISTANCES

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X2E  RETRACTABLE STRUT EXTENDED 5 FEET                                                  8/19/66          PAGE   7

TRANSMITTER     RECEIVER      R TO T LENGTH      THETA-RT      PHI-RT      THETA-R      PHI-R        ANGLE-R TO RT

   X2L            HF1          57' 11.075''        -5.821      182.652     -32.000     273.007          87.219
                  HF2          56' 11.400''        -5.921      182.698     -33.000     272.733          86.808
                  HF3          56'  0.460''        -6.018      182.721     -33.000     272.733          86.737
                  HF4          55'  1.522''        -6.118      182.745     -34.000     272.733          86.574
                  HF5          54'  3.579''        -6.211      182.765     -35.000     272.733          86.416
                  HF6          53'  4.622''        -6.318      182.746     -35.000     273.007          86.394
                  HF7          52'  6.671''        -6.418      182.744     -36.000     273.007          86.445
                  HF8          51'  7.716''        -6.532      182.723     -37.000     273.007          86.300
                  HF9          50' 10.776''        -6.628      182.740     -38.500     273.007          86.082
                  HF10         54'  7.194''        -8.967      181.372     -19.500     275.333          90.704
                  HF11         54'  5.657''        -7.391      181.771     -25.000     274.517          85.058
                  HF12         54'  4.608''        -7.185      182.213     -28.000     273.750          87.582
                  HF13         54'  2.900''        -5.245      183.449     -40.000     272.013          85.533
                  LF1           9'  0.741''       -31.227      194.559     -65.500     272.267          56.821
                  LF2           7'  1.101''       -41.150      200.556     -65.500     272.267          45.631
                  LF3           5'  7.752''       -56.695      216.254     -68.000     271.983          27.035
                  LF4           5'  8.605''       -52.256      329.007     -69.500     272.005          30.971
                  LF5           7'  4.843''       -38.660      342.055     -70.500     272.005          47.328
                  LF6           9'  7.377''       -28.753      348.162     -71.500     272.300          58.391
                  LF7          11' 10.006''       -23.061      350.862     -72.500     272.300          64.631
                  LF8          14'  4.088''       -18.463      352.962     -72.500     272.005          69.704
                  LF9           9' 10.193''       -65.441       90.000     -39.500     272.267          75.044
                  LF10          [illegible]'  2.691''       -69.614       90.000     -47.000     274.867          63.331
                  LF11          6'  7.479''       -77.188       90.000     -55.000     274.983          47.775
                  LF12          5'  9.020''       -88.568      270.000     -62.500     273.750          26.011
                  LF13          5'  4.764''       -48.991      270.000     -72.000     270.767          23.012
                  G1           17'  3.630''       -40.829       28.931     -28.500     276.450          86.652
                  G2           17'  9.012''       -39.590       27.590     -28.500     276.450          86.563
                  G3           21'  1.914''       -32.452       22.620     -28.500     276.450          87.215
                  G4           21'  8.300''       -31.480       21.825     -28.500     276.450          87.108
                  G5           14' 10.700''       -39.586      356.774     -38.000     276.333          60.451
                  G6           15'  4.927''       -38.009      356.951     -36.000     276.333          61.293
                  G7           20'  1.628''       -28.084       21.751     -38.500     276.400          83.669
                  G8           20'  5.226''       -27.274       20.982     -39.000     276.400          83.426
                  G9           20'  9.357''       -38.653       32.629     -24.000     276.450          93.480
                  G10          21'  2.690''       -37.700       31.403     -23.500     276.450          93.570
                  M1           11' 10.079''       -24.758      188.805     -63.500     272.850          65.366
                  M2           19'  2.332''       -23.508        6.149     -64.000     275.933          69.084
                  M3           18'  4.958''       -18.094        6.989     -69.000     274.567          71.868
                  M4           12'  3.483''       -12.733      148.788     -78.000     270.600          75.102
                  M5           43'  0.217''        -6.312        1.061     -76.500     273.350          83.329
                  M6           50' 11.529''        -6.243        4.529     -69.000     270.717          85.536
                  M7           55'  0.446''        -5.556        4.844     -71.000     274.767          84.357
                  M8           70'  5.190''        -4.990        4.459     -73.000     274.333          85.705
                  M9           55'  2.092''        -4.331        0.486     -78.500     272.817          85.291
                  M10          59'  7.736''        -3.007      356.706     -80.000     270.417          85.612
```

FIGURE 2-7f. TRANSMITTER-RECEIVER DISTANCES

X4 FIXED STRUT AT FRAME 82 8/19/66 PAGE

| TRANSMITTER | RECEIVER | R TO T LENGTH | THETA-RT | PHI-RT | THETA-N | PHI-N | ANGLE-N TO RT |
|---|---|---|---|---|---|---|---|
| X4 | HF1 | 116' 9.450" | -3.452 | 180.860 | -32.000 | 273.007 | 89.989 |
| | HF2 | 115' 9.723" | -3.481 | 180.867 | -33.000 | 272.733 | 89.667 |
| | HF3 | 114' 10.741" | -3.509 | 180.864 | -33.000 | 272.733 | 89.655 |
| | HF4 | 113' 11.759" | -3.537 | 180.860 | -34.000 | 272.733 | 89.573 |
| | HF5 | 113' 1.775" | -3.563 | 180.856 | -35.000 | 272.733 | 89.492 |
| | HF6 | 112' 2.787" | -3.592 | 180.831 | -35.000 | 273.007 | 89.719 |
| | HF7 | 111' 4.801" | -3.619 | 180.816 | -36.000 | 273.007 | 89.643 |
| | HF8 | 110' 5.813" | -3.649 | 180.790 | -37.000 | 273.007 | 89.572 |
| | HF9 | 109' 8.829" | -3.674 | 180.785 | -38.500 | 273.007 | 89.450 |
| | HF10 | 113' 3.964" | -4.893 | 180.190 | -19.500 | 275.333 | 93.154 |
| | HF11 | 113' 3.073" | -4.420 | 180.381 | -25.000 | 274.517 | 91.869 |
| | HF12 | 113' 2.433" | -4.031 | 180.592 | -28.000 | 273.750 | 90.889 |
| | HF13 | 113' 1.274" | -3.099 | 181.184 | -40.000 | 272.013 | 88.643 |
| | LF1 | 66' 9.182" | -5.030 | 180.888 | -65.500 | 272.267 | 85.995 |
| | LF2 | 64' 3.258" | -5.198 | 180.858 | -65.500 | 272.267 | 85.859 |
| | LF3 | 61' 9.441" | -5.456 | 180.854 | -68.000 | 271.983 | 85.365 |
| | LF4 | 56' 3.526" | -5.788 | 180.906 | -69.500 | 272.005 | 84.564 |
| | LF5 | 53' 9.821" | -6.167 | 180.926 | -70.500 | 272.005 | 84.548 |
| | LF6 | 51' 1.016" | -6.498 | 180.917 | -71.500 | 272.300 | 84.277 |
| | LF7 | 48' 7.238" | -6.844 | 180.965 | -72.500 | 272.300 | 83.875 |
| | LF8 | 45' 10.336" | -7.137 | 180.944 | -72.500 | 272.005 | 83.514 |
| | LF9 | 60' 0.840" | -9.694 | 175.146 | -39.500 | 272.267 | 89.266 |
| | LF10 | 59' 9.383" | -6.527 | 176.333 | -47.000 | 274.867 | 89.521 |
| | LF11 | 59' 6.446" | -7.348 | 177.685 | -55.000 | 274.983 | 88.138 |
| | LF12 | 59' 4.442" | -6.356 | 179.241 | -62.500 | 273.750 | 86.438 |
| | LF13 | 59' 3.473" | -5.060 | 182.547 | -72.000 | 270.767 | 84.638 |
| | G1 | 49' 8.177" | -14.535 | 171.329 | -28.500 | 276.450 | 95.863 |
| | G2 | 49' 0.526" | -14.728 | 171.208 | -28.500 | 276.450 | 95.862 |
| | G3 | 44' 11.692" | -16.109 | 169.611 | -28.500 | 276.450 | 96.441 |
| | G4 | 44' 4.138" | -16.344 | 169.449 | -28.500 | 276.450 | 96.447 |
| | G5 | 48' 8.637" | -12.622 | 179.674 | -38.000 | 276.333 | 87.401 |
| | G6 | 48' 0.833" | -12.795 | 179.669 | -38.000 | 276.333 | 87.296 |
| | G7 | 44' 5.374" | -13.844 | 169.992 | -38.500 | 276.400 | 93.767 |
| | G8 | 43' 9.730" | -14.049 | 169.636 | -39.000 | 276.400 | 93.564 |
| | G9 | 48' 5.519" | -16.959 | 167.963 | -24.000 | 276.450 | 99.116 |
| | G10 | 47' 10.042" | -17.187 | 167.788 | -23.500 | 276.450 | 99.352 |
| | H1 | 69' 10.761" | -5.019 | 180.600 | -63.500 | 272.850 | 86.512 |
| | H2 | 42' 6.213" | -11.962 | 176.137 | -64.000 | 275.933 | 83.493 |
| | H3 | 42' 0.999" | -9.402 | 178.318 | -69.000 | 274.567 | 83.452 |
| | H4 | 41' 10.809" | -7.112 | 183.519 | -76.000 | 270.600 | 82.438 |
| | H5 | 17' 4.406" | -19.809 | 173.999 | -76.500 | 273.350 | 72.513 |
| | H6 | 11' 10.636" | -34.298 | 149.954 | -69.000 | 270.717 | 67.998 |
| | H7 | 9' 5.460" | -51.261 | 90.000 | -71.000 | 274.767 | 57.691 |
| | H8 | 14' 4.559" | -27.965 | 30.094 | -73.000 | 274.333 | 70.460 |
| | H9 | 5' 9.608" | -75.864 | 90.000 | -78.500 | 272.817 | 25.628 |
| | H10 | 5' 7.608" | -64.001 | 270.000 | -80.000 | 270.417 | 15.999 |

FIGURE 2-7g. TRANSMITTER-RECEIVER DISTANCES

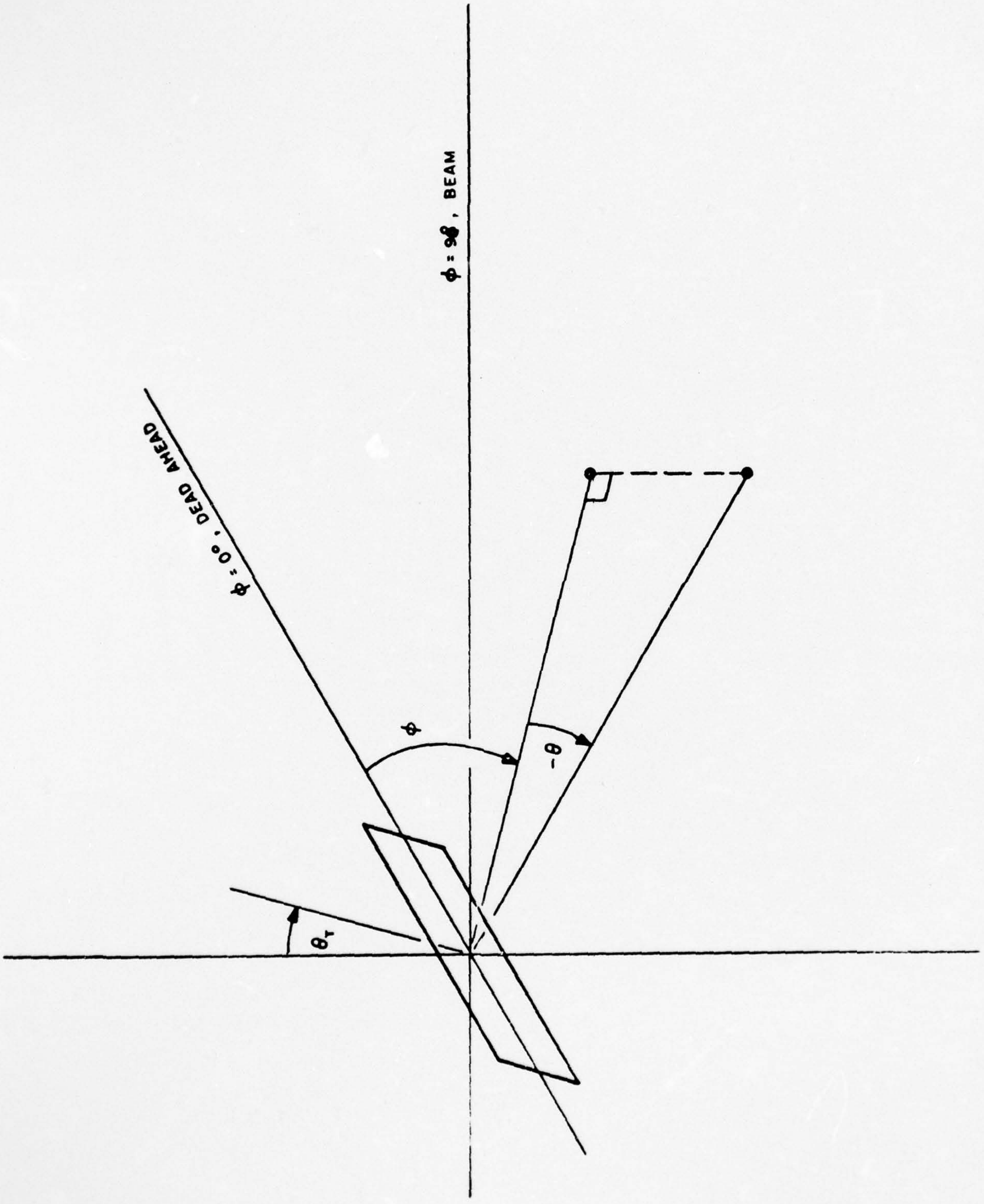

FIGURE 2-8. C/P SONAR COORDINATE SYSTEM

# SECTION III

## SHIPBOARD INSTRUMENTATION

### A. RECORDING CENTER

A functional block diagram of the PURVIS II instrumentation appears in Figure 3-1. The equipment configuration within each rack of the Shipboard Recording Center is described in Figure 3-2. This facility contains all of the instruments necessary for amplifying signal conditioning and recording on magnetic tape, up to 60 data channels plus 10 timing and tape speed control signals simultaneously. In addition, the equipment contains variable and fixed filters, power amplifiers, a direct write recording oscillograph, waveform analyzers, and other instruments useful in performing a "quick-look" analysis of data prior to, during, or after a "run" has been completed. All equipment needed to calibrate the tape recorders is also included within the facility.

A detailed description of the equipment within the Shipboard Recording Center used during the PURVIS I Sea Trials appears in Reference 1. This configuration was basically retained for the PURVIS II Sea Trials with the following modifications:

a) The number of Signal Conditioning Amplifiers (SCAs) was increased from 48 to 84. This provided the capability of connecting each sonar transducer (hydrophone or accelerometer) preamplifier output directly to a SCA. In this manner the "patching" of signals (limited by the number of tape recording channels to a maximum of 48 high bandwidth channels simultaneously) was performed at the SCA outputs, where the amplified signal levels were considerably higher than at the SCA inputs. (The latter technique was used for PURVIS I.)

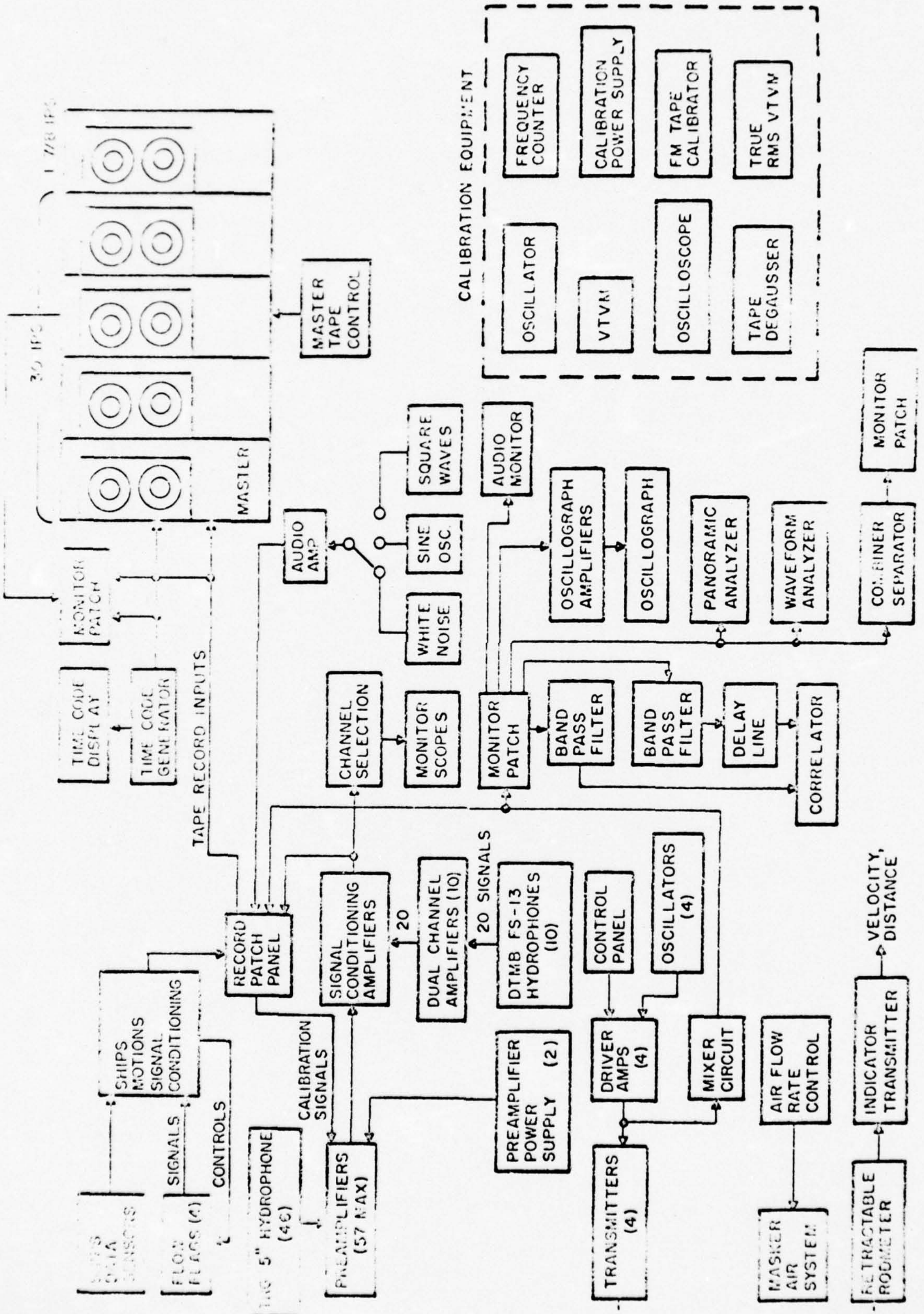

FIGURE 3-1. PURVIS II INSTRUMENTATION, BLOCK DIAGRAM

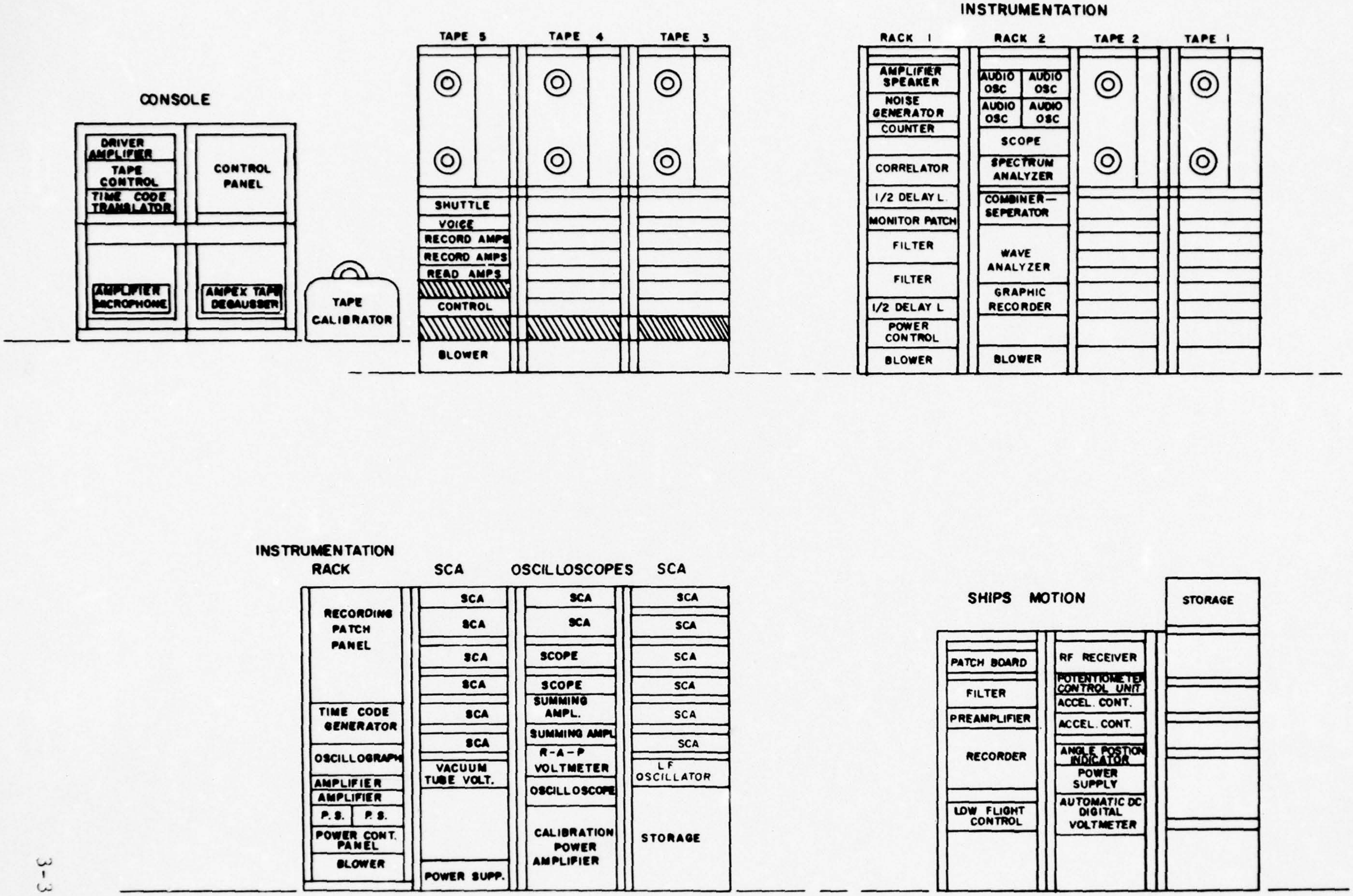

FIGURE 3-1 PURVIS II SHIPBOARD RECORDING CENTER

b) Ten variable gain dual-channel and summing amplifiers were added to the Recording Center for the acoustic and vibration signals originating at the 10 FS-13 hydrophones located in Sea Chest 1. The gain of each channel was set at 20 db and essentially served as a preamplifier for the signals from Sea Chest 1.

c) The pushbutton oscillator used for PURVIS I was supplemented by the addition of 3 more units, in order to have 4 variable frequency sources for the four driver-amplifiers and acoustic transmitters.

d) A "combiner-separator" panel was fabricated and installed. This unit used a summing network for combining a monitor output signal for each driver-amplifier into one composite signal which could then be recorded on the magnetic tapes during transmission tests. In addition, it contained fixed-frequency, narrow band-pass filters which could be used to separate any one frequency of the four transmitting frequencies from a hydrophone output during either the "real time" or during tape playback.

e) A flow flag instrumentation and control panel was installed in the ship's motion electronics rack for conditioning the 400 Hz signals from the four flow flags, in DC signals suitable for magnetic tape recording at 1-7/8 ips.

Other modifications included a change in the cabling used (from the bulkhead terminal strips to the SCAs) from TTRS-16 to Triaxial type, adding new preamplifier power supplies and eliminating the calibration patch panel.

## B. OTHER SHIPBOARD INSTRUMENTATION

The experiments planned for PURVIS II included transmission tests for determining the effects of bubble sweepdown, ship's motion, etc., on the amplitude and phase of the received signals, at various hydrophones. For this purpose, three struts (2 fixed, 1 retractable) were installed on the port side of the ship, each containing a hydrophone suitable for transmitting. (A fourth transmitter had been installed in the Sonar Dome prior to the PURVIS I tests.) Four driver amplifiers were installed, one in the vicinity of each transmitter, to provide the necessary power amplification for the sinusoidal transmitting signals which were generated by test oscillators located in the Recording Center.

The output signals from most of the 46 5-inch hydrophones and 11 miniature accelerometers mounted on the rear mass of some of the hydrophones were connected to 20 db gain preamplifiers which were mounted on the back cover of each hydrophone sea chest. Since the hydrophones mounted in Sea Chest II were installed in a water-floodable area, the preamplifiers, which were not designed to be completely watertight, were mounted approximately 10 feet away in a dry area.

Four flow flags, each containing a rotating inductor, were fabricated by GD/EB and installed on the ship (3 on the port side, and 1 on the starboard side). These devices, operating with 400 Hz excitation, generated signals as a function of the position changes of the flag due to water flow around it.

The masker system (bubble generators) was modified to permit three different flow rates of bubbles from each masker.

A velocity transmitter-indicator unit was installed near the retractable strut, since this device was basically a velocity sensing rodmeter which was modified by the addition of a transmitting hydrophone.

## SECTION IV

## SUMMARY OF RUNS

### A. RUN CLASSIFICATION/DESCRIPTION

The PURVIS II Sea Trials were performed in two basic series of tests: a) Naval Architecture (Photographic) and b) Acoustics. Each run in both series was assigned a predetermined three-digit run number. The magnetic tape data recorded during the run was identified by both voice annotation and the range time code, which contained the thumb-wheel controlled run number within the code recorded on each tape. The external photographic data was identified by photographing an underwater slate containing the appropriate run number prior to the start of each. A brief description of the test conditions for each series appears below.

### B. NAVAL ARCHITECTURE SERIES

The Naval Architecture Series is more commonly described as the photographic series, since both external and on-board (Fish-eye) cameras were employed to obtain photographic data of the bubble flow patterns associated with both natural bubbles and artificial bubbles injected by the shipboard Masker System and /or Bow Wave Hose. The run numbers for the photographic series were generally subdivided into 3 "hundreds" series as follows:

| | |
|---|---|
| "0" hundred (i.e., 021) | No Maskers were used |
| "1" hundred (i.e., 114) | Masker No. 3 used |
| "2" hundred (i.e., 216) | Masker Nos. 2 & 4 used |

A tabulation of all photographic runs appears in Appendix A.

### C. ACOUSTIC SERIES

The Acoustic Series was identified by run numbers between 300 and 999. The general description of each "hundred" series was as follows:

| | | |
|---|---|---|
| "3" hundred (i.e., 336) | Passive Runs, ships heading WRT sea | 0° |
| "4" hundred (i.e., 448) | " " " " " " | 90° |
| "5" hundred (i.e., 550) | " " " " " " | 180° |
| "6" hundred (i.e., 642) | " " " " " " | 270° |
| "7" hundred (i.e., 782) | Transmission runs, various headings | |
| "8" hundred (i.e., 835) | Transmission runs and electrical calibrations | |
| "9" hundred (i.e., 970) | Special tests, such as Ship's motion data only, electrical calibrations, overside acoustic calibrations, etc. | |

A complete tabulation of all Acoustic Series runs in numerical order appears in Appendix B-2. A cross-referenced tabulation of these runs by calendar date appears in Appendix B-1.

# SECTION V

## IN-SITU CALIBRATION

### A. GENERAL DESCRIPTION

In-situ calibrations were performed at the TOTO test area. during July 6-12, 1966. The hydrophone locations are shown in Figures 2-1a and 2-1b. A block diagram of the transmission instrumentation set-up is shown in Figure 5-1. The scanning frequency was derived from a General Radio Wave Analyzer. The current to the transmitter was monitored on both an oscilloscope and an RMS voltmeter. The transmitter current was kept constant by manually controlling the Wave Analyzer voltage while viewing the meter. The current (voltage across a 1 ohm resistor) was also recorded on a magnetic tape channel during each calibration along with the hydrophones covered at each station. The hydrophones and record combinations are summarized in Figure 5-2.

The in-situ calibrations were performed at five stations along the portside of the ship corresponding to the approximate center of each grouping of hydrophones. (See Figures 5-4 to 5-8)*. The transmitting projector was placed at four different depths at each station while the transmitting frequency was swept from 50 Hz to 20 KHz.

The frequency was swept in three ranges: (1) 50 Hz to 3 KHz, (2) 2 KHz to 6 KHz, and (3) 5 KHz to 20 KHz, with a 1 KHz overlap between Parts 1 and 2 and between Parts 2 and 3. The sweep rates and currents are summarized in Figure 5-9. In addition, at each range, a 30 second "constant frequency" and a 30 second "ambient level" (no transmission) were recorded. The summary of runs is given in Figure 5-3. The distance between each 5" receiver and the J-9 transmitter (R to T length) for each calibration position is tabulated in Figure 5-10 (Note: R to T lengths for receivers D1H through D10H were not available for inclusion in this report.

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*Reference GD/EB Dwg. No. 200771

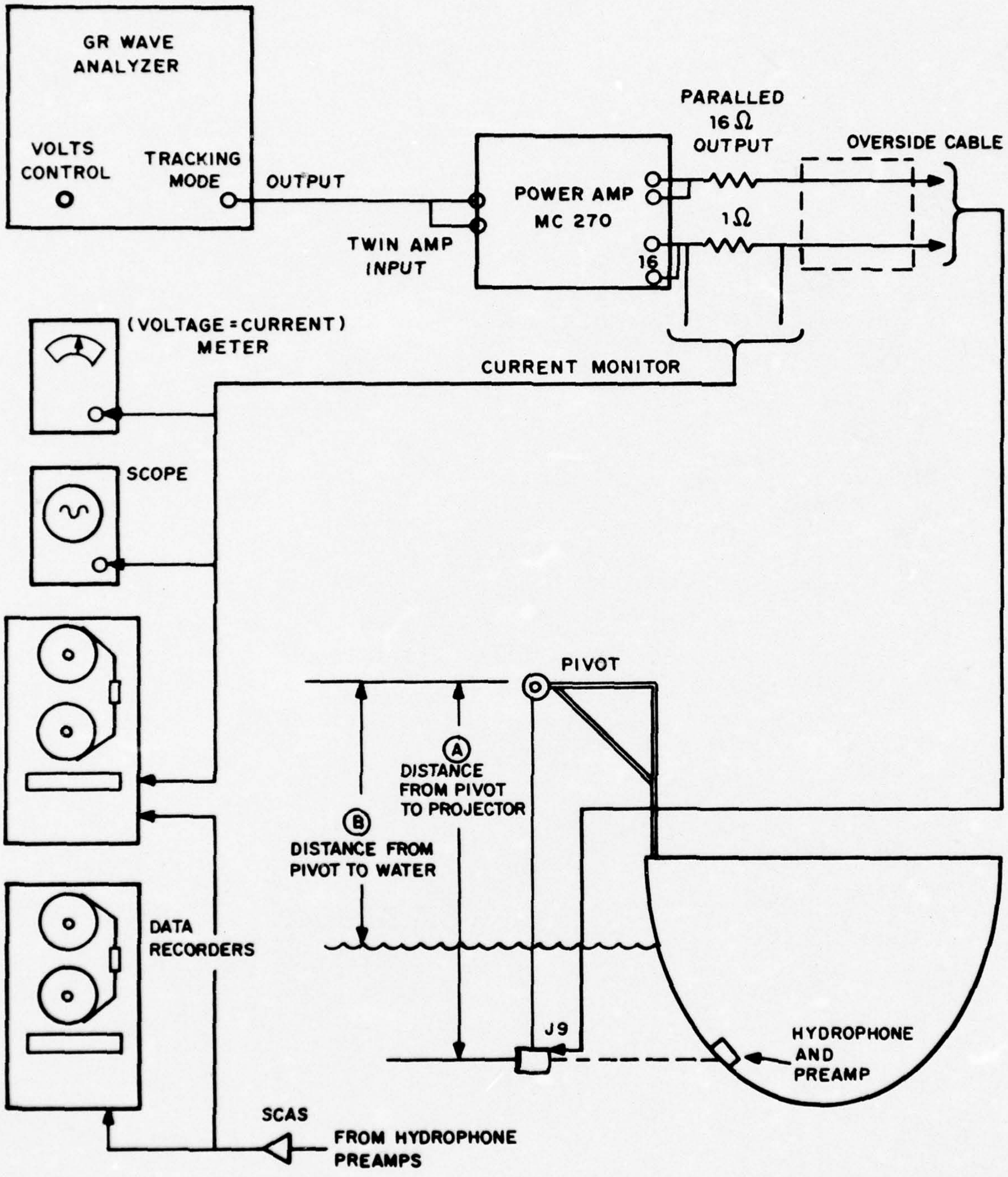


FIGURE 5-1. OVERSIDE CALIBRATION TRANSMITTER SETUP

## B. INSTRUMENTATION CONFIGURATION

Each of the five calibration stations were selected to provide an approximate central forward-aft position for each of the five groups of receiving elements, as follows:

Fr. 17-1/2: Station 1 - High Frequency Array (HF-1 through HF-13)
Fr. 22-1/2: Station 2 - Sea Chest 1 (D1H through D10H)
Fr. 48-1/2: Station 3 - Low Frequency Array (LF-1 through LF-13) and Hull Element H-1
Fr. 56-1/2: Station 4 - Sea Chest 2 (G-1 through G-10) and Hull Elements H-2 through H-4
Fr. 80-1/2: Station 5 - Hull Elements H-5 through H-10

The tape recording combinations were arranged so that only 2 of the 4 high speed 30 ips recorders were in use when the projector was at Stations 1, 2, 3, and 4, and only 1 was required for Station 5 calibrations, thus permitting an efficient utilization of the magnetic tapes for this operation.

The gain and frequency controls on each of the Signal Conditioning Amplifiers (SCAs) were set prior to the start of each of the three frequency sweeps. This was done by driving the transmitter at a constant pre-determined frequency within each band which yielded the maximum output from the transmitter. Hence, during Part 1(50 Hz to 3 KHz) the SCA gain controls were set with the transmitter input at 2.5 KHz, during Part 2 (2 KHz to 6 KHz) the setting frequency was 6 KHz, and during Part 3 (5KHz to 20 KHz) the setting frequency was 12.5 KHz. The SCA pre-emphasis (pre-whitening) controls were generally set in the "Flat" position for Parts 1 and 2, and in the 1 KHz position for Part 3.

FIGURE 5-2 RECORD COMBINATIONS USED AT EACH CALIBRATION STATION

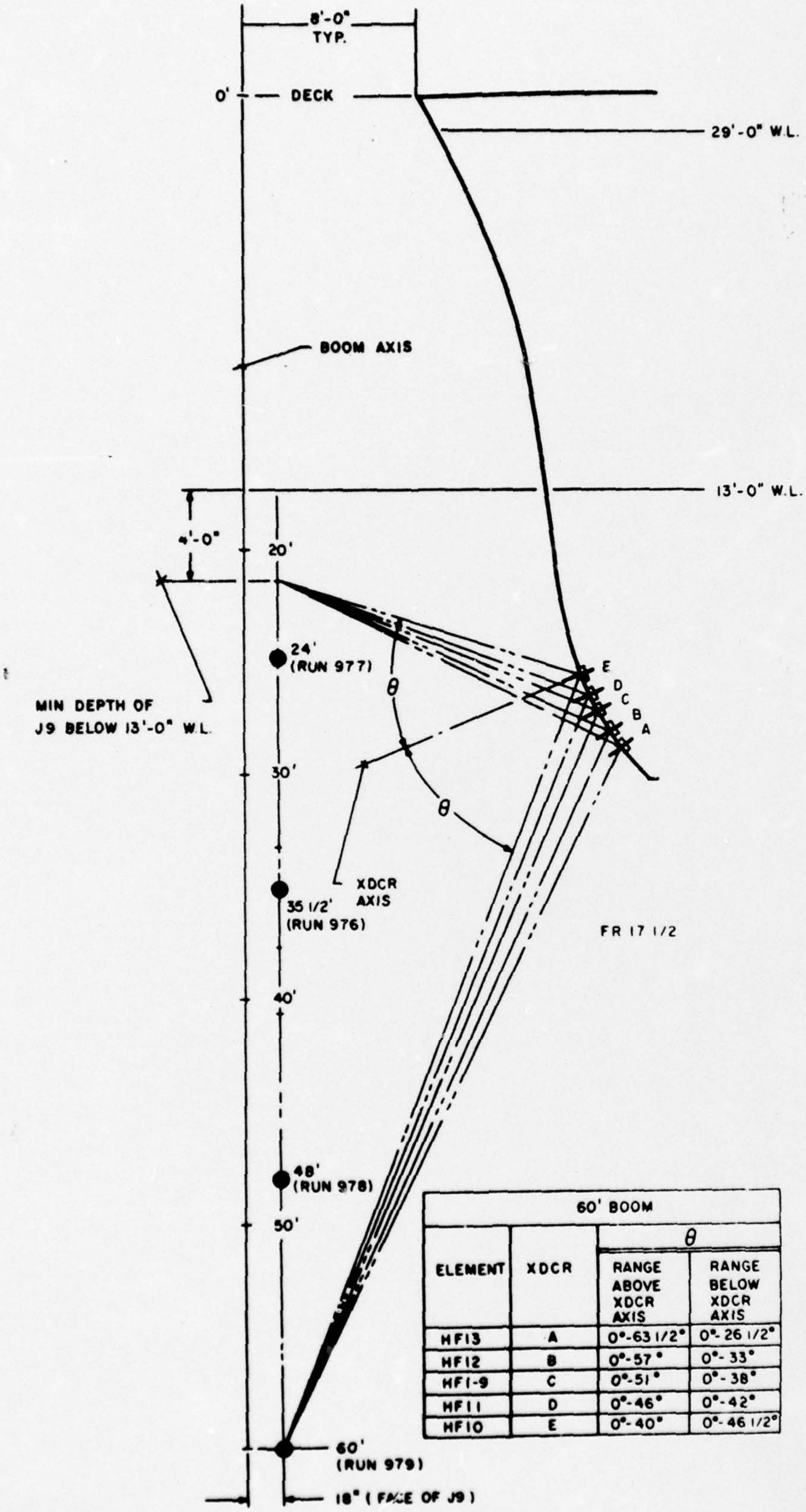
| | |
|---|---|
| STATION I: | Combination 1-1: Recorders 1,2,4*<br>Hydrophones HF1 → HF13 (plus A1,4,5,7,9; LF1,9,13; G8; H5) |
| STATION II: | Combination 1-1: Recorders 3,4<br>Hydrophones D1H → D10H, D1A → D10A (plus H1, H10; LF8) |
| STATION III: | Combination 2-1: Recorders 1,2,4*<br>Hydrophones LF1 → LF13 (plus H1; HF2,3,9,10,13; A5,7; D5H, D6H) |
| STATION IV: | Combination 2-1: Recorders 3,4<br>Hydrophones G1 → G10, H2,H3,H4 (plus A1,2,3,4,9,11; D1H,D2H,D4H, H5) |
| STATION V: | Combination 3-1: Recorders 2,4*<br>Hydrophones H5 through H10 (plus A8,9; G5,8) |

* SERVO ONLY (used no tape)

| POSITION | STATION | Ⓐ<br>PIVOT TO PROJ. | Ⓑ<br>PIVOT TO WATER | RUN NO. | DATE | TAPE NO | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 39 1/2 | 18 1/2 | 971 | 7/6 | 170 | 270 | 372 | 476 |
| 2 | 3 | 52 | 18 1/2 | 973 | 7/6 | 171 | 271 | 373 | 477 |
| 3 | 5 | 51 | 15 1/2 | 974 | 7/7 | 172 | 272 | 374 | 478 |
| 4 | 5 | 37 | 15 1/2 | 975 | ↓ | 173 | 273 | 375 | 479 |
| 5 | 1 | 40 1/2 | 22 | 976 | ↓ | 174 | 274 | 376 | 480 |
| 6 | 1 | 29 | 22 | 977 | ↓ | 174,$\bar{5}$ | 274,$\bar{5}$ | 376,$\bar{7}$ | 480,$\bar{1}$ |
| 7 | 1 | 53 | 22 | 978 | ↓ | 175,$\bar{6}$ | 275,$\bar{6}$ | X | X |
| 8 | 1 | 65 | 22 | 979 | ↓ | 176 | 276 | X | X |
| 9 | 2 | 65 | 21 1/2 | 980 | 7/8 | X | X | 37$\bar{7}$,8 | 48$\bar{1}$,2 |
| 10 | 2 | 53 | 21 1/2 | 981 | 7/10 | X | X | 38$\bar{1}$,2 | 48$\bar{5}$,6 |
| 11 | 2 | 40 | 21 1/2 | 982 | ↓ | X | X | 382 | 486 |
| 12 | 2 | 28 | 21 1/2 | 983 | ↓ | X | X | 383 | 487 |
| 13 | 3 | 26 | 18 1/2 | 984 | 7/11 | 18$\bar{0}$,2 | 28$\bar{0}$,2 | X | X |
| 14 | 3 | 65 | 18 1/2 | 985 | ↓ | 182 | 282 | X | X |
| 15 | 4 | 65 | | 986 | ↓ | X | X | 38$\bar{3}$,5 | 48$\bar{7}$,9 |
| 16 | 4 | 52 | | 987 | ↓ | X | X | 385,$\bar{6}$ | 48$\bar{9}$,90 |
| 17 | 4 | 38 | | 988 | ↓ | X | X | 386 | 490 |
| 18 | 4 | 25 | | 989 | ↓ | X | X | 387 | 491 |
| 19 | 5 | 23 | 15 1/2 | 990 | 7/12 | X | 283 | X | X |
| 20 | 5 | 65 | 15 1/2 | 991 | 7/12 | X | 283,$\bar{4}$ | X | X |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

Ⓐ
Ⓑ } SEE FIG. 5-1

FIGURE 5-3. OVERSIDE CALIBRATION RUN SUMMARY

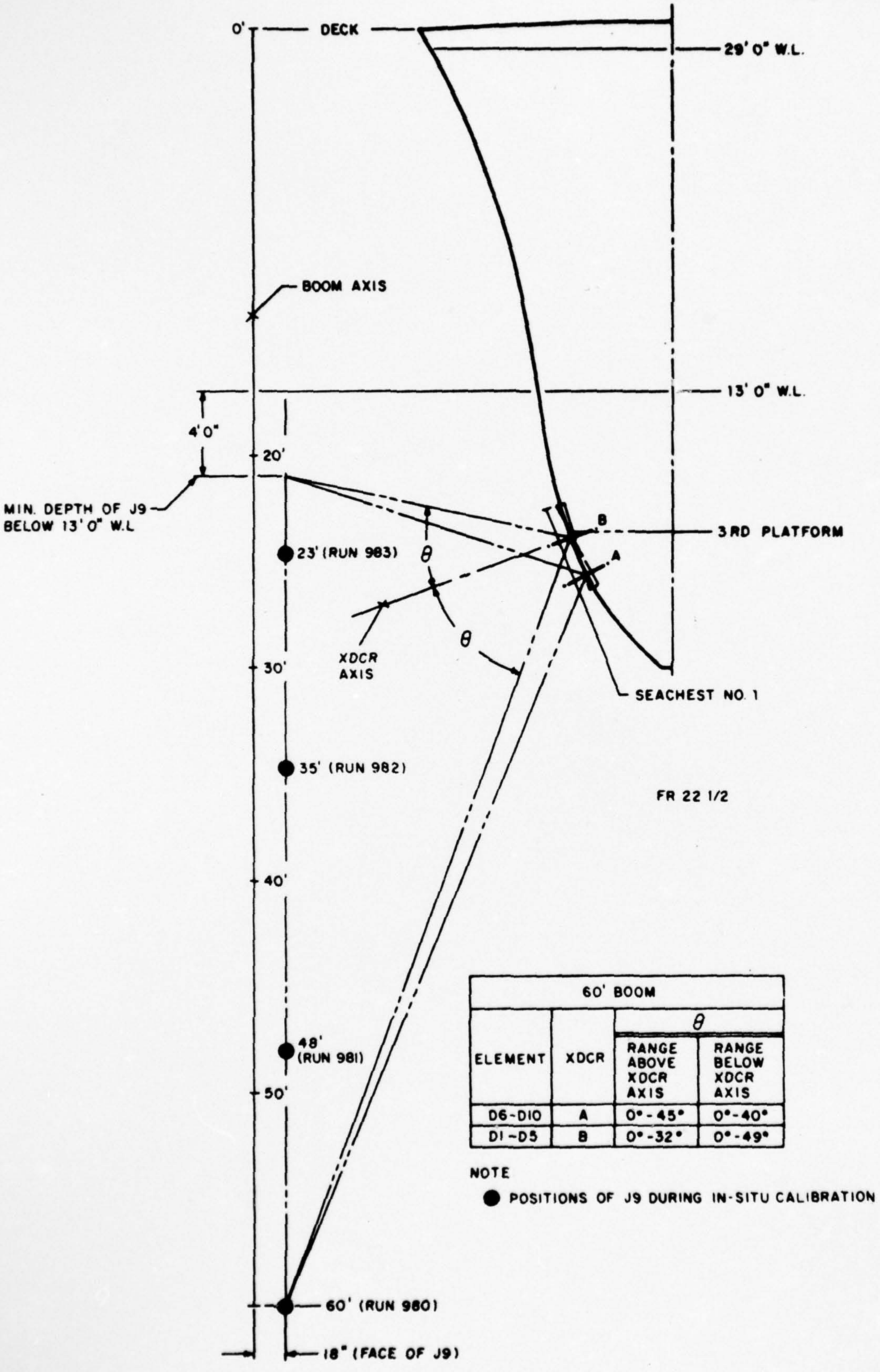


| 60' BOOM | | | |
|---|---|---|---|
| ELEMENT | XDCR | θ | |
| | | RANGE ABOVE XDCR AXIS | RANGE BELOW XDCR AXIS |
| HF13 | A | 0°-63 1/2° | 0°-26 1/2° |
| HF12 | B | 0°-57° | 0°-33° |
| HF1-9 | C | 0°-51° | 0°-38° |
| HF11 | D | 0°-46° | 0°-42° |
| HF10 | E | 0°-40° | 0°-46 1/2° |

NOTE

● POSITIONS OF J9 DURING IN-SITU CALIBRATION

FIGURE 5-4 CALIBRATION STATION 1: HIGH-FREQUENCY ARRAY

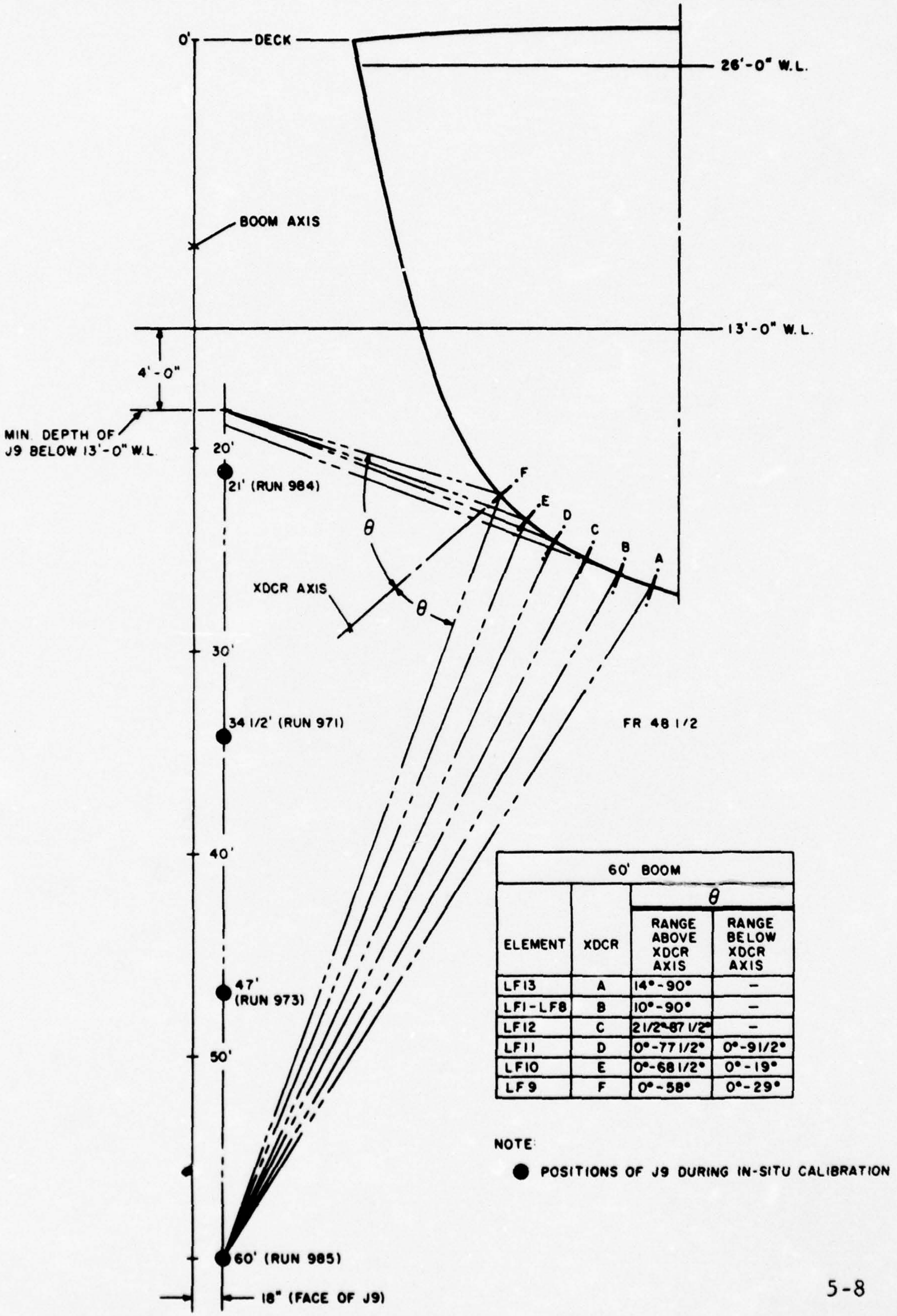


| 60' BOOM | | | |
|---|---|---|---|
| | | θ | |
| ELEMENT | XDCR | RANGE ABOVE XDCR AXIS | RANGE BELOW XDCR AXIS |
| D6-D10 | A | 0°-45° | 0°-40° |
| D1-D5 | B | 0°-32° | 0°-49° |

NOTE

● POSITIONS OF J9 DURING IN-SITU CALIBRATION

FIGURE 5-5 CALIBRATION STATION 2: SEA CHEST No. 1

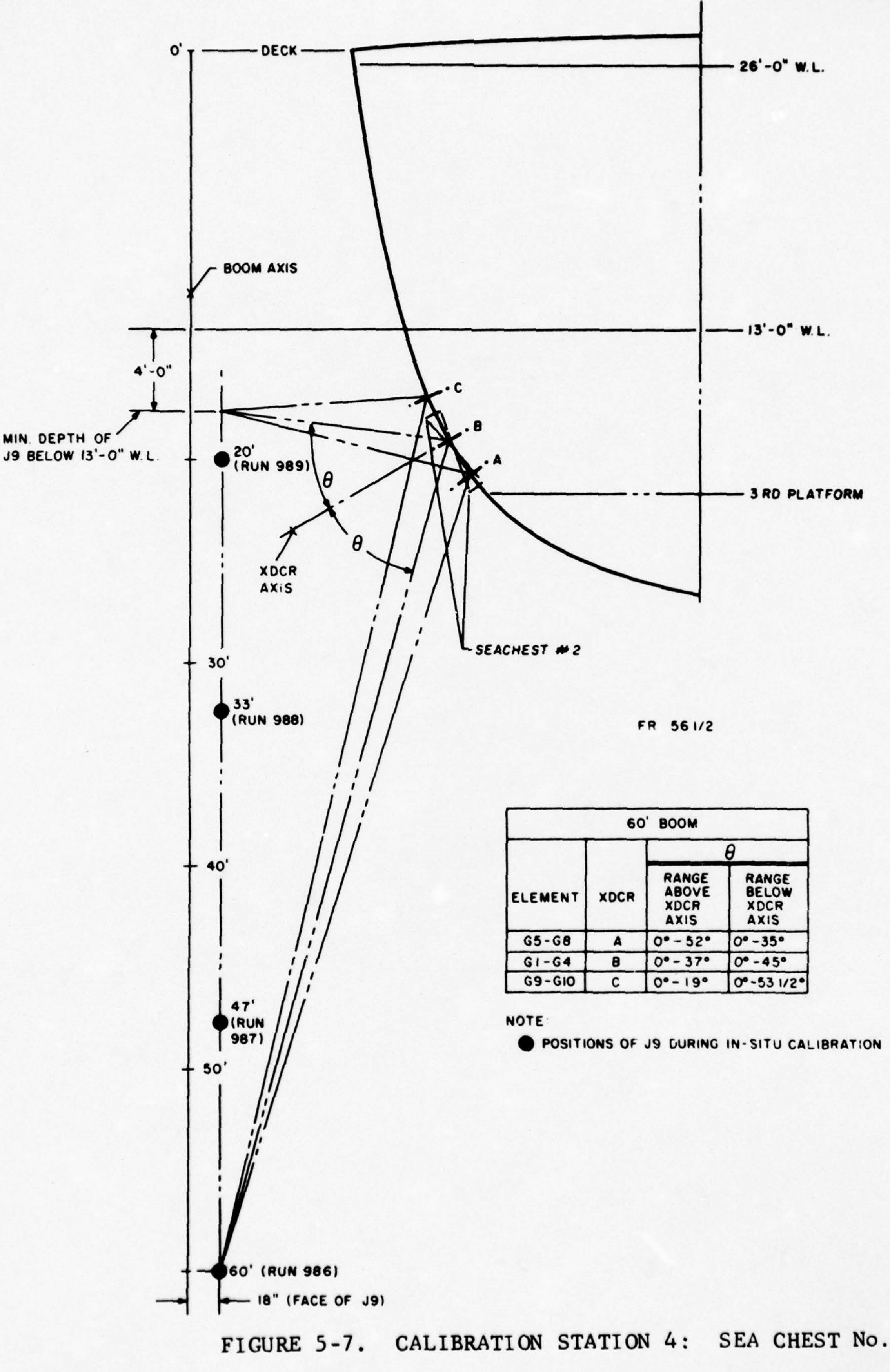


| 60' BOOM | | | |
|---|---|---|---|
| | | θ | |
| ELEMENT | XDCR | RANGE ABOVE XDCR AXIS | RANGE BELOW XDCR AXIS |
| LF13 | A | 14°-90° | – |
| LF1-LF8 | B | 10°-90° | – |
| LF12 | C | 2 1/2°-87 1/2° | – |
| LF11 | D | 0°-77 1/2° | 0°-9 1/2° |
| LF10 | E | 0°-68 1/2° | 0°-19° |
| LF9 | F | 0°-58° | 0°-29° |

NOTE:

● POSITIONS OF J9 DURING IN-SITU CALIBRATION

FIGURE 5-6 CALIBRATION STATION 3: LOW-FREQUENCY ARRAY

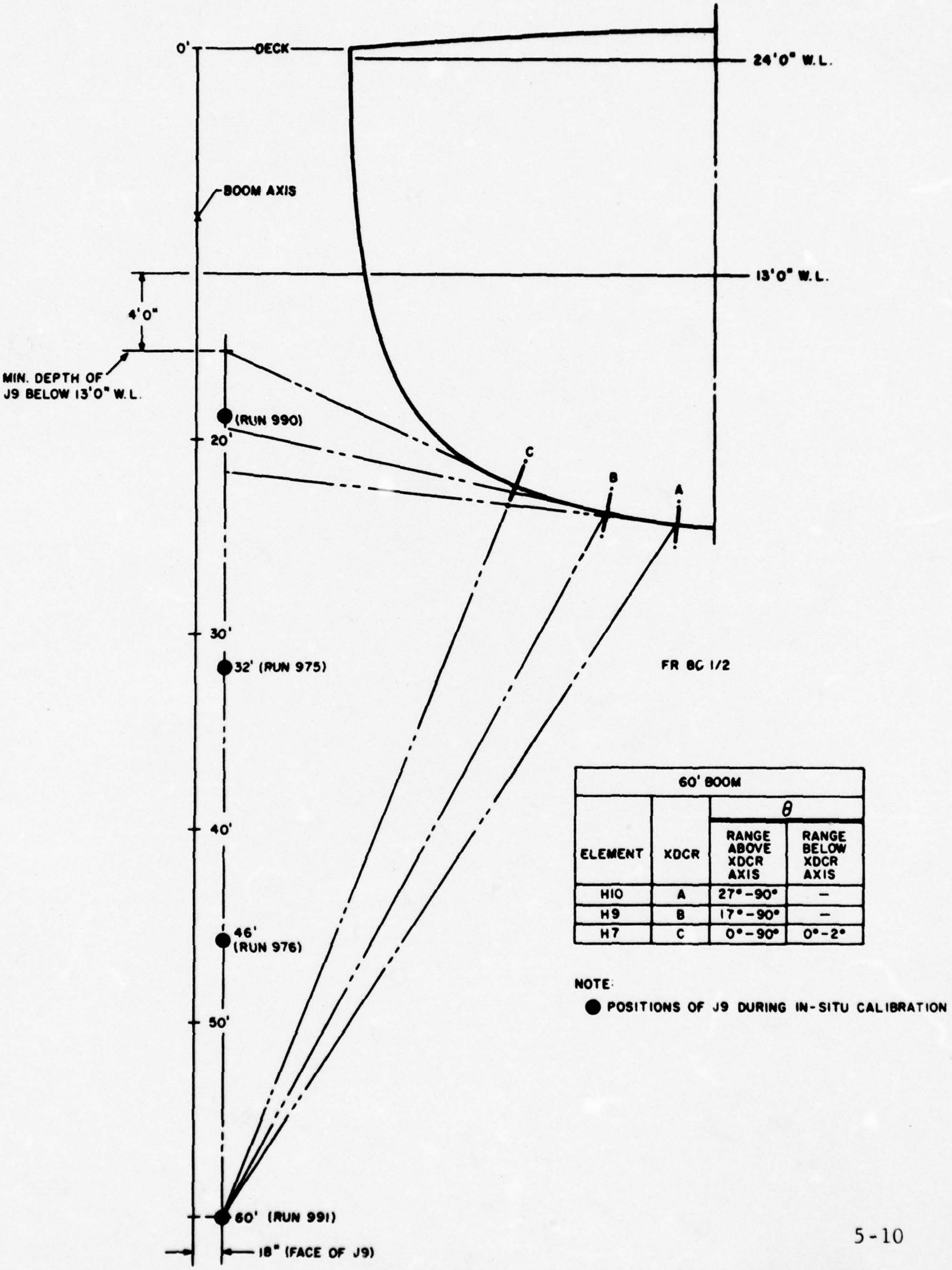


| 60' BOOM | | | |
|---|---|---|---|
| | | θ | |
| ELEMENT | XDCR | RANGE ABOVE XDCR AXIS | RANGE BELOW XDCR AXIS |
| G5-G8 | A | 0° - 52° | 0° -35° |
| G1-G4 | B | 0° - 37° | 0° -45° |
| G9-G10 | C | 0° - 19° | 0°-53 1/2° |

NOTE

● POSITIONS OF J9 DURING IN-SITU CALIBRATION

FIGURE 5-7. CALIBRATION STATION 4: SEA CHEST No. 2



| 60' BOOM | | | |
|---|---|---|---|
| | | θ | |
| ELEMENT | XDCR | RANGE ABOVE XDCR AXIS | RANGE BELOW XDCR AXIS |
| H10 | A | 27°-90° | – |
| H9 | B | 17°-90° | – |
| H7 | C | 0°-90° | 0°-2° |

NOTE:

● POSITIONS OF J9 DURING IN-SITU CALIBRATION

FIGURE 5-8 CALIBRATION STATION 5: HULL ELEMENTS

### Part 1

a) Frequency: 50 hz to 30 khz sweep
J9 current: 0.7 amperes (0.8 amperes initially)
Sweep rate: $\left(\frac{1.5 \times 1 \text{ ipm}}{2 \text{ in/KHz}}\right) = 750$ hz/min

b) Constant frequency: 3 khz, 30 seconds

c) Ambient Levels: 30 seconds

### Part 2

a) Frequency: 2 khz to 6 KHz sweep
J9 Current: 0.5 amperes
Sweep rate: $\left(\frac{1.5 \times 1 \text{ ipm}}{2 \text{ in/KHz}}\right) \approx 750$ hz/min

b) Constant frequency: 6 khz, 30 seconds

c) Ambient levels: 30 seconds

### Part 3

a) Frequency: 5 khz to 20 khz sweep
J9 current: 0.2 amperes (0.3 amperes initially)
Sweep rate: $\left(\frac{0.5 \times 10 \text{ ipm}}{2 \text{ in/KHz}}\right) = 2.5$ khz/min

b) Constant frequency: 5 khz, 30 seconds

c) Ambient levels: 30 seconds

FIGURE 5.9 OVERSIDE CALIBRATION RANGES

OVERSIDE CALIBRATION GEOMETRY FOR STATION 1    8/23/66    PAGE 1

| | POSITION 1 | | POSITION 2 | | POSITION 3 | | POSITION 4 | |
|---|---|---|---|---|---|---|---|---|
| RECEIVER | R TO T LENGTH | COHEN ANGLE | R TO T LENGTH | COHEN ANGLE | R TO T LENGTH | COHEN ANGLE | R TO T LENGTH | COHEN ANGLE |
| HF1 | 10' 9.891'' | 59.229 | 12' 1.526'' | 20.095 | 22' 2.487'' | 34.708 | 33' 4.369'' | 42.459 |
| HF2 | 10' 6.511'' | 58.897 | 11' 10.518'' | 15.222 | 22' 0.857'' | 32.968 | 33' 3.286'' | 41.155 |
| HF3 | 10' 4.049'' | 58.083 | 11' 8.336'' | 11.022 | 21' 11.689'' | 32.481 | 33' 2.512'' | 40.977 |
| HF4 | 10' 2.529'' | 58.502 | 11' 6.995'' | 6.467 | 21' 10.978'' | 31.148 | 33' 2.042'' | 39.850 |
| HF5 | 10' 1.974'' | 59.237 | 11' 6.506'' | 2.380 | 21' 10.720'' | 29.976 | 33' 1.871'' | 38.778 |
| HF6 | 10' 1.878'' | 59.298 | 11' 6.421'' | 3.034 | 21' 10.675'' | 30.028 | 33' 1.842'' | 38.809 |
| HF7 | 10' 2.817'' | 60.534 | 11' 7.249'' | 6.709 | 21' 11.112'' | 29.191 | 33' 2.131'' | 37.858 |
| HF8 | 10' 4.598'' | 62.038 | 11' 8.822'' | 11.152 | 21' 11.948'' | 28.598 | 33' 2.684'' | 36.999 |
| HF9 | 10' 7.063'' | 63.958 | 11' 11.008'' | 14.792 | 22' 1.121'' | 27.545 | 33' 3.461'' | 35.622 |
| HF10 | 8' 1.257'' | 30.746 | 12' 4.815'' | 30.807 | 23' 10.040'' | 51.074 | 35' 4.508'' | 57.547 |
| HF11 | 8' 8.301'' | 41.679 | 11' 11.472'' | 21.050 | 23' 1.053'' | 43.905 | 34' 6.616'' | 51.081 |
| HF12 | 9' 3.970'' | 48.415 | 11' 8.683'' | 13.968 | 22' 6.350'' | 39.193 | 33' 10.907'' | 47.073 |
| HF13 | 11' 1.727'' | 67.154 | 11' 6.832'' | 9.087 | 21' 4.303'' | 22.353 | 32' 5.619'' | 32.225 |
| LF1 | 47' 7.106'' | 90.638 | 47' 7.599'' | 78.475 | 50' 10.058'' | 65.219 | 56' 4.301'' | 55.121 |
| LF2 | 50' 0.342'' | 90.627 | 50' 0.728'' | 79.061 | 53' 1.340'' | 66.367 | 58' 4.933'' | 56.533 |
| LF3 | 52' 5.609'' | 91.185 | 52' 6.109'' | 79.962 | 55' 5.252'' | 67.554 | 60' 6.529'' | 57.766 |
| LF4 | 57' 10.675'' | 91.493 | 57' 10.675'' | 81.223 | 60' 6.193'' | 69.724 | 65' 2.277'' | 60.388 |
| LF5 | 60' 4.084'' | 91.513 | 60' 4.313'' | 81.602 | 62' 10.852'' | 70.468 | 67' 5.174'' | 61.338 |
| LF6 | 63' 0.561'' | 91.529 | 63' 0.780'' | 81.989 | 65' 6.059'' | 71.230 | 69' 10.361'' | 62.317 |
| LF7 | 65' 6.186'' | 91.620 | 65' 6.418'' | 82.390 | 67' 10.656'' | 71.948 | 72' 1.252'' | 63.225 |
| LF8 | 68' 2.814'' | 91.706 | 68' 2.854'' | 82.845 | 70' 5.804'' | 72.787 | 74' 6.458'' | 64.318 |
| LF9 | 54' 0.865'' | 86.880 | 54' 11.650'' | 79.554 | 58' 8.615'' | 71.934 | 64' 4.281'' | 66.326 |
| LF10 | 54' 2.207'' | 85.765 | 54' 9.956'' | 77.275 | 58' 3.704'' | 68.305 | 63' 8.985'' | 61.590 |
| LF11 | 54' 4.414'' | 87.127 | 54' 9.119'' | 77.588 | 57' 11.571'' | 67.283 | 63' 2.364'' | 59.353 |
| LF12 | 54' 7.475'' | 89.305 | 54' 9.644'' | 79.000 | 57' 9.270'' | 67.669 | 62' 9.869'' | 58.745 |
| LF13 | 55' 3.355'' | 92.383 | 55' 2.281'' | 91.453 | 57' 10.067'' | 69.213 | 62' 7.519'' | 59.337 |
| G1 | 65' 5.658'' | 83.546 | 66' 7.285'' | 79.071 | 70' 2.014'' | 74.449 | 75' 3.913'' | 70.989 |
| G2 | 66' 1.657'' | 83.554 | 67' 3.148'' | 79.122 | 70' 9.481'' | 74.534 | 75' 10.874'' | 71.087 |
| G3 | 70' 6.143'' | 83.985 | 71' 6.830'' | 79.813 | 74' 10.754'' | 75.430 | 79' 9.009'' | 72.058 |
| G4 | 71' 2.142'' | 83.988 | 72' 2.712'' | 79.853 | 75' 6.288'' | 75.502 | 80' 4.089'' | 72.145 |
| G5 | 65' 10.414'' | 80.318 | 66' 8.347'' | 74.454 | 69' 10.977'' | 68.298 | 74' 9.582'' | 63.615 |
| G6 | 66' 6.365'' | 80.365 | 67' 4.200'' | 74.558 | 70' 6.472'' | 68.449 | 75' 4.592'' | 63.786 |
| G7 | 70' 6.028'' | 85.228 | 71' 3.295'' | 79.705 | 74' 3.526'' | 73.737 | 78' 10.866'' | 69.001 |
| G8 | 71' 2.027'' | 85.265 | 71' 11.209'' | 79.731 | 74' 11.121'' | 73.740 | 79' 6.020'' | 68.969 |
| G9 | 67' 9.149'' | 84.710 | 69' 1.523'' | 81.063 | 72' 10.334'' | 77.307 | 78' 1.172'' | 74.485 |
| G10 | 68' 5.138'' | 84.707 | 69' 9.356'' | 81.167 | 73' 5.768'' | 77.517 | 78' 8.112'' | 74.770 |
| H1 | 44' 5.471'' | 89.849 | 44' 6.773'' | 77.034 | 48' 0.541'' | 63.289 | 53' 10.924'' | 53.145 |
| H2 | 71' 8.393'' | 87.458 | 72' 2.167'' | 79.540 | 74' 10.182'' | 70.689 | 79' 1.825'' | 63.322 |
| H3 | 71' 10.953'' | 89.778 | 72' 1.158'' | 81.556 | 74' 5.170'' | 72.256 | 78' 5.537'' | 64.412 |
| H4 | 72' 5.574'' | 92.860 | 72' 4.678'' | 84.304 | 74' 5.061'' | 74.523 | 78' 2.332'' | 66.166 |
| H5 | 97' 0.884'' | 91.462 | 97' 1.169'' | 85.120 | 98' 8.559'' | 77.800 | 101' 8.041'' | 71.341 |
| H6 | 104' 7.570'' | 91.521 | 104' 8.862'' | 85.876 | 106' 4.047'' | 79.363 | 109' 2.124'' | 73.596 |
| H7 | 113' 0.923'' | 90.008 | 113' 2.911'' | 84.719 | 114' 9.592'' | 78.608 | 117' 6.046'' | 73.170 |
| H8 | 124' 1.041'' | 90.550 | 124' 2.153'' | 85.674 | 125' 6.395'' | 80.018 | 127' 11.392'' | 74.945 |
| H9 | 113' 3.663'' | 91.581 | 113' 3.602'' | 86.106 | 114' 7.903'' | 79.755 | 117' 2.246'' | 74.076 |
| H10 | 113' 7.342'' | 92.084 | 113' 6.649'' | 86.596 | 114' 10.180'' | 80.223 | 117' 3.810'' | 74.515 |

FIGURE 5-10a. OVERSIDE CALIBRATION GEOMETRY

OVERSIDE CALIBRATION GEOMETRY FOR STATION 2      8/23/66      PAGE 2

| | POSITION 1 | | POSITION 2 | | POSITION 3 | | POSITION 4 | |
|---|---|---|---|---|---|---|---|---|
| RECEIVER | R TO T LENGTH | COHEN ANGLE | R TO T LENGTH | COHEN ANGLE | R TO T LENGTH | COHEN ANGLE | R TO T LENGTH | COHEN ANGLE |
| HF1 | 16' 11.662'' | 69.124 | 17' 10.677'' | 46.090 | 26' 0.855'' | 42.258 | 36' 2.611'' | 44.899 |
| HF2 | 16' 3.306'' | 68.459 | 17' 2.766'' | 43.438 | 25' 7.480'' | 40.128 | 35' 10.758'' | 43.293 |
| HF3 | 15' 7.641'' | 67.456 | 16' 7.542'' | 41.100 | 25' 2.670'' | 38.966 | 35' 7.337'' | 42.759 |
| HF4 | 15' 0.322'' | 67.097 | 16' 0.676'' | 38.544 | 24' 10.188'' | 37.067 | 35' 4.174'' | 41.343 |
| HF5 | 14' 5.989'' | 66.870 | 15' 6.762'' | 36.080 | 24' 6.401'' | 35.251 | 35' 1.521'' | 39.977 |
| HF6 | 13' 11.075'' | 66.069 | 15' 0.339'' | 33.508 | 24' 2.369'' | 34.310 | 34' 10.715'' | 39.640 |
| HF7 | 13' 5.330'' | 65.945 | 14' 7.029'' | 30.762 | 23' 11.101'' | 32.516 | 34' 8.456'' | 38.319 |
| HF8 | 12' 11.348'' | 65.844 | 14' 1.532'' | 27.605 | 23' 7.783'' | 30.659 | 34' 6.175'' | 36.999 |
| HF9 | 12' 7.180'' | 66.354 | 13' 9.720'' | 24.932 | 23' 5.523'' | 28.508 | 34' 4.630'' | 35.235 |
| HF10 | 12' 10.771'' | 55.407 | 16' 2.088'' | 45.541 | 26' 3.165'' | 53.377 | 37' 2.593'' | 58.087 |
| HF11 | 13' 4.179'' | 58.883 | 15' 10.088'' | 40.920 | 26' 7.054'' | 46.961 | 36' 5.217'' | 51.793 |
| HF12 | 13' 10.108'' | 61.219 | 15' 8.160'' | 38.341 | 25' 1.110'' | 42.833 | 35' 9.976'' | 47.872 |
| HF13 | 15' 3.481'' | 71.615 | 15' 7.364'' | 36.594 | 24' 0.904'' | 29.798 | 34' 5.890'' | 33.966 |
| LF1 | 39' 5.811'' | 90.811 | 39' 6.380'' | 74.806 | 43' 5.940'' | 59.325 | 49' 11.408'' | 48.488 |
| LF2 | 41' 10.414'' | 90.789 | 41' 10.844'' | 75.710 | 45' 7.832'' | 60.943 | 51' 10.059'' | 50.329 |
| LF3 | 44' 3.125'' | 91.486 | 44' 3.701'' | 76.985 | 47' 10.603'' | 62.606 | 53' 9.895'' | 51.973 |
| LF4 | 49' 7.327'' | 91.852 | 49' 7.267'' | 78.798 | 52' 9.297'' | 65.585 | 58' 2.135'' | 55.379 |
| LF5 | 52' 0.353'' | 91.881 | 52' 0.583'' | 79.367 | 55' 1.223'' | 66.629 | 60' 3.812'' | 56.638 |
| LF6 | 54' 8.470'' | 91.919 | 54' 8.689'' | 79.952 | 57' 7.630'' | 67.694 | 62' 7.692'' | 57.934 |
| LF7 | 57' 1.824'' | 92.027 | 57' 2.060'' | 80.513 | 59' 11.604'' | 68.660 | 64' 9.531'' | 59.109 |
| LF8 | 59' 10.179'' | 92.094 | 59' 10.179'' | 81.101 | 62' 6.054'' | 69.728 | 67' 1.594'' | 60.458 |
| LF9 | 45' 5.394'' | 85.687 | 46' 7.212'' | 76.282 | 51' 1.233'' | 67.786 | 57' 7.172'' | 62.099 |
| LF10 | 45' 7.599'' | 84.890 | 46' 5.502'' | 73.955 | 50' 7.836'' | 63.820 | 56' 11.234'' | 56.862 |
| LF11 | 45' 10.882'' | 86.672 | 46' 4.862'' | 74.380 | 50' 3.385'' | 62.594 | 56' 4.088'' | 54.179 |
| LF12 | 46' 3.211'' | 89.271 | 46' 5.928'' | 76.020 | 50' 1.132'' | 62.973 | 55' 11.404'' | 53.338 |
| LF13 | 47' 1.858'' | 92.900 | 47' 0.425'' | 78.935 | 50' 3.010'' | 64.807 | 55' 9.627'' | 53.996 |
| G1 | 56' 8.872'' | 82.447 | 58' 1.844'' | 76.897 | 62' 3.754'' | 71.873 | 68' 1.885'' | 68.380 |
| G2 | 57' 4.867'' | 82.469 | 58' 9.647'' | 76.978 | 62' 11.042'' | 71.991 | 68' 8.553'' | 68.504 |
| G3 | 61' 9.192'' | 83.037 | 63' 0.836'' | 77.906 | 66' 11.113'' | 73.135 | 72' 4.807'' | 69.680 |
| G4 | 62' 5.189'' | 83.051 | 63' 8.670'' | 77.972 | 67' 6.500'' | 73.235 | 72' 11.640'' | 69.790 |
| G5 | 57' 4.555'' | 78.861 | 58' 4.862'' | 71.561 | 62' 2.011'' | 64.792 | 67' 8.424'' | 59.986 |
| G6 | 58' 0.462'' | 78.930 | 59' 0.632'' | 71.711 | 62' 9.316'' | 64.995 | 68' 3.137'' | 60.201 |
| G7 | 61' 9.316'' | 84.557 | 62' 8.738'' | 77.731 | 66' 2.921'' | 71.132 | 71' 5.534'' | 66.152 |
| G8 | 62' 5.313'' | 84.611 | 63' 4.614'' | 77.780 | 66' 10.384'' | 71.155 | 72' 0.456'' | 66.131 |
| G9 | 58' 11.656'' | 83.775 | 60' 7.968'' | 79.288 | 64' 11.953'' | 75.236 | 70' 10.815'' | 72.395 |
| G10 | 59' 7.649'' | 83.777 | 61' 3.740'' | 79.427 | 65' 7.212'' | 75.493 | 71' 5.475'' | 72.726 |
| H1 | 36' 4.627'' | 89.860 | 36' 6.273'' | 72.754 | 40' 10.350'' | 56.654 | 47' 8.960'' | 45.944 |
| H2 | 63' 1.407'' | 87.335 | 63' 8.480'' | 77.563 | 66' 9.804'' | 67.654 | 71' 8.264'' | 59.681 |
| H3 | 63' 4.910'' | 89.952 | 63' 7.579'' | 79.811 | 66' 4.404'' | 69.362 | 70' 11.309'' | 60.814 |
| H4 | 64' 1.539'' | 93.432 | 64' 0.393'' | 82.914 | 66' 5.067'' | 71.919 | 70' 8.500'' | 62.771 |
| H5 | 88' 5.871'' | 91.789 | 88' 6.176'' | 84.225 | 90' 4.306'' | 76.204 | 93' 7.730'' | 69.225 |
| H6 | 95' 11.587'' | 91.666 | 96' 1.087'' | 84.977 | 97' 10.799'' | 77.883 | 101' 0.439'' | 71.684 |
| H7 | 104' 4.607'' | 90.154 | 104' 6.918'' | 83.926 | 106' 3.892'' | 77.309 | 109' 3.524'' | 71.486 |
| H8 | 115' 4.637'' | 90.726 | 115' 5.911'' | 85.026 | 117' 0.055'' | 78.940 | 119' 7.722'' | 73.530 |
| H9 | 104' 8.385'' | 91.876 | 104' 8.284'' | 85.436 | 106' 2.667'' | 78.559 | 109' 0.023'' | 72.471 |
| H10 | 105' 1.007'' | 92.398 | 105' 0.165'' | 85.947 | 106' 5.699'' | 79.051 | 109' 2.283'' | 72.935 |

FIGURE 5-10b. OVERSIDE CALIBRATION GEOMETRY

OVERSIDE CALIBRATION GEOMETRY FOR STATION 3 8/23/66 PAGE 3

| RECEIVER | POSITION 1 | | POSITION 2 | | POSITION 3 | | POSITION 4 | |
|---|---|---|---|---|---|---|---|---|
| | R TO T LENGTH | COHEN ANGLE | R TO T LENGTH | COHEN ANGLE | R TO T LENGTH | COHEN ANGLE | R TO T LENGTH | COHEN ANGLE |
| HF1 | 59' 7.516'' | 82.011 | 60' 4.818'' | 74.668 | 63' 4.949'' | 69.638 | 69' 0.004'' | 65.190 |
| HF2 | 58' 8.196'' | 81.786 | 59' 5.646'' | 74.111 | 62' 6.315'' | 68.865 | 68' 2.242'' | 64.248 |
| HF3 | 57' 9.545'' | 81.639 | 58' 7.138'' | 73.847 | 61' 8.328'' | 68.547 | 67' 5.094'' | 63.917 |
| HF4 | 56' 10.906'' | 81.673 | 57' 8.646'' | 73.545 | 60' 10.370'' | 68.020 | 66' 7.993'' | 63.208 |
| HF5 | 56' 1.238'' | 81.726 | 56' 11.116'' | 73.266 | 60' 1.338'' | 67.517 | 65' 11.756'' | 62.522 |
| HF6 | 55' 2.483'' | 81.827 | 56' 0.519'' | 73.235 | 59' 3.311'' | 67.419 | 65' 2.631'' | 62.398 |
| HF7 | 54' 4.764'' | 81.897 | 55' 2.947'' | 72.959 | 58' 6.269'' | 66.912 | 64' 6.422'' | 61.705 |
| HF8 | 53' 6.028'' | 81.974 | 54' 4.379'' | 72.667 | 57' 8.300'' | 66.378 | 63' 9.394'' | 60.981 |
| HF9 | 52' 9.355'' | 82.157 | 53' 7.845'' | 72.394 | 57' 0.265'' | 65.786 | 63' 2.133'' | 60.114 |
| HF10 | 55' 7.575'' | 81.821 | 57' 1.610'' | 77.100 | 60' 9.706'' | 74.164 | 67' 1.535'' | 71.830 |
| HF11 | 55' 9.097'' | 81.629 | 57' 0.236'' | 75.533 | 60' 6.282'' | 71.599 | 66' 8.244'' | 68.354 |
| HF12 | 55' 10.852'' | 81.333 | 56' 11.602'' | 74.491 | 60' 3.923'' | 70.002 | 66' 4.293'' | 66.242 |
| HF13 | 56' 4.267'' | 82.301 | 56' 11.306'' | 72.767 | 59' 11.412'' | 66.128 | 65' 7.826'' | 60.209 |
| LF1 | 17' 2.396'' | 86.048 | 18' 10.013'' | 40.228 | 26' 5.593'' | 20.162 | 37' 6.562'' | 12.380 |
| LF2 | 16' 2.680'' | 85.873 | 17' 11.063'' | 36.739 | 25' 9.729'' | 15.873 | 37' 0.923'' | 8.640 |
| LF3 | 15' 7.103'' | 87.876 | 17' 4.751'' | 36.288 | 25' 5.663'' | 14.283 | 36' 10.322'' | 4.667 |
| LF4 | 15' 8.963'' | 89.827 | 17' 4.447'' | 38.314 | 25' 4.380'' | 15.846 | 36' 8.596'' | 4.979 |
| LF5 | 16' 4.418'' | 90.361 | 18' 0.236'' | 41.166 | 25' 10.323'' | 19.309 | 37' 1.161'' | 8.801 |
| LF6 | 17' 5.463'' | 91.142 | 19' 0.151'' | 45.175 | 26' 6.739'' | 23.770 | 37' 7.069'' | 12.925 |
| LF7 | 18' 9.297'' | 91.772 | 20' 2.859'' | 49.110 | 27' 5.480'' | 28.119 | 38' 2.764'' | 16.718 |
| LF8 | 20' 5.588'' | 91.892 | 21' 9.043'' | 52.797 | 28' 8.650'' | 32.356 | 38' 11.937'' | 20.526 |
| LF9 | 8' 7.521'' | 45.905 | 16' 0.329'' | 18.196 | 26' 5.623'' | 31.613 | 38' 11.949'' | 37.807 |
| LF10 | 10' 0.577'' | 59.825 | 15' 8.661'' | 5.270 | 25' 8.783'' | 20.731 | 38' 0.901'' | 28.144 |
| LF11 | 11' 8.641'' | 72.266 | 15' 8.716'' | 10.805 | 25' 2.040'' | 8.887 | 37' 3.169'' | 17.615 |
| LF12 | 13' 6.842'' | 81.910 | 16' 2.940'' | 24.594 | 25' 0.276'' | 3.661 | 36' 9.585'' | 7.268 |
| LF13 | 17' 2.758'' | 91.827 | 18' 4.502'' | 43.896 | 25' 10.378'' | 20.805 | 36' 10.872'' | 8.054 |
| G1 | 13' 2.867'' | 56.349 | 20' 7.677'' | 46.318 | 30' 4.739'' | 49.494 | 42' 5.844'' | 52.362 |
| G2 | 13' 9.888'' | 57.626 | 21' 0.238'' | 47.055 | 30' 7.852'' | 49.746 | 42' 8.075'' | 52.443 |
| G3 | 17' 7.462'' | 65.292 | 23' 8.367'' | 52.930 | 32' 8.628'' | 52.599 | 44' 0.711'' | 53.875 |
| G4 | 18' 3.007'' | 65.971 | 24' 2.022'' | 53.575 | 32' 10.763'' | 52.913 | 44' 3.773'' | 54.011 |
| G5 | 17' 7.491'' | 50.684 | 22' 6.594'' | 26.989 | 31' 0.659'' | 28.952 | 42' 4.877'' | 33.949 |
| G6 | 18' 0.815'' | 51.593 | 22' 10.775'' | 28.349 | 31' 3.705'' | 29.567 | 42' 7.112'' | 34.181 |
| G7 | 17' 8.032'' | 70.475 | 22' 6.936'' | 48.597 | 31' 0.861'' | 44.687 | 42' 4.987'' | 44.633 |
| G8 | 18' 3.558'' | 71.131 | 23' 0.866'' | 49.310 | 31' 5.192'' | 44.862 | 42' 8.168'' | 44.464 |
| G9 | 14' 7.455'' | 64.858 | 22' 7.753'' | 57.674 | 32' 4.665'' | 58.781 | 44' 5.110'' | 60.205 |
| G10 | 15' 2.999'' | 65.700 | 23' 0.683'' | 58.471 | 32' 8.128'' | 59.382 | 44' 7.640'' | 60.726 |
| H1 | 18' 5.451'' | 84.692 | 20' 2.096'' | 43.296 | 27' 6.540'' | 24.945 | 38' 4.839'' | 17.581 |
| H2 | 20' 8.987'' | 80.384 | 23' 11.804'' | 46.535 | 31' 5.376'' | 31.427 | 42' 1.598'' | 23.905 |
| H3 | 21' 10.819'' | 87.384 | 23' 10.041'' | 52.422 | 30' 7.401'' | 34.365 | 40' 10.863'' | 23.860 |
| H4 | 24' 6.957'' | 95.519 | 25' 4.464'' | 62.236 | 31' 2.531'' | 42.346 | 40' 9.815'' | 28.757 |
| H5 | 44' 9.008'' | 92.167 | 45' 4.968'' | 74.145 | 49' 0.963'' | 61.274 | 55' 10.176'' | 49.554 |
| H6 | 51' 6.079'' | 90.836 | 52' 3.716'' | 75.853 | 55' 8.285'' | 65.017 | 61' 10.903'' | 54.832 |
| H7 | 59' 8.320'' | 89.434 | 60' 6.600'' | 76.340 | 63' 7.393'' | 66.690 | 69' 3.025'' | 57.249 |
| H8 | 70' 7.050'' | 90.417 | 71' 2.158'' | 79.188 | 73' 8.440'' | 70.709 | 78' 6.131'' | 62.064 |
| H9 | 60' 6.822'' | 92.211 | 60' 11.981'' | 78.777 | 63' 8.736'' | 68.708 | 69' 0.314'' | 58.681 |
| H10 | 61' 6.241'' | 92.828 | 61' 9.797'' | 79.519 | 64' 4.977'' | 69.489 | 69' 6.715'' | 59.434 |

FIGURE 5-10c OVERSIDE CALIBRATION GEOMETRY

OVERSIDE CALIBRATION GEOMETRY FOR STATION 4 8/23/66 PAGE 4

| | POSITION 1 | | POSITION 2 | | POSITION 3 | | POSITION 4 | |
|---|---|---|---|---|---|---|---|---|
| RECEIVER | R TO T LENGTH | COHEN ANGLE | R TO T LENGTH | COHEN ANGLE | R TO T LENGTH | COHEN ANGLE | R TO T LENGTH | COHEN ANGLE |
| HF1 | 73' 4.538'' | 83.652 | 73' 9.221'' | 78.266 | 76' 8.300'' | 73.001 | 81' 5.910'' | 68.920 |
| HF2 | 72' 5.096'' | 83.448 | 72' 9.840'' | 77.836 | 75' 9.358'' | 72.356 | 80' 7.620'' | 68.120 |
| HF3 | 71' 6.336'' | 83.350 | 71' 11.139'' | 77.667 | 74' 11.080'' | 72.132 | 79' 9.967'' | 67.873 |
| HF4 | 70' 7.583'' | 83.400 | 71' 0.446'' | 77.490 | 74' 0.820'' | 71.733 | 79' 0.344'' | 67.309 |
| HF5 | 69' 9.807'' | 83.465 | 70' 2.727'' | 77.330 | 73' 3.502'' | 71.354 | 78' 3.617'' | 66.766 |
| HF6 | 68' 10.950'' | 83.613 | 69' 3.934'' | 77.401 | 72' 5.167'' | 71.358 | 77' 5.950'' | 66.735 |
| HF7 | 68' 1.127'' | 83.692 | 68' 6.170'' | 77.248 | 71' 7.826'' | 70.980 | 76' 9.225'' | 66.189 |
| HF8 | 67' 2.279'' | 83.779 | 67' 7.390'' | 77.091 | 70' 9.524'' | 70.587 | 75' 11.618'' | 65.624 |
| HF9 | 66' 5.494'' | 83.946 | 66' 10.661'' | 76.951 | 70' 1.190'' | 70.138 | 75' 3.857'' | 64.935 |
| HF10 | 69' 4.994'' | 84.005 | 70' 3.809'' | 80.513 | 73' 10.553'' | 77.284 | 79' 3.420'' | 74.939 |
| HF11 | 69' 6.299'' | 83.697 | 70' 3.018'' | 79.230 | 73' 7.664'' | 75.012 | 78' 10.876'' | 71.882 |
| HF12 | 69' 7.789'' | 83.318 | 70' 2.783'' | 78.329 | 73' 5.678'' | 73.571 | 78' 7.495'' | 70.006 |
| HF13 | 70' 0.359'' | 83.820 | 70' 3.231'' | 76.927 | 73' 1.883'' | 70.106 | 78' 0.271'' | 64.776 |
| LF1 | 26' 10.605'' | 87.840 | 27' 4.534'' | 62.025 | 34' 0.074'' | 41.212 | 43' 5.031'' | 30.500 |
| LF2 | 24' 10.802'' | 87.709 | 25' 5.003'' | 59.696 | 32' 5.218'' | 37.985 | 42' 2.283'' | 27.586 |
| LF3 | 23' 0.221'' | 88.950 | 23' 7.261'' | 58.096 | 31' 0.708'' | 34.955 | 41' 1.901'' | 24.309 |
| LF4 | 19' 6.157'' | 90.345 | 20' 0.889'' | 53.077 | 28' 4.446'' | 27.466 | 39' 1.244'' | 17.227 |
| LF5 | 18' 2.199'' | 90.860 | 18' 10.272'' | 50.549 | 27' 6.900'' | 24.064 | 38' 6.786'' | 13.921 |
| LF6 | 17' 0.468'' | 91.834 | 17' 9.062'' | 48.422 | 26' 10.011'' | 20.955 | 38' 0.473'' | 10.621 |
| LF7 | 16' 4.496'' | 92.735 | 17' 1.518'' | 47.289 | 26' 5.137'' | 19.128 | 37' 9.090'' | 8.245 |
| LF8 | 16' 0.539'' | 93.054 | 16' 8.866'' | 46.400 | 26' 1.540'' | 17.672 | 37' 6.190'' | 6.238 |
| LF9 | 16' 9.117'' | 69.218 | 20' 5.479'' | 45.979 | 30' 8.820'' | 41.213 | 42' 2.881'' | 42.002 |
| LF10 | 17' 7.196'' | 75.102 | 20' 4.409'' | 46.451 | 30' 1.198'' | 36.258 | 41' 4.673'' | 35.301 |
| LF11 | 18' 8.078'' | 80.567 | 20' 6.299'' | 48.092 | 29' 7.459'' | 31.791 | 40' 7.741'' | 28.183 |
| LF12 | 19' 11.461'' | 85.453 | 21' 0.772'' | 51.499 | 29' 6.093'' | 30.090 | 40' 2.723'' | 22.879 |
| LF13 | 22' 8.661'' | 91.595 | 22' 11.436'' | 59.263 | 30' 3.228'' | 34.162 | 40' 4.297'' | 22.036 |
| G1 | 7' 6.318'' | 31.242 | 15' 11.790'' | 37.745 | 29' 1.347'' | 48.427 | 41' 9.754'' | 52.384 |
| G2 | 7' 4.031'' | 27.604 | 15' 10.723'' | 36.936 | 29' 0.763'' | 48.167 | 41' 9.348'' | 52.234 |
| G3 | 7' 0.844'' | 23.888 | 15' 9.377'' | 36.611 | 29' 0.088'' | 48.164 | 41' 8.918'' | 52.258 |
| G4 | 7' 4.083'' | 27.166 | 15' 10.850'' | 36.808 | 29' 0.892'' | 48.108 | 41' 9.476'' | 52.194 |
| G5 | 14' 2.764'' | 43.430 | 18' 9.746'' | 12.893 | 29' 10.986'' | 25.696 | 41' 9.757'' | 33.267 |
| G6 | 14' 1.565'' | 42.655 | 18' 8.841'' | 10.946 | 29' 10.418'' | 25.247 | 41' 9.350'' | 33.051 |
| G7 | 7' 3.353'' | 45.928 | 14' 3.443'' | 22.951 | 27' 3.507'' | 36.739 | 39' 11.698'' | 41.447 |
| G8 | [illegible]' 6.502'' | 47.677 | 14' 5.068'' | 23.169 | 27' 4.361'' | 36.241 | 40' 0.282'' | 40.902 |
| G9 | [illegible] 4.812'' | 11.220 | 16' 5.653'' | 50.009 | 30' 2.004'' | 57.340 | 43' 0.721'' | 59.943 |
| G10 | 5' 4.936'' | 7.897 | 16' 5.693'' | 50.208 | 30' 2.026'' | 57.688 | 43' 0.737'' | 60.339 |
| H1 | 2[illegible] 2.766'' | 87.100 | 29' 9.593'' | 63.893 | 36' 1.027'' | 44.716 | 45' 1.698'' | 34.333 |
| H2 | 1[illegible]' 3.300'' | 76.302 | 15' 11.401'' | 23.824 | 27' 3.341'' | 5.012 | 39' 4.416'' | 9.229 |
| H3 | 14' 2.966'' | 87.537 | 16' 0.126'' | 37.223 | 26' 3.624'' | 10.997 | 38' 0.497'' | 3.849 |
| H4 | 18' 3.142'' | 97.856 | 18' 6.234'' | 56.506 | 27' 0.484'' | 27.825 | 37' 11.788'' | 15.336 |
| H5 | 31' 11.013'' | 93.532 | 32' 4.172'' | 70.732 | 38' 1.595'' | 50.437 | 46' 8.767'' | 37.792 |
| H6 | 38' 9.[illegible]10'' | 91.208 | 38' 8.135'' | 72.959 | 43' 10.700'' | 56.219 | 51' 8.904'' | 45.071 |
| H7 | 46' [illegible].246'' | 89.754 | 46' 8.830'' | 74.501 | 51' 3.835'' | 59.914 | 58' 3.925'' | 49.322 |
| H8 | 56' 9.879'' | 90.869 | 57' 3.064'' | 78.342 | 60' 10.844'' | 65.808 | 66' 9.448'' | 55.956 |
| H9 | 47' 2.700'' | 93.134 | 47' 5.344'' | 77.639 | 51' 5.914'' | 62.376 | 58' 1.072'' | 50.926 |
| H10 | 48' 5.959'' | 93.759 | 48' 6.806'' | 78.572 | 52' 4.606'' | 63.455 | 58' 9.130'' | 51.955 |

FIGURE 5-10d OVERSIDE CALIBRATION GEOMETRY

OVERSIDE CALIBRATION GEOMETRY FOR STATION 5 8/23/66 PAGE 5

| | POSITION 1 | | POSITION 2 | | POSITION 3 | | POSITION 4 | |
|---|---|---|---|---|---|---|---|---|
| RECEIVER | R TO T LENGTH | COHEN ANGLE | R TO T LENGTH | COHEN ANGLE | R TO T LENGTH | COHEN ANGLE | R TO T LENGTH | COHEN ANGLE |
| HF1 | 114' 11.307'' | 86.176 | 115' 3.139'' | 82.480 | 117' 3.162'' | 78.936 | 120' 10.374'' | 75.666 |
| HF2 | 113' 11.708'' | 85.981 | 114' 3.572'' | 82.149 | 116' 3.794'' | 78.476 | 119' 11.348'' | 75.090 |
| HF3 | 113' 0.812'' | 85.939 | 113' 4.707'' | 82.076 | 115' 5.119'' | 78.376 | 119' 0.998'' | 74.970 |
| HF4 | 112' 1.918'' | 85.990 | 112' 5.845'' | 81.991 | 114' 6.450'' | 78.160 | 118' 2.659'' | 74.633 |
| HF5 | 111' 4.013'' | 86.048 | 111' 7.968'' | 81.916 | 113' 8.751'' | 77.955 | 117' 5.264'' | 74.308 |
| HF6 | 110' 5.042'' | 86.247 | 110' 9.030'' | 82.081 | 112' 10.014'' | 78.089 | 116' 6.869'' | 74.416 |
| HF7 | 109' 7.099'' | 86.313 | 109' 11.117'' | 82.012 | 112' 0.285'' | 77.888 | 115' 9.454'' | 74.093 |
| HF8 | 108' 8.131'' | 86.386 | 109' 0.182'' | 81.945 | 111' 1.557'' | 77.685 | 114' 11.077'' | 73.767 |
| HF9 | 107' 11.216'' | 86.503 | 108' 3.296'' | 81.877 | 110' 4.840'' | 77.437 | 114' 2.650'' | 73.348 |
| HF10 | 111' 0.731'' | 87.334 | 111' 8.665'' | 84.948 | 114' 1.321'' | 82.694 | 118' 1.443'' | 80.653 |
| HF11 | 111' 1.626'' | 86.821 | 111' 8.144'' | 83.791 | 113' 11.430'' | 80.914 | 117' 10.281'' | 78.294 |
| HF12 | 111' 2.643'' | 86.307 | 111' 7.998'' | 82.934 | 113' 10.149'' | 79.724 | 117' 7.943'' | 76.793 |
| HF13 | 111' 5.743'' | 86.050 | 111' 8.315'' | 81.413 | 113' 7.738'' | 76.942 | 117' 2.970'' | 72.798 |
| LF1 | 65' 10.777'' | 89.161 | 66' 2.460'' | 78.054 | 69' 4.738'' | 67.601 | 75' 1.214'' | 58.551 |
| LF2 | 63' 5.749'' | 89.145 | 63' 9.490'' | 77.611 | 67' 1.068'' | 66.803 | 72' 11.638'' | 57.538 |
| LF3 | 61' 0.814'' | 89.580 | 61' 4.843'' | 77.368 | 64' 10.015'' | 65.963 | 70' 10.956'' | 56.258 |
| LF4 | 55' 10.081'' | 90.108 | 56' 1.894'' | 76.606 | 59' 10.126'' | 64.119 | 66' 4.068'' | 53.741 |
| LF5 | 53' 5.511'' | 90.284 | 53' 9.818'' | 76.096 | 57' 8.151'' | 63.063 | 64' 4.990'' | 52.374 |
| LF6 | 50' 10.281'' | 90.688 | 51' 2.807'' | 75.687 | 55' 3.309'' | 62.010 | 62' 3.275'' | 50.966 |
| LF7 | 48' 6.243'' | 91.002 | 48' 11.020'' | 75.191 | 53' 1.673'' | 60.885 | 60' 4.644'' | 49.513 |
| LF8 | 45' 11.520'' | 91.068 | 46' 4.221'' | 74.361 | 50' 9.129'' | 59.389 | 58' 3.387'' | 47.734 |
| LF9 | 57' 0.012'' | 84.014 | 58' 4.634'' | 75.266 | 62' 11.217'' | 67.824 | 70' 0.395'' | 62.202 |
| LF10 | 57' 3.510'' | 86.789 | 58' 4.461'' | 76.681 | 62' 7.711'' | 67.782 | 69' 6.231'' | 60.791 |
| LF11 | 57' 8.100'' | 88.124 | 58' 5.383'' | 76.791 | 62' 5.215'' | 66.572 | 69' 0.948'' | 58.307 |
| LF12 | 58' 1.823'' | 88.979 | 58' 8.055'' | 76.743 | 62' 4.917'' | 65.508 | 68' 10.141'' | 56.207 |
| LF13 | 59' 3.117'' | 90.340 | 59' 5.446'' | 77.406 | 62' 10.170'' | 65.283 | 68' 11.639'' | 54.966 |
| G1 | 45' 3.884'' | 85.243 | 47' 8.990'' | 77.372 | 53' 9.967'' | 71.457 | 62' 6.119'' | 67.621 |
| G2 | 44' 8.039'' | 85.088 | 47' 1.549'' | 77.121 | 53' 3.376'' | 71.184 | 62' 0.450'' | 67.375 |
| G3 | 40' 3.319'' | 84.603 | 42' 11.894'' | 75.906 | 49' 7.940'' | 69.799 | 58' 11.525'' | 66.162 |
| G4 | 39' 7.492'' | 84.418 | 42' 4.570'' | 75.607 | 49' 1.611'' | 69.490 | 58' 6.202'' | 65.899 |
| G5 | 47' 1.979'' | 80.251 | 48' 11.784'' | 70.183 | 54' 5.526'' | 62.408 | 62' 7.765'' | 57.300 |
| G6 | 46' 6.444'' | 80.046 | 48' 4.533'' | 69.852 | 53' 11.012'' | 62.036 | 62' 2.109'' | 56.957 |
| G7 | 40' 3.961'' | 86.172 | 42' 5.249'' | 74.407 | 48' 7.865'' | 65.570 | 57' 8.034'' | 59.996 |
| G8 | 39' 8.146'' | 86.065 | 41' 9.827'' | 73.991 | 48' 1.403'' | 64.989 | 57' 2.591'' | 59.366 |
| G9 | 42' 9.710'' | 86.621 | 45' 10.568'' | 79.682 | 52' 7.507'' | 74.671 | 61' 10.244'' | 71.520 |
| G10 | 42' 1.816'' | 86.497 | 45' 3.210'' | 79.617 | 52' 1.103'' | 74.706 | 61' 4.802'' | 71.657 |
| H1 | 68' 9.794'' | 88.965 | 69' 1.954'' | 78.514 | 72' 3.271'' | 68.659 | 77' 9.779'' | 60.065 |
| H2 | 40' 8.439'' | 87.631 | 42' 2.299'' | 70.238 | 47' 10.937'' | 55.918 | 56' 7.128'' | 45.833 |
| H3 | 41' 4.930'' | 90.064 | 42' 2.847'' | 72.040 | 47' 4.591'' | 56.584 | 55' 7.941'' | 45.283 |
| H4 | 43' 1.351'' | 93.071 | 43' 4.386'' | 74.780 | 47' 10.804'' | 58.429 | 55' 8.166'' | 45.866 |
| H5 | 20' 2.416'' | 96.301 | 21' 2.420'' | 57.486 | 29' 8.569'' | 32.684 | 41' 3.985'' | 20.863 |
| H6 | 13' 2.450'' | 91.946 | 15' 5.327'' | 35.188 | 26' 4.282'' | 12.897 | 39' 3.349'' | 9.307 |
| H7 | 11' 3.463'' | 92.319 | 14' 6.127'' | 28.264 | 26' 2.226'' | 6.489 | 39' 4.868'' | 5.011 |
| H8 | 17' 8.286'' | 94.427 | 19' 5.215'' | 51.784 | 28' 10.643'' | 28.397 | 41' 0.322'' | 18.967 |
| H9 | 15' 11.851'' | 99.836 | 17' 0.257'' | 49.794 | 26' 9.065'' | 22.567 | 39' 1.992'' | 11.157 |
| H10 | 19' 9.274'' | 98.768 | 20' 2.959'' | 57.853 | 28' 7.813'' | 30.993 | 40' 3.563'' | 17.893 |

FIGURE 5-10e OVERSIDE CALIBRATION GEOMETRY

# SECTION VI

## ACOUSTIC DATA

### A. DISCUSSION OF NOISE MEASUREMENTS

We discuss salient features of the available results, make comparisons with previous results, and provide some theoretical orientation. The present discussion is based only on the following data from PURVIS II: noise measurements from 0.5 to 5 kc for flush elements G1, G8, and recessed elements G3, G5, all in Sea Chest 2, and flush element G10 in the hull nearby, and from 0 to 10 kc for all D elements in Sea Chest 1; overside (in-situ) calibrations for all D and G elements and a frequency-independent intrinsic (free-field) sensitivity for the D elements. No free-field calibrations were available for the G elements.

The D elements are covered by layers of thicknesses given below. The layers covering elements D1, D5, D6, and D10 are planar, and those covering the others are of limited lateral extent corresponding to a 60° conical divergence from the element periphery to the outer surface, merging, however, into a planar layer of thickness 1/2".

| Element | D1 | D2 | D3 | D4 | D5 | D6 |
|---|---|---|---|---|---|---|
| Thickness (in). | 1-5/32 | 1-47/64 | 2-51/64 | 4-59/64 | 5/8 | 13/16 |

| Element | D7 | D8 | D9 | D10 |
|---|---|---|---|---|
| Thickness (in.) | 1-23/32 | 2-25/32 | 5-1/32 | 59/64 |

#### 1. Results for G elements (Figures 6-1 to 6-8)

Because of a decided change in character of these noise spectra above 3 kc, we discuss first the interval 0.5 to 3 kc. For flush window-mounted elements G1 and G8 the dependence

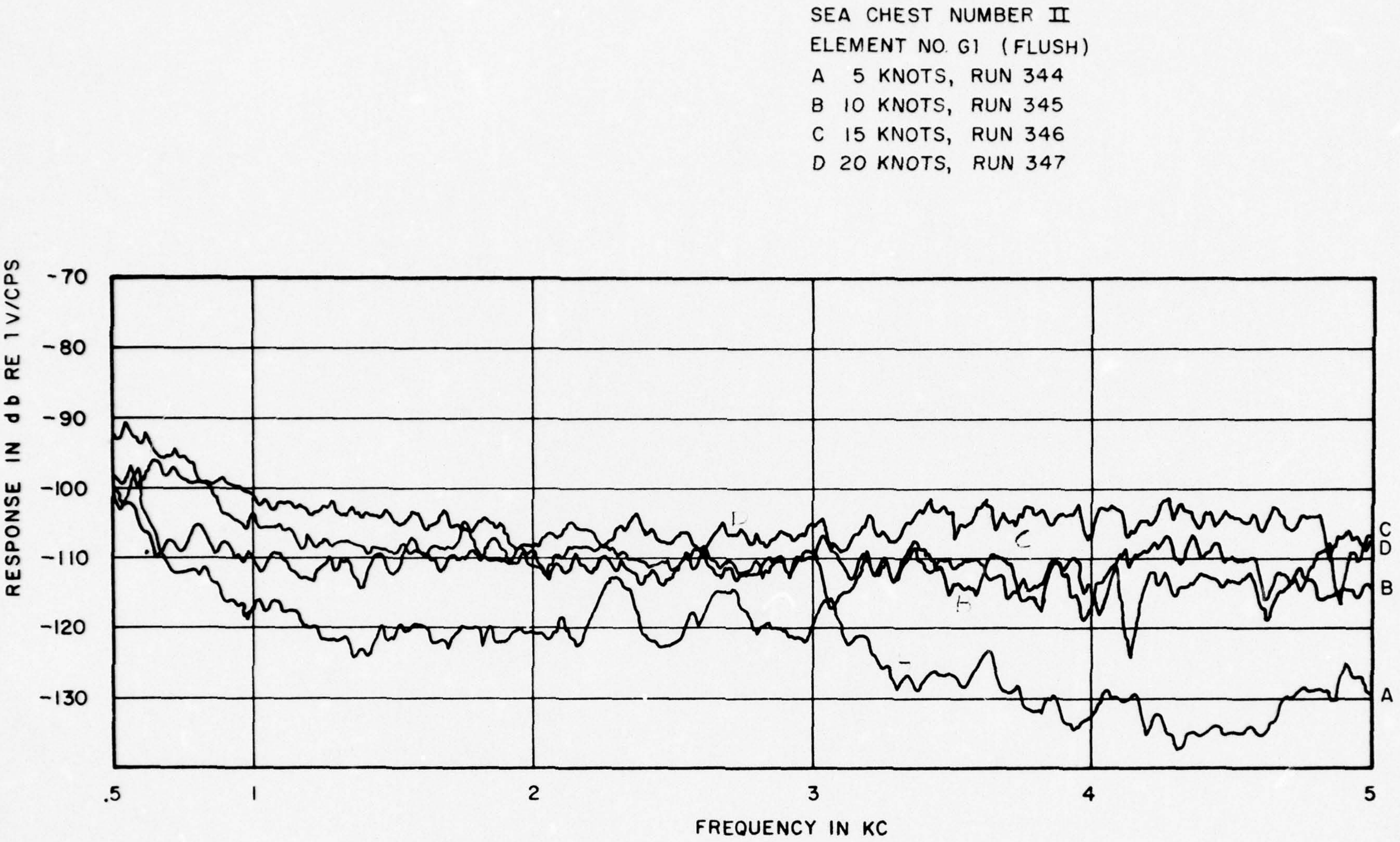


FIGURE 6-1 G1 NOISE SPECTRA: 5, 10, 15, 20 KNOTS

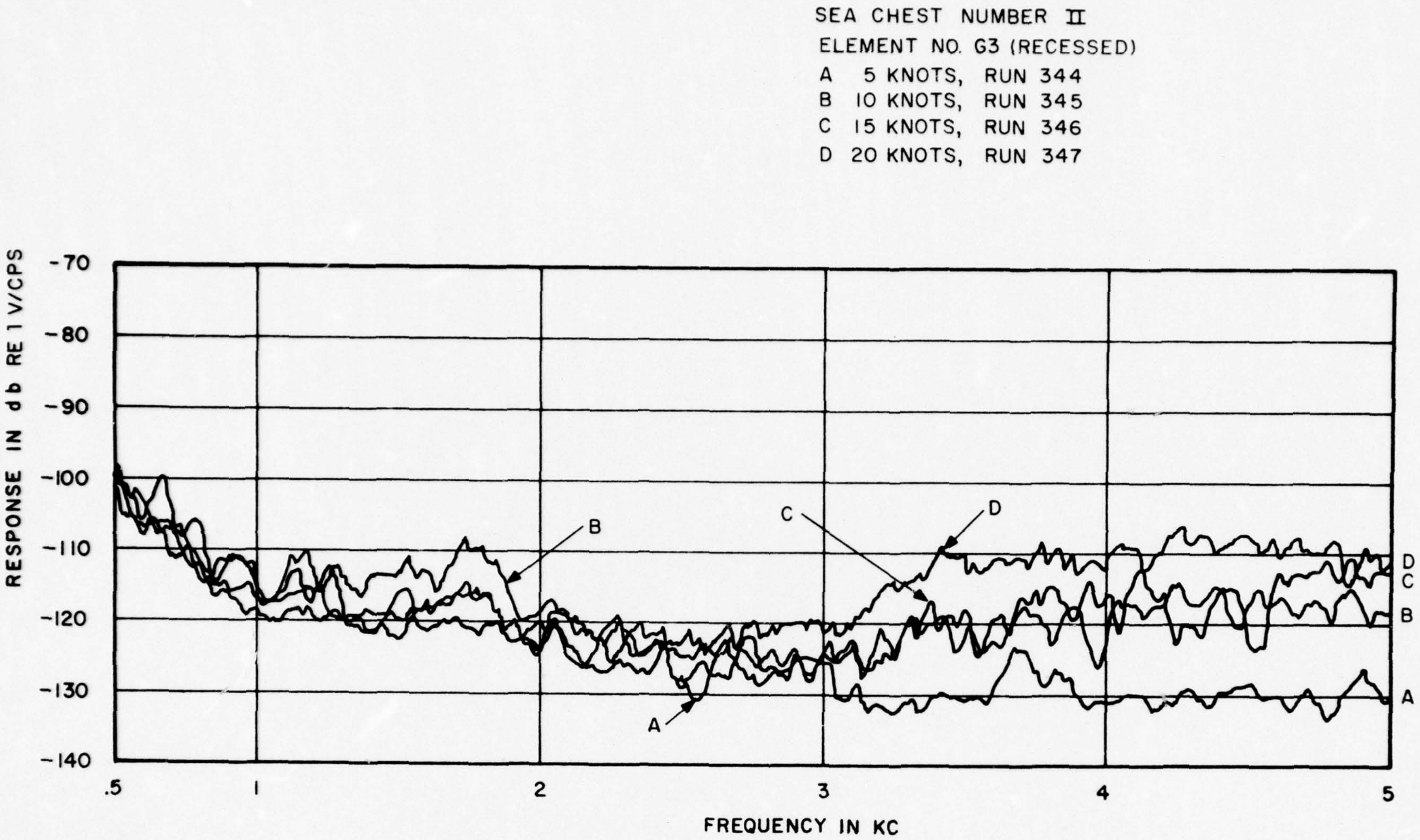


FIGURE 6-2 G3 NOISE SPECTRA: 5, 10, 15, 20 KNOTS

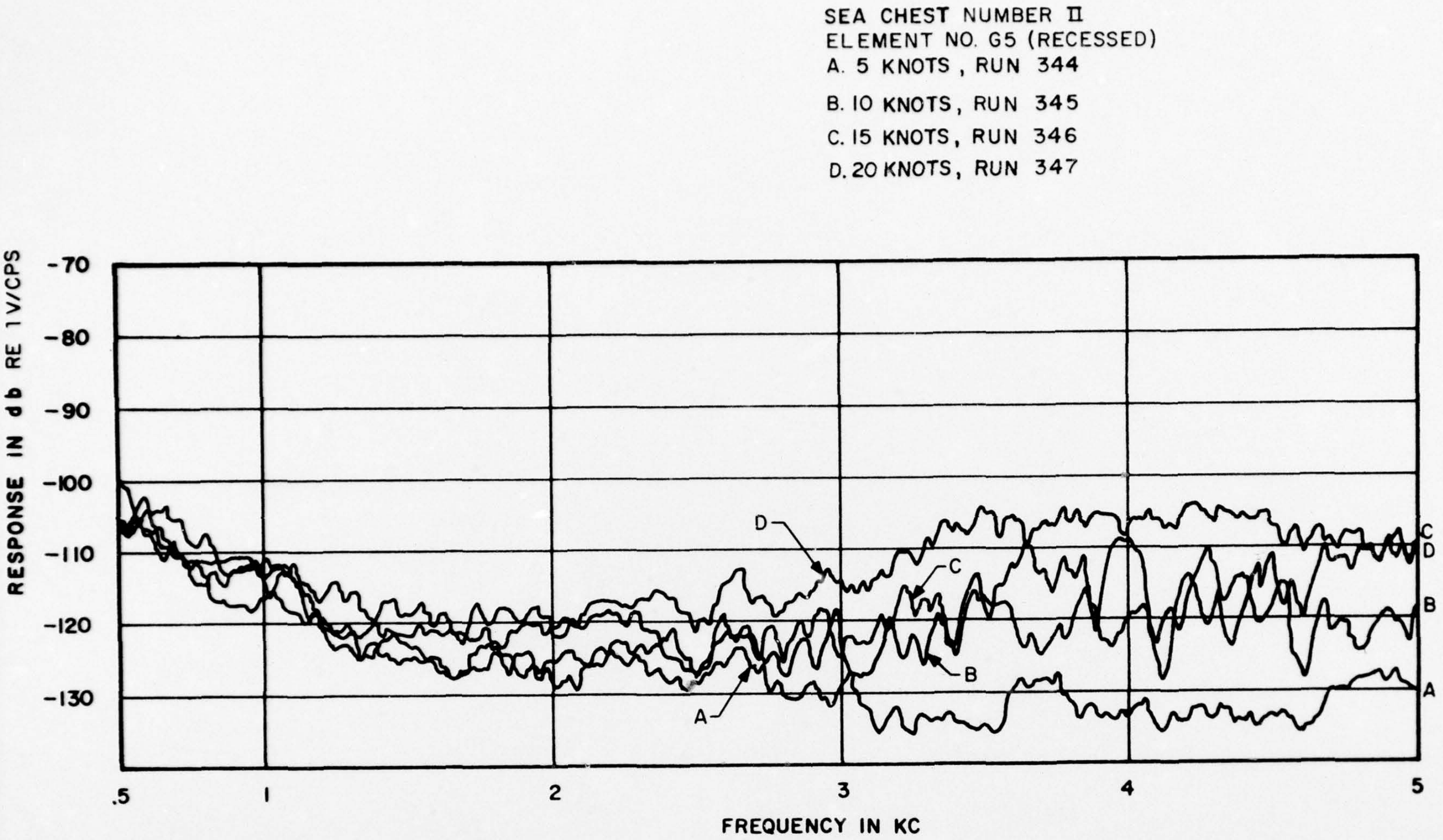


FIGURE 6-3 G5 NOISE SPECTRA: 5, 10, 15, 20 KNOTS

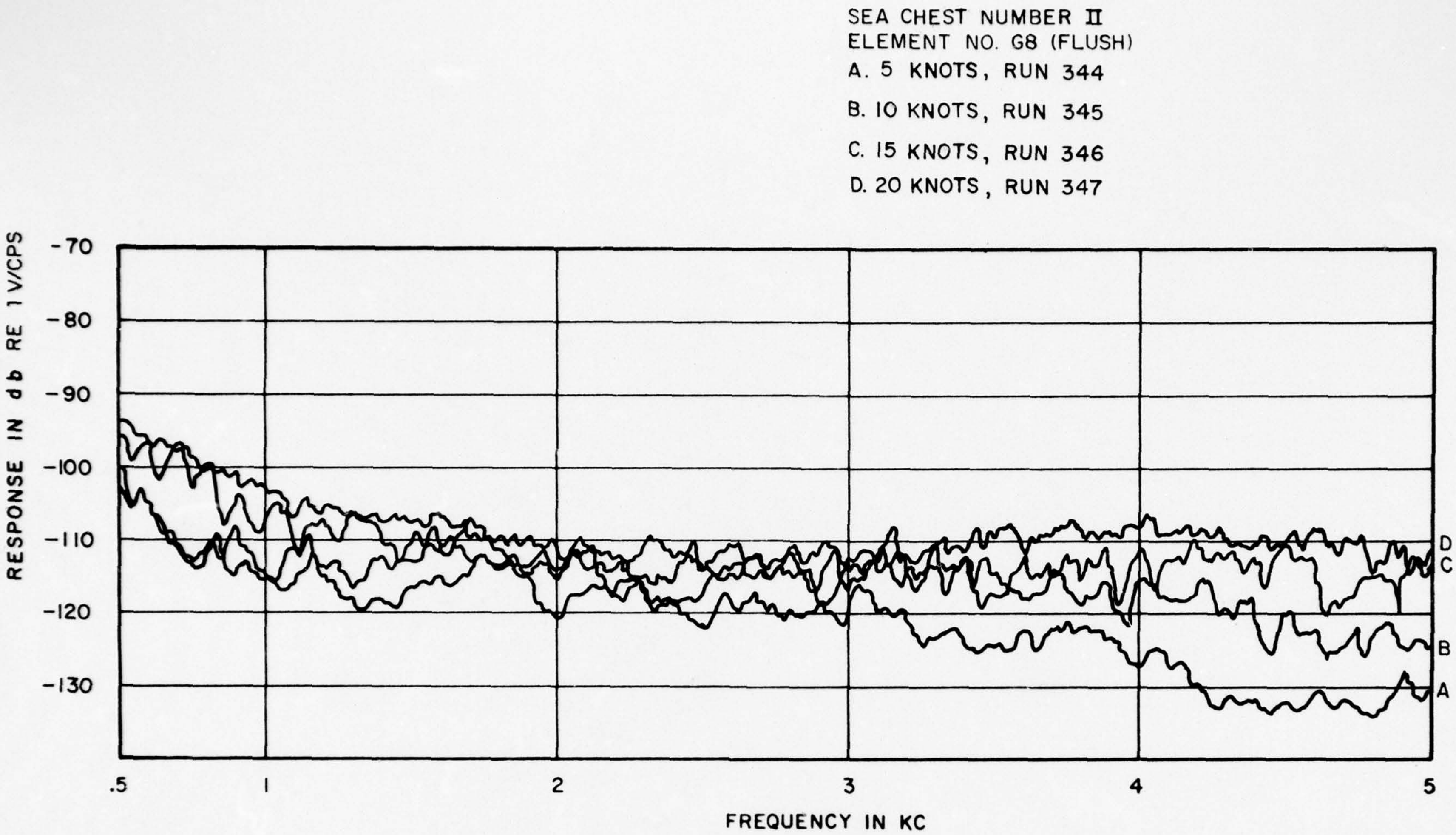


FIGURE 6-4 G8 NOISE SPECTRA: 5, 10, 15, 20 KNOTS

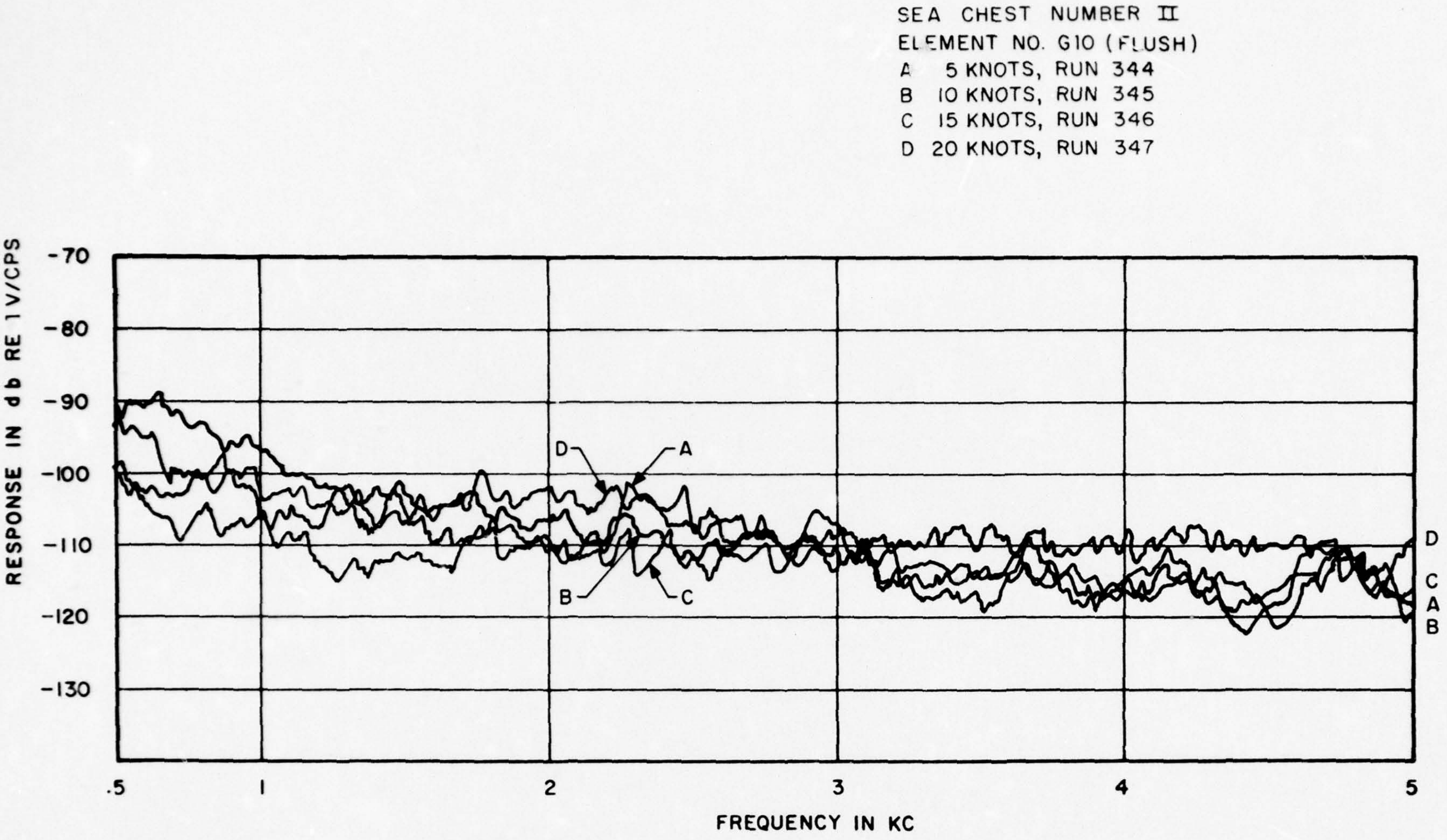
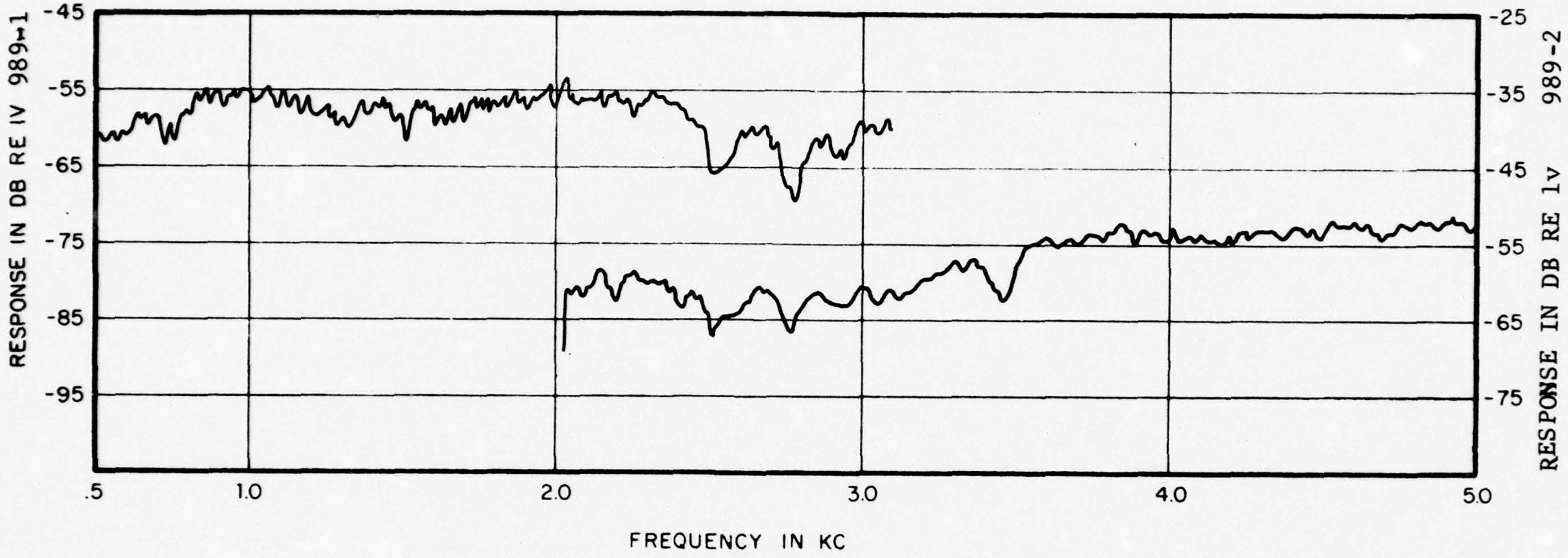


FIGURE 6-5 G10 NOISE SPECTRA: 5, 10, 15, 20 KNOTS

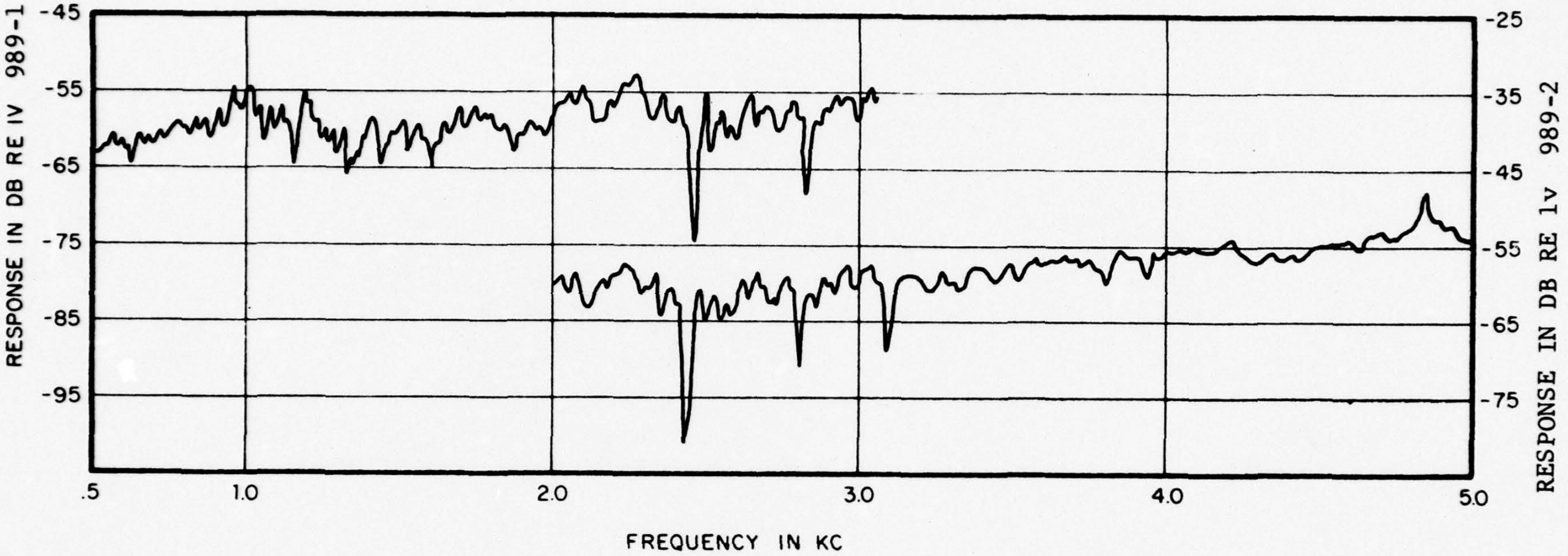


OVERSIDE CALIBRATION RUN NO. 989-1,-2 ELEMENT G-5

FIGURE 6-6

OVERSIDE CALIBRATION RUN NO. 989-1,-2 ELEMENT G-8

FIGURE 6-7



OVERSIDE CALIBRATION RUN NO. 989-1,-2 ELEMENT H-3

FIGURE 6-8

on ship speed ($U_\infty$) is relatively weak up to 3 kc, specifically $\lesssim$ 10 db/speed octave for $U_\infty \sim$10 to 20 kt, corresponding to power dependence roughly as $U_\infty^3$. For the flush, hull-mounted element G10 this behavior continues on to 5 kc. In the case of the recessed elements, up to 3 kc the speed dependence is still weaker, except that there is a hump for G3 at 20 kt near 1.8 kc.

The levels for the recessed elements in this frequency interval at the higher speeds are for the most part lower than for the flush elements by ~10 db, and their lack of speed dependence may correspond to the presence of a speed-independent noise component that is exceeded by the speed-dependent contribution for the flush elements but not for the recessed elements. Levels for the recessed elements are comparable with one another, except that the level for 5 kt is very low for G1. These comparisons of levels for different elements are significant only on assumption that free-field calibrations will indicate that the elements have similar sensitivities.

The frequency dependence of the noise for the flush elements from 0.5 to 2 kc at 20 kt is roughly -8db/octave, or as $\omega^{-2.7}$. This dependence refers to the raw noise measurements and will apply to the true noise spectra only if the free-field calibrations show that the element responses are nearly frequency-independent in the frequency range in question.

A disturbing feature of the overside calibrations of recessed and flush elements mounted in this sea chest is that repetition of a calibration run in some overlapping frequency range resulted in many cases in quite a different level both in magnitude and frequency dependence. No reliable conjecture as to the cause can yet be offered. No such discrepancies are observed in overside calibrations of hull-mounted elements. Also, in a given calibration run the spread among the levels for different recessed elements for the most part is greater than for flush elements in the sea chest.

The observed speed and frequency dependence may be compared with those for the 3"-diameter 5E elements of PURVIS 1, and the joint dependence compared with the theoretically conjectured scaling laws. The frequency dependence for 0.5 to 2 kc is generally similar to that for the 5E's, except somewhat weaker for 0.5 to 1 kc. (Results for the 5E's were somewhat erratic, however). The speed dependence for the flush elements (and still more for the recessed elements) is weaker for 0.5 to 3 kc than was observed for the 5E's. Likewise, the joint speed-frequency dependence disagrees with the conventional "outer" law for the spectrum $Q_o(\omega)$ of turbulent boundary-layer (TBL) pressure fluctuations on a large element, namely

$$(1) \qquad Q_o(\omega) = (\omega R_o/U_\infty)^{-2}\rho^2\delta_* U_\infty^3 N(\delta_*/R_o, \omega\delta_*/U_\infty),$$

where $R_o$ denotes element radius and N is a function of the indicated dimensionless arguments*. Specifically, from form (1), for $Q_o(\omega) \propto \omega^{-2.7}$, as observed we would infer**

$$Q_o(\omega) \underset{\sim}{\propto} U_\infty^6.$$

An assessment of the effect of area dependence based on comparison with the 5E elements must await availability of free field calibrations.

We turn now to the frequency range 3 to 5 kc. The spectra for the flush elements tend to level off from 2 to 3 kc. Though levels for the lower speeds for the most part decline between 3 and 5 kc, those for the higher speeds remain roughly level or even rise somewhat. For the window-mounted flush G1 and G8, levels increase greatly from 5 to 15 or 20 kt in this

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*See Reference 4

**The observed dependence disagrees still more with the "inner" law for a large element, namely

$$(\omega R_o/v_*)^{-3}\rho^2 \nu v_*^2 L_+(\omega\nu/v_*^2).$$

The corresponding inner law for the TBL point pressure spectrum may be more nearly correct at high frequency than the conventional one.

frequency interval, but the increase is erratic with the levels for different speeds even crossing at some frequencies. For the hull-mounted flush G10, on the other hand, the levels for 5 to 15 kt in this frequency interval are roughly independent of speed but higher than for the window elements at 5 kt.

It is recessed elements, however, that display the most conspicuous anomaly in the higher frequency interval. For speeds 10 kt and greater the levels broadly increase between 3 and 5 kc in a pronounced though erratic way. The overside calibration curves for the recessed elements on the other hand, though for the most part tending to rise somewhat between 3 and 4 kc, do not increase to such a degree as the noise levels between 3 and 5 kc. Likewise, so far as the gross behavior of the calibration curves in this range is concerned, the recessed elements are fairly similar to the flush ones. Pending further consideration, we advance no explanation for this anomalous apparent increase of noise with frequency.

2. Results for D elements (Figures 6-9 to 6-14)

The most striking feature of the results for the D elements is this: in no extensive frequency range do the noise levels for the elements beneath various thicknesses of layers have the inverse order of the thicknesses, even though in some ranges the differences in levels are substantial. Furthermore, the in-situ (overside) calibrations are very different for the various elements and likewise do not, in any appreciable frequency range, have the inverse (or direct) order of the corresponding thicknesses.

Since the measured noise spectra, even at the higher speeds, do not have the inverse order of the layer thicknesses, as would be expected if the elements have equal intrinsic sensitivities, we might conjecture that the in-situ calibrations differ not because of different total pressures on the elements in the calibration configuration, but because of some unintended alteration in the intrinsic sensitivity of some elements due to

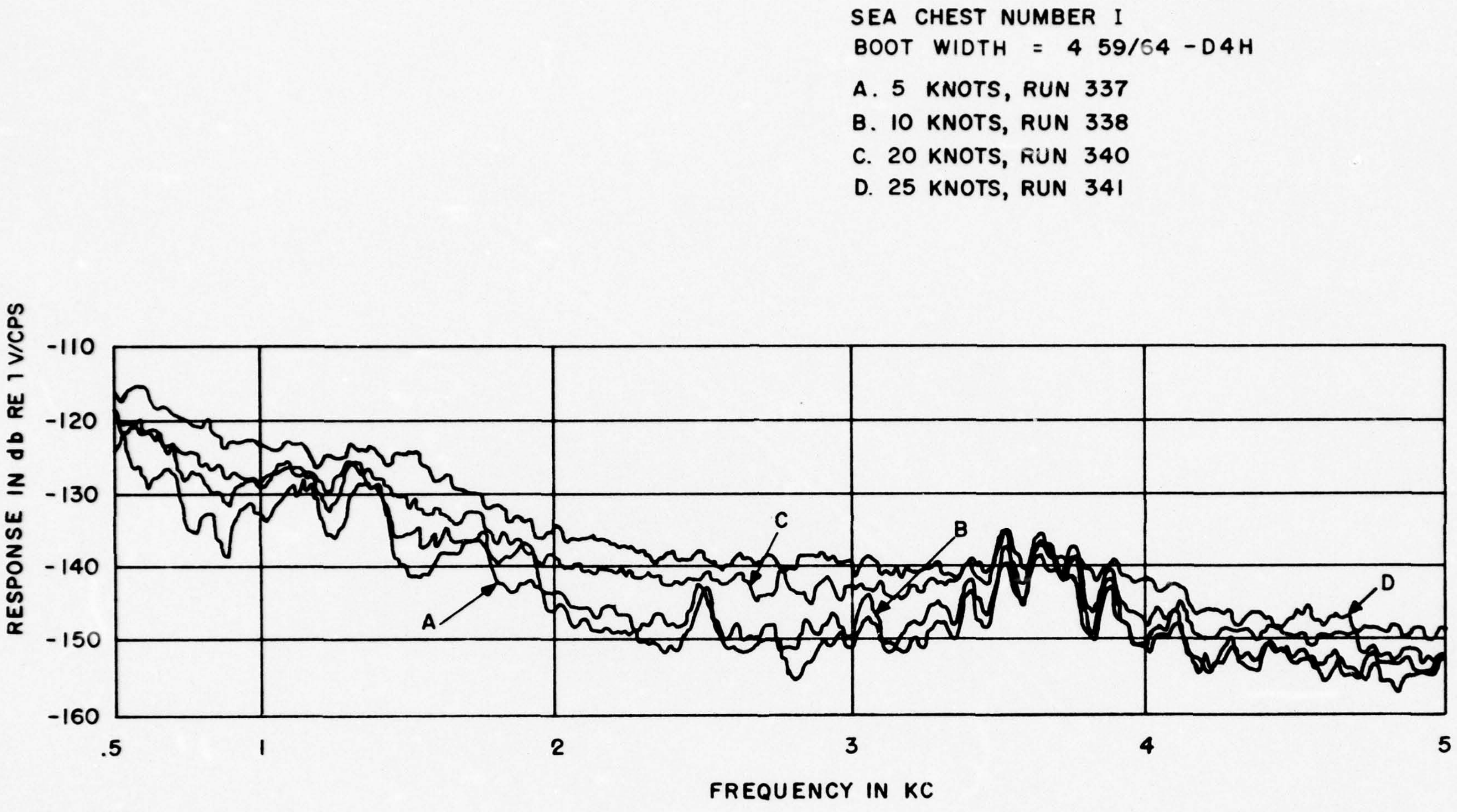

FIGURE 6-9 D4 NOISE SPECTRA

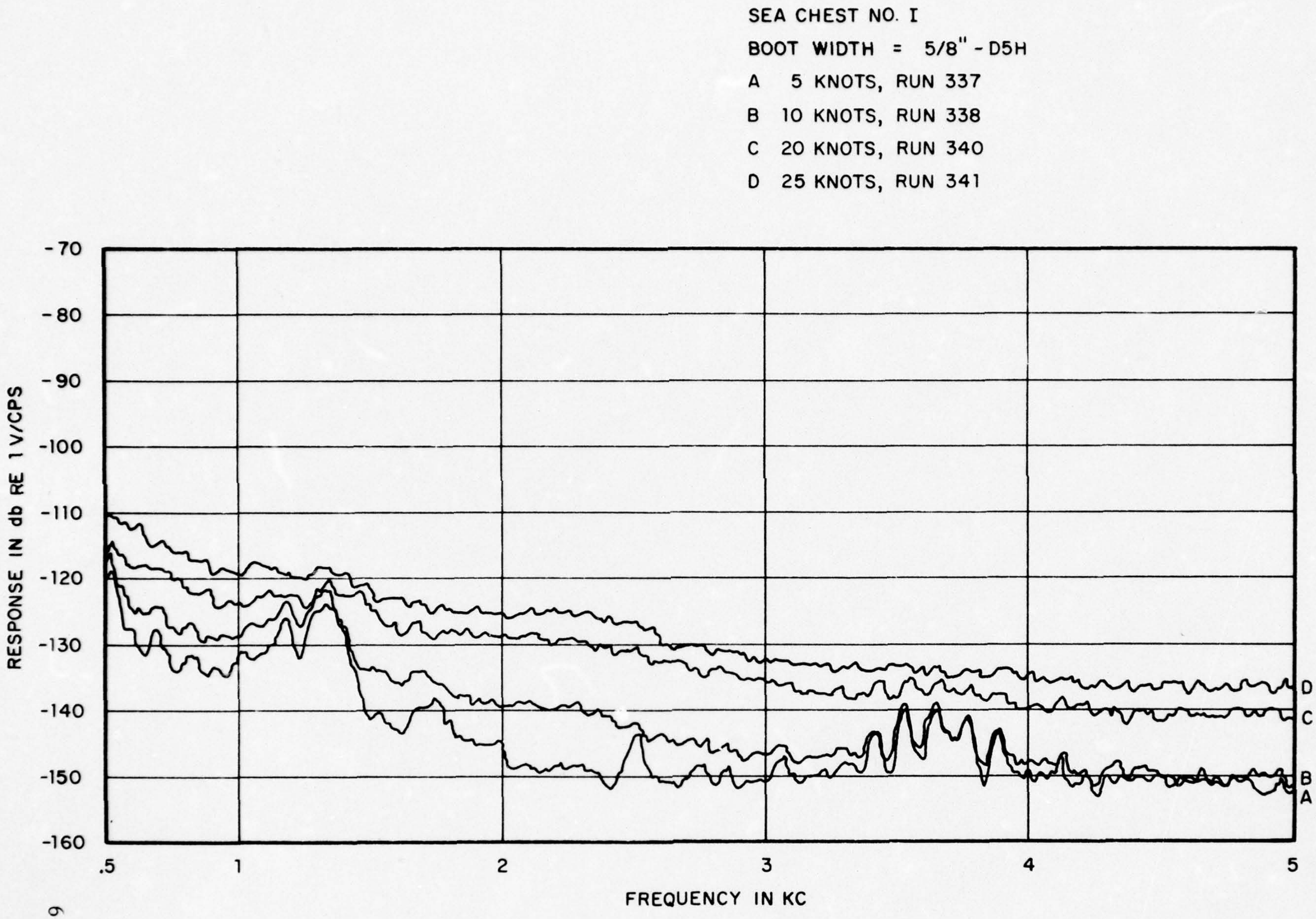

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FIGURE 6-10 D5 NOISE SPECTRA

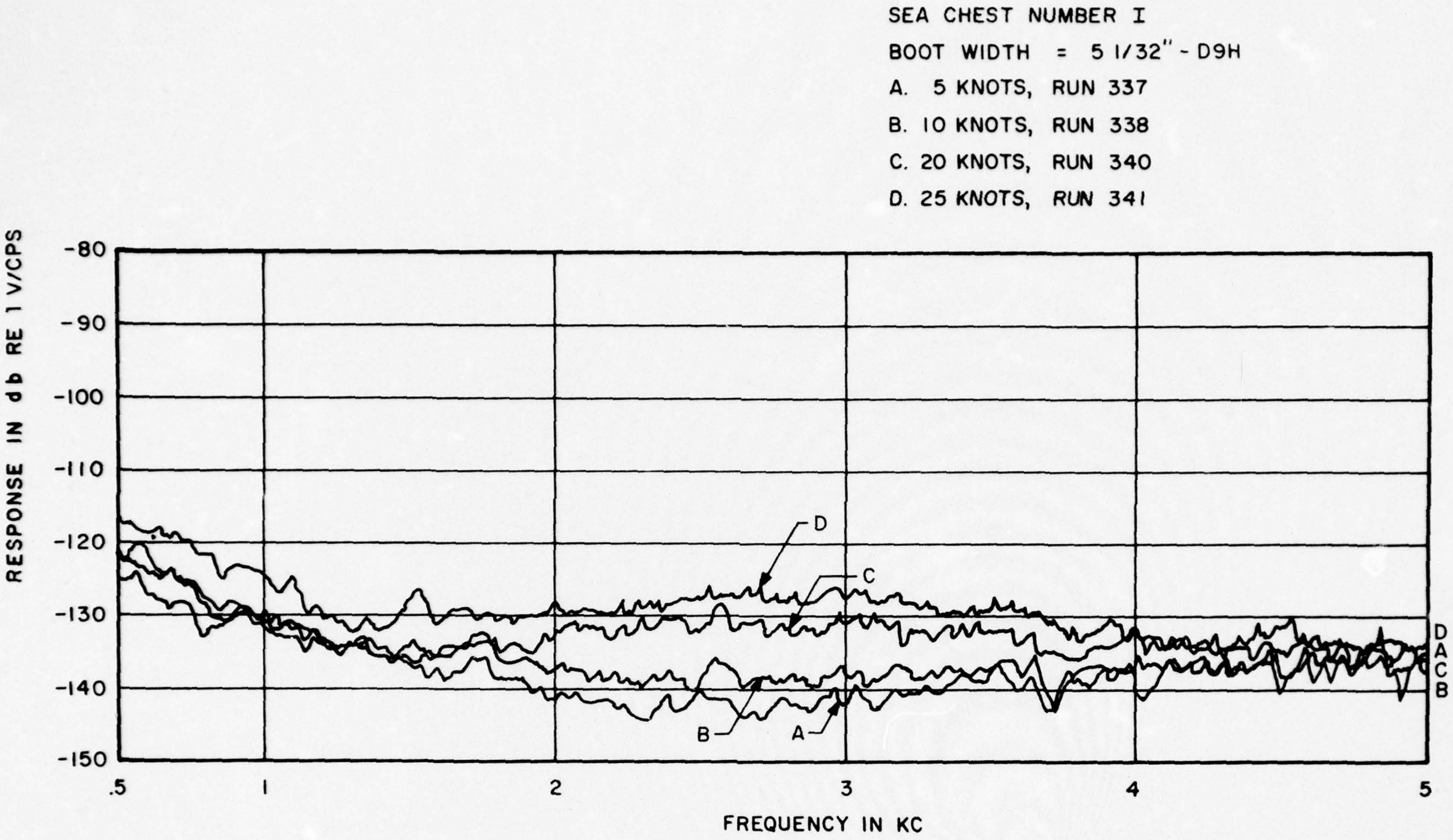
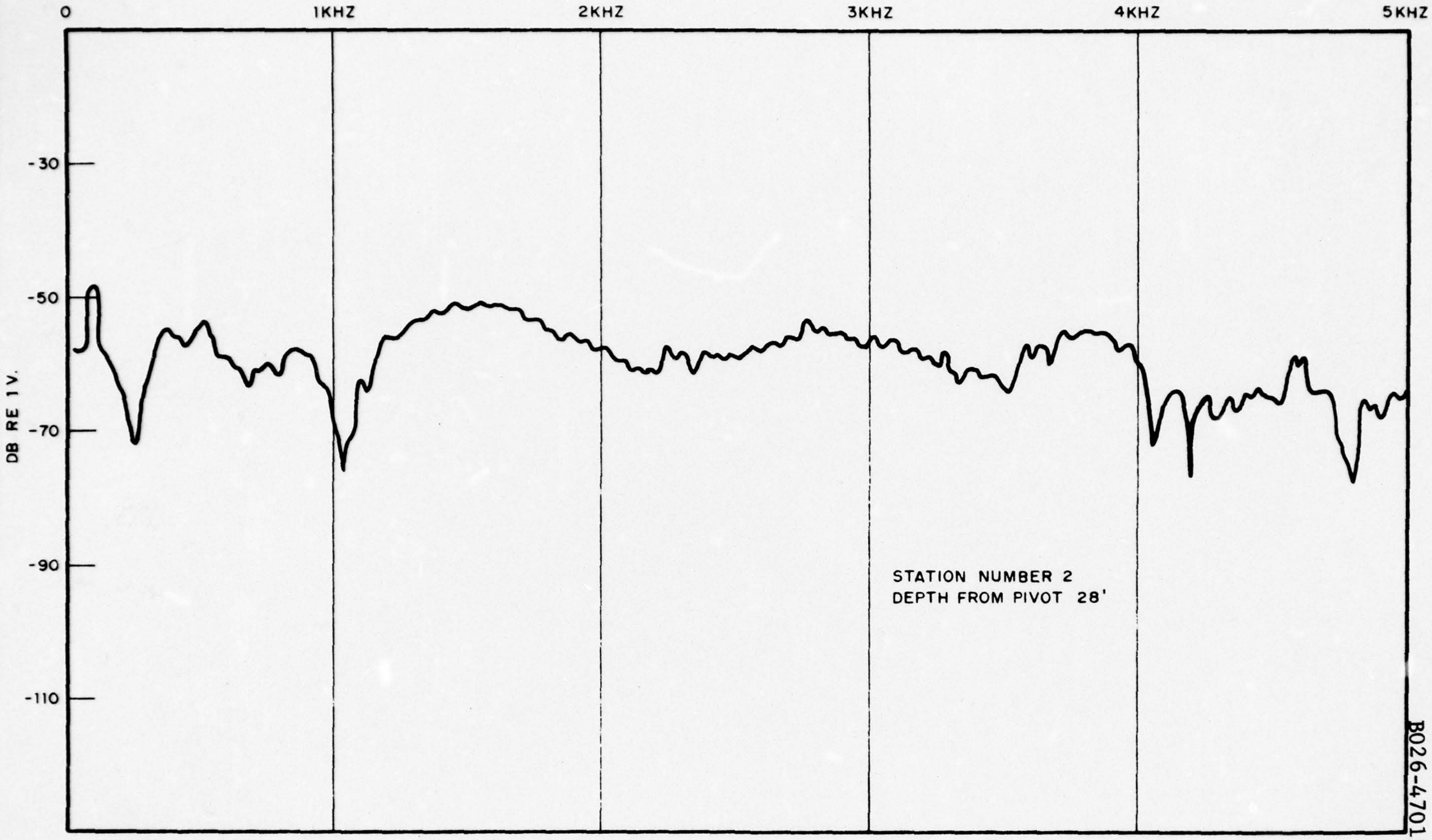
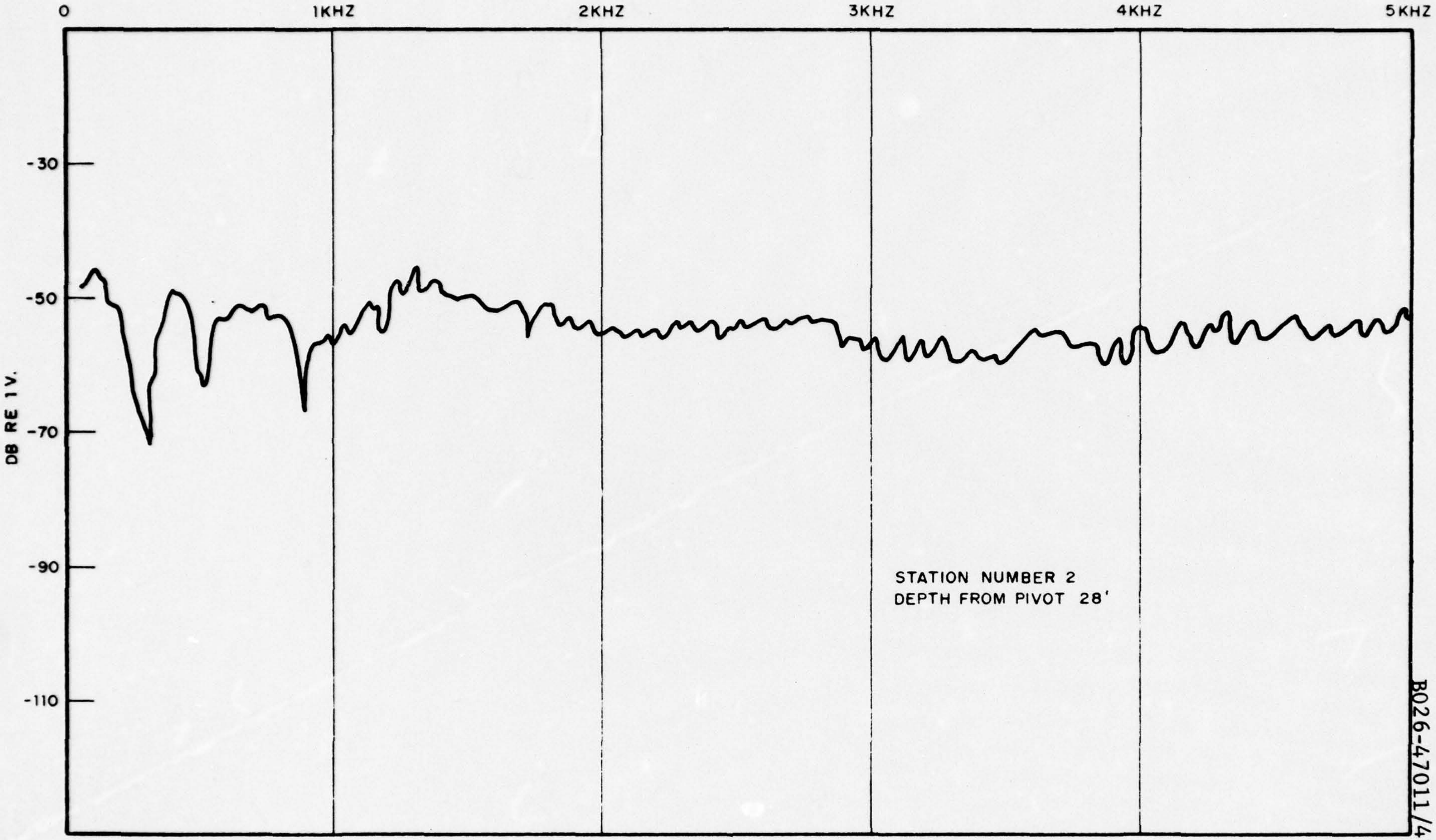


FIGURE 6-11 D9 NOISE SPECTRA



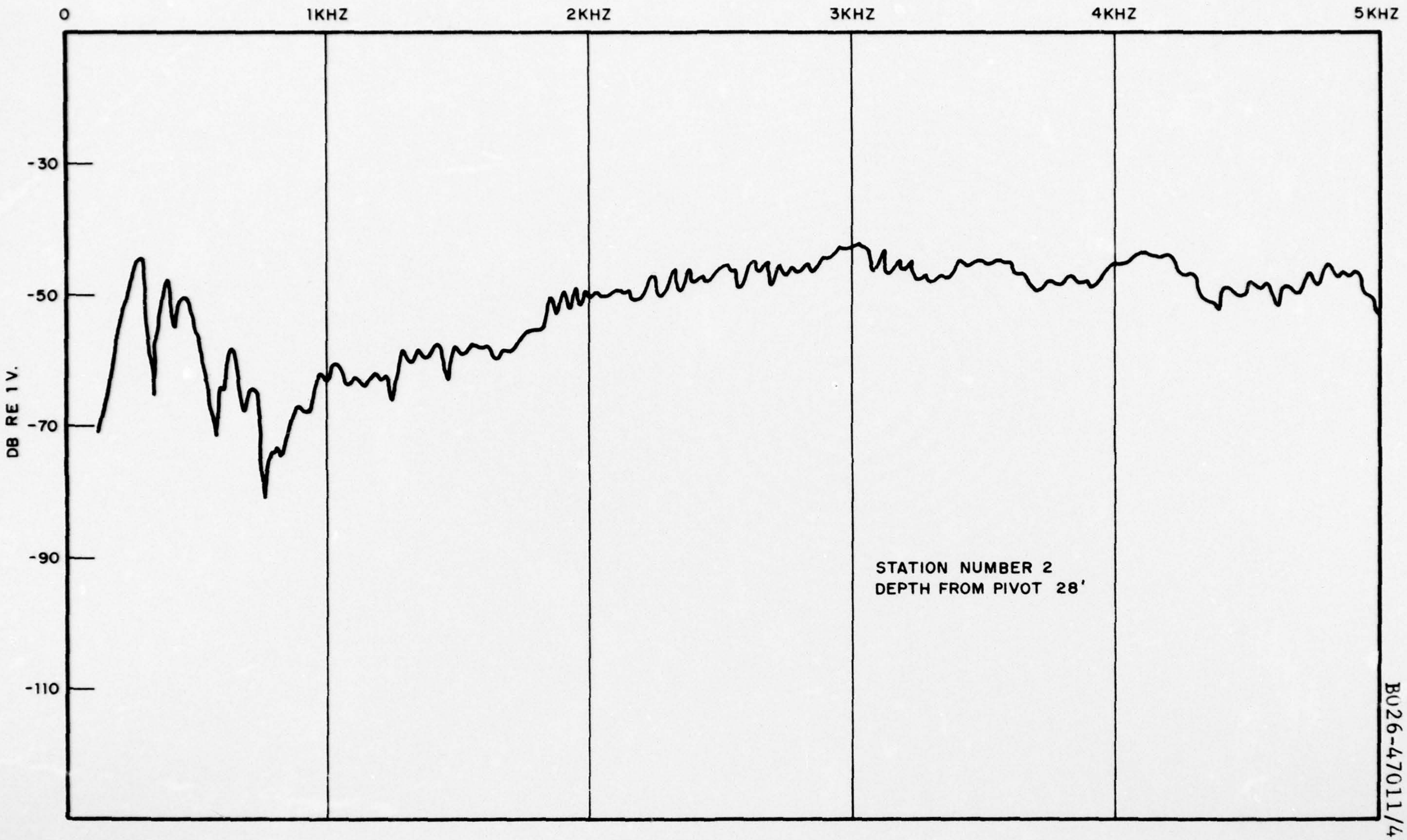
OVERSIDE CALIBRATION ELEMENT D4H
RUN 983
FIGURE 6-12



OVERSIDE CALIBRATION ELEMENT D5H

RUN 983

FIGURE 6-13



OVERSIDE CALIBRATION ELEMENT D9H
RUN 983
FIGURE 6-14

peculiarities of their installation. A similar supposition is that trapped air was present under the layer over some elements, which would effect the response of the element to either a signal or noise applied on the outer face of the layer. Under such conditions, the desired absolute noise levels for properly mounted elements beneath the various layer thicknesses would be given more nearly by reducing observed noise levels by use of the in-situ sensitivities than by use of the intrinsic (or free-field) sensitivities of the unmounted elements. Unfortunately, however, application of this procedure yields reduced noise spectra that still do not have the inverse (or direct) order of thickness in any substantial frequency range.

Considerable doubt is cast on the validity of the in-situ calibrations, in any case, apart from their wide and erratic variations among elements, by the observation that the noise spectra at 5 kt, where the noise may be expected to be primarily acoustic in character, are much closer to one another, in general, than are the calibration curves. This fact suggests regarding the 5-kt spectra as effective relative calibration curves to use for the spectra at higher speeds. This procedure, however, also fails to yield a plausibly ordered set of spectra.

At very low frequencies, i.e., up to nearly 0.25 kc, however, for the higher speeds (20 and 25 kt) the order of the noise levels for the various elements (with the exception of D6 and D10 at 25 kt) is the expected inverse order of thicknesses. In this range, beginning from zero frequency the spectra are mostly rather flat for a short interval and then decline precipitately up to about 0.4 kc, by which point the level order is mixed; the rate of decline with frequency then becomes smaller on the order of that observed at such frequencies with flush elements. We are unable to propose a positive reason why the regular order of levels observed at very low frequencies should not persist to much higher frequencies.

A theoretical account of the possible acoustic noise reduction by a covering layer is given in summary in Appendix G.

We also supply here a brief theoretical orientation. The noise spectrum is regarded as the sum of three parts: (a) high-wave number (eddy-convection) noise due to the TBL: (b) low-wave number noise due to the TBL (c) noise due to a radiated sound field (including any associated with the TBL). Component (b) (with suitable adjustments in (a) and (c)) may be roughly assumed to be wave-number white.

In the present tests, even the thinnest layer (5/8") is expected to be sufficient to eliminate the high-wave number component (a). All of the layers, on the other hand, are expected to leave the radiative component (c) nearly unaffected. Finally, the layers will reduce wave number-white noise as a function of thickness L and frequency according to a formula given in Appendix A. Thus only component (b) of the noise is expected to depend on L over the range of L embraced by the tests. Hence, if the L-dependence is substantial at very low frequency, as observed, it will remain substantial up to frequencies where either (1) the wave length ($\lambda = 2\pi c/\omega$) of sound in the water or layer is only $\lesssim 3/2$ times the element diameter or $\lesssim 9$ times the layer thickness, so that component (b) becomes L independent, or (2) the entire component (b) has become rather smaller than component (c) on account of a more rapid decrease with frequency. If the L-dependence observed at low frequency in the tests is real, its obliteration above $\sim$0.25 kc would not be due to the former condition and could be attributed only to the latter. The pronounced but erratically variable dependence on thickness at higher frequencies, however, remains totally unaccounted for.

We are thus unable to make much sense of the results. If some credible criterion could be discerned for accepting the data for some elements as meaningful and those for others as not, then some apparently sensible account might be given. Since there is no clear criterion to use, however, the likelihood of selecting data to suit one's prejudice is obvious.

We shall now discuss further the observations for elements D4, D5, and D9, for which the noise levels at multiple speeds are shown in Figures 6-9 through 6-11. That part of the discussion which concerns the reduction of noise relative to a flush element or the reduction by the thicker layer relative to the thinner is given by way of example, but the conclusions are not to be credited, since, in accord with the remarks above, the selection of other elements would lead to conclusions different from and inconsistent with these. Similarly, the discussion based on in-situ calibration curves is not to be accepted.

The noise spectra for D5 and D4 clearly indicate some speed-independent component in fairly narrow bands centered at about 1.3 and 3.7 kc. Assuming, as we shall, an intrinsic element sensitivity of -108 db re 1 v/μbar, the maximum levels of these components appear to be about -19 db and -32 db re 1 $(\mu\text{bar})^2$/cps. respectively. In the case of element D9 the component at 1.3 kc appears to be absent, and that at 3.7 kc also does not appear, though it could be masked by the higher noise level seemingly prevailing there for this element.

We discuss results for the element D5 with the thinner boot. The speed dependence weakens as the frequency decreases toward 0.5 kc; in fact, there is a suggestion of another speed-independent component with peak near 0.5 kc. Concerning speed dependence in the ranges apparently least affected by speed-independent components, at ~0.8 kc for 10 to 20 kt the speed dependence is roughly as $U_\infty^2$ (6 dt/speed octave) and for 10 to 20 kt as $U_\infty^{2.6}$; at ~2 kc for 10 to 20 kt the dependence is as $U_\infty^{3.6}$ and for 10 to 25 kt as $U_\infty^4$. As for the frequency dependence, at 25 kt we have the result:

| Frequency interval (kc) | 0.5 to 1 | 1 to 2 | 2 to 4 |
|---|---|---|---|
| Db decrease | 9 | 7 | 9 |

The average dependence over 0.5 to 4 kc is thus as $\omega^{-2.7}$, just as found (at 20 kt) for the flush G elements. Hence, again the speed dependence is too weak to correspond to scaling form (1) (which, in the regime in question, remains roughly correct for a shielded element if correct for a flush element, so far as the speed and frequency dependence are concerned).

Regarding absolute noise levels, using the assumed sensitivity, we obtain the levels recorded for 20 kt in the following table along with comparative levels at 20 kt obtained for typical elements in the PURVIS I tests and for an element at similar distance aft in G. Franz's measurements on the submarine Albacore.

TABLE 6-1. Noise levels in db re 1 $(\mu\text{bar})^2$/cps for various elements at 20 kt.

| Test, element | Element diam. (in.) | Frequency (kc) 0.5 | 1 | 2 | 4 |
|---|---|---|---|---|---|
| Albacore, 46 ft aft | 0.11 | 36 | 33 | 18 | |
| PURVIS I, 1638 | 0.125 | 29 | 22 | 7 | -13 |
| PURVIS I, 5E61 | 3 | -14 | -25 | -30 | -37 |
| PURVIS I, 5E111 | 3 | 0 | -12 | -18 | -27 |
| PURVIS II, D5 | 1.5 | -7 | -15 | -21 | -32 |
| PURVIS II, D4 | 1.5 | -12 | -20 | -31 | -39 |
| PURVIS II, D9 | 1.5 | -14 | -22 | (-25) | (-25) |

It is unfortunate that there is no flush element of the same size and type as the D elements with which comparisons of noise levels on the layer-covered elements can be made. As it is, comparison can best be made with the 5E's of PURVIS I. The 5E which was at the source station aft was 5E61. That element, however, measured noise levels 12 db or more below those measured by the other 5E's, all of which were stationed further aft in or near Sea Chest 2 (for example, see noise for element 5E111 in Table 6-1). This difference obtained despite the fact that element 5E111 was situated about 9 feet below the lower edge of Sea Chest 2 and hence far removed from the water surface. If, nevertheless, we credit the measurement of 5E61, we note that the noise level for D5 with the 5/8" covering layer was 5 to 10 db higher; this difference might be atributed to the greater area of the 5E element, but in any case suggests no substantial noise reduction by the layer on D5. If, on the other hand, we discredit 5E61 and suppose that such an element at that location should measure noise no lower than that measured by 5E111 further aft, we note that the noise level for D5 was 3 to 7 db lower than that for 5E111, despite the larger area of the latter, thus suggesting substantial noise reduction by the layer.

We recall the contingent theoretical expectation with regard to the effect of the 5/8" layer on the noise relative to a flush element of the same (1.5") diameter: (a) high-wave number (eddy-convention) TBL noise should be virtually eliminated; (b) wavenumber-white TBL noise should be reduced by 7.4 db; (c) noise due to a radiated sound field should be left nearly unaffected.

We proceed to consider the results for elements D4 and D9 with the thicker layers (actually conically expanded boots). Though the layer thicknesses for D4 and D9 are nearly equal, and the noise levels are likewise nearly the same up to ~2 kc, the levels for D9 become much higher than for D4 at higher frequency. Comparing in-situ (overside) calibrations, we see that the calibrations for D4 and D9 are similar in form and rough magnitude up to 1.7 kc, but that the indicated sensitivity of D9 then rises, while that of D4 falls, so that whereas the average sensitivity for D9 from 2 to 4 kc is ~-46 db, that for D4 is ~-58 db. The calibration curve for D5, on the other hand, is similar to that for D4 on up to ~4 kc. We are led to think that the in-situ sensitivities for D4 and D9 differ in the higher frequency range not because the effective pressures in calibration in-situ differ, but because some differences in installation have caused the effective intrinsic sensitivities of the two elements in this frequency range to differ, thus affecting also the sensitivity to noise pressure. On this assumption as stated earlier, even though it is a comparison of absolute noise levels that is desired, the respective noise levels measured by the elements in this range should be altered to reflect the in-situ calibration difference. The levels so corrected no longer display the anomalous difference noted.

Comparing results for D4 and D5 at 20 kt, we see that the thicker layer has apparently reduced the noise level relative to the thinner by ~5 to 10 db. Correspondingly, the levels for D4 are lower than those for 5E111 of PURVIS I by 8 to 13 db; they are roughly the same as those for 5E61 of PURVIS I.

Returning to theoretical expectations, the effect of the thicker boot on the high-wavenumber noise is irrelevant (since this is negligible even with the thinner boot) and on the radiation noise is still minor. On the other hand, up to about 1 kc the wavenumber-white noise should be reduced by 18 db relative to the thinner boot, and by a decreasing amount at higher frequency.* This estimate applies to a laterally large planar layer, however, and the reduction would be expected to be somewhat smaller for a conical boot of the type employed. No trend toward convergence of the spectra with increasing frequency is discernible from the measurements.

## B. TRANSMISSION TESTS (Figures 6-15 to 6-18)

Analysis of data from transmission tests to date have been limited to analog records of the envelope of received signals after narrow band filtering. Two different techniques were employed for this purpose.

Figure 6-15 is an oscillographic record of the filtered signals from several hydrophones during a transmission test. This particular record was selected from a longer record made during real time on board the PURVIS, at a point when the received signal at one of the flush-mounted hydrophones was significantly affected by bubble clouds passing between the transmitter and the receiver. Ship's speed was 20 knots.

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*The results quoted here for wavenumber-white noise are based on the formula given in Appendix G.

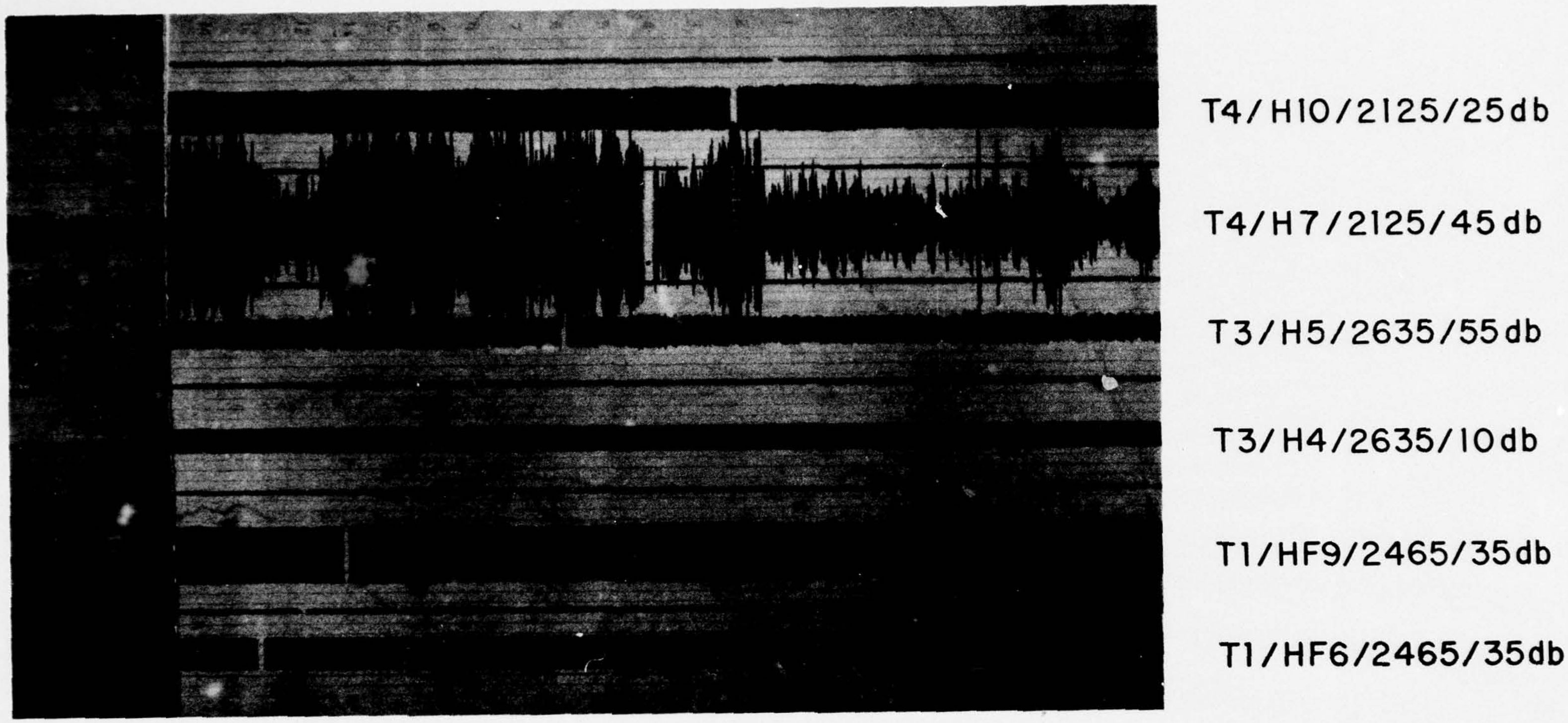
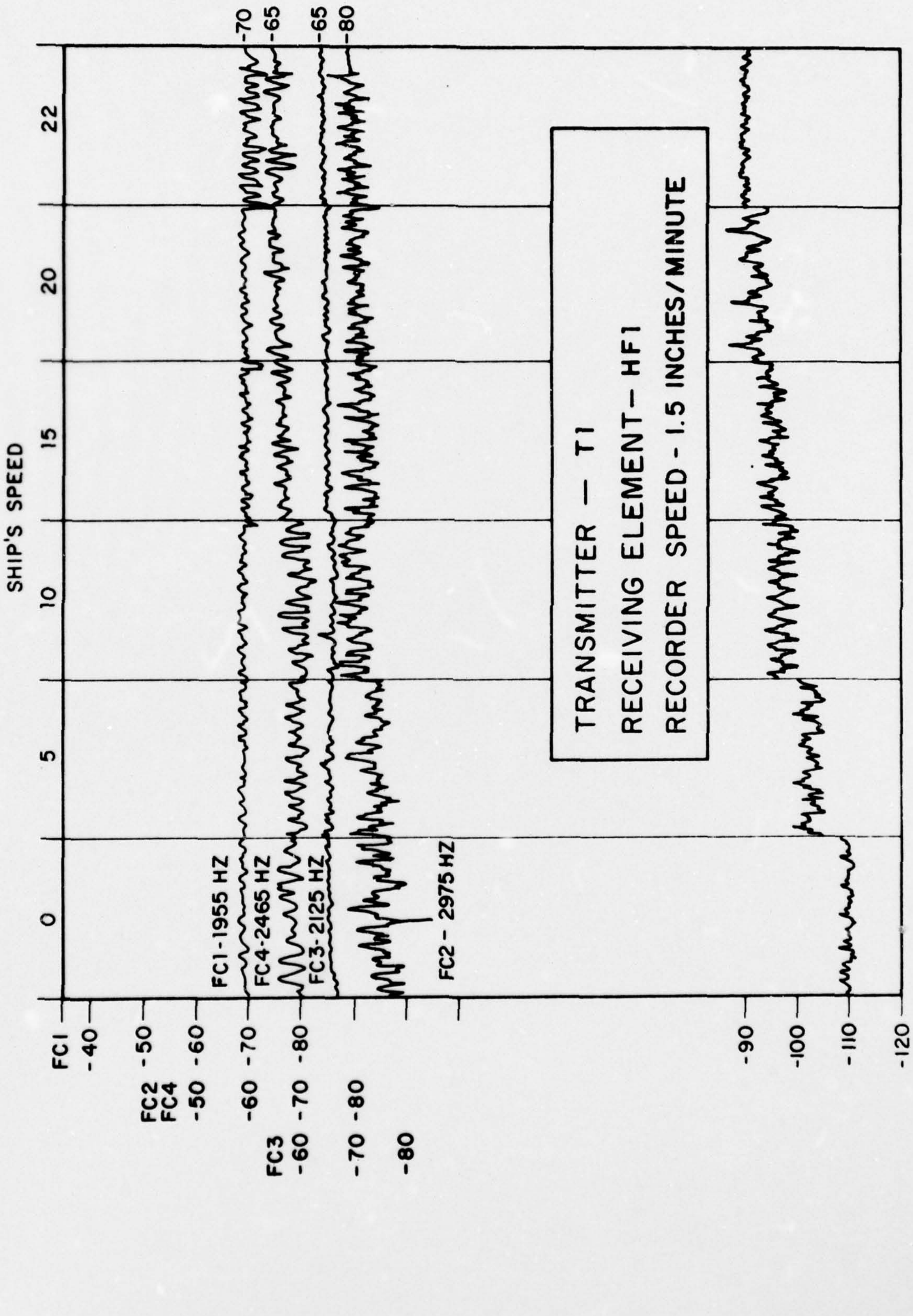
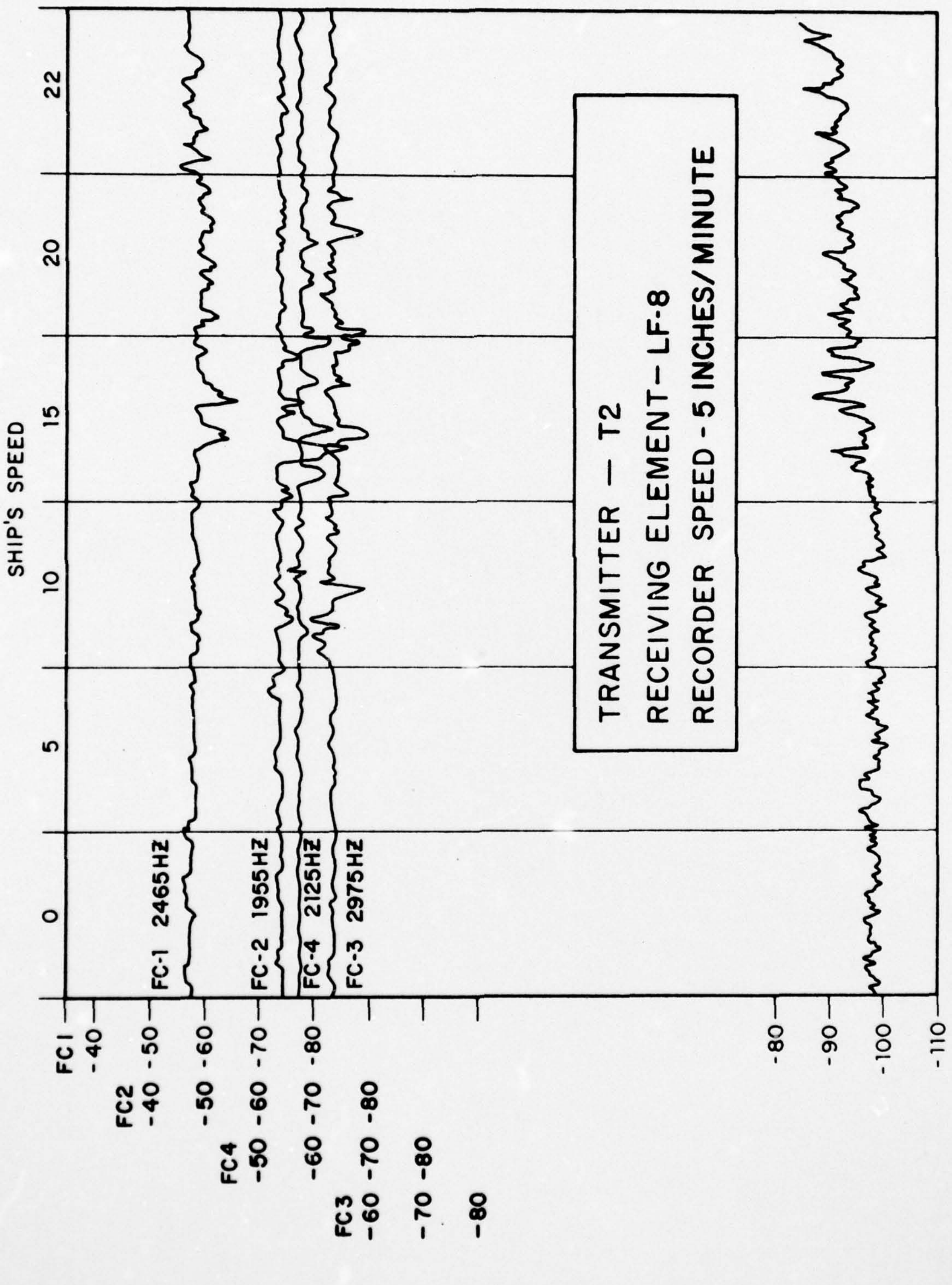


FIGURE 6-15 OSCILLOGRAPH OF HULL RECEIVERS DURING TRANSMISSION



PASSIVE RECEPTION AT 2465 HZ

FIGURE 6-16



TYPICAL PASSIVE RECORDING - 2465 HZ

FIGURE 6-17

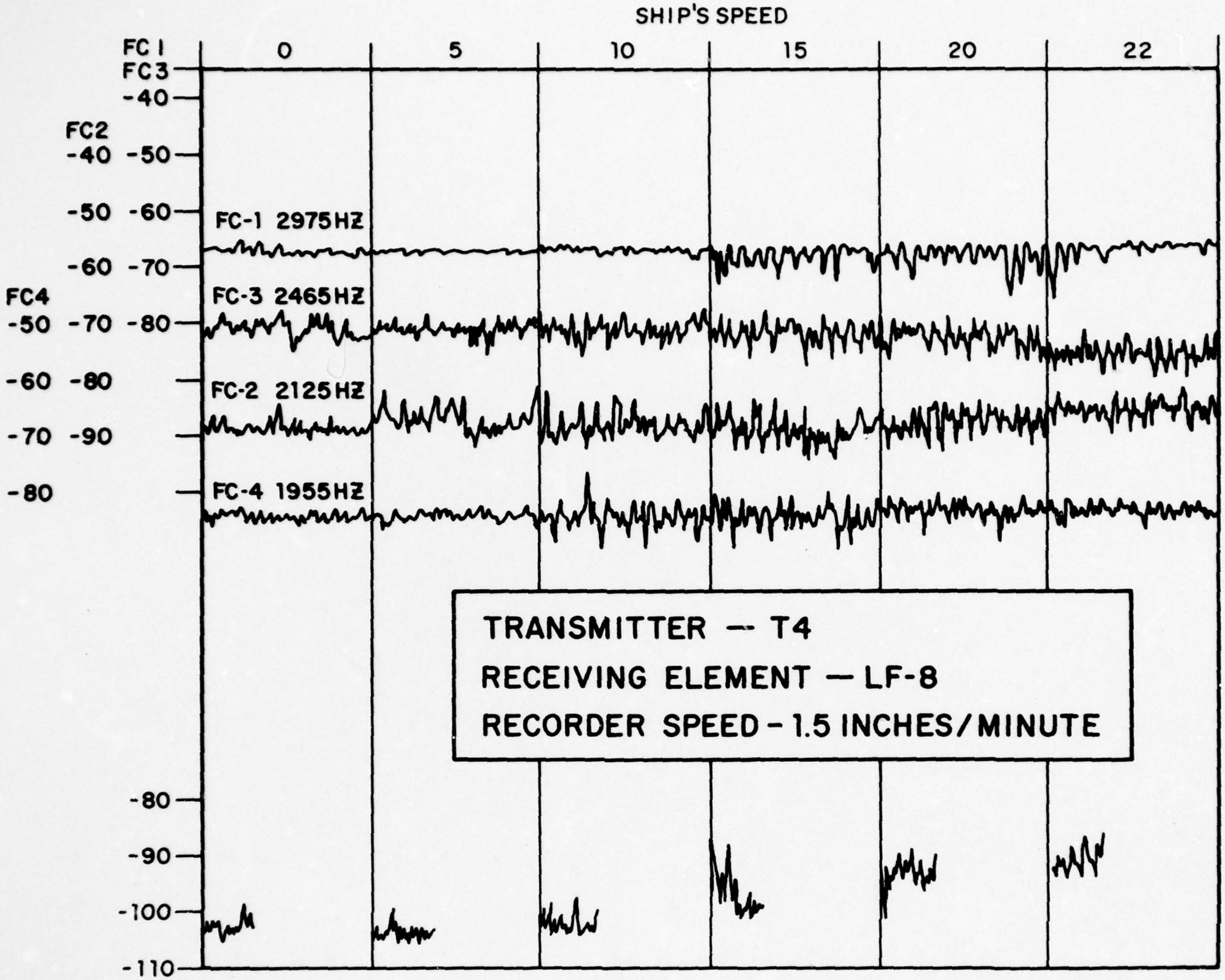


FIGURE 6-18 TYPICAL PASSIVE RECORDING - 2465 HZ

The traces at the extreme left side of the record represents the ambient noise levels prior to transmission appearing at each hydrophone in a 80 Hz band centered at one of the three transmission frequencies subsequently used. The balance of the record was made during the transmission period. The amplitude variations observed at receiver H-7 were quite discernible. In this short time history record (i.e., approximately 5 seconds) some of the amplitude depressions are between 15 and 20 db down from the nominal amplitude. The same transmitted signal received at H-10, however, shows practically no amplitude variations during the same time interval. This condition is, as expected, since receiver H-7 is located approximately 2 feet above the keel and 10 feet off the ship's center line, whereas receiver H-10 is located a few inches above the keel and 1 foot off the ship's center line. (Note: the "db" values for each at the six traces refer to amplification added after the narrow band pass filters of the Combiner-Separator panel.)

A second method of obtaining analog records of the transmission tests utilized the General Radio wave analyser and level recorder. For this application the GR center frequency was set to one of the transmission frequencies with a bandwidth of 50 Hz, and a time history at a receiver signal was recorded as a logarithmic amplitude record. Figures 6-16, 6-17 and 6-18 are composite records of the received signal at one hydrophone from one transmitter, at various ships speed and transmitting frequencies. The passive noise levels at 2465 Hz for each speed are also illustrated. The passive noise levels indicate that at receiver LF-8 the amplitude at 2465 Hz was essentially constant until the ship's speed was 15 knots or greater. At 15 knots large amplitude modulations were exhibited in the received signal level at LF-3 for all four frequencies, from both transmitters T2 and T4, due to bubble clouds, ship's motion, etc. The sea state during these runs was "2".

## C. ACTIVE TRANSMISSION

For active transmission runs we are interested in the normalized mean and variance of the envelope or average power of the received signal for finite time intervals. The normalization is with respect to zero speed or flow to indicate absolute levels of attenuation. We are also concerned with the mean and the variance of the phase difference between the transmitted and received signals normalized with respect to phase difference at zero speed.

The finite time intervals of interest correspond to the inverse bandwidths of anticipated active sonar input filters (long or short CW pulses), and the mean and variance as a function of consecutive time intervals are of interest to correspond to the motions or flow of bubble clouds.

Although special programs could be prepared to analyse these items, the timing and funding may preclude any such effort at this time. As an alternative, we are preparing oscillograph runs of received signals to show instantaneous output signals and variations in the envelope when passed through appropriate band pass filters. The cross-correlation between the transmitted and received signals will yield a function which is dependent on both amplitude and phase variations. Band limiting (clipping) of the signals prior to cross-correlation will give only phase dependent results.

## SECTION VII

## PLANS FOR FINAL DATA REDUCTION

### A. GENERAL

A joint TRG-DTMB meeting was held at the Model Basin on September 7, 1966 for the purpose of reviewing the status of acoustic data processing and analysis for both PURVIS I and II. During the meeting, TRG presented an analysis plan for the PURVIS II data (see end of section) which would satisfy the prime test objectives of the PURVIS II Sea Trials. This plan was basically accepted, supplemented by some additional requirements put forth by DTMB for both PURVIS I and II.

Subsequent to the meeting, funding for data processing and analysis was significantly reduced for the balance of Fiscal 1967. In view of this, the comprehensive processing and analysis planned for both PURVIS I and II acoustic data had to be judiciously "pruned". In addition, the implementation of new computer programs for new applications (i.e., transmission attenuation) or more efficient computer usage (i.e., Cooley-Tukey high speed spectrum analysis), was essentially terminated.

### B. PROGRAMMING EFFORTS

One general agreement between TRG-DTMB was that all noise spectra data being plotted in the dimensional form of power (db re 1 $\text{microbar}^2$-sec) vs. frequency in Hz should be plotted on one continuous plot rather than in 3 linear frequency bands, as is presently being performed for PURVIS I data. Note: the 3 frequency bands used were 100 Hz to 1000 Hz, 1000 Hz to 3000 Hz and 3000 Hz to 10000 Hz. Formatting and digital computations were performed 3 times for the same analog data by using analog filters prior to formatting). Programming efforts have been initiated to modify the present output plotting tape to include this capability as well as a "non-dimensional" form with a log frequency abscissa. Additional programming efforts may be required for processing transmission attenuation data, after an analysis of the results from the data reduction order described below has been completed.

## C. ACOUSTIC CALIBRATIONS

Another general agreement at the joint meeting was that free-field calibrations should be used for the presentation of all noise spectra (PURVIS I and PURVIS II). The processing operation at NEL Data Conversion Center (See Appendix E) presently provides for the inclusion of correction data, such as tape skew correction, hydrophone acoustic sensitivity, etc., on the header record preceding the digitized and formatted analog data on the formatted digital tape. The analysis program, which performs the computations for auto-and cross-correlation, and cross and noise spectra, utilizes both the header record and the formatted data.

The TRG 5-inch elements had not been calibrated prior to installation in the ship and acoustic calibrations are presently being performed at the U.S. Navy Underwater Sound Reference Laboratory (USNUSRL), Orlando, Fla., under the cognizance of DTMB.

However, these tests for frequency response are just starting, and TRG has not been furnished with any test results to date. Hence, TRG plans to defer formatting and analysis of acoustic data requiring frequency response corrections until the latter information has been received.

## D. PURVIS II DATA REDUCTION ORDER

An initial data reduction order has been submitted to the Data Conversion Center at NEL (see end of section), and to DTMB. The acoustic data processing requirements within this order include auto and cross correlations, power and cross

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PURVIS II SEA TRIALS.(U)
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UNCLASSIFIED TRG-023-TM-66-32/34 NL

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12 - 76

spectrums, amplitude distributions and some analog recording of received signals during transmission runs. Accelerometer data associated with both the TRG 5" receivers and the DTMB FS-13 receivers will be processed using the General Radio Wave Analyzer.

As a result of recent processing tests the specifications for formatting have been modified for improved efficiency above the PURVIS I procedures. Instead of using three frequency bands between 100 Hz and 10 KHz, two processing bands (200 Hz to 2 KHz, 1 KHz to 8 KHz) will be used, with a "switchover" at 1.4 KHz during plotting operations. The reduced bandwidth will also permit sampling data at a slower rate (i.e., 50 KHz vs. 100 KHz) as well as reduce the number of operations, digital files, analysis program, output plotting tapes, etc., by 1/3.

The selection of run numbers for processing and analysis was made from runs which were performed after the fixed transmitting strut at frame 58 was removed from the ship.

## Noise Measurements in Purvis II: Outline of Proposed Analysis

D. Chase, Sept. 6, 1966

Broadly, two purposes may be distinguished for the noise measurements in Purvis II: first, to obtain noise levels on elements in typical positions and installations, together with correlations between neighboring similar elements, and thus to infer directly the noise levels for arrays in similar configurations; second, to determine the relative contributions of the various noise sources and properties of the corresponding noise fields in order to suggest noise-optimized configurations and assess the noise reduction possible by shielding elements from the flow. For the second purpose, the Purvis I measurements must be considered in parallel.

The flush-mounted TRG elements are especially pertinent to the former purpose. To achieve it, we examine the noise spectra for elements over the entire range of positions. For these identical elements we must investigate dependence on ship speed, distance aft (and the relation to interior noise sources), vertical position (proximity to water surface), ship maneuver, and sea state. Since the corresponding effective noise for an arbitrary array depends on the noise correlation among elements as well as the level for each element, narrow-band cross-correlations of the noise between neighboring elements must also be investigated.

The measured noise levels should be referred both to free-field and in-situ calibrations. The latter is appropriate so far as the acoustic configuration (baffle properties) conforms to that of ultimate interest, but the former permits inference of noise levels for different configurations without reference to the particular one used in the measurements.

We turn to the second purpose. The evident possible types and sources of noise are enumerated as follows.

1. acoustic
    a. machinery, other internal ship noise
    b. flow-excited hull, dome, or strut vibration
    c. cavitation (at screws, struts, protrusions)
    d. splash and other noise associated with ship-water-air interface
    e. bubbles
    f. natural turbulence (sea state)
2. turbulent-boundary-layer pressure fluctuations (transmitted acoustically if element is shielded from flow)

These contributions to the noise measured by an individual element will depend in various ways on the following salient variables:

1. frequency
2. speed
3. element size

4. element location
5. type of element shielding (if any)
6. impedance of surrounding flow boundary
7. ship maneuver, sea state

Likewise, the cross-spectra of noise between elements, both in magnitude and phase, will differ distinctly for the acoustic and boundary-layer contributions. The same is true of the magnitude of the cross-spectra between noise on an element and acceleration at a nearby point of the flow boundary.*

Calibrations

The use of free-field calibrations should be emphasized if and when these are available, especially with reference to the sea-chest mounted elements, since the acoustic configuration for these is rather special and not characteristic of a probable final system design. Until free-field calibrations are available, the over-side in-situ ones will be used wherever credible. If they are not credible in the instance of the sheathed elements in Sea Chest 1, e.g. if they differ greatly from one element to another, but noise measurements

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* Acceleration sensitivity of the element must also be considered in conjunction with readings of the accelerometers mounted on the rear masses of several elements.

for these elements at low speed coincide, the relative calibrations will tentatively be assumed equivalent among elements.

In evaluation of calibration results, those for neighboring identical elements will be compared. The appropriate extent and mode of frequency-averaging of the calibration curves must be established for noise data reduction.

We discuss briefly various sets of elements and data to be studied with regard to the noise sources and variables enumerated earlier.

Sea Chest 1 (sheathed elements: D1-D10)

We compare reduced noise spectra among elements beneath layers of differing thicknesses; we compare these also for pairs of elements of same nominal thickness to eliminate influence of fore-aft position. Acoustic contribution to noise is expected to be nearly independent of depth. Boundary-layer contribution has distinguishable components which will be reduced to varying degrees dependent on different parameters. If wave numbers $K \gg \pi R_o^{-1}$ do not contribute substantially, where $R_o$ is element radius, and if wave number spectrum of pressure depends only weakly on $K$ in the pertinent range, the noise spectrum is expected to be reduced relative to flush mounting in a rigid baffle by a factor $\sim (R_o/R_e)^2$ if $R_e \gtrsim R_o$, where

$$R_e^{-2} = (1/4) \left[ (\omega/c)^2 + 1/2L^2 \right],$$

c is the order of the transverse ( or possibly longitudinal) sound velocity in the material of the layer, and L is the layer thickness; the noise is expected not to be reduced if $R_e \lesssim R_o$, i.e. if

$$(\omega/c)^2 \gtrsim 4/R_o^2 - 1/2L^2.$$

Cross-spectra between various pairs of elements will be examined to help determine the predominant wave numbers in the pressure field at the depth L in question.

TRG elements at series of distances aft (large, flush elements: HF, LF, H)

Cross-spectra between neighboring elements at various distances aft will be examined to try to see in what frequency range the noise is predominantly attributable to the boundary layer and in what (higher) range to an acoustic field. In each range, the dependence on distance aft at fixed ship speed will be studied. In the range where boundary-layer noise is thought to predominate, it will be determined whether the noise decreases with distance aft in rough accord (given the observed frequency dependence) with two suggested alternative scaling forms for this type of noise. The variation with distance will be studied also where acoustic noise is thought to predominate. Cross-spectra of noise with acceleration measured at neighboring points will also be employed in distinguishing the acoustic contribution.

Noise spectra for elements at different vertical heights will be compared. In this connection, and also as a complicating factor in connection with dependence on distance aft, the intensity of turbulence, it is noted, may be significantly influenced by proximity to the motions generated at the ship-water-air interface. Along with an increased rms fluctuating velocity, an increased turbulent energy dissipation would also occur and perhaps be of greater importance on account of its relation to the decay of eddies and the associated non-convective effect; the latter may be significant for boundary-layer noise on large elements at high frequency.

Sea Chest 2 (flush window-mounted and dome-housedelements: G)

Here the comparison between noise spectra for the flush and the shielded elements is to be emphasized. A similar comparison between cross-spectra of noise on pairs of elements is important to indicate to what extent the wave number spectrum of pressure differes within the dome. Cross-spectra between noise and acceleration are likewise useful to indicate the relative contribution of acoustic sources to the noise on flush and shielded elements. Comparison of noise spectra with spectra from Purvis I will be used in consideration of the area-averaging effect. Noise spectra for flush window-mounted elements and those for neighboring, similar, flush hull-mounted elements will be compared to assess the probable effect of vibration of the sea-chest window.

Comparisons of noise spectra on various elements will be made with those on comparable elements in the U.S.S. Albacore measurements.

For all elements considered, cross-spectra between noise and ship motion will be examined with a view to evaluating the contribution of acoustic sources lc - le in the earlier enumeration.

September 27, 1966

Mr. J. Luistro
Department of the Navy
David Taylor Model Basin
Washington, D.C. 20007

Re: Contract NObsr 93023 PURVIS II
Data Reduction

Dear Mr. Luistro:

Enclosed is a copy of a draft of the PURVIS II Data Reduction order memo which I am having typed for transmission to our facility at NEL.

Programming has been started to permit conversion of the output tape to a single plot, including non-dimensional scales and with a log frequency abscissa.

It should be noted that the active transmission run data reductions are not fully specified. Complete active transmission data reduction requirements will be forwarded to you shortly.

Data completion time estimates for PURVIS II will be forwarded to you as soon as they are completed.

Very truly yours,

N. Nesenoff

NN/Mc
cc: M. Baldwin, NEL
H. Seberg, TRG
W. Landauer, TRG
W. Graham, TRG
R. Newman, TRG
J. Franz, DTMB
I. Cook, DTMB

Enclosure

# INTER-OFFICE MEMORANDUM

September 27, 1966

TO: H. Seberg

FROM: N. Nesenoff

SUBJECT: PURVIS II DATA REDUCTION

Enclosed are the order runs for PURVIS II Data Reduction.

The first 25 items are for Sea States 0(and 1) Headings with respect to sea of 000°, and speeds of 0, 10, 20, and 30 knots. Four pairs of hydrophones are used for the high frequency array, four pairs for the low frequency array, four pairs for the DTMB (D) Sea Chest 1 hydrophones, and two pairs for the GD (G) Sea Chest 2 hydrophone. (Table I)

Selected probability distribution curves are also specified for band limited signals in two bands; 2Kc → 3Kc and 7Kc → 8Kc.

Accelerometer spectra are also specified, but they can be performed on the GR wave analyzer since no "cross-correlations/or spectra are required.

In accordance with your recommendations for improved efficiency, we are specifying two processing bands.

200 cps → 2Kc
1 Kc → 8Kc
with switch over of curves at 1.4Kc.

The hydrophone pairs and accelerometers are specified for the HF (high frequency array), LF (low frequency array), D (Sea Chest 1), and G (Sea Chest 2) and are given in Table II.

The statistical data reduction program results in a total of 8 curves for a pair of hydrophones. These curves are summarized in Table III.

An additional set of curves is specified for headings with respect to sea "around-the-clock". These are taken at Sea State I, and at a speed of 20 knots. The runs are specified in Table I, items 26 through 31.

For the active transmission runs, a preliminary set of cross-correlations are specified for 16 speeds, 0, 5, 10, 15, 20, 22 knots; a heading with respect to sea of 000°, and sea state 2 and frequency combination F1. These are given in Table I items 32 through 37. The active combinations are also given in Table II.

The presently available plots are to be made with priority given to:

1. Power Spectrum
2. Cross Power Spectrum
3. Correlations

Additional plotting programs are to be prepared to yield "dimensionless" plots in accordance with memo from Dave Chose of 9-13-66. Power Spectrum is to be plotted on a single curve (not 2.or 3 curves) with ordinate and abscissa in dimensionless form and plots to be made as logarithm of power (decibels) and logarithm of frequency. The cross-power will also have a dimensionless form and will be the subject of another memo by Dave Chose. It will essentially be a linear plot pf phase and frequency (same as now), and a <u>linear</u> plot of frequency verses normalized cross-spectrum, where frequency is in normalized form.

NN/Mc
cc: R. Newman
D. Chase
W. Landauer
W. Graham
M. Zullo

# TABLE I

## PURVIS II Passive Data Processing

| | Item | Run No. | Date | Pairs | Speed | Sea State | Description | No. of Curves | HW Sea |
|---|---|---|---|---|---|---|---|---|---|
| Passive Acoustic-Hulls | 1 | 336 | 7/14 | HF | 0 | 0 | Statistical Set | 68 | |
| | 2 | 338 | 7/14 | HF | 10 | 0 | " | 68 | |
| | 3 | 340A | 7/14 | HF | 20 | 0 | " | 68 | |
| | 4 | 340 | 7/9 | HF | 20 | 1+ | " | 68 | |
| | 5 | 342 | 7/15 | HF | 30 | 1+ | " | 68 | |
| | 6 | 343 | 7/14 | LF | 0 | 0 | " | 68 | |
| | 7 | 345 | 7/14 | LF | 10 | 0 | " | 68 | |
| | 8 | 347A | 7/14 | LF | 20 | 0 | " | 68 | |
| | 9 | 347 | 7/9 | LF | 20 | 1+ | " | 68 | |
| | 10 | 349 | 7/15 | LF | 30 | 1 | " | 68 | |
| Ampl. Distr. | 11 | 343 | 7/14 | HF5,LF3,H5 | 0 | 0 | Amplit dist. + cum (2 Bands 2Kc→3Kc 7Kc→8Kc) | 12 | |
| | 12 | 345 | 7/14 | " | 10 | 0 | " | 12 | |
| | 13 | 347A | 7/14 | " | 20 | 0 | " | 12 | |
| | 14 | 347 | 7/9 | " | 20 | 1+ | " | 12 | |
| | 15 | 349 | 7/15 | " | 30 | 1 | " | 12 | |
| | 16 | 336 | 7/14 | D | 0 | 0 | Statistical Set | 76 | |
| | 17 | 338 | 7/14 | D | 10 | 0 | " | 76 | |
| | 18 | 340A | 7/14 | D | 20 | 0 | " | 76 | |
| | 19 | 340 | 7/9 | D | 20 | 1+ | " | 76 | |
| | 20 | 342 | 7/15 | D | 30 | 1+ | " | 76 | |
| | 21 | 343 | 7/14 | G | 0 | 0 | " | 36 | |
| | 22 | 345 | 7/14 | G | 10 | 0 | " | 36 | |
| | 23 | 347A | 7/14 | G | 20 | 0 | " | 36 | |
| | 24 | 347 | 7/9 | G | 20 | 1+ | " | 36 | |
| | 25 | 349 | 7/15 | G | 30 | 1 | " | 36 | |
| | 26 | 436 | 7/9 | HF | 20 | 1+ | " | 68 | 090° |
| | 27 | 536 | 7/9 | HF | 20 | 1+ | " | 68 | 180° |
| | 28 | 637 | 7/9 | HF | 20 | 1+ | " | 68 | 270° |
| | 29 | 443 | 7/9 | LF | 20 | 1+ | " | 68 | 090° |
| | 30 | 543 | 7/9 | LF | 20 | 1+ | " | 68 | 180° |
| | 31 | 644 | 7/9 | LF | 20 | 1+ | " | 68 | 270° |
| | 32 | 860 | 7/20 | A | 0 | 2 | Active Curves A | | 000° |
| | 33 | 859 | 7/20 | A | 5 | 2 | "(Table II) | | 000° |
| | 34 | 858 | 7/20 | A | 10 | 2 | " | | 000° |
| | 35 | 857 | 7/20 | A | 15 | 2 | " | | 000° |
| | 36 | 856 | 7/20 | A | 20 | 2 | " | | 000° |
| | 37 | 862 | 7/20 | A | 22 | 2 | " | | 000° |

## TABLE II

## Pairs

| | Pair | Curves |
|---|---|---|
| HF | 1. HF5 - HF4 | 16 |
| | 2. HF5 - HF3 | 16 |
| | 3. HF5 - HF12 | 16 |
| | 4. HF2 - H5 | 16 |
| | 5. A5 | 2 (Power Spectrum only*) |
| | 6. A9 | 2 (Power Spectrum only*) |
| LF | 1. LF3 - LF2 | 16 |
| | 2. LF3 - LF1 | 16 |
| | 3. LF12-LF11 | 16 |
| | 4. HF2 - H5 | 16 |
| | 5. A5 | 2 (Power Spectrum*) |
| | 6. A9 | 2 (Power Spectrum*) |
| D | 1. D1H - D2H | 16 |
| | 2. D3H - D8H | 16 |
| | 3. D4H - D9H | 16 |
| | 4. D10H - HF10 | 16 |
| | 5. D1A | 2 (Power Spectrum*) |
| | 6. D2A | 2 (Power Spectrum*) |
| | 7. D3A | 2 (Power Spectrum*) |
| | 8. D4A | 2 (Power Spectrum*) |
| | 9. D9A | 2 (Power Spectrum*) |
| | 10. D10A | 2 (Power Spectrum*) |
| G | 1. G5 - G6 | 16 |
| | 2. G7 - G8 | 16 |
| | 3. G9 - G10 | 16 |
| | 4. A1 | 2 (Power Spectrum*) |
| | 5. A4 | 2 (Power Spectrum*) |

* Power Spectrum can be analog GR plot

A
1. T2 - LF1
2. T4 - H5
3. T1 - HF5

T = Transmitting strut; use frequency combination F1.

Active Curves "A"

Processing Consists of:

1. Received Signal O'graph plot (include scaling)

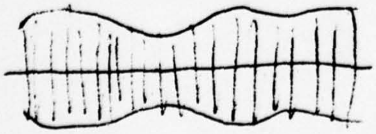
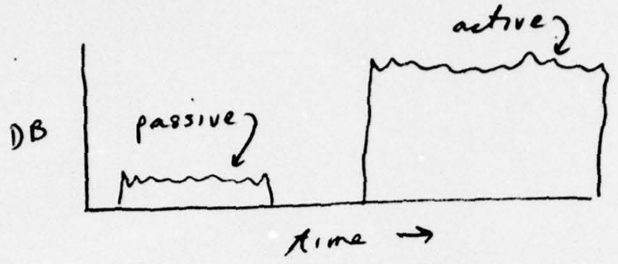


TABLE II (continued)

2. GR wave analyzer, 50 c.p.s. bandwidth at center frequency of transmitter.



3. Cross-correlation of transmitted signal and hydrophone filter at center frequency, 200 c.p.s. bandwidth.

4. Cross-correlation - Sample at 50Kc N = 2

   Record length at 1/5 sec. Run for 15 time intervals for all three pairs at 20 knot speed only. Time intervals to be separated by 1 second.

## TABLE III

| Pair XY | Statistical Set | |
|---|---|---|
| Auto Corr. | X | 8 Curves |
| Auto Corr. | Y | |
| X . Corr. | XY | |
| X . Corr. | YX | |
| Spect | X | |
| Spect | Y | |
| X.Spec Mag | XY | |
| X.Spec Phase | XY | |

2 Bands (switch at 1.4Kc)
200 c.p.s. → 2Kc
1Kc → 8Kc

## TABLE IV

Summary, "Around-the-compass-runs"

Various heading with respect to Sea at 20 knots, Sea State 1

| Run | Date | Record Combination | HW Sea | Sea State |
|---|---|---|---|---|
| 436 | 7/9 | 1-1 | 090 | 1+ |
| 536 | 7/9 | 1-1 | 180 | 1+ |
| 637 | 7/9 | 1-1 | 270 | 1+ |
| 443 | 7/9 | 2-1 | 090 | 1+ |
| 543 | 7/9 | 2-1 | 180 | 1+ |
| 644 | 7/9 | 2-1 | 270 | 1+ |

## TABLE V

## Summary, Preliminary Active Runs

HWS = 0° Sea State 2, Freq. Combo. F1, Rec. Combo 3-1

| Run | Date | Speed | Rec. Combo. | HWS | SS | Freq. Combo |
|---|---|---|---|---|---|---|
| 860 | 7/20 | 0 | 3-1 | 000 | 2 | 3-1 |
| 859 | 7/20 | 5 | 3-1 | 000 | 2 | 3-1 |
| 858 | 7/20 | 10 | 3-1 | 000 | 2 | 3-1 |
| 857 | 7/20 | 15 | 3-1 | 000 | 2 | 3-1 |
| 856 | 7/20 | 20 | 3-1 | 000 | 2 | 3-1 |
| 862 | 7/20 | 22 | 3-1 | 000 | 2 | 3-1 |

## TABLE VI

Summary, Passive Runs
(Items 1 through 25, Table I)

Heading was 0° except at 0 knots
HWS° = 90°

| Knots | Rec 1-1 | Data | Sea State | Rec 2-1 | Date | Sea State |
|---|---|---|---|---|---|---|
| 0 | 336 | 7/14 | 0 | 343 | 7/14 | 0 |
| 10 | 338 | 7/14 | 0 | 345 | 7/14 | 0 |
| 20 | 340A | 7/14 | 0 | 347A | 7/14 | 0 |
| 20 | 340 | 7/9 | 1+ | 347 | 7/9 | 1+ |
| 30 | 342 | 7/15 | 1+ | 349 | 7/15 | 1 |

Subject PURVIS II Naval Architecture Series (Photographic)

Sheet 1 of 2

| Line No. | Col.A Run No. | Col.B Speed Knots | Col.C Date | Col.D Heading WRT Sea | Col.E Masker No. | Col.E Masker Rate | Col.F Bow Wave Hose | Col.G Fisheye Camera | Col.H RPM Port | Col.H RPM Stbd | Col.I True Wind Vel. | Col.J True Wind Dir. | Col.K Water T° | Col.L Sea State | Col.M Ships Course | Col.N Time & Index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 216 P | 10 | 6/22 | 0° | 2+4 | Low | -- | xx | 88 | 88 | 4 | --- | 82 | 0 | --- | 13:21:37 |
| 2 | 217 P | 15 | 6/22 | 0° | 2+4 | Low | xx | xx | 135 | 135 | 4 | --- | 82 | 0 | 121° | 13:43:34 |
| 3 | 021 | 5 | 6/23 | 0° | --- | --- | -- | -- | 043 | 043 | 4.5 | 035° | 82 | 0-1 | 020 | 11:37:11 |
| 4 | 022 | 10 | 6/23 | 0° | --- | --- | xx | xx | 088 | 088 | 4.5 | 035 | 82 | 0-1 | 020 | 11:53:50 |
| 5 | 217 | 15 | 6/23 | 0° | 2+4 | Low | xx | -- | 135 | 135 | 4.5 | 035 | 82 | 0-1 | 020 | 12:08:37 |
| 6 | 216 | 10 | 6/23 | 0° | 2+4 | Low | -- | xx | 088 | 088 | 4.5 | 035 | 82 | 0-1 | 020 | 12:24:46 |
| 7 | 023 | 15 | 6/23 | 0° | --- | --- | -- | -- | 135 | 135 | 4.5 | 035 | 82 | 0-1 | 020 | 12:40:18 |
| 8 | 218 | 20 | 6/23 | 0° | 2+4 | Hi | xx | -- | 184 | 184 | 4.5 | 030 | 82 | 0-1 | 035 | 12:52:30 |
| 9 | 116 | 20 | 6/23 | 0° | 3 | Med | -- | -- | 184 | 184 | 4 | 050 | 82 | 0-1 | 059 | 14:06:30 |
| 10 | 024 | 20 | 6/23 | 0° | --- | --- | -- | xx | 184 | 184 | 4 | 050 | 82 | 0-1 | 039 | [illegible]:38 |
| 11 | 115 | 15 | 6/23 | 0° | 3 | Med | -- | xx | 135 | 135 | 4 | 050 | 82 | 0-1 | 057 | 1[illegible]8:13 |
| 12 | 114 | 10 | 6/23 | 0° | 3 | Low | (Aft) | -- | 088 | 088 | 4 | 050 | 82 | 0-1 | 049 | 14:58:13 |
| 13 | 223 | 15 | 6/23 | 270° | 2+4 | Low | (Aft) | xx | 135 | 135 | 4 | 050 | 82 | 0-1 | 142 | 15:18:25 |
| 14 | 029 | 15 | 6/23 | 270° | --- | --- | -- | -- | 135 | 135 | 4 | 050 | 82 | 0-1 | 147 | 15:36:45 |
| 15 | 121 | 15 | 6/23 | 270° | 3 | Med | (Aft) | xx | 135 | 135 | 4 | 050 | 82 | 0-1 | 129 | 15:53:07 |
| 16 | 122 | 20 | 6/23 | 270° | 3 | Med | -- | -- | 184 | 184 | 9 | 064 | 82 | 0-1 | 125 | 16:07:27 |
| 17 | 224 | 20 | 6/23 | 270° | 2+4 | Hi | -- | -- | 184 | 184 | 9 | 064 | 82 | 0-1 | 113 | 16:26:10 |
| 18 | 030 | 20 | 6/23 | 270° | --- | --- | (Aft) | xx | 184 | 184 | 6 | 055 | 82 | 0-1 | 104 | 16:39:03 |
| 19 | 028 | 10 | 6/23 | 270° | --- | --- | (Aft) | xx | 088 | 088 | 5 | 035 | 82 | 0-1 | 090 | 17:01:13 |
| 20 | 222 | 10 | 6/24 | 0° | 2+4 | Low | -- | -- | 088 | 088 | 4 | 187 | 81 | 0 | 058 | 11:20:40 |
| 21 | 025 | 25 | 6/24 | 0° | --- | --- | -- | xx | 241 | 241 | 4 | 187 | 81 | 0 | 074 | 11:43:00 |
| 22 | 117 | 25 | 6/24 | 0° | 3 | Med | -- | xx | 241 | 241 | 4 | 187 | 81 | 0 | 074 | 11:58:10 |
| 23 | 219 | 25 | 6/24 | 0° | 2+4 | Hi | -- | xx | 241 | 241 | 4 | 187 | 81 | 0 | 055 | 12:21:10 |
| 24 | 123 | 25 | 6/24 | 270° | 3 | Med | -- | -- | 241 | 241 | 4 | 187 | 81 | 0 | 152 | 12:37:08 |
| 25 | 225 | 25 | 6/24 | 270° | 2+4 | Low | -- | -- | 241 | 241 | 4 | 187 | 81 | 0 | 123 | 12:52:40 |

APPENDIX A RUN SUMMARY-NAVAL ARCHITECTURE SERIES

Subject **PURVIS II Naval Architecture Series (Photographic)**

Sheet 2 of 2

| Line No. | Col.A Run No. | Col.B Speed Knots | Col.C Date | Col.D Heading WRT Sea | Col.E Masker | | Col.F Bow Wave Hose | Col.G Fisheye Camera | Col.H RPM | | Col.I True Wind Vel. | Col.J True Wind Dir. | Col.K Water T° | Col.L Sea State | Col.M Ships Course | Col.N Time & Index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | No. | Rate | | | Port | Stbd. | | | | | | |
| 1 | 031 | 25 | 6/24 | 270° | -- | -- | (Aft) | xx | 241 | 241 | 4 | 212 | 82 | 1 | 116° | --- |
| 2 | 026 | 30 | 6/24 | 0° | -- | -- | -- | xx | 306 | 306 | 9 | 212 | 81 | 1 | 020 | 14:51:58 |
| 3 | 1[illegible]3 | 30 | 6/24 | 0° | 3 | Hi | -- | -- | 306 | 306 | 9 | 212 | 81 | 1 | 020 | 15:07:07 |
| 4 | 220 | 30 | 6/24 | 0° | 2+4 | Low | -- | xx | 306 | 306 | 9 | 212 | 81 | 1 | 022 | 15:22:24 |
| 5 | 032 | 30 | 6/24 | 270° | -- | -- | -- | -- | 306 | 306 | 9 | 212 | 81 | 1 | 122 | 15:36:42 |
| 6 | 226 | 30 | 6/24 | 270 | 2+4 | Low | -- | -- | 306 | 306 | 9 | 212 | 81 | 1 | 116 | 15:52:33 |
| 7 | 124 | 30 | 6/24 | 270° | 3 | Hi | -- | xx | 306 | 306 | 9 | 212 | 81 | 1 | 122 | 16:05:02 |
| 8 | 043 | 20 | 6/24 | 090° | -- | -- | -- | -- | 184 | 184 | 7 | 125° | 81 | 1 | 301 | 16:25:03 |
| 9 | 960 | 0 | 6/25 | Ship's Motion Recording Only From 10:53:00 to 11:28:00 | | | | | | | | | | | | |
| 10 | 041 | 10 | 6/25 | 90° | -- | -- | -- | -- | 088 | 088 | 10 | 055 | 82° | 0 | 358 | 11:36:12 |
| 11 | 042 | 15 | 6/25 | 90° | -- | -- | (Aft) | -- | 135 | 135 | 10 | 055 | 82 | 0 | 350 | 11:52:32 |
| 12 | 044 | 25 | 6/25 | 90° | -- | -- | (Aft) | xx | 241 | 241 | 10 | 055 | 82 | 0 | 003 | 12:09:44 |
| 13 | 134 | 20 | 6/25 | 90° | 3 | Med | -- | -- | 184 | 184 | 10 | 045 | 82 | 1 | 008 | 12:28:02 |
| 14 | 236 | 20 | 6/25 | 270° | 2+4 | Low | -- | xx | 184 | 184 | 10 | 045 | 82 | 1 | 188 | 12:43:39 |
| 15 | 128 | 20 | 6/25 | 180° | 3 | Low | -- | xx | 184 | 184 | 13 | 110 | 82 | 1 | 323 | 13:00:59 |
| 16 | 036 | 20 | 6/25 | 180° | -- | -- | (Aft) | xx | 184 | 184 | 13 | 110 | 82 | 1 | 316 | 13:20:00 |
| 17 | 230 | 20 | 6/25 | 180° | 2+4 | Low | -- | xx | 184 | 184 | 13 | 110 | 82 | 1 | 325 | 13:34:45 |
| 18 | 049 | 15 | 6/25 | Full L Rudder | -- | -- | -- | xx | 135 | 135 | 6 | 124 | 82 | 0 | --- | 15:14:55 |
| 19 | 048 | 15 | 6/25 | Full R Rudder | -- | -- | -- | xx | 135 | 135 | 6 | 124 | 80 | 0 | --- | 15:25:20 |
| 20 | 053 | 25 | 6/25 | Full L Rudder | -- | -- | -- | xx | 241 | 241 | 6 | 124 | 82 | 0 | --- | 15:41:31 |
| 21 | 052 | 25 | 6/25 | Full R Rudder | -- | -- | -- | xx | 241 | 241 | 6 | 124 | 82 | 0 | -- | 15:53:45 |

NOTES:
1. Record combination 1 Rev 0 used for all runs except run 960 (Ship's Motion)
2. Chesapeak Probe (Xmitter) extended 3 feet for all runs of June 25.

## APPENDIX B-1

## PURVIS II ACOUSTIC RUNS BY DATE

| Date | Run No. | Type | Speed | Heading | Record Comb. |
|---|---|---|---|---|---|
| 28 June | 163 | Overside Cal. | 0 | --- | 1-1 |
| 28 June | 964 | Sondome Damage Noise Effect | 5 | 180 | 4-0 |
| 28 June | 965 | " | 10 | 180 | 4-0 |
| 28 June | 966 | " | 15 | 180 | 4-0 |
| 28 June | 967 | " | 20 | 180 | 4-0 |
| 28 June | 968 | " | 27 | 180 | 4-0 |
| 29 June | 969 | Elec. Calibration | 0 | 0 | Recorder No. 4 only |
| 29 June | 738 | Transmission | 0 | 000 | 3-1 |
| 30 June | 739 | Transmission Ship Motion Cal. | 5 | 0 | 3-1 |
| 30 June | 766 | Transmission | 5 | 0 | 3-1 |
| 30 June | 746 | " | 5 | 90 | 3-1 |
| 30 June | 755 | " | 15 | 180 | 3-1 |
| 30 June | 756 | " | 20 | 180° | 3-1 |
| 30 June | 740 | " | 10 | 0 | 3-1 |
| 30 June | 747 | " | 10 | 90 | 3-1 |
| 30 June | 754 | " | 10 | 180 | 3-1 |
| 30 June | 761 | " | 10 | 270 | 3-1 |
| 30 June | 767 | " | 10 | 0 | 3-1 |
| 30 June | 768 | " | 15 | 0 | 3-1 |
| 30 June | 741 | " | 15 | 0 | 3-1 |
| 30 June | 769 | " | 20 | 0 | 3-1 |
| 30 June | 763 | " | 20 | 270 | 3-1 |
| 30 June | 762 | " | 15 | 270 | 3-1 |
| 1 July | 742 | " | 20 | 000 | 3-1 |
| 1 July | 743 | " | 25 | 000 | 3-1 |
| 1 July | 744 | " | 30 | 000 | 3-1 |
| 1 July | 749 | " | 20 | 090 | 3-1 |
| 1 July | 750 | " | 25 | 090 | 3-1 |
| 1 July | 765 | " | 30 | 270 | 3-1 |
| 1 July | 757 | " | 25 | 180 | 3-1 |
| 1 July | 751 | " | 30 | 90 | 3-1 |
| 1 July | 758 | " | 30 | 180 | 3-1 |
| 1 July | 762 | " | 15 | 270 | 3-1 |
| 1 July | 764 | " | 25 | 270 | 3-1 |
| 1 July | 770 | " | 25 | 000 | 3-1 |
| 1 July | 771 | " | 30 | 000 | 3-1 |
| 1 July | 772 | " | 25 | 000 | 3-1 |
| 1 July | 773 | " | 25 | 000 | 3-1 |
| 1 July | 774 | " | 25 | 000 | 3-1 |
| 1 July | 820 | " | 20 | 360 turn 1/2 right | 3-1 |
| 1 July | 821 | " | 20 | 360 turn 1/2 left | 3-1 |
| 1 July | 822 | " | 20 | 360° turn F. right | 3-1 |
| 1 July | 823 | " | 20 | 360° turn F. left | 3-1 |

## PURVIS II ACOUSTIC RUNS BY DATE
(Continued)

| Date | Run No. | Type | Speed | Heading | Record Comb. |
|---|---|---|---|---|---|
| 1 July | 820 | Transmission | 20 | 000 | 3-1 |
| 1 July | 831 | " | 20 | 000 | 3-1 |
| 1 July | 832 | " | 20 | 000 | 3-1 |
| 1 July | 833 | " | 20 | 000 | 3-1 |
| 1 July | 834 | " | 20 | 000 | 3-1 |
| 1 July | 835 | " | 20 | 000 | 3-1 |
| 1 July | 838 | " | 20 | 000 | 3-1 |
| 1 July | 842 | " Picture | 25 | 360 turn F. right | 3-1 |
| 1 July | 843 | Transmission | 25 | 360 turn F. left | 3-1 |
| 2 July | 775 | " | 20 | 000 | 3-1 |
| 2 July | 776 | " | 20 | 000 | 3-1 |
| 2 July | 777 | " | 20 | 000 | 3-1 |
| 2 July | 970 | Passive | 17 | 000 | 4-1 |
| 2 July | 971 | " | 19 | 000 | 4-1 |
| 2 July | 972 | " | 21 | 000 | 4-1 |
| 2 July | 973 | " | 23 | 000 | 4-1 |
| 2 July | 974 | " | 25 | 000 | 4-1 |
| 2 July | 975 | " | 20 | 000 | 4-1 |
| 5 July | 350 | Passive Cal. for Transmission | 5 | 000 | 5-0 |
| 5 July | 351 | " | 10 | 000 | 5-0 |
| 5 July | 352 | " | 15 | 000 | 5-0 |
| 5 July | 353 | " | 17 | 000 | 5-0 |
| 5 July | 354 | " | 20 | 000 | 5-0 |
| 5 July | 782 | Transmission | 20 | 000 | 5-0 |
| 5 July | 781 | " | 17 | 000 | 5-0 |
| 5 July | 780 | " | 15 | 000 | 5-0 |
| 5 July | 778-741 | " | 5 | 000 | 5-0 |
| 5 July | 779-742 | " | 10 | 000 | 5-0 |
| 5 July | 780-743 | " | 15 | 000 | 5-0 |
| 5 July | 781-748 | " | 17 | 000 | 5-0 |
| 5 July | 782-749 | " | 20 | 000 | 5-0 |
| 6 July | 358 | Passive | 5 | 000 | 5-0 |
| 6 July | 355 | " | 21 | 000 | 5-0 |
| 6 July | 356 | " | 23 | 000 | 5-0 |
| 6 July | 357 | " | 25 | 000 | 5-0 |
| 6 July | 783/750 | Transmission | 21 | 000 | 5-0 |
| 6 July | 784/763 | " | 23 | 000 | 5-0 |
| 6 July | 785/764 | " | 25 | 000 | 5-0 |
| 6 July | 971-1-3 | Overside Cal. | 0 | --- | 2-1 |
| 6 July | 972 | " | 0 | --- | 2-0 |
| 6 July | 973-1-5 | " | 0 | --- | 2-1 |
| 7 July | 974-1-3 | " | 0 | --- | 3-1 |
| 7 July | 975-1-3 | " | 0 | --- | 3-1 |
| 7 July | 976-1-3 | " | 0 | --- | 1-1 |
| 7 July | 9 7-1-3 | " | 0 | --- | 1-1 |

## PURVIS II ACOUSTIC RUNS BY DATE
(Continued)

| Date | Run No. | Type | Speed | Heading | Record Comb. |
|---|---|---|---|---|---|
| 7 July | 978-1-3 | Overside Cal. | 0 | --- | 1-1 |
| 7 July | 979-1-3 | " | 0 | --- | 1-1 |
| 7 July | 980-1-3 | " | 0 | --- | 1-1 |
| 9 July | 340 | Passive | 20 | 000 | 1-1 |
| 9 July | 341 | " | 25 | 000 | 1-1 |
| 9 July | 346 | " | 15 | 000 | 1-1 |
| 9 July | 347 | " | 20 | 000 | 2-1 |
| 9 July | 348 | " | 25 | 000 | 2-1 |
| 9 July | 436 | " | 20 | 090 | 1-1 |
| 9 July | 443 | " | 20 | 090 | 2-1 |
| 9 July | 535 | " | 15 | 180 | 1-1 |
| 9 July | 536 | " | 20 | 180 | 1-1 |
| 9 July | 543 | " | 20 | 180 | 2-1 |
| 9 July | 637 | " | 20 | 270 | 1-1 |
| 9 July | 644 | " | 20 | 270 | 2-1 |
| 9 July | 787-756 | Transmission | 20 | 180 | 3-1 |
| 9 July | 995 | Ship Motion | 0 | 000 | 3-1 |
| 9 July | 784A | Transmission | 20 | 270 | 3-1 |
| 9 July | 779A | " | 20 | 000 | 3-1 |
| 9 July | 782A | " | 20 | 090 | 3-1 |
| 9 July | 778A | " | 15 | 000 | 3-1 |
| 9 July | 780A | " | 25 | 000 | 3-1 |
| 9 July | 339 | Passive | 15 | 000 | 1-1 |
| 14 July | 336 | " | 0 | 000 | 1-1 |
| 14 July | 337 | " | 5 | 000 | 1-1 |
| 10 July | 996-1-3 | Electrical Cal. | 0 | --- | 1-1 |
| 10 July | 981-1-3 | Overside Cal. | 0 | 000 | 1-1 |
| 10 July | 982-1-3 | Overside Cal. | 0 | --- | 1-1 |
| 10 July | 983-1-3 | " | 0 | --- | 1-1 |
| 10 July | 997 | Transmission/Cal. | 0 | --- | 3-1 5-0 |
| 10 July | 997 | " | 0 | --- | 5-0 3-1 |
| 11 July | 999 | Electrical Cal. | 0 | --- | 2-1 |
| 11 July | 984-1-3 | Overside Cal. | 0 | --- | 2-1 |
| 11 July | 985-1-3 | " | 0 | --- | 2-1 |
| 11 July | 986-1-3 | " | 0 | --- | 2-1 |
| 11 July | 987-1-3 | " | 0 | --- | 2-1 |
| 11 July | 988-1-3 | " | 0 | --- | 2-1 |
| 11 July | 989-1-3 | " | 0 | --- | 2-1 |
| 11 July | 950 | Transmission/Cal. | 0 | --- | 3-1 |
| 12 July | 990-1-3 | Overside Cal. | 0 | --- | 3-1 |
| 12 July | 991-1-3 | " | 0 | --- | 3-1 |
| 14 July | 338 | Passive | 10 | 000 | 1-1 |
| 14 July | 339 | " | 15 | 000 | 1-1 |
| 14 July | 339-A | " | 15 | 000 | 1-1 |
| 14 July | 340-A | " | 20 | 000 | 2-1 |
| 14 July | 343 | " | 0 | 000 | 2-1 |
| 14 July | 344 | " | 5 | 000 | 2-1 |

## PURVIS II ACOUSTIC RUNS BY DATE
(Continued)

| Date | Run No. | Type | Speed | Heading | Record Comb. |
|---|---|---|---|---|---|
| 14 July | 345 | Passive | 10 | 000 | 2-1 |
| 14 July | 346-A | " | 15 | 000 | 2-1 |
| 14 July | 347-A | " | 20 | 000 | 2-1 |
| 14 July | 793-738 | Transmission | 0 | 000 | 3-1 |
| 14 July | 992 | Electrical Cal. | 0 | 000 | 2-1 & 1-1 |
| 15 July | 993 | " | 0 | --- | 2-1 & 1-1 |
| 15 July | 341-A | Passive | 25 | 000 | 1-1 |
| 15 July | 342 | " | 30 | 000 | 1-1 |
| 15 July | 348-A | " | 25 | 000 | 2-1 |
| 15 July | 349 | " | 30 | 000 | 2-1 |
| 15 July | 437 | " | 25 | 090 | 1-1 |
| 15 July | 438 | " | 30 | 090 | 1-1 |
| 15 July | 444 | " | 25 | 090 | 2-1 |
| 15 July | 445 | " | 30 | 090 | 2-1 |
| 15 July | 449/44 | " | 20 | 090 | 2-1 |
| 15 July | 537 | " | 30 | 180 | 1-1 |
| 15 July | 544 | " | 25 | 180 | 2-1 |
| 15 July | 551 | " | 25 | 180 | 1-1 |
| 15 July | 545 | " | 30 | 180 | 2-1 |
| 15 July | 549/536 | | 15 | 180 | 1-1 |
| 15 July | 638 | Passive | 25 | 270 | 1-1 |
| 15 July | 639 | " | 30 | 270 | 1-1 |
| 15 July | 645 | " | 25 | 270 | 2-1 |
| 15 July | 646 | " | 30 | 270 | 2-1 |
| 15 July | 649-639 | " | 20 | 270 | 1-1 |
| 15 July | 650-644 | | 20 | 270 | 2-1 |
| 15 July | 794 | Passive | 20 | 000 | 3-1 |
| 15 July | 796/794 | Transmission | 20 | 000 | 3-1 |
| 15 July | 797 | Transmission | 10 | 000 | 3-1 |
| 17 July | 435 | Passive | 15 | 090 | 1-1 |
| 17 July | 441 | " | 10 | 090 | 2-1 |
| 17 July | 442 | " | 15 | 090 | 2-1 |
| 17 July | 448/436 | " | 20 | 090 | 1-1 |
| 17 July | 531 | " | 10 | 180 | 1-1 |
| 17 July | 541 | " | 10 | 180 | 2-1 |
| 17 July | 542 | " | 15 | 180 | 2-1 |
| 17 July | 550/535 | " | 15 | 180 | 1-1 |
| 17 July | 552/543 | " | 20 | 180 | 2-1 |
| 17 July | 634 | " | 5 | 270 | 1-1 |
| 17 July | 635 | " | 10 | 270 | 1-1 |
| 17 July | 636 | " | 15 | 270 | 1-1 |
| 17 July | 641 | " | 5 | 270 | 2-1 |
| 17 July | 642 | " | 10 | 270 | 2-1 |
| 17 July | 643 | " | 15 | 270 | 2-1 |
| 17 July | 753 | Transmission | 5 | 180 | 3-1 |
| 17 July | 760 | " | 5 | 270 | 3-1 |
| 17 July | 795 | " | 15 | 000 | 3-1 |

## PURVIS II ACOUSTIC RUNS BY DATE
(Continued)

| Date | Run No. | Type | Speed | Heading | Record Comb. |
|---|---|---|---|---|---|
| 17 July | 839 | Transmission | 20 | 000 | 3-1 |
| 17 July | 994-1-3 | Electrical Cal.<br>Ship Motion | 4 | 000 | 5-0 Cal. |
| 17 July | 762-A | Transmission | 15 | 270 | 3-1 |
| 20 July | 851 | Electrical (4 part) | -- | --- | 1 & 4 1-1<br>2 & 3 2 - 1 |
| 20 July | 852 | Passive Ship Motion | -- | --- | 1-1 |
| 20 July | 855 | Transmission | 25 | 000 | 3-1 |
| 20 July | 858 | " | 10 | 000 | 3-1 |
| 20 July | 859 | " | 5 | 000 | 3-1 |
| 20 July | 860 | " | 0 | 000 | 3-1 |
| 20 July | 861 | " | 22 | 000 | 3-1 |
| 20 July | 862 | " | 22 | 000 | 3-1 |
| 20 July | 863 | " | 20 | 000 | 3-1 |
| 20 July | 864 | " | 15 | 000 | 3-1 |
| 20 July | 865 | " | 10 | 000 | 3-1 |
| 20 July | 866 | " | 5 | 000 | 3-1 |
| 20 July | 867 | " | 0 | 000 | 3-1 |
| 20 July | 868 | " | 22 | 000 | 3-1 |
| 20 July | 869 | " | 20 | 000 | 3-1 |
| 20 July | 870 | " | 15 | 000 | 3-1 |
| 20 July | 871 | " | 10 | 000 | 3-1 |
| 20 July | 872 | " | 5 | 000 | 3-1 |
| 20 July | 873 | " | 0 | 000 | 3-1 |
| 20 July | 874 | " | 22 | 000 | 3-1 |
| 20 July | 875 | " | 20 | 000 | 3-1 |
| 20 July | 876 | " | 15 | 000 | 3-1 |
| 20 July | 877 | " | 10 | 000 | 3-1 |
| 20 July | 878 | " | 5 | 000 | 3-1 |
| 20 July | 879 | " | 0 | 000 | 3-1 |

Subject **PURVIS II Acoustic Series**

Sheet 1 of 6

| Line No. | Col.A Run No. | Col.B Probe Ext. ft. | Col.B Date | Col.C Speed-Kts. | Col.D Record Comb. | Col.E Heading to Sea | Col.F Sea State | Col.F Masker | Col.G Transmit Freq. Comb. | Col.H RPM Port | Col.H RPM Stbd. | Col.I Relative Wind Vel. | Col.J Relative wind Direction | Col.K Ships Course | Col.L Water Temp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 336 | 0 | 7/14 | 0 | 1-1 | 090 | 0 | -- | -- | 0 | 0 | 2 KTS | 090 | --- | 83° |
| 2 | 337 | 0 | 7/14 | 5 | 1-1 | 000 | 0 | -- | -- | 043 | 043 | 7 | 030 | 090 | 83° |
| 3 | 338 | 0 | 7/14 | 10 | 1-1 | 000 | 0 | -- | -- | 088 | 088 | 14 | 010 | 090 | 83° |
| 4 | 339 | 4.0 | 7/9 | 15 | 1-1 | 000 | 1+ | -- | -- | 135 | 135 | 27 | 350 | 120 | 80° |
| 5 | 339-A | 0.5 | 7/14 | 15 | 1-1 | 000 | 0 | -- | -- | 135 | 135 | 20 | 010 | 090 | 83° |
| 6 | 340 | 4.0 | 7/9 | 20 | 1-1 | 000 | 1+ | -- | -- | 184 | 184 | 25 | 355 | 125 | 80° |
| 7 | 340-A | 0 | 7/14 | 20 | 1-1 | 000 | 0 | -- | -- | 184 | 184 | 30 | 350 | 125 | 80° |
| 8 | 341 | 4.0 | 7/9 | 25 | 1-1 | 000 | 2 | -- | -- | 241 | 241 | 38 | 355 | 115 | 80° |
| 9 | 341-A | 0.0 | 7/15 | 25 | 1-1 | 000 | 1-1 | -- | -- | 241 | 241 | 25 | 000 | 130 | 82° |
| 10 | 342 | 0 | 7/15 | 30 | 1-1 | 000 | 1-1 | -- | -- | 306 | 306 | 40 | 000 | 136 | 82° |
| 11 | 343 | 0 | 7/14 | 0 | 2-1 | 090 | 0 | -- | -- | 0 | 0 | 2 | 090 | --- | 83° |
| 12 | 344 | 0 | 7/14 | 5 | 2-1 | 000 | 0 | -- | -- | 043 | 043 | 7 | 030 | 090 | 83° |
| 13 | 345 | 0 | 7/14 | 10 | 2-1 | 000 | 0 | -- | -- | 088 | 088 | 14 | 010 | 090 | 83° |
| 14 | 346 | 4.0 | 7/9 | 15 | 2-1 | 000 | 1+ | -- | -- | 135 | 135 | 27 | 350 | 120 | 80° |
| 15 | 346-A | 0.5 | 7/14 | 15 | 2-1 | 000 | 0 | -- | -- | 135 | 135 | 20 | 010 | 090 | 83° |
| 16 | 347 | 4.0 | 7/9 | 20 | 2-1 | 000 | 1+ | -- | -- | 184 | 184 | 30 | 350 | 125° | 80° |
| 17 | 347-A | 0 | 7/14 | 20 | 2-1 | 000 | -0 | -- | -- | 184 | 184 | 25 | 350 | 125 | 80° |
| 18 | 348 | 4.0 | 7/9 | 25 | 2-1 | 000 | 2 | -- | -- | 241 | 241 | 38 | 355 | 115 | 82° |
| 19 | 348-A | 0 | 7/15 | 25 | 2-1 | 000 | 1 | -- | -- | 241 | 241 | 25 | 000 | 130 | 82° |
| 20 | 349 | 0 | 7/15 | 30 | 2-1 | 000 | 1 | -- | -- | 306 | 306 | 40 | 000 | 136 | 82° |
| 21 | 350 | 0 | 7/5 | 5 | 5-0 | 000 | 0 | -- | -- | 043 | 043 | 6 | 340 | 245 | 82° |
| 22 | 351 | 0 | 7/5 | 10 | 5-0 | 000 | 0 | -- | -- | 0 | 0 | 6 | 331 | 245 | 82° |
| 23 | 352 | 0 | 7/5 | 15 | 5-0 | 000 | 0 | -- | -- | 135 | 135 | 14 | 332 | 245 | 82° |
| 24 | 353 | 0 | 7/5 | 17 | 5-0 | 000 | 0 | -- | -- | 154 | 153 | 24 | 334 | 245 | 82° |
| 25 | 354 | 0 | 7/5 | 20 | 5-0 | 000 | 0 | -- | -- | 184 | 184 | 25 | 340 | 245 | 82° |
| 26 | 355 | 0 | 7/6 | 21 | 5-0 | 000 | 0 | -- | -- | 195 | 195 | 25 | 000 | 240 | 81° |
| 27 | 356 | 0 | 7/6 | 23 | 5-0 | 000 | 0 | -- | -- | 217 | 217 | 30 | 000 | 240 | 81° |
| 28 | 357 | 0 | 7/6 | 25 | 5-0 | 000 | 0 | -- | -- | 241 | 241 | 32 | 000 | 240 | 81° |
| 29 | 358 | 0 | 7/6 | 5 | 5-0 | 000 | 0 | -- | -- | 043 | 043 | 8 | 350° | 240 | 81° |

APPENDIX B-2 RUN SUMMARY-ACOUSTIC SERIES

Subject

Sheet 2 of 6

| Line No. | Col.A Run No. | Col.B Probe Ext. ft. | Date | Col.C Speed-Kts. | Col.D Record Comb. | Col.E Heading to Sea | Col.F Sea State | Masker | Col.G Transmit Freq. Comb. | Col.H RPM Port | Stbd. | Col.I Relative Wind Vel. | Col.J Relative wind Direction | Col.K Ships Course | Col.L Water Temp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 435 | 0 | 7/14 | 15 | 1-1 | 090 | 1 | -- | -- | 135 | 135 | 0-1 | 310 | 050 | 80 |
| 2 | 436 | 4.0 | 7/14 | 20 | 1-1 | 090 | 1+ | -- | -- | 184 | 184 | 24 | 025 | 030 | 80 |
| 3 | 437 | 0 | 7/15 | 25 | 1-1 | 090 | 1 | -- | -- | 241 | 241 | 28 | 010 | 045 | 82 |
| 4 | 438 | 0 | 7/15 | 30 | 1-1 | 090 | 1 | -- | -- | 306 | 306 | 34 | 010 | 040 | 82 |
| 5 | 441 | 0 | 7/17 | 10 | 2-1 | 090 | 1 | -- | -- | 088 | 088 | 0-1 | 14 | 050 | 80 |
| 6 | 442 | 0 | 7/17 | 15 | 2-1 | 090 | 1 | -- | -- | 135 | 135 | 0-1 | 310 | 050 | 80 |
| 7 | 443 | 4.0 | 7/9 | 20 | 2-1 | 090 | 1+ | -- | -- | 184 | 184 | 24 | 025 | 030 | 80 |
| 8 | 444 | 0 | 7/15 | 25 | 2-1 | 090 | 1 | -- | -- | 241 | 241 | 28 | 010 | 045 | 82 |
| 9 | 445 | 0 | 7/15 | 30 | 2-1 | 090 | 1 | -- | -- | 306 | 306 | 34 | 010 | 040 | 82 |
| 10 | 448/436 | 0 | 7/17 | 20 | 1-1 | 090 | 1 | -- | -- | 184 | 184 | 0-1 | 040 | 055 | 80 |
| 11 | 449/443 | 0 | 7/15 | 20 | 2-1 | 090 | 1 | -- | -- | 184 | 184 | 23 | 019 | 045 | 82 |
| 12 | 531 | 0 | 7/17 | 10 | 1-1 | 180 | 1 | -- | -- | 088 | 088 | 10 | 280 | 320 | 80 |
| 13 | 535 | 4.0 | 7/9 | 15 | 1-1 | 180 | 1+ | -- | -- | 135 | 135 | 0 | 090 | 315 | 80 |
| 14 | 536 | 4.0 | 7/9 | 20 | 1-1 | 180 | 1+ | -- | -- | 184 | 184 | 4 | 020 | 315 | 80° |
| 15 | 537 | 0 | 7/15 | 30 | 1-1 | 180 | 1 | -- | -- | 306 | 306 | 22 | 000 | 310 | 82 |
| 16 | 541 | 0 | 7/17 | 10 | 2-1 | 180 | 1 | -- | -- | 088 | 088 | 10 | 280 | 320 | 80 |
| 17 | 542 | 0 | 7/17 | 15 | 2-1 | 180 | 1 | -- | -- | 135 | 135 | 15 | 310 | 320 | 80 |
| 18 | 543 | 4.0 | 7/9 | 20 | 2-1 | 180 | 1+ | -- | -- | 184 | 184 | 4 | 020 | 315 | 80 |
| 19 | 544 | 0 | 7/15 | 25 | 2-1 | 180 | 1 | -- | -- | 241 | 241 | 8 | 334 | 310 | 82 |
| 20 | 545 | 0 | 7/15 | 30 | 2-1 | 180 | 1 | -- | -- | 306 | 306 | 22 | 000 | 310 | 82 |
| 21 | 549/536 | 0 | 7/15 | 20 | 1-1 | 180 | 1 | -- | -- | --- | --- | -- | --- | --- | -- |
| 22 | 550/535 | 0 | 7/17 | 15 | 1-1 | 180 | 1 | -- | -- | 135 | 135 | 15 | 310 | 320° | 80 |
| 23 | 551/536 | 0 | 7/18 | 25 | 1-1 | 180 | 1 | -- | -- | 241 | 241 | 8 | 334 | 310 | 82 |
| 24 | 552/543 | 0 | 7/17 | 20 | 2-1 | 180 | 1 | -- | -- | 784 | 184 | 19 | 315 | 320° | 80 |

APPENDIX B-2 RUN SUMMARY-ACOUSTIC SERIES

Subject

Sheet 3 of 6

| Line No. | Col.A Run No. | Col.B Probe Ext. ft. | Date | Col.C Speed-Kts. | Col.D Record Comb. | Col.E Heading to Sea | Col.F Sea State | Masker | Col.G Transmit Freq. Comb. | Col.H RPM Port | Stbd. | Col.I Relative Wind Vel. | Col.J Relative wind Direction | Col.K Ships Course | Col.L Water Temp. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 634 | 0 | 7/17 | 5 | 1-1 | 270 | 1 | - | - | 043 | 043 | 16 | 345 | 230 | 80° |
| 2 | 635 | 0 | 7/17 | 10 | 1-1 | 270 | 1 | - | - | 088 | 088 | 22 | 342 | 230 | 80 |
| 3 | 636 | 0 | 7/17 | 15 | 1-1 | 270 | 1 | - | - | 135 | 135 | 28 | 350 | 230 | 80 |
| 4 | 637 | 4.0 | 7/9 | 20 | 1-1 | 270 | 1+ | - | - | 184 | 184 | 5 | 320 | 225 | 80 |
| 5 | 638 | 0.0 | 7/15 | 25 | 1-1 | 270 | 1 | - | - | 241 | 241 | 15 | 331 | 230 | 82 |
| 6 | 639 | 0 | 7/15 | 30 | 1-1 | 270 | 1 | - | - | 306 | 306 | 20 | 330 | 225 | 82 |
| 7 | 641 | 0 | 7/17 | 5 | 2-1 | 270 | 1 | - | - | 043 | 043 | 16 | 35° | 230 | 80 |
| 8 | 642 | 0 | 7/17 | 10 | 2-1 | 270 | 1 | - | - | 088 | 088 | 22 | 342° | 230 | 80 |
| 9 | 643 | 0 | 7/17 | 15 | 2-1 | 270 | 1 | - | - | 135 | 135 | 28 | 350 | 230 | 80 |
| 10 | 644 | 4.0 | 7/9 | 20 | 2-1 | 270 | 1+ | - | - | 184 | 184 | 5 | 320 | 225 | 80 |
| 11 | 645 | 0 | 7/15 | 25 | 2-1 | 270 | 1 | - | - | 241 | 241 | 14 | 330 | 225 | 82° |
| 12 | 646 | 0 | 7/15 | 30 | 2-1 | 270 | 1 | - | - | 306 | 306 | 20 | 330 | 225 | 82 |
| 13 | 649/639 | 0 | 7/15 | 20 | 1-1 | 270 | 1 | - | - | 184 | 184 | 8 | 320 | 225 | 82 |
| 14 | 650/644 | 0 | 7/15 | 20 | 2-1 | 270 | 1 | - | - |  |  | - |  |  |  |
| 15 | 651 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 16 | 738 | 5.0 | 6/29 | 0 | 3-1 | 000 | 1 | - | F1 |  |  | - | - | - | - |
| 17 | 739 | 5.0 | 6/30 | 5 | 3-1 | 000 | 1 | - | F1 | 043 | 043 | 15 | 020 | 130 | 79° |
| 18 | 740 | 5.0 | 6/30 | 10 | 3-1 | 000 | 0 | - | F1 | 088 | 088 | 20 | 000 | 135 | 79° |
| 19 | 741 | 5.0 | 6/30 | 15 | 3-1 | 000 | 0 | - | F1 | 135 | 135 | 30 | 355° | 140 | 79° |
| 20 | 742 | 5.0 | 7/1 | 20 | 3-1 | 000 | 0 | - | F1 | 184 | 184 | 30 | 000 | 160 | 80° |
| 21 | 743 | 4.0 | 7/1 | 25 | 3-1 | 000 | 0 | - | F1 | 241 | 241 | 35 | 355 | 160 | 80° |
| 22 | 744 | 4.0 | 7/1 | 30 | 3-1 | 000 | 0 | - | F1 | 306 | 306 | 39 | 355 | 160 | 80° |
| 23 | 746 | 5.0 | 6/30 | 5 | 3-1 | 090 | 1 | - | F1 | 043 | 043 | 5 | 100 | 030 | 79° |
| 24 | 747 | 5.0 | 6/30 | 10 | 3-1 | 090 | 0 | - | F1 | 088 | 088 | 13 | 050 | 045 | 79° |
| 25 | 749 | 5.0 | 7/1 | 20 | 3-1 | 090 | 0 | - | F1 | 184 | 184 | 18 | 030 | 055 | 80° |
| 26 | 750 | 4.0 | 7/1 | 25 | 3-1 | 090 | 0 | - | F1 | 241 | 241 | 32 | 005 | 090 | 80° |
| 27 | 751 | 4.0 | 7/1 | 30 | 3-1 | 090 | 0 | - | F1 | 306 | 306 | 32 | 020 | 070 | 80° |
| 28 | 753 | 5.0 | 7/17 | 5 | 3-1 | 180 | 1 | - | F1orF6 | 043 | 043 | 11 | 260 | 320 | 80° |
| 29 | 754 | 5.0 | 6/30 | 10 | 3-1 | 180 | 0 | - | F1 | 088 | 088 | 1 | 170 | 315 | 79° |
| 30 | 755 | 5.0 | 6/30 | 15 | 3-1 | 180 | 1 | - | F1 | 135 | 135 | 1 | 310 | 325 | 79° |

APPENDIX B-2 RUN SUMMARY-ACOUSTIC SERIES

ubjec.

Sheet 4 of 6

| Line No. | Col.A Run No. | Col.B Probe Ext. ft. | Col.B Date | Col.C Speed-Kts. | Col.D Record Comb. | Col.E Heading to Sea | Col.F Sea State | Col.F Masker | Col.G Transmit Freq. Comb. | Col.H RPM Port | Col.H RPM Stbd. | Col.I Relative Wind Vel. | Col.J Relative wind Direction | Col.K Ships Course | Col.L Water Temp. | Col.M COMMENTS | Col.N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 756 | 5.0 | 6/30 | 20 | 3-1 | 180 | 1 | - | F1 | 184 | 184 | 1 | 045 | 325 | 79° | | |
| 2 | 757 | 4.0 | 7/1 | 25 | 3-1 | 180 | 0 | - | F1 | 241 | 241 | 20 | 015 | 000 | 80° | | |
| 3 | 758 | 4.0 | 7/1 | 30 | 3-1 | 180 | 0 | - | F1 | 306 | 306 | 16 | 016 | 340 | 80° | | |
| 4 | 760 | 5.0 | 7/17 | 5 | 3-1 | 270 | 1 | - | F1 orF6 | 043 | 043 | 18 | 350 | 230 | 80° | | |
| 5 | 761 | 5.0 | 6/30 | 10 | 3-1 | 270 | 0 | - | F1 | 088 | 088 | 18 | 290 | 225 | 79° | | |
| 6 | 762 | 5.0 | 7/1 | 15 | 3-1 | 270 | 0 | - | F1 | 135 | 135 | 5 | 315 | 240 | 80° | | |
| 7 | 763 | 5.0 | 6/30 | 20 | 3-1 | 270 | 0 | - | F1 | 184 | 184 | 8 | 310 | 235 | 79° | | |
| 8 | 764 | 4.0 | 7/1 | 25 | 3-1 | 270 | 0 | - | F1 | 241 | 241 | 14 | 064 | 290 | 80° | | |
| 9 | 765 | 4.0 | 7/1 | 30 | 3-1 | 270 | 0 | - | F1 | 306 | 306 | 19 | 325 | 250 | 80° | | |
| 10 | 766 | 5.0 | 6/30 | 5 | 3-1 | 000 | 1 | 3M | F1 | 043 | 043 | 15 | 020 | 130 | 79° | | |
| 11 | 767 | 5.0 | 6/30 | 10 | 3-1 | 000 | 0 | 3M | F1 | 088 | 088 | 22 | 000 | 135 | 79° | | |
| 12 | 768 | 5.0 | 6/30 | 15 | 3-1 | 000 | 0 | 3M | F1 | 135 | 135 | 30 | 355 | 140 | 79° | | |
| 13 | 769 | 5.0 | 6/30 | 20 | 3-1 | 000 | 0 | 3M | F1 | 184 | 184 | 33 | 358 | 145° | 79° | | |
| 14 | 770 | 4.0 | 7/1 | 25 | 3-1 | 000 | 0 | 3M | F1 | 241 | 241 | 35 | 355 | 160 | 80° | | |
| 15 | 771 | 4.0 | 7/1 | 30 | 3-1 | 000 | 0 | 3M | F1 | 306 | 306 | 38 | 355 | 160 | 80° | | |
| 16 | 772 | 4.0 | 7/1 | 25 | 3-1 | 000 | 0 | - | F2 | 241 | 241 | 21 | 030 | 180 | 80° | | |
| 17 | 773B | 4.0 | 7/1 | 25 | 3-1 | 000 | 0 | - | F3 | 241 | 241 | 30 | 345 | 165 | 80° | 773A Aborted | |
| 18 | 774 | 4.0 | 7/1 | 25 | 3-1 | 000 | 0 | - | F4 | 241 | 241 | 30 | 345 | 165 | 80° | | |
| 19 | 775 | 5.0 | 7/2 | 20 | 3-1 | 000 | 0 | - | F2 | 184 | 184 | 24 | 320 | 252 | 80° | | |
| 20 | 776 | 5.0 | 7/2 | 20 | 3-1 | 000 | 0 | - | F3 | 184 | 184 | 24 | 320 | 252 | 80° | | |
| 21 | 777 | 5.0 | 7/2 | 20 | 3-1 | 000 | 0 | - | F4 | 184 | 184 | 24 | 320 | 340 | 80° | | |
| 22 | 778/741 | 5.0 | 7/5 | 5 | 5-0 | 000 | 0 | - | F5 | 043 | 043 | 6 | 343 | 260 | 82° | | |
| 23 | 779/742 | 5.0 | 7/5 | 10 | 5-0 | 000 | 0 | - | F5 | 088 | 088 | 11 | 345 | 260 | 82° | | |
| 24 | 780/743 | 5.0 | 7/5 | 15 | 5-0 | 000 | 0 | - | F5 | 135 | 135 | 15 | 342 | 260 | 82° | | |
| 25 | 781/748 | 5.0 | 7/5 | 17 | 5-0 | 000 | 0 | - | F5 | 154 | 154 | 21 | 340 | 260 | 82° | | |
| 26 | 782/749 | 5.0 | 7/5 | 20 | 5-0 | 000 | 0 | - | F5 | 184 | 184 | 25 | 340 | 245 | 82° | | |
| 27 | 783/750 | 4.0 | 7/6 | 21 | 5-0 | 000 | 0 | - | F5 | 195 | 195 | 26 | 000 | 24 | 81° | | |
| 28 | 784/763 | 4.0 | 7/6 | 23 | 5-0 | 000 | 0 | - | F5 | 217 | 217 | 29 | 355 | 240 | 81° | | |
| 29 | 785/764 | 4.0 | 7/6 | 25 | 5-0 | 000 | 0 | - | F5 | 241 | 241 | 29 | 350 | 240 | 81° | | |
| 30 | 787/756 | 4.0 | 7/9 | 20 | 3-1 | 180 | 1+ | - | F1 | 184 | 184 | 4 | 020 | 345 | 80° | | |

Subject

Sheet 5 of 6

| Line No. | Col.A Run No. | Col.B Probe Ext. ft. | Date | Col.C Speed-Kts. | Col.D Record Comb. | Col.E Heading to Sea | Col.F Sea State | Masker | Col.G Transmit Freq. Comb. | Col.H RPM Port | Stbd. | Col.I Relative Wind Vel. | Col.J Relative wind Direction | Col.K Ships Course | Col.L Water Temp. | Col.M COMMENTS | Col.N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 793/738 | | 7/14 | 0 | 3-1 | 000 | 0 | - | F1,2,3,4 | 0 | 0 | 2 | 090 | 0 | 83 | | |
| 2 | 794 | | 7/15 | 1 | 3-1 | 000 | 1 | - | F1,2,3,4 | 184 | 184 | 30 | 350 | 130 | 82 | | |
| 3 | 795 | | 7/17 | 1 | 3-1 | 000 | 1 | - | F1,2,3,4 | 135 | 135 | 10 | 050 | 140 | 80 | | |
| 4 | 796/794 | | 7/15 | 1 | 3-1 | 000 | 1 | - | F1,F2 | 184 | 184 | 28 | 000 | 130 | 82 | | |
| 5 | 797 | | 7/15 | 1 | 3-1 | 000 | 1 | - | F2,F1 | 088 | 088 | 19 | 357 | 130 | 82 | | |
| 6 | 820 | | | 0 | 3-1 | 360° turn ½ rt. | 0 | - | F1 | 184 | 184 | 19 | 020 | 050 | 80 | | |
| 7 | 821 | | 7/1 | 0 | 3-1 | 360° turn ½ lft. | 0 | - | F1 | 184 | 184 | 8 | 230 | 270 | 80 | | |
| 8 | 822 | | 7/1 | 0 | 3-1 | 360° turn F. rt | 0 | - | F1 | 184 | 184 | - | - | half rt. rudder | 80 | | |
| 9 | 823 | | 7/1 | 0 | 3-1 | 360° turn F. lft. | 0 | - | F1 | 184 | 184 | - | - | full lft. rudder | 80 | | |
| 10 | 830 | | 7/1 | 0 | 3-1 | 000 | 0 | - | F1 | 184 | 184 | 29 | 350 | 170 | 80 | | |
| 11 | 831 | | 7/1 | 0 | 3-1 | 000 | 0 | - | F1 | 184 | 184 | 11 | 020 | 000 | 80 | | |
| 12 | 832 | | 7/1 | 0 | 3-1 | 000 | 0 | - | F1 | 184 | 184 | 12 | 020 | 345 | 80 | | |
| 13 | 833 | | 7/1 | 0 | 3-1 | 000 | 0 | - | F1 | 184 | 184 | 12 | 020 | 345 | 80 | | |
| 14 | 834 | | 7/1 | 0 | 3-1 | 000 | 0 | - | F1 | 184 | 184 | 12 | 020 | 345 | 80 | | |
| 15 | 835 | | 7/1 | 0 | 3-1 | 000 | 0 | - | F1 | 184 | 184 | 12 | 020 | 345 | 80 | T1 Amplitude adjustment | |
| 16 | 838 | | 7/1 | 0 | 3-1 | 000 | 0 | 4L | F1 | 184 | 184 | 12 | 020 | 345 | 80 | T4 failed | |
| 17 | | | | | | | | | | | | | | | | | |
| 18 | 842 | | 7/1 | 0 | 3-1 | 360° turn f. rt | 0 | - | F1 | 241 | 241 | 13 | 330° | 230° | 80 | | |
| 19 | 843 | | 7/1 | 0 | 3-1 | 360° turn f lft. | 0 | - | F1 | 241 | 241 | 20 | 015 | 000 | 80 | | |
| 20 | 963 | | 6/28 | 1 | 1-1 | - | 1 | - | - | | | overside cal. | | | 82 | | |
| 21 | 964 | | 6/28 | 1 | 4-0 | 180 | 1 | - | - | 043 | 043 | 14 | 135 | 350 | 81 | sondome damage<br>noise effect | |
| 22 | 965 | | 6/28 | 1 | 4-0 | 180 | 1 | - | - | 088 | 088 | 8 | 125 | 350 | 81 | sondome damage<br>noise effect | |
| 23 | 966 | | 6/28 | 1 | 4-0 | 180 | 1 | - | - | 135 | 135 | 0 | 125 | 350 | 81 | sondome damage<br>noise effect | |
| 24 | 967 | | 6/28 | 1 | 4-0 | 180 | 1 | - | - | 184 | 184 | 10 | 050 | 350 | 81 | sondome damage<br>noise effect | |
| 25 | 968 | | 6/28 | 1 | 4-0 | 180 | 1 | - | - | 267 | 267 | 15 | 030 | 350 | 81 | sondome damage<br>noise effect | |
| 26 | 969 | | 6/29 | 0 | | | | | | | | 13 | 320 | 252 | 80 | electrical cal. | |
| 27 | 970 | | 7/2 | 0 | 4-1 | 000 | 0 | - | - | | | 13 | 320 | 252 | 80 | strut noise effects | |
| 28 | 971 | | 7/2 | 0 | 4-1 | 000 | 0 | - | - | | | 13 | 320 | 252 | 80 | strut noise effects | |
| 29 | 972 | | 7/2 | 0 | 4-1 | 000 | 0 | - | - | | | 13 | 320 | 252 | 80 | strut noise effects | |

APPENDIX B-2 RUN SUMMARY-ACOUSTIC SERIES

Subject

Sheet 6 of 6

| Line No. | Col.A Run No. | Col.B Probe Ext. ft. | Col.B Date | Col.C Speed-Kts. | Col.D Record Comb. | Col.E Heading to Sea | Col.F Sea State | Col.F Masker | Col.G Transmit Freq. Comb. | Col.H RPM Port | Col.H RPM Stbd. | Col.I Relative Wind Vel. | Col.J Relative wind Direction | Col.K Ships Course | Col.L Water Temp. | Col.M COMMENTS | Col.N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 973 | | 7/2 | 23 | 4-1 | 000 | 0 | - | - | - | - | 13 | 320 | 252 | 80 | strut noise effects | |
| 2 | 974 | | 7/2 | 25 | 4-1 | 000 | 0 | - | - | - | - | 13 | 320 | 252 | 80 | strut noise effects | |
| 3 | 975 | | 7/2 | 21 | 4-1 | 000 | 0 | - | - | - | - | 13 | 320 | 352 | 80 | strut noise effects | |
| 4 | 975A | | 7/7 | 0 | 3-1 | 000 | 0 | - | - | - | - | OVERSIDE CALIBRATION | | | | | |
| 5 | 995 | | 7/9 | 0 | 5 only | 000 | 1 | - | - | - | - | 11 kts | 135 | 135 | 81 | | |
| 6 | 992 | | 7/14 | 0 | 5 only cal. | 000 | 0 | - | - | - | - | ELECTRICAL CALIBRATION | | | | | |
| 7 | 994 | | 7/17 | 4 | 5 only cal. | 000 | 1 | - | - | 034 | 034 | - | 050 | 140 | 80 | ships motion cal. | |
| 8 | 784A | | 7/9 | 20 | 3-1 | 270 | 1$^+$ | - | F1 | 184 | 184 | 5 | 320 | 225 | 80 | | |
| 9 | 779A | | 7/9 | 20 | 3-1 | 000 | 1$^+$ | - | F1 | 184 | 184 | 26 | 350 | 135 | 80 | | |
| 10 | 782A | | 7/9 | 20 | 3-1 | 090 | 1$^+$ | - | F1 | 184 | 184 | 24 | 025 | 030 | 80 | | |
| 11 | 778A | | 7/9 | 15 | 3-1 | 000 | 1$^+$ | - | F1 | 135 | 135 | 27 | 350 | 120 | 80 | | |
| 12 | 780A | | 7/9 | 25 | 3-1 | 000 | 2 | - | F1 | 241 | 241 | 38 | 355 | 115 | 80 | | |
| 13 | 762A | | 7/9 | 15 | 3-1 | 270 | 1 | - | FlorF6 | 135 | 135 | 29 | 355 | 230 | 80 | | |
| 14 | 855 | | 7/20 | 25 | 1-1 | 0 | 2 | - | F1 | 241 | 241 | 7kts | 160 | 230 | 72 | | |
| 15 | 856 | | 7/20 | 20 | 3-1 | 0 | 2 | - | F1 | 241 | 241 | 7kts | 160 | 230 | 72 | | |
| 16 | 857 | | 7/20 | 15 | 3-1 | 0 | 2 | - | F1 | 241 | 241 | 7kts | 160 | 230 | 72 | | |
| 17 | 858 | | 7/20 | 10 | 3-1 | 0 | 2 | - | F1 | 088 | 088 | 7kts | 160 | 230 | 72 | | |
| 18 | 859 | | 7/20 | 5 | 3-1 | 0 | 2 | - | F1 | 043 | 043 | 7kts | 160 | 230 | 72 | | |
| 19 | 860 | | 7/20 | 0 | 3-1 | 0 | 2 | - | F1 | 000 | 000 | 7kts | 160 | 230 | 72 | | |
| 20 | 861 | | 7/20 | 22 | 3-1 | 0 | 2 | - | F2 | 206 | 206 | 7kts | 160 | 230 | 72 | | |
| 21 | 862 | | 7/20 | 22 | 3-1 | 0 | 2 | - | F1 | 206 | 206 | 7kts | 160 | 230 | 72 | | |
| 22 | 863 | | 7/20 | 20 | 3-1 | 0 | 2 | - | F2 | 195 | 195 | 7kts | 160 | 230 | 72 | | |
| 23 | 864 | | 7/20 | 15 | 3-1 | 0 | 2 | - | F2 | 135 | 135 | 7kts | 160 | 230 | 72 | | |
| 24 | 865 | | 7/20 | 10 | 3-1 | 0 | 2 | - | F2 | 088 | 088 | 7kts | 160 | 230 | 72 | | |
| 25 | 866 | | 7/20 | 5 | 3-1 | 0 | 2 | - | F2 | 043 | 043 | 7kts | 160 | 230 | 72 | | |
| 26 | 867 | | 7/20 | 0 | 3-1 | 0 | 2 | - | F2 | 000 | 000 | 7kts | 160 | 230 | 72 | | |
| 27 | 868 | | 7/20 | 22 | 3-1 | 0 | 2 | - | F3 | 206 | 206 | 11kts | 000 | 175 | 72 | | |
| 28 | 869 | | 7/20 | 20 | 3-1 | 0 | 2 | - | F3 | 195 | 195 | 11kts | 000 | 175 | 72 | | |

APPENDIX B-2 RUN SUMMARY-ACOUSTIC SERIES

# APPENDIX C

# RECORDING COMBINATIONS

**C/P SONAR PROGRAM**

**FORM NO.** CP-3

**EFFECTIVE DATE**

## PURVIS II RECORDING COMBINATION 1 REV 0

(REPLACES PURVIS II RECORDING COMBINATION ____ REV ____)

| TRACK NO. | RECORDER NO. 1 | | | | | | RECORDER NO. 2 | | | | | | RECORDER NO. 3 | | | | | | RECORDER NO. 4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | |
| | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. |
| 1 | 1 | 1 | 2 | 1 | HF-1 | P1007 | 10 | 1 | 2 | 10 | HF-10 | P1060 | 60 | 1 | 4 | 1 | D1H | | | Spare (Cal) | | | |
| 2 | 7 | 1 | 2 | 7 | HF-7 | P1030 | 35 | 2 | 4 | 5 | G-5 | P1020 | 61 | 1 | 4 | 2 | D2H | | | Spare | | | |
| 3 | 2 | 1 | 2 | 2 | HF-2 | P1011 | 11 | 1 | 2 | 11 | HF-11 | P1031 | 62 | 1 | 4 | 3 | D3H | | 75 | 1 | 3 | 1 | D1A |
| 4 | 8 | 1 | 2 | 8 | HF-8 | P1002 | 43 | 2 | 4 | 13 | A-1 | 999 | 63 | 1 | 4 | 4 | D4H | | 76 | 1 | 3 | 2 | D2A |
| 5 | 2 | 1 | 2 | 3 | HF-3 | P1076 | 12 | 1 | 2 | 12 | HF-12 | P1009 | 64 | 1 | 4 | 5 | D5H | | 77 | 1 | 3 | 3 | D3A |
| 6 | 9 | 1 | 2 | 9 | HF-9 | P1014 | 38 | 2 | 4 | 8 | G-8 | P1071 | 65 | 1 | 4 | 6 | D6H | | 78 | 1 | 3 | 4 | D4A |
| 9 | 4 | 1 | 2 | 4 | HF-4 | P1036 | | SPARE(Cal) | | | | | 66 | 1 | 4 | 7 | D7H | | 79 | 1 | 3 | 5 | D5A |
| 10 | 29 | 2 | 2 | 14 | A-7 | 966 | 44 | 2 | 4 | 14 | A-4 | 995 | 67 | 1 | 4 | 8 | D8H | | 80 | 1 | 3 | 6 | D6A |
| 11 | 5 | 1 | 2 | 5 | HF-5 | P1027 | 13 | 1 | 2 | 13 | HF-13 | P1008 | 68 | 1 | 4 | 9 | D9H | | 81 | 1 | 3 | 7 | D7A |
| 12 | 16 | 2 | 2 | 1 | LF-1 | P1015 | 50 | 3 | 2 | 5 | H-5 | P1046 | 69 | 1 | 4 | 10 | D10H | | 82 | 1 | 3 | 8 | D8A |
| 13 | 6 | 1 | 2 | 6 | AF-6 | P1019 | | SPARE | | | | | | Spare (Cal) | | | | | 83 | 1 | 3 | 9 | D9A |
| 14 | 14 | 1 | 2 | 14 | A-5 | 1002 | 56 | 3 | 2 | 11 | A-9 | 997 | | SPARE | | | | | 84 | 1 | 3 | 10 | D10A |

Notes: 1. During electrical calibrations, CAL signal is applied to tracks indicated as spare (CAL.)

2. CAL signal to DTMB signals are patched via Q20 to J161 on Mac panel to CAL T's on DTMB amps.

**PREPARED BY:** R. Newman

**DATE:** 25 June 1966

**C/P SONAR PROGRAM**

FORM NO. CP-3

EFFECTIVE DATE

# PURVIS II RECORDING COMBINATION 2 REV 0

(REPLACES PURVIS II RECORDING COMBINATION ____ REV ____)

| TRACK NO. | RECORDER NO. 1 | | | | | | RECORDER NO. 2 | | | | | | RECORDER NO. 3 | | | | | | RECORDER NO. 4 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | |
| | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. |
| 1 | 21 | 2 | 2 | 6 | LF-6 | P1063 | | SPARE (CAL) | | | | | 31 | 2 | 4 | 1 | G-1 | P1095 | 43 | 2 | 4 | 13 | A-1 | 999 |
| 2 | 20 | 2 | 2 | 5 | LF-5 | P1043 | 64 | 1 | 4 | 5 | D5H | | 32 | 2 | 4 | 2 | G-2 | P1073 | 60 | 1 | 4 | 1 | D1H | |
| 3 | 2 | 1 | 2 | 2 | HF-2 | P1011 | 24 | 2 | 2 | 9 | LF-9 | P1068 | 33 | 2 | 4 | 3 | G-3 | P1021 | 61 | 1 | 4 | 2 | D2H | |
| 4 | 19 | 2 | 2 | 4 | LF-4 | P1001 | | SPARE | | | | | 35 | 2 | 4 | 5 | G-5 | P1020 | 47 | 2 | 6 | 10 | H-2 | P1051 |
| 5 | 3 | 1 | 2 | 3 | HF-3 | P1076 | 25 | 2 | 2 | 10 | LF-10 | P1012 | 38 | 2 | 4 | 8 | G-8 | P1071 | 48 | 2 | 6 | 11 | H-3 | P1078 |
| 6 | 18 | 2 | 2 | 3 | LF-3 | P1010 | 65 | 1 | 4 | 6 | D6H | | 34 | 2 | 4 | 4 | G-4 | P1098 | 49 | 2 | 6 | 12 | H-4 | P1057 |
| 9 | 22 | 2 | 2 | 7 | LF-7 | P1029 | 26 | 2 | 2 | 11 | LF-11 | P1062 | 36 | 2 | 4 | 6 | G-6 | P1042 | 62 | 1 | 4 | 3 | CAL<br>D3H | |
| 10 | 17 | 2 | 2 | 2 | LF-2 | P1034 | | SPARE | | | | | 37 | 2 | 4 | 7 | G-7 | P1045 | 63 | 1 | 4 | 4 | D4H | |
| 11 | 23 | 2 | 2 | 8 | LF-8 | P1059 | 27 | 2 | 2 | 12 | LF-12 | P1050 | 44 | 2 | 4 | 14 | (CAL)<br>A-4 | 995 | 39 | 2 | 4 | 9 | G-9 | P1079 |
| 12 | 16 | 2 | 2 | 1 | LF-1 | P-1015 | 46 | 2 | 6 | 9 | H-1 | P1075 | 40 | 2 | 4 | 10 | G-10 | P1052 | 45 | 2 | 4 | 15 | A-11 | 992 |
| 13 | 29 | 2 | 2 | 14 | A-7 | 966 | 28 | 2 | 2 | 13 | LF-13 | P1065 | 41 | 2 | 4 | 11 | A-2 | 994 | 50 | 3 | 2 | 5 | H-5 | P1096 |
| 14 | 14 | 1 | 2 | 14 | (CAL)<br>A-5 | 1002 | | SPARE | | | | | 42 | 2 | 4 | 12 | A-3 | 993 | 56 | 3 | 2 | 11 | A-9 | 997 |

NOTES: Same as record combination 1

(CAL) indicates CAL signal applied in EL CAL panels

PREPARED BY: R. Newman

DATE: 25 June 1966

**C/P SONAR PROGRAM**

**FORM NO. CP-3**

**EFFECTIVE DATE**

## PURVIS II RECORDING COMBINATION 3 REV 0

(REPLACES PURVIS II RECORDING COMBINATION ____ REV ____)

| TRACK NO. | RECORDER NO. 1 | | | | | | RECORDER NO. 2 | | | | | | RECORDER NO. 3 | | | | | | RECORDER NO. 4 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | |
| | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. |
| 1 | 1 | 1 | 2 | 1 | HF-1 | P1007 | 51 | 3 | 2 | 6 | H-6 | P1061 | 16 | 2 | 2 | 1 | LF-1 | P1015 | 49 | 2 | 6 | 12 | H-4 | P1057 |
| 2 | 7 | 1 | 2 | 7 | HF-7 | P1030 | 35 | 2 | 4 | 5 | G-5 | P1020 | 21 | 2 | 2 | 6 | LF-6 | P1063 | 60 | 1 | 4 | 1 | D1H | |
| 3 | 2 | 1 | 2 | 2 | HF-2 | P1011 | 55 | 3 | 2 | 10 | H-10 | P1049 | 17 | 2 | 2 | 2 | LF-2 | P1034 | 61 | 1 | 4 | 2 | D2H | |
| 4 | 8 | 1 | 2 | 8 | HF-8 | P1002 | 43 | 2 | 4 | 13 | A-1 | 999 | 64 | 1 | 4 | 5 | D5H | | 25 | 2 | 2 | 10 | LF-10 | P1012 |
| 5 | 3 | 1 | 2 | 3 | HF-3 | P1076 | 54 | 3 | 2 | 9 | H-9 | P1009 | 65 | 1 | 4 | 6 | D6H | | 26 | 2 | 2 | 11 | LF-11 | P1062 |
| 6 | 9 | 1 | 2 | 9 | HF-9 | P1014 | 38 | 2 | 4 | 8 | G-8 | P1071 | 22 | 2 | 2 | 7 | LF-7 | | 47 | 2 | 6 | 10 | H-2 | P1051 |
| 9 | 4 | 1 | 2 | 4 | HF-4 | P1036 | 53 | 3 | 2 | 8 | H-8 | P1016 | 18 | 2 | 2 | 3 | LF-3 | P1010 | 62 | 1 | 4 | 3 | D3H | |
| 10 | 14 | 1 | 2 | 14 | A-5 | 1002 | 44 | 2 | 4 | 15 | A-4 | 995 | 23 | 2 | 2 | 8 | LF-8 | P1059 | 63 | 1 | 4 | 4 | D4H | |
| 11 | 5 | 1 | 2 | 5 | HF-5 | P1029 | 52 | 3 | 2 | 7 | H-7 | P1029 | 19 | 2 | 2 | 4 | LF-4 | P1001 | 27 | 2 | 2 | 12 | LF-12 | P1050 |
| 12 | 29 | 2 | 2 | 14 | A-7 | 966 | 50 | 3 | 2 | 5 | H-5 | P1046 | 46 | 2 | 6 | 9 | H-1 | P1075 | 48 | 2 | 6 | 11 | H-3 | P1078 |
| 13 | 6 | 1 | 2 | 6 | HF-6 | P1019 | 56 | 3 | 2 | 11 | A-9 | 997 | 20 | 2 | 2 | 5 | LF-5 | P1043 | 28 | 2 | 2 | 13 | LF-13 | P1065 |
| 14 | | | | | TC | (CAL) | | | | | TC | (CAL) | | | | | TC | (CAL) | | | | | TC | (CAL) |

NOTES: 1. During Electrical calibrations, CAL signal is applied to tracks indicated as TC(CAL). TC (Transmitted composite) is applied during data runs.

PREPARED BY: R. Newman

DATE: 25 June 1966

**C/P SONAR PROGRAM**

**FORM NO. CP-3**

**EFFECTIVE DATE**

## PURVIS II RECORDING COMBINATION 4 REV 0

**(REPLACES PURVIS II RECORDING COMBINATION ____ REV ____)**

S.M. included

| TRACK NO. | RECORDER NO. 1 | | | | | | RECORDER NO. 2 | | | | | | RECORDER NO. 3 | | | | | | RECORDER NO. 4 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | |
| | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. |
| 1 | | | | | | | | | | | | | | | | | | | 2 | 1 | 2 | 2 | HF-2 | P1011 |
| 2 | | | | | | | | | | | | | | | | | | | 9 | 1 | 2 | 9 | HF-9 | P1014 |
| 3 | | | | | | | | | | | | | | | | | | | 16 | 2 | 2 | 1 | LF-1 | P1015 |
| 4 | | | | | | | | | | | | | | | | | | | 23 | 2 | 2 | 8 | LF-8 | P1059 |
| 5 | | | | | | | | | | | | | | | | | | | 55 | 3 | 2 | 10 | H-10 | P1049 |
| 6 | | | | | | | | | | | | | | | | | | | 53 | 3 | 2 | 8 | H-8 | P1016 |
| 9 | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | | | | | |

PREPARED BY: M.E. Casciolo

DATE: 28 June 1966

**C/P SONAR PROGRAM**

FORM NO. CP-3

EFFECTIVE DATE

## PURVIS II RECORDING COMBINATION 5 REV 0

(REPLACES PURVIS II RECORDING COMBINATION ____ REV ____)

No ships motion

| TRACK NO. | RECORDER NO. 1 | | | | | | RECORDER NO. 2 | | | | | | RECORDER NO. 3 Basic | | | | | | RECORDER NO. 4 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | |
| | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. |
| 1 | | | | | | | | | | | | | 60 | | | | D1-H | | 75 | | | | D1A | |
| 2 | | | | | | | | | | | | | 64 | | | | D5-H | | 79 | | | | D5A | |
| 3 | | | | | | | | | | | | | 9 | | | | HF-9 | | 1 | | | | HF-1 | |
| 4 | | | | | | | | | | | | | 10 | | | | HF-10 | | 12 | | | | HF-12 | |
| 5 | | | | | | | | | | | | | 35 | | | | G-5 | | 36 | | | | G-6 | |
| 6 | | | | | | | | | | | | | 33 | | | | G-3 | | 34 | | | | G-4 | |
| 9 | | | | | | | | | | | | | 23 | | | | LF8 | | 55 | | | | H-10 | |
| 10 | | | | | | | | | | | | | 16 | | | | LF1 | | 51 | | | | H-6 | |
| 11 | | | | | | | | | | | | | 19 | | | | LF4 | | 49 | | | | H-4 | |
| 12 | | | | | | | | | | | | | 21 | | | | LF6 | | 52 | | | | H-7 | |
| 13 | | | | | | | | | | | | | 53 | | | | H8 | | | | | | | TC |
| 14 | | | | | | | | | | | | | 62 | | | | D3H | | 77 | | | | D3-A | |

PREPARED BY: N. NESENOFF

DATE:

**C/P SONAR PROGRAM**

FORM NO. CP-3

EFFECTIVE DATE

## PURVIS II RECORDING COMBINATION All REV 0

(REPLACES PURVIS II RECORDING COMBINATION ____ REV ____)

| TRACK NO. | RECORDER NO. 5 | | | | | | RECORDER NO. 2 | | | | | | RECORDER NO. 3 | | | | | | RECORDER NO. 4 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SCA NO. | TRANSDUCER DESCRIPTION MAC coordin | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | |
| | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. |
| 1 | | Sway | | | SM1 | UV13 | | | | | | | | | | | | | | | | | | |
| 2 | | Surge | | | SM2 | UV14 | | | | | | | | | | | | | | | | | | |
| 3 | | Heave | | | SM3 | UV15 | | | | | | | | | | | | | | | | | | |
| 4 | | Flow Flag A | | | SM4 | UV16 | | | | | | | | | | | | | | | | | | |
| 5 | | Bow Probe | | | SM5 | UV17 | | | | | | | | | | | | | | | | | | |
| 6 | | Sea State | | | SM7 | UV19 | | | | | | | | | | | | | | | | | | |
| 9 | | Pitch | | | SM8 | UV20 | | | | | | | | | | | | | | | | | | |
| 10 | | Roll | | | SM15 | WX19 | | | | | | | | | | | | | | | | | | |
| 11 | | Yaw | | | SM16 | WX20 | | | | | | | | | | | | | | | | | | |
| 12 | | Flow Flag B | | | SM9 | WX13 | | | | | | | | | | | | | | | | | | |
| 13 | | Flow Flag C | | | SM10 | WX14 | | | | | | | | | | | | | | | | | | |
| 14 | | Flow Flag D | | | SM11 | WX15 | | | | | | | | | | | | | | | | | | |

PREPARED BY: M. Casciolo

DATE: 28 June 1966

**C/P SONAR PROGRAM**

FORM NO. CP-3

EFFECTIVE DATE

## PURVIS II RECORDING COMBINATION 1 REV 1

(REPLACES PURVIS II RECORDING COMBINATION 1 REV 0)

| TRACK NO. | RECORDER NO. 1 | | | | | | RECORDER NO. 2 | | | | | | RECORDER NO. 3 | | | | | | RECORDER NO. 4 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | |
| | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. |
| 1 | 1 | 1 | 2 | 1 | HF-1 | P1007 | 10 | 1 | 2 | 10 | HF-10 | P1060 | 60 | 1 | 4 | 1 | D1H | | 55 | 3 | 2 | 10 | H-10 | P1049 |
| 2 | 7 | 1 | 2 | 7 | HF-7 | P1030 | 35 | 2 | 4 | 5 | G-5 | P1020 | 61 | 1 | 4 | 2 | D2H | | | (OVERSIDE CAL) | | | | |
| 3 | 2 | 1 | 2 | 2 | HF-2 | P1011 | 11 | 1 | 2 | 11 | HF-11 | P1031 | 62 | 1 | 4 | 3 | D3H | | 75 | 1 | 3 | 1 | D1A | |
| 4 | 8 | 1 | 2 | 8 | HF-8 | P1002 | 43 | 2 | 4 | 13 | A-1 | 999 | 63 | 1 | 4 | 4 | D4H | | 76 | 1 | 3 | 2 | D2A | |
| 5 | 3 | 1 | 2 | 3 | HF-3 | P1076 | 12 | 1 | 2 | 12 | HF-12 | P1009 | 64 | 1 | 4 | 5 | D5H | | 77 | 1 | 3 | 3 | D3A | |
| 6 | 9 | 1 | 2 | 9 | HF-9 | P1014 | 38 | 2 | 4 | 8 | G-8 | P1071 | 65 | 1 | 4 | 6 | D6H | | 78 | 1 | 3 | 4 | D4A | |
| 9 | 4 | 1 | 2 | 4 | HF-4 | P1036 | 28* | 2 | 2 | 13 | LF-13 | P1065 | 66 | 1 | 4 | 7 | D7H | | 79 | 1 | 3 | 5 | D5A | |
| 10 | 29 | 2 | 2 | 14 | A-7 | 966 | 44 | 2 | 4 | 14 | A-4 | 995 | 67 | 1 | 4 | 8 | D8H | | 80 | 1 | 3 | 6 | D6A | |
| 11 | 5 | 1 | 2 | 5 | HF-5 | P1027 | 13 | 1 | 2 | 13 | HF-13 | P1008 | 68 | 1 | 4 | 9 | D9H | | 81 | 1 | 3 | 7 | D7A | |
| 12 | 16 | 2 | 2 | 1 | LF-1 | P1015 | 50 | 3 | 2 | 5 | H-5 | P1046 | 69 | 1 | 4 | 10 | D10H | | 82 | 1 | 3 | 8 | DD8A | |
| 13 | 6 | 1 | 2 | 6 | HF-6 | P1019 | 24 | 2 | 2 | 9 | LF-9 | P1068 | 46 | 2 | 6 | 9 | H-1 | P1075 | 83 | 1 | 3 | 9 | D9A | |
| 14 | 14 | 1 | 2 | 14 | A-5 | 1002 | 56 | 3 | 2 | 11 | A-9 | 997 | 23 | 2 | 2 | 8 | LF-8 | P1059 | 84 | 1 | 3 | 10 | D10A | |

NOTES:
1. During electrical calibrations, CAL signal is applied to tracks marked with star (*) from power amplifier. (* connect 1, 2 to CAL amp out)
2. CAL signal to DTMB channels are patched via Q-20 to J-161 on MAC panel to CAL T's on DTMB Amps.
3. Overside CAL signal derived from 1 ohm resistor in $T_1$ circuit.
4. Records overside cal on runs 9-18

PREPARED BY: M. Casciolo

DATE: 26 June 1966

C/P SONAR PROGRAM

FORM NO. CP-3__________

EFFECTIVE DATE__________

# PURVIS II RECORDING COMBINATION 2 REV 1

(REPLACES PURVIS II RECORDING COMBINATION 2 REV 0)

| TRACK NO. | RECORDER NO. 1 | | | | | | RECORDER NO. 2 | | | | | | RECORDER NO. 3 | | | | | | RECORDER NO. 4 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | |
| | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. |
| 1 | 21 | 2 | 2 | 6 | LF-6 | P1063 | 10 | 1 | 2 | 10 | HF-10 | P1060 | 31 | 2 | 4 | 1 | G-1 | P1095 | 43 | 2 | 4 | 13 | A-1 | 999 |
| 2 | 20 | 2 | 2 | 5 | LF-5 | P1043 | 64 | 1 | 4 | 5 | D5H | | 32 | 2 | 4 | 2 | G-2 | P1073 | 60 | 1 | 4 | 1 | D1H | |
| 3 | 2 | 1 | 2 | 2 | HF-2 | P1011 | 24 | 2 | 2 | 9 | LF-9 | P1068 | 33 | 2 | 4 | 3 | G-3 | P1021 | 61 | 1 | 4 | 2 | D2H | |
| 4 | 19 | 2 | 2 | 4 | LF-4 | P1001 | 13 | 1 | 2 | 13 | HF-13 | P1008 | 35 | 2 | 4 | 5 | G-5 | P1020 | 47 | 2 | 6 | 10 | H-2 | P1051 |
| 5 | 3 | 1 | 2 | 3 | HF-3 | P1076 | 25 | 2 | 2 | 10 | LF-10 | P1012 | 38 | 2 | 4 | 8 | G-8 | P1071 | 48 | 2 | 6 | 11 | H-3 | P1078 |
| 6 | 18 | 2 | 2 | 3 | LF-3 | P1010 | 65 | 1 | 4 | 6 | D6H | | 34 | 2 | 4 | 4 | G-4 | P1098 | 49 | 2 | 6 | 12 | H-4 | P1057 |
| 9 | 22 | 2 | 2 | 7 | LF-7 | P1029 | 26 | 2 | 2 | 11 | LF-11 | P1062 | 36 | 2 | 4 | 6 | G-6 | P1042 | 62* | 1 | 4 | 3 | (CAL) D3H | |
| 10 | 17 | 2 | 2 | 2 | LF-2 | P1034 | 9 | 1 | 2 | 9 | HF-9 | P1014 | 37 | 2 | 4 | 7 | G-7 | P1045 | 63 | 1 | 4 | 4 | D4H | |
| 11 | 23 | 2 | 2 | 8 | LF-8 | P1059 | 27 | 2 | 2 | 12 | LF-12 | P1050 | * 44 | 2 | 4 | 14 | (CAL) A-4 | 995 | 39 | 2 | 4 | 9 | G-9 | P1079 |
| 12 | 16 | 2 | 2 | 1 | LF-1 | P1015 | 46 | 2 | 6 | 9 | H-1 | P1075 | 40 | 2 | 4 | 10 | G-10 | P1052 | 45 | 2 | 4 | 15 | A-11 | 992 |
| 13 | 29 | 2 | 2 | 14 | A-7 | 966 | 28 | 2 | 2 | 13 | LF-13 | P1065 | 41 | 2 | 4 | 11 | A-2 | 994 | 50 | 3 | 2 | 5 | H-5 | P1046 |
| 14 | * 14 | 1 | 2 | 14 | (CAL) A-5 | 1002 | * | | | | (CAL) | O.S. CAL | 42 | 2 | 4 | 12 | A-3 | 993 | 56 | 3 | 2 | 11 | A-9 | 997 |

NOTES: Same as combo 1, rev. 1,
"CAL" indicates calibration signal is applied in elec. calib. panels

PREPARED BY: M.E. Casciolo
DATE: 27 June 1966

**C/P SONAR PROGRAM**

FORM NO. CP-3

EFFECTIVE DATE

## PURVIS II RECORDING COMBINATION 3 REV 1

(REPLACES PURVIS II RECORDING COMBINATION 3 REV 0)

| TRACK NO. | RECORDER NO. 1 | | | | | | RECORDER NO. 2 | | | | | | RECORDER NO. 3 | | | | | | RECORDER NO. 4 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | |
| | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. |
| 1 | 1 | 1 | 2 | 1 | HF-1 | P1007 | 51 | 3 | 2 | 6 | H-6 | P1061 | 16 | 2 | 2 | 1 | LF-1 | P1015 | 49 | 2 | 6 | 12 | H-4 | P1057 |
| 2 | 7 | 1 | 2 | 7 | HF-7 | P1030 | 35 | 2 | 4 | 5 | G-5 | P1020 | 21 | 2 | 2 | 6 | LF-6 | P1063 | 60 | 1 | 4 | 1 | D1H | |
| 3 | 2 | 1 | 2 | 2 | HF-2 | P1011 | 55 | 3 | 2 | 10 | H-10 | P1049 | 17 | 2 | 2 | 2 | LF-2 | P1034 | 61 | 1 | 4 | 2 | D2H | |
| 4 | 8 | 1 | 2 | 8 | HF-8 | P1002 | 30 | 2 | 2 | 15 | A-8 | 1003 | 64 | 1 | 4 | 5 | D5H | | 25 | 2 | 2 | 10 | LF-10 | P1012 |
| 5 | 3 | 1 | 2 | 3 | HF-3 | P1076 | 54 | 3 | 2 | 9 | H-9 | P1009 | 65 | 1 | 4 | 6 | D6H | | 26 | 2 | 2 | 11 | LF-11 | P1062 |
| 6 | 9 | 1 | 2 | 9 | HF-9 | P1014 | 38 | 2 | 4 | 8 | G-8 | P1071 | 22 | 2 | 2 | 7 | LF-7 | P1029 | 47 | 2 | 6 | 10 | H-2 | P1051 |
| 9 | 4 | 1 | 2 | 4 | HF-4 | P1036 | 53 | 3 | 2 | 8 | H-8 | P1016 | 18 | 2 | 2 | 3 | LF-3 | P1010 | 62 | 1 | 4 | 3 | D34 | |
| 10 | 15 | 1 | 1 | 15 | A-6 | 1001 | | | | | O.S. CAL | | 23 | 2 | 2 | 8 | LF-8 | P1059 | 63 | 1 | 4 | 4 | D4H | |
| 11 | 5 | 1 | 2 | 5 | HF-5 | P1027 | 52 | 3 | 2 | 7 | H-7 | P1029 | 19 | 2 | 2 | 4 | LF-4 | P1001 | 27 | 2 | 2 | 12 | LF-12 | P1050 |
| 12 | 29 | 2 | 2 | 14 | A-7 | 966 | 50 | 3 | 2 | 5 | H-5 | P1046 | 46 | 2 | 6 | 9 | H-1 | P1075 | 48 | 2 | 6 | 11 | H-3 | P1078 |
| 13 | 6 | 1 | 2 | 6 | HF-6 | P1019 | 56 | 3 | 2 | 11 | A-9 | 997 | 20 | 2 | 2 | 5 | LF-5 | P1043 | 28 | 2 | 2 | 13 | LF-13 | P1065 |
| 14 | | | | | TC | (CAL) | | | | | TC | (CAL) | | | | | TC | (CAL) | | | | | TC* | (CAL) |

NOTES: During elec. Calib., CAL signal is applied to tracks marked "TC (CAL)". TC(transmitted composite) is applied during data runs. * gets overside cal signal during overside cal

PREPARED BY: M.E. Casciolo

DATE: 27 June 1966

Rec 2 track 10 gets data from monitor patch 3.

**C/P SONAR PROGRAM**

FORM NO. CP-3

EFFECTIVE DATE

## PURVIS II RECORDING COMBINATION 4 REV 1

(REPLACES PURVIS II RECORDING COMBINATION 4 REV 0 )

| TRACK NO. | RECORDER NO. 1 | | | | | | RECORDER NO. 2 | | | | | | RECORDER NO. 3 | | | | | | RECORDER NO. 4 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | |
| | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. |
| 1 | | | | | | | | | | | | | | | | | | | 2 | 1 | 2 | 2 | HF-2 | P1011 |
| 2 | | | | | | | | | | | | | | | | | | | 9 | 1 | 2 | 9 | HF-9 | P1014 |
| 3 | | | | | | | | | | | | | | | | | | | 16 | 2 | 2 | 1 | LF-1 | P1015 |
| 4 | | | | | | | | | | | | | | | | | | | 23 | 2 | 2 | 8 | LF-8 | P1059 |
| 5 | | | | | | | | | | | | | | | | | | | 55 | 3 | 2 | 10 | H-10 | P1049 |
| 6 | | | | | | | | | | | | | | | | | | | 53 | 3 | 2 | 8 | H-8 | P1016 |
| 9 | | | | | | | | | | | | | | | | | | | 19 | 2 | 2 | 4 | LF-4 | P1001 |
| 10 | | | | | | | | | | | | | | | | | | | 21 | 2 | 2 | 6 | LF-6 | P1063 |
| 11 | | | | | | | | | | | | | | | | | | | 51 | 3 | 2 | 6 | H-6 | P1061 |
| 12 | | | | | | | | | | | | | | | | | | | 49 | 3 | 2 | 8 | H-4 | P1016 |
| 13 | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | | | | | |

PREPARED BY: M. Casciolo

DATE: 21 July 1966

# APPENDIX D

# SHIPBOARD DATA FORMS

# CP SONAR PROGRAM-RUN DESCRIPTION SHEET

DATE__________ FORM NO. CP1 SERIAL NO.__________ RUN NO.__________

☐ BOW WAVE HOSE
☐ EXTERNAL CAMERA
☐ FISH EYE CAMERA
☐ FULL TURN

☐ TRANSMISSION RUN
☐ PASSIVE RUN
☐ OVERSIDE CALIBRATION
☐ ELECTRICAL CALIBRATION

☐ OTHER

---

START TIME__________ INDEX TIME__________ STOP TIME__________

---

SHIPS SPEED__________KNOTS
RECORD COMB__________REV._____
HEADING WRT SEA__________
PORT ENGINE RPM__________
STBD ENGINE RPM__________
WIND VELOCITY REL.__________KNOTS
WIND DIRECTION REL.__________
WATER TEMPERATURE__________
SEA STATE__________
SHIPS COURSE__________

MASKER COMBINATION__________
AIR FLOW RATE__________SCFM
RUDDER ANGLE__________
RECORDING FLOW FLAGS A B C D
TRANSMIT 1 FREQUENCY__________kHz
TRANSMIT 2 FREQUENCY__________kHz
TRANSMIT 3 FREQUENCY__________kHz
TRANSMIT 4 FREQUENCY__________kHz
PROBE EXTENSION__________FEET
PROBE VELOCITY__________KNOTS

COMMENTS__________

| RECORDER NO. | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| TAPE REEL NO. | | | | | |
| COUNTER START | | | | | |
| COUNTER STOP | | | | | |

CONSOLE OPERATOR__________

**C/P SONAR PROGRAM**

FORM NO. CP-3____________

EFFECTIVE DATE____________

## PURVIS II RECORDING COMBINATION____REV____

(REPLACES PURVIS II RECORDING COMBINATION ____REV____)

| TRACK NO. | RECORDER NO. 1 | | | | | | RECORDER NO. 2 | | | | | | RECORDER NO. 3 | | | | | | RECORDER NO. 4 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | | SCA NO. | TRANSDUCER DESCRIPTION | | | | |
| | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. | | STA. | CABLE NO. | CONN. NO. | ELEMENT NO. | SERIAL NO. |
| 1 | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | | | | | |

PREPARED BY:____________

DATE:____________

**C/P SONAR PROGRAM**

FORM NO. CP-4

**MAGNETIC TAPE DESCRIPTION SHEET**

TAPE REEL NO. ____________________

DATE AT START OF RECORDING ____________________

DATE AT END OF RECORDING ____________________

| RUN NO. | RECORD COMBIN. | DATE | TIME | | COUNTER | |
|---|---|---|---|---|---|---|
| | | | START | STOP | START | STOP |
| | | | | | | |
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COMMENTS: ____________________

B026-47011/47013

# C/P SONAR PROGRAM—GAIN SETTING SHEET

DATE ____________ FORM NO. CP2 SERIAL NO. ____________ RUN NO. ____________

☐ BOW WAVE HOSE
☐ EXTERNAL CAMERA
☐ FISHEYE CAMERA
☐ FULL TURN

☐ TRANSMISSION RUN
☐ PASSIVE RUN
☐ OVERSIDE CALIBRATION
☐ ELECTRICAL CALIBRATION

☐ OTHER

## RECORD COMBO I

| SCA NO. | GAIN SETTING DB | FREQ. FILTER SETTING Hz | SCA NO. | GAIN SETTING DB | FREQ. FILTER SETTING Hz | SCA NO. | GAIN SETTING DB | FREQ. FILTER SETTING Hz | SHIP MOTION | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | TRACK | SIGNAL NAME | GAIN SETTING | L.P. FILTER Hz |
| 1 | | | 29 | | | 57 | | | 1 | SWAY | | |
| 2 | | | 30 | | | 58 | | | 2 | SURGE | | |
| 3 | | | 31 | | | 59 | | | 3 | HEAVE | | |
| 4 | | | 32 | | | 60 | | | 4 | FF A | | |
| 5 | | | 33 | | | 61 | | | 5 | BOW P | | |
| 6 | | | 34 | | | 62 | | | 6 | SEA S | | |
| 7 | | | 35 | | | 63 | | | 9 | PITCH | | |
| 8 | | | 36 | | | 64 | | | 10 | ROLL | | |
| 9 | | | 37 | | | 65 | | | 11 | YAW | | |
| 10 | | | 38 | | | 66 | | | 12 | FF B | | |
| 11 | | | 39 | | | 67 | | | 13 | FF C | | |
| 12 | | | 40 | | | 68 | | | 14 | FF D | | |
| 13 | | | 41 | | | 69 | | | | | | |
| 14 | | | 42 | | | 70 | | | | | | |
| 15 | | | 43 | | | 71 | | | | | | |
| 16 | | | 44 | | | 72 | | | | | | |
| 17 | | | 45 | | | 73 | | | | | | |
| 18 | | | 46 | | | 74 | | | | | | |
| 19 | | | 47 | | | 75 | | | | | | |
| 20 | | | 48 | | | 76 | | | | | | |
| 21 | | | 49 | | | 77 | | | | | | |
| 22 | | | 50 | | | 78 | | | | | | |
| 23 | | | 51 | | | 79 | | | | | | |
| 24 | | | 52 | | | 80 | | | | | | |
| 25 | | | 53 | | | 81 | | | | | | |
| 26 | | | 54 | | | 82 | | | | | | |
| 27 | | | 55 | | | 83 | | | | | | |
| 28 | | | 56 | | | 84 | | | | | | |

RECORDED BY ____________

CHECKED BY ____________

B026-47011/47013

# C/P SONAR PROGRAM—GAIN SETTING SHEET

DATE ____________________ FORM NO. CP2 SERIAL NO. ______________ RUN NO. ____________________

☐ BOW WAVE HOSE
☐ EXTERNAL CAMERA
☐ FISHEYE CAMERA
☐ FULL TURN

☐ TRANSMISSION RUN
☐ PASSIVE RUN
☐ OVERSIDE CALIBRATION
☐ ELECTRICAL CALIBRATION

☐ OTHER

## RECORDING COMBO 2

| SCA NO. | GAIN SETTING DB | FREQ. FILTER SETTING Hz | SCA NO. | GAIN SETTING DB | FREQ. FILTER SETTING Hz | SCA NO. | GAIN SETTING DB | FREQ. FILTER SETTING Hz | SHIP MOTION | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | TRACK | SIGNAL NAME | GAIN SETTING | L.P. FILTER Hz |
| 1 | | | 29 | | | 57 | | | 1 | SWAY | | |
| H 2 | | | 30 | | | 58 | | | 2 | SURGE | | |
| H 3 | | | 31 GI | | | 59 | | | 3 | HEAVE | | |
| 4 | | | 32 | | | 60 | | | 4 | FF A | | |
| 5 | | | 33 | | | 61 | | | 5 | BOW P | | |
| 6 | | | 34 | | | 62 | | | 6 | SEA S | | |
| 7 | | | 35 | | | 63 | | | 9 | PITCH | | |
| 8 | | | 36 | | | 64 | | | 10 | ROLL | | |
| 9 | | | 37 | | | 65 | | | 11 | YAW | | |
| 10 | | | 38 | | | 66 | | | 12 | FF B | | |
| 11 | | | 39 | | | 67 | | | 13 | FF C | | |
| 12 | | | 40 GIO | | | 68 | | | 14 | FF D | | |
| 13 | | | 41 A | | | 69 | | | | | | |
| 14 | | | 42 A | | | 70 | | | | | | |
| 15 | | | 43 A | | | 71 | | | | | | |
| 16 | | | 44 A | | | 72 | | | | | | |
| 17 | | | 45 A | | | 73 | | | | | | |
| 18 | | | 46 H | | | 74 | | | | | | |
| 19 | | | 47 H | | | 75 | | | | | | |
| 20 | | | 48 H | | | 76 | | | | | | |
| 21 | | | 49 H | | | 77 | | | | | | |
| 22 | | | 50 H | | | 78 | | | | | | |
| 23 | | | 51 | | | 79 | | | | | | |
| 24 | | | 52 | | | 80 | | | | | | |
| 25 | | | 53 | | | 81 | | | | | | |
| 26 | | | 54 | | | 82 | | | | | | |
| 27 | | | 55 | | | 83 | | | | | | |
| 28 | | | 56 | | | 84 | | | | | | |

LF1-13

RECORDED BY ____________________

CHECKED BY ____________________

# C/P SONAR PROGRAM—GAIN SETTING SHEET

DATE________________ FORM NO. CP2 SERIAL NO.________________ RUN NO.________________

☐ BOW WAVE HOSE
☐ EXTERNAL CAMERA
☐ FISHEYE CAMERA
☐ FULL TURN

☐ TRANSMISSION RUN
☐ PASSIVE RUN
☐ OVERSIDE CALIBRATION
☐ ELECTRICAL CALIBRATION

☐ OTHER

## RECORDING COMBO 3

| SCA NO. | GAIN SETTING DB | FREQ. FILTER SETTING Hz | SCA NO. | GAIN SETTING DB | FREQ. FILTER SETTING Hz | SCA NO. | GAIN SETTING DB | FREQ. FILTER SETTING Hz |
|---|---|---|---|---|---|---|---|---|
| 1 | | | 29 | | | 57 | | |
| 2 | | | 30 | | | 58 | | |
| 3 | | | 31 | | | 59 | | |
| 4 | | | 32 | | | 60 | | |
| 5 | | | 33 | | | 61 | | |
| 6 | | | 34 | | | 62 | | |
| 7 | | | 35 | | | 63 | | |
| 8 | | | 36 | | | 64 | | |
| 9 | | | 37 | | | 65 | | |
| 10 | | | 38 | | | 66 | | |
| 11 | | | 39 | | | 67 | | |
| 12 | | | 40 | | | 68 | | |
| 13 | | | 41 | | | 69 | | |
| 14 | | | 42 | | | 70 | | |
| 15 | | | 43 | | | 71 | | |
| 16 | | | 44 | | | 72 | | |
| 17 | | | 45 | | | 73 | | |
| 18 | | | 46 | | | 74 | | |
| 19 | | | 47 | | | 75 | | |
| 20 | | | 48 | | | 76 | | |
| 21 | | | 49 | | | 77 | | |
| 22 | | | 50 | | | 78 | | |
| 23 | | | 51 | | | 79 | | |
| 24 | | | 52 | | | 80 | | |
| 25 | | | 53 | | | 81 | | |
| 26 | | | 54 | | | 82 | | |
| 27 | | | 55 | | | 83 | | |
| 28 | | | 56 | | | 84 | | |

| SHIP MOTION | | | |
|---|---|---|---|
| TRACK | SIGNAL NAME | GAIN SETTING | L.P. FILTER Hz |
| 1 | SWAY | | |
| 2 | SURGE | | |
| 3 | HEAVE | | |
| 4 | FF A | | |
| 5 | BOW P | | |
| 6 | SEA S | | |
| 9 | PITCH | | |
| 10 | ROLL | | |
| 11 | YAW | | |
| 12 | FF B | | |
| 13 | FF C | | |
| 14 | FF D | | |

RECORDED BY

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CHECKED BY

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# APPENDIX E

# DATA PROCESSING

The digital data processing for the PURVIS test consists of both auto and cross correlations of the output from sonar hydrophones, spectral density and cross spectral density, including both the magnitude and phase, and both the amplitude probability distribution, and the cumulative probability distribution. The spectral density is obtained by solving for the Fourier transform of the correlation function. A general block diagram of the data processing is shown in Figure E-1a and E-1b. The digital magnetic tapes (two used for the cross correlation or cross power spectrum) are applied to the input of the digital computer. The first operation is a cross or auto correlation. In the case where one tape contains ship's motion data, the average power from the sonar hydrophone is cross correlated with the ship's motion to determine if there is any effect of ship's motion on average signal power.

The auto correlation is a symmetrical function and thus the auto correlation is presented for only positive displacements. Cross correlation is non-symmetrical and there are both the positive and negative displacements for cross correlation. In the system presented, filtering is performed during the analog formatting process. There is no digital filtering performed in this system. The spectral density as indicated before is obtained by taking the Fourier transform of the correlation function. Frequency

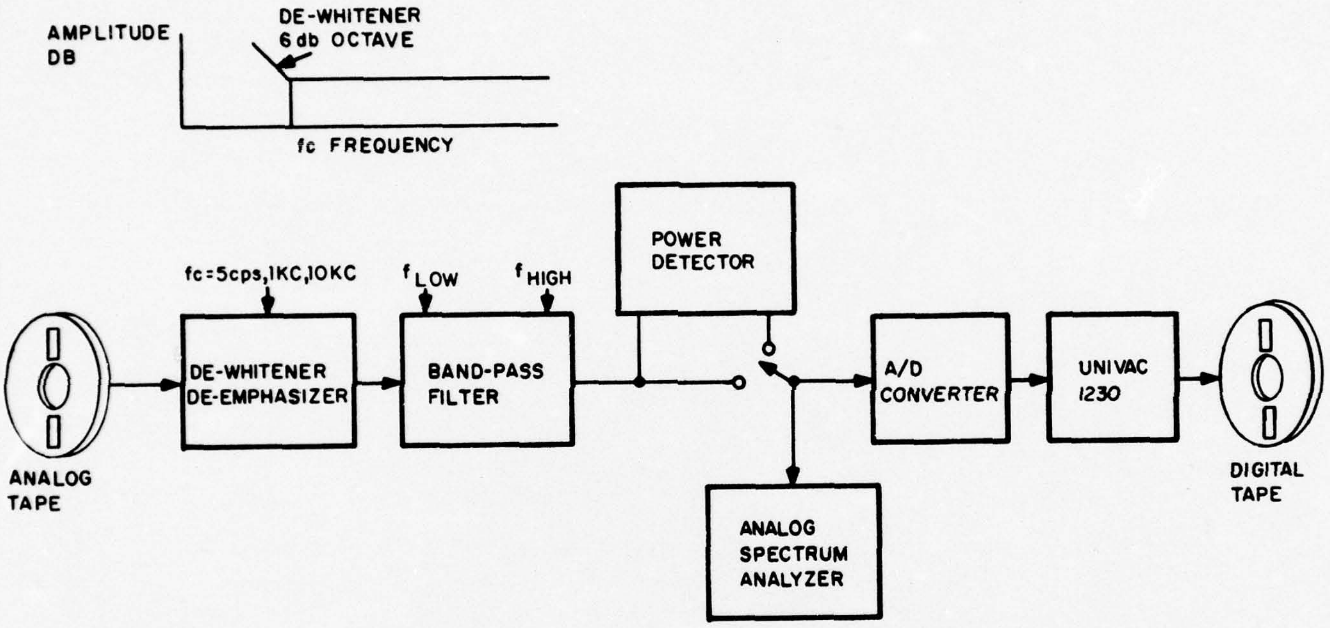


FIGURE E-1a. BLOCK DIAGRAM: ANALOG DATA FORMATTING AND PROCESSING

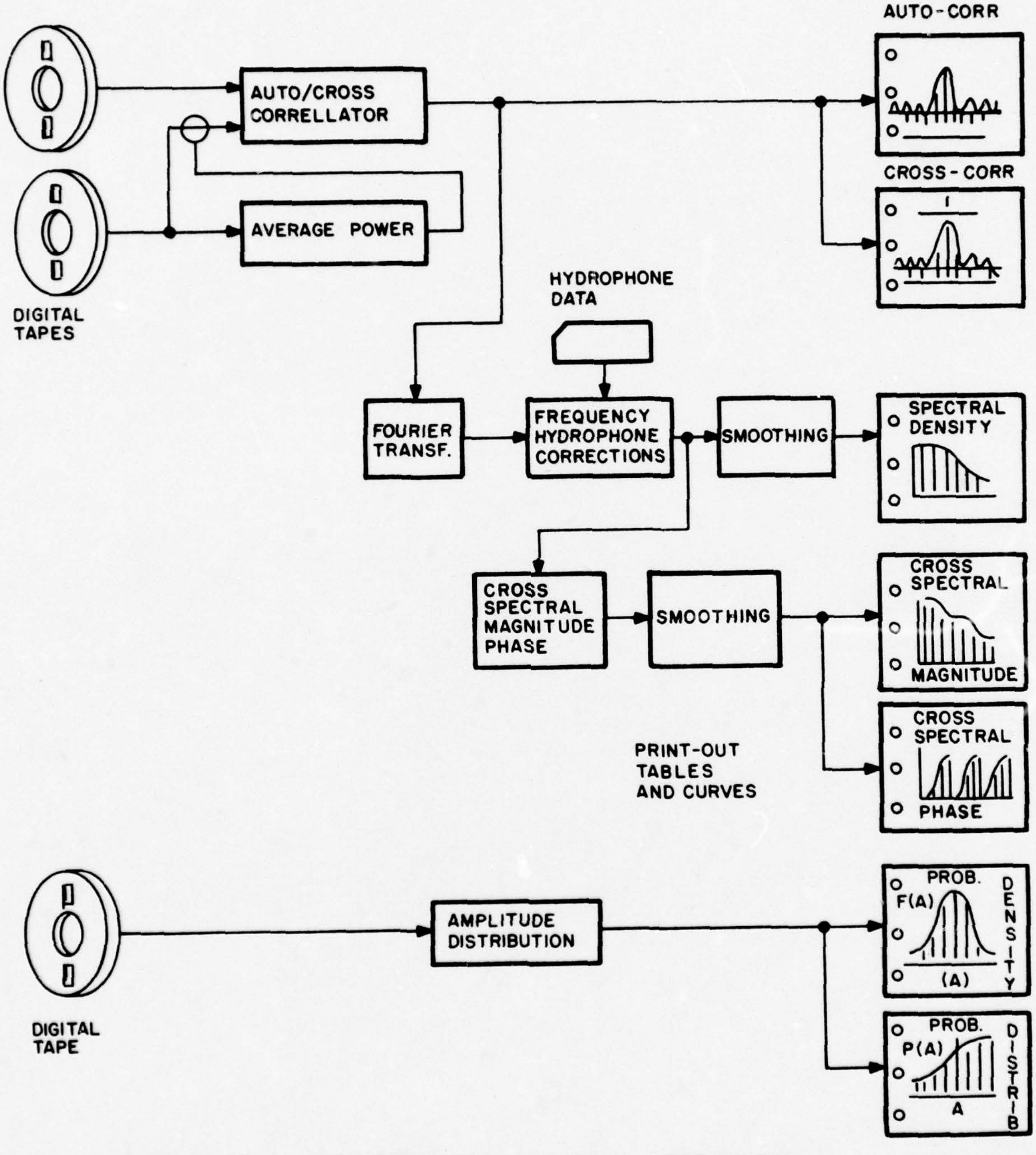


FIGURE E-1b. REPRESENTATION OF DATA PROCESSING correction for "preemphasis" or "whitening" of the signal is also performed in the formatting operation and corrections for hydrophone sensitivity are performed in the digital computer. The outputs are presented both in a tabular fashion and by special plotting routines. Curves are available via an automatic plotter. The probability density and the cumulative probability distribution are also calculated by the program.

The equations that are used for the processing have been separated into three categories: (1) correlation, (2) spectral density, and (3) probability density. The computer equations are indicated in the following pages.

The processing of acoustic data is done in five stages as illustrated in Figure E-2.

(1) PREPARE CORRECTION DATA

Hydrophone sensitivity data, skew correction data, and information which cross-references hydrophone vs. tape recorder track is encoded on cards and tables are generated on the program tape by the utility program.

(2) FORMAT

The analog data is digitized and stored on magnetic tape by the TRG formatting equipment operating online with the Univac 1230 Computer.

The pertinent data generated in step 1 and identification data entered by card are assembled into a header record which precedes the data on the formatted data tape.

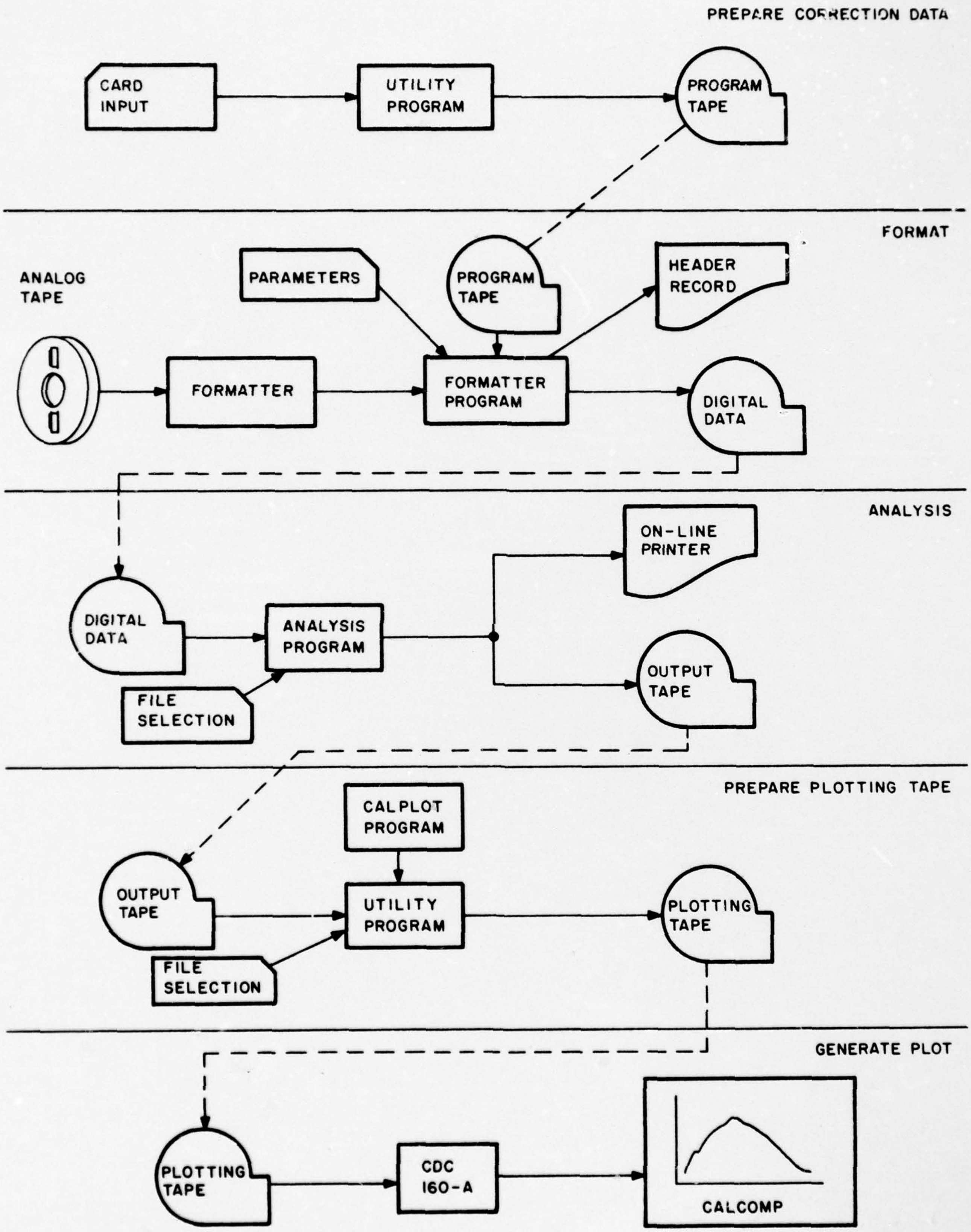


FIGURE E-2. PROCESSING OF ACOUSTIC DATA

A portion of the header record is outputted on the on-line printer and serves as a log for the formatting operation.

### (3) ANALYSIS

The formatted data is used as input to the analysis program. Data selection is accomplished by card input. Results of the analysis are outputted on magnetic tape and on the on-line printer.

### (4) PREPARE PLOTTING TAPE

The output tape generated by the analysis program is used as input to a program which generates a tape containing data for plotting. The data to be plotted is selected by card input.

The utility program contains the routine used for preparing the plotting tape; and, in turn, uses the CALPLOT routine which is in the Mongoose monitor system.

### (5) GENERATE PLOT

The output of step 4 is used as input to the CDC 160-A computer, which generates a $\frac{1}{100}$ inch resolution plot of the analysis output.

### CORRELATION

The cross-covariance of two stationary processes x(t) and y (t) may be defined as

$$C_{xy}(\tau) = E\left[(x(t) - \mu_x)(y^*(t+\tau) - \mu_y^*)\right]$$

where E denoted expected value and * denotes conjugate $\mu_x$ and $\mu_y$ are the expected values of x and y respectively.

This is equivalent to

$$C_{xy}(\tau) = \lim_{T \to \infty} \frac{1}{2T} \int_{-T}^{T} \left[ x(t) - \mu_x \right] \left[ y^*(t+\tau) - \mu_y^* \right] dt.$$

We will approximate the above integral by a finite sum and restrict x and y to real functions for our application.

Then

$$C_{xy}(\tau) = C_{xy}(p \Delta t) \cong \frac{1}{(n-p) \Delta t} \sum_{k=1}^{n-p} (x_k - \mu_x)(y_{k+p} - \mu_y) \Delta t$$

where $\tau = p \Delta t$

and

$$\overline{{}^{(2)}y_p} = \frac{1}{n-p} \sum_{k=1}^{n-p} y_{k+p} \quad \text{respectively,} \qquad \text{(Eq. 2)}$$

and hence,

$$C_{xy}(\tau) \cong B_{xy}(p \Delta t) = \frac{1}{(n-p)} \sum_{k=1}^{n-p} (x_k - \overline{{}^{(1)}x_p})(y_{k+p} - \overline{{}^{(2)}y_p}) \quad \text{(Eq. 3)}$$

Figure E-3 illustrates the technique used. The x and y records are sampled at n points providing sample sets ($x_1$, $x_2$, $x_y$, and $x_n$) and ($Y_1$, $Y_2$, $Y_3$, and $Y_n$) respectively and the above calculation is performed. Note that total time interval effectively used decreases as p increases; therefore, it is necessary that n be much greater than p in order to maintain accuracy. A ratio of 10 or 20 to one is adequate.

We now wish to approximate the normalized cross-covariance defined by

$$R_{xy}(\tau) = \frac{C_{xy}(\tau)}{\sqrt{\sigma_x^2 \ \sigma_y^2}} .$$

The variance of a stationary process X(t) is given by

$$\sigma_x^2 = E\left[(X(t) - \bar{X})^2\right] = C_{xx}(0) .$$

Rather than estimating $\sigma^2_x$ and $\sigma^2_y$ by using the total x or y record, we use only the portion of the record which is used in the covariance calculation. Hence, the estimate for $\sigma^2_x$ and $\sigma^2_y$ will be a function of p. The estimates are made by means of the expressions,

$$\sigma_x^2 \cong \left({}^{(1)}s_{x_p}\right)^2 = \frac{1}{n-p} \sum_{k=1}^{n-p} (x_k - \quad x_p')^2 \quad \text{and}$$

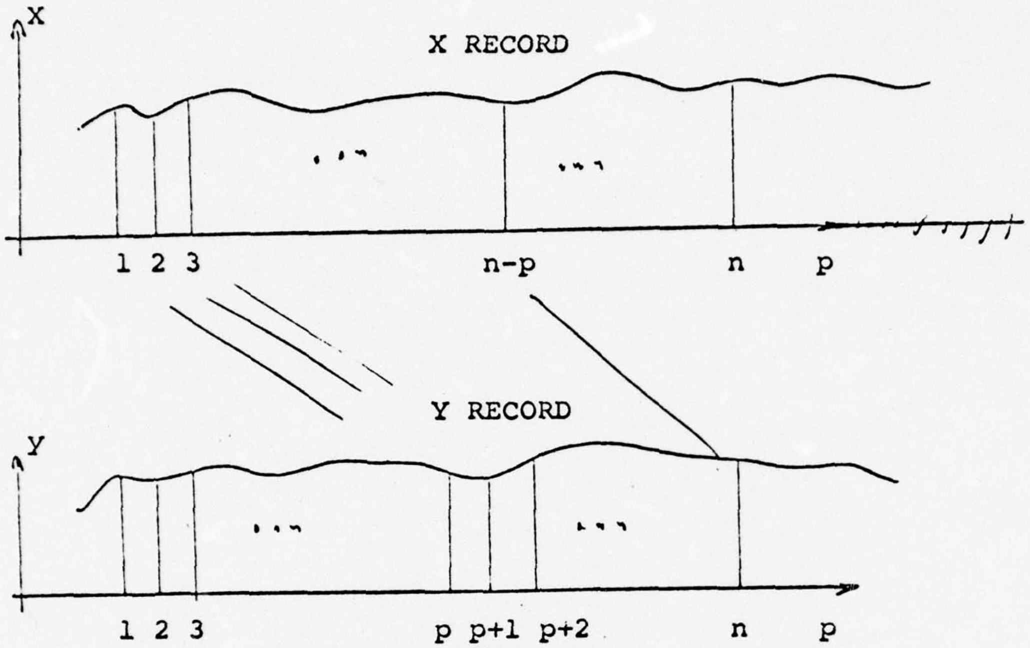


FIGURE E-3

The mean values $\mu_x = \lim_{T \to \infty} \frac{1}{2T} \int_{-T}^{T} x(t)\,dt$ and

$\mu_y = \lim_{T \to \infty} \frac{1}{2T} \int_{-T}^{T} y(t)\,dt$ are replaced by

$$\overline{{}^{(1)}x_p} = \frac{1}{n-p} \sum_{k=1}^{n-p} x_k \qquad \text{(Eq. 1)}$$

$$\sigma_y^2 \cong \left({}^{(2)}s_{y_p}\right)^2 = \frac{1}{n-p}\sum_{k=1}^{n-p}\left(y_{k+p} - \overline{{}^{(2)}y_p}\right)^2$$

Now the estimate for $R_{xy}$ $(\tau)$ becomes

$$R_{xy}(\tau) = R_{xy}(p\Delta t) \cong \frac{B_{xy}(p\Delta t)}{\left({}^{(1)}s_{x_p}\right)\left({}^{(2)}s_{y_p}\right)}$$

For any two processes x(t) and y(t), $R_{xy}$ $(\tau) = R_{yx}$ $(-\tau)$; hence, we may find $R_{xy}$ $(\tau)$ for $\tau < 0$ by calculating $R_{yx}$ $(|\tau|)$

$$R_{xy}(\tau) = R_{yx}(|\tau|) \text{ for } \tau < 0.$$

Similarly, the autocovariance and hormalized autocovariance of a process x(t) may be calculated using the same formula, where ${}^{(2)}y_p$ is replaced by ${}^{(2)}x_p$. Since $C_{xx}$ $(\tau) = C_{xx}(-\tau)$ for a real process, we need only calculate $R_{xy}$ $(p\Delta t)$ for $p \geq 0$.

## SPECTRAL DENSITY

The cross-spectral density may be defined as the fourier transform of the cross-covariance function

$$\phi_{xy}(\omega) = \int_{-\infty}^{\infty} C_{xy}(\tau) e^{-j\omega\tau} d\tau .$$

By simple substitution, this expression becomes

$$\phi_{xy}(\omega) = \int_{-\infty}^{\infty} \left[ (C_{xy}(\tau))_{REAL} \cos \omega\tau + (C_{xy}(\tau))_{IMAG} \sin \omega\tau \right] d\tau$$

$$-j \int_{-\infty}^{\infty} \left[ (C_{xy}(\tau))_{REAL} \sin \omega\tau - (C_{xy}(\tau))_{IMAG} \cos \omega\tau \right] d\tau$$

For our application, $C_{xy}(\tau)$ is real, therefore,

$$\phi_{xy}(w) = \int_{-\infty}^{\infty} C_{xy}(\tau) \cos \omega\tau \, d\tau - j \int_{-\infty}^{\infty} C_{xy}(\tau) \sin \omega\tau \, d\tau . \qquad \text{(Eq. 4)}$$

$$= a_{xy}(\omega) - j\, b_{xy}(\omega)$$

We now define $\alpha_{xy}(\tau) = \frac{1}{2}(C_{xy}(\tau) + C_{yx}(\tau))$

and $\beta_{xy}(\tau) = \frac{1}{2}(C_{xy}(\tau) - C_{yx}(\tau))$.

Then $C_{xy}(\tau) = \alpha_{xy}(\tau) + B_{xy}(\tau)$ and, therefore, $\alpha_{xy} + B_{xy}$ may be substituted for $C_{xy}$ in equation 4. Since $C_{xy}(-\tau) = C_{yx}(\tau)$, $\alpha_{xy}(\tau)$ is even and $B_{xy}(\tau)$ is odd; therefore, equation reduces to

$$\phi_{xy}(\omega) = 2\int_0^{\infty} \alpha_{xy}(\tau)\cos\omega\tau\, d\tau - j2\int_0^{\infty} \beta_{xy}(\tau)\sin\omega\tau\, d\tau .$$

Again, we approximate the integrals by finite sums as illustrated in Figure E-4, and hence,

FIGURE E-4.

$$a_{xy}(\omega) = a_{xy}(q\Delta\omega) = 2\left[\frac{\Delta t}{2}\alpha_{xy}(0) + \sum_{p=1}^{P_{MAX}-1} \alpha_{xy}(p\Delta t)\cos(\omega p\Delta t)\Delta t\right.$$

$$\left. + \frac{\Delta t}{2}\alpha_{xy}(P_{MAX}\Delta t)\cos(\omega P_{MAX}\Delta t)\right] \text{ where } \omega = q\Delta\omega. \quad \text{(Eq.5)}$$

The frequency resolution in herta denoted by $\Delta f$ is given by $\Delta f = \frac{1}{2\tau_{MAX}}$ .

Hence, $\omega \Delta t = q \Delta \omega \Delta t = q(2\pi \frac{1}{2p_{MAX} \Delta t}) \Delta t = \frac{q\pi}{p_{MAX}}$

Thus, equation 5 reduces to

$$a_{xy}(q \Delta \omega) = \Delta t \left[ \alpha_{xy}(0) + 2 \sum_{p=1}^{p_{max}-1} \alpha_{xy}(p \Delta t) \cos(\frac{pq\pi}{p_{MAX}}) \right.$$

$$\left. + \alpha_{xy}(p_{MAX} \Delta t)(-1)^q \right] .$$

Similarly, for $b_{xy}(\omega)$

$$b_{xy}(\omega) = b_{xy}(q \Delta \omega) = \Delta t \left[ 2 \sum_{p=1}^{p_{max}-1} \beta_{xy}(p \Delta t) \sin(\frac{pq\pi}{p_{MAX}}) \right] .$$

The estimates $a_{xy}(q \Delta \omega)$ and $b_{xy}(q \Delta \omega)$ are smoothed using hanning weights.

$$\hat{a}_{xy}(0) = \frac{1}{2}\left[ a_{xy}(0) + a_{xy}(\Delta \omega) \right]$$

$$\hat{a}_{xy}(q \Delta \omega) = \frac{1}{4} a_{xy}((q-1) \Delta \omega) + \frac{1}{2} a_{xy}(q \Delta \omega) + \frac{1}{4} a_{xy}((q+1) \Delta \omega)$$

for $0 < q < q_{max}$ , and

$$\hat{a}_{xy}(q_{MAX} \Delta \omega) = \frac{1}{2}\left[ a_{xy}((q_{MAX}-1) \Delta w) + a_{xy}(q_{MAX} \Delta \omega) \right.$$

The $\hat{b}_{xy}(q \Delta \omega)$ are found similarly.

The spectral density is a special case of the above. To find $\emptyset_{xx}(w)$, $C_{xy}(\tau)$ is replaced by $C_{xx}(\tau)$. Thus, $B_{xy}(\tau) = 0$, and, hence $\emptyset_{xx}(\omega) \cong a_{xx}(\omega)$. The $a_{xx}(q\Delta\omega)$ values are determined as in the cross-spectrum case.

The cross-spectral estimates are normalized with respect to the spectral densities of the individual signals

$$G_{xy}(\omega) = \frac{\phi_{xy}(\omega)}{\sqrt{\phi_{xx}(\omega)\,\phi_{yy}(\omega)}} .$$

The real and imaginary parts of the normalized cross-spectral estimates are denoted by $A_{xy}(q\Delta\omega)$ and $B_{xy}(q\Delta\omega)$ respectively, and are given by

$$A_{xy}(q\Delta\omega) = \frac{\hat{a}_{xy}(q\Delta\omega)}{\sqrt{\hat{a}_{xx}(q\Delta\omega)\,\hat{a}_{yy}(q\Delta\omega)}}$$ called "Cospectrum", and

$$B_{xy}(q\Delta\omega) = \frac{\hat{b}_{xy}(q\Delta\omega)}{\sqrt{\hat{a}_{xx}(q\Delta\omega)\,\hat{a}_{yy}(q\Delta\omega)}}$$ called "Quadrature spectrum."

Thus, $G_{xy}(q\Delta\ ) \cong A(q\Delta\omega) - jB(q\Delta\omega)$ and $G_{xy}(q\Delta\omega) = A^2(q\Delta\omega) + B^2(q\Delta\omega)$

$$\angle G_{xy}(q\Delta\omega) \cong \tan^{-1}\left[\frac{-B_{xy}(q\Delta\omega)}{A_{xy}(q\Delta\omega)}\right] .$$

# APPENDIX F

## SHIPBOARD INSPECTION REPORTS

13B026/7000 - 113

ROUTE 110 • MELVILLE, NEW YORK 11746 • 516/531-0600

June 21, 1966

Mr. J. Luistro, Code 589
Department of the Navy
David Taylor Model Basin
Washington, D. C. 20007

Subject: Measurements of Clearances Between TRG Sea Chests and Transducers Installed for PURVIS II Tests

Reference: Contract NObsr 93023

Dear Mr. Luistro:

Enclosed are the measurements taken with a feeler gage of the clearances between the rubber face of the transducer element and the sea chests.

Very truly yours,

J. Koestner

cc:
M. Baldwin
I. Cook
R. Duerr
G. Franz
J. Gilbreath

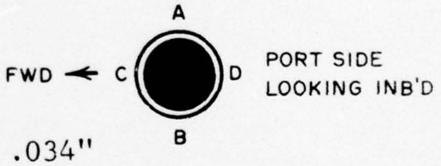
bcc:
W. Graham
W. Landauer
N. Nesenoff
R. Newman
I. Melnick
A. Raff

ONTROL DATA CORPORATION

## LOW FREQUENCY ARRAY

| ELEMENT NO. | A | B | C | D |
|---|---|---|---|---|
| LF1 | .022" | .032" | .037 | .027 |
| LF2 | .027 | .025 | .039 | .039 |
| LF3 | .027 | .025 | .037 | .037 |
| LF4 | .010 | .010 | .027 | .026 |
| LF5 | .030 | .029 | .038 | .027 |
| LF6 | .037 | .018 | .037 | .027 |
| LF7 | .037 | .037 | .035 | .037 |
| LF8 | .037 | .025 | .037 | .039 |
| LF9 | .002 | .037 | .015 | .018 |
| LF10 | .025 | .027 | .036 | .018 |
| LF11 | .026 | .027 | .036 | .018 |
| LF12 | .027 | .025 | .039 | .037 |
| LF13 | .022 | .032 | .036 | .026 |

## HIGH FREQUENCY ARRAY



| | | | | |
|---|---|---|---|---|
| HF1 | .032" | .032" | .028" | .034" |
| HF2 | .032 | .035 | .035 | .040 |
| HF3 | .035 | .032 | .032 | .037 |
| HF4 | .031 | .035 | .035 | .034 |
| HF5 | .038 | .031 | .029 | .027 |
| HF6 | .034 | .027 | .027 | .025 |
| HF7 | .027 | .030 | .023 | .021 |
| HF8 | .035 | .017 | .021 | .019 |
| HF9 | .025 | .026 | .026 | .023 |
| HF10 | .025 | .027 | .025 | .027 |
| HF11 | .025 | .027 | .015 | .012 |
| HF12 | .035 | .038 | .035 | .025 |
| HF13 | .034 | .022 | .027 | .029 |

SEA CHEST NO. 2 (GENERAL DYNAMICS)

| | A | B | C | D |
|---|---|---|---|---|
| G1 | .006" | .006" | .006" | .006" |
| G2 | .006 | .004 | .005 | .005 |
| G7 | .005 | .004 | .005 | .004 |
| G8 | .005 | .003 | .010 | .005 |
| G9 | .006 | .007 | .008 | .005 |
| G10 | .006 | .008 | .008 | .006 |

# TRIP REPORT

To: Distribution Below
From: Joseph Koestner
Date of Trip: August 1 through August 6, 1966.
Place: Boston Naval Shipyard
Subject: The inspection and removal of all hardware installed aboard the U.S.S. Hugh Purvis (DD 709) for the Purvis II Tests.
Attendees: J. Luistro, DTMB; R. Duerr, DTMB; J. Koestner, TRG; E. Doerrlamm, TRG; M. Casiolo, TRG; H. Katz, TRG; R. Steckman, TRG; A. Stora TRG-Boston; R. Giordano, TRG-Boston.

A) The hardware removed is as follows:

1. All TRG transducers (46) were removed and disassembled for shipping. They were packed two assemblies in a box. Each assembly contained a TRG element with its extension, retainer and preamplifier. This also included the accelerometer and its preamplifier if any. The connector between the element and preamplifier was taken off to remove element and put on again to facilitate the calibration of transducer. The following conditions were found upon removal.

a) There was water up to the first O'ring past the rubber face on all transducers except those in number "2" (GD) Seachest. This was due to weld distortion of those seachests installed by BNS.

b) Due to the water there were considerable salt deposits on the brass of the transducer up to the first O'ring. The rubber appeared unaffected and in good condition.

c) All transducers were washed with fresh water and their rubber faces coated with silicone grease then covered with a protective cap for handling.

d) A listing of actual locations of each element, its preamplifier and accelerometer preamplifier is attached to this report.

Contd..

2. The TRG Seachests (8) in Number 2 (GD)Seachest were removed and are being shipped with the TRG transducers. Extra covers, bolts, barrel nuts and gaskets have been included. All the remaining TRG Seachests will be scrapped.

3. All DTMB FS-13 Hydrophones (10) in the No. 1 (GD)Seachest were removed, tagged and shipped to DTMB as per R. Duerr's instructions. Attached to this report is a listing of the rubber thickness at each Hydrophone.

4. The McIntosh amplifier was removed and will be shipped back to TRG. The remaining amplifiers are DTMB's property and are being shipped as per R. Duerr's instructions.

5. The retractable and fixed struts are being removed by BNS and put into DTMB's Store at BNS to wait later disposition.

6. All Flow Flags with the exception of one were to be scrapped. The remaining one is being shipped to DTMB for analysis.

7. The fisheye cameras and dead light windows are to be shipped to DTMB.

8. The recording center air-conditioner was removed and packed. It will be put in DTMB's store at BNS.

9. The hydrophones (LC-57) in the sonar dome (T-1) and in No. 2 TRG Strut (T-4) were removed. They will be shipped with TRG transducers. Included with them will be the mount used on T-4.

B. An inspection of the hull surfaces disclosed the following conditions:

1. Devcon filler around the TRG Seachests had lifted up forming a scoop that was 1/2 inch wide by 1/4 inch high and 3/8 inches deep. This was next to the element face. In some places it had broken away leaving a 1/16 inch deep hole. This condition was predominant at H8, H9, H10 and LF4.

2. About 80% of the elements had an 18 inch circular pattern of rust that had a rough raised surface similar to weld splatter 1/8 inch high.

3. The TRG strut had a flap of pliobond cement protruding from the joint where the strut and its end-cap meet. This flap

extend 3/4 of an inch out. The paint on the bottom section of the strut was gone.

4. There was a full cover of grass on No. 1 and No. 2 (GD)Seachests. The hull had a 10% grass coverage. White lines and numbers varied in coverage from zero to 100%.

5. A light barnacle coverage existed on the aft end of TRG strut and the ships sonar dome.

6. The Sonar Dome was badly damaged on its bottom. This was previously reported.

C. All the following measurements taken are based on the ship being reasonably level in drydock. This was checked by clinometer readings on the bridge that indicated a list to port of 1/2° and the forward engine room clinometer read 1/4° (to port). A further check by sighting a plumb line down the bow indicated that the ship was sitting level. Complete measurements were not obtained due to shipyard conditions.

1. Dimension "Z" is the height above keel bottom to the lower edge of the element and dimension "Y" is the distance off the center-line to some point as dimension "Z". Angle "A" is the true angle of the transducer face off the vertical.

| Element Number | Hydrophone Serial No. | Signal Pre-Amp Serial No. | Accel. Pre-Amp. Serial No. | DIM Z | DIM Y | Angle A |
|---|---|---|---|---|---|---|
| HF 1 | P1007 | 110 | --- | -- | -- | 58° |
| 2 | P1011 | 117 | 256 | -- | -- | 57° |
| 3 | P1076 | 253 | 160 | -- | -- | 57° |
| 4 | P1036 | 121 | --- | -- | -- | 56° |
| 5 | P1027 | 146 | --- | 2'-0" | 2'-1$\frac{1}{2}$" | 55° |
| 6 | P1019 | 125 | --- | -- | -- | 55° |
| 7 | P1030 | 136 | --- | -- | -- | 54° |
| 8 | P1002 | 112 | --- | -- | -- | 53° |
| 9 | P1014 | 130 | --- | -- | -- | $52\frac{1}{2}°$ |
| 10 | P1060 | 137 | --- | -- | -- | $70\frac{1}{2}°$ |
| 11 | P1031 | 149 | --- | -- | -- | 65° |
| 12 | P1004 | 103 | --- | -- | -- | 62° |
| 13 | P1008 | 122 | --- | -- | -- | 50° |
| G 1 | P1095 | 144 | --- | -- | -- | $61\frac{1}{2}°$ |
| 2 | P1073 | 135 | 153 | -- | -- | $61\frac{1}{2}°$ |
| 3 | P1021 | 131 | 132 | -- | -- | -- |
| 4 | P1098 | 152 | --- | -- | -- | -- |
| 5 | P1020 | 141 | 151 | -- | -- | -- |
| 6 | P1042 | 145 | --- | -- | -- | -- |
| 7 | *P1045 | 156 | --- | -- | -- | $51\frac{1}{2}°$ |
| 8 | P1071 | 143 | 164 | -- | --- | 15° |
| 9 | P1079 | 155 | 140 | -- | -- | 66° |
| 10 | *P1052 | 133 | --- | -- | -- | $66\frac{1}{2}°$ |

| Element Number | Hydrophone Serial No. | Signal Pre-Amp Serial No. | Accel. Pre-Amp. Serial No. | DIM Z | DIM Y | Angle A |
|---|---|---|---|---|---|---|
| LF-1 | P1015 | 111 | 116 | 0'-10" | 2'-9½" | 24½° |
| 2 | P1034 | 259 | 258 | --- | --- | 24½° |
| 3 | P1010 | 120 | --- | --- | --- | 22° |
| 4 | P1001 | 127 | --- | --- | --- | 20½° |
| 5 | P1043 | 113 | --- | 0'-10¼" | 2'-11⅜" | 19½° |
| 6 | P1063 | 106 | --- | --- | --- | 18½° |
| 7 | P1029 | 150 | --- | --- | --- | 17½° |
| 8 | P1059 | 118 | --- | 0'-2" | 1'-2" | 17½° |
| 9 | P1068 | 142 | --- | 4'-11½" | 8'-10½" | --- |
| 10 | P1012 | 123 | --- | 3'-8½" | 7'-6" | --- |
| 11 | P1062 | 107 | --- | 2'-6½" | 6'-1" | 35° |
| 12 | P1050 | 102 | --- | 1'-6" | 4'-6¼" | 27½° |
| 13 | P1065 | 134 | --- | 0'-2⅜" | 1'-1⅝" | 18° |
| H-1 | P1075 | 105 | --- | 1'-1" | 3'-0" | 26½° |
| 2 | P1051 | 148 | --- | --- | --- | 26° |
| 3 | P1078 | 126 | --- | --- | --- | 21° |
| 4 | P1057 | 159 | --- | --- | --- | 12° |
| 5 | P1046 | 158 | --- | 0'-11" | 5'-5" | 13½° |
| 6 | P1061 | 255 | 168 | 1'-8" | 8'-8" | 21° |
| 7 | P1056 | 251 | --- | 1'-10½" | 9'-8½" | 19° |
| 8 | P1016 | 139 | --- | 1'-9" | 10'-0" | 17° |
| 9 | P1009 | 114 | 147 | 0'-6¾" | 5'-0" | 11½° |
| 10 | P1049 | 129 | --- | 0'-1" | 1'-3" | 10° |

2. Measurements of the rubber thickness at each element in the No. "1" (GD)Seachest obtained from R. Duerr (DTMB).

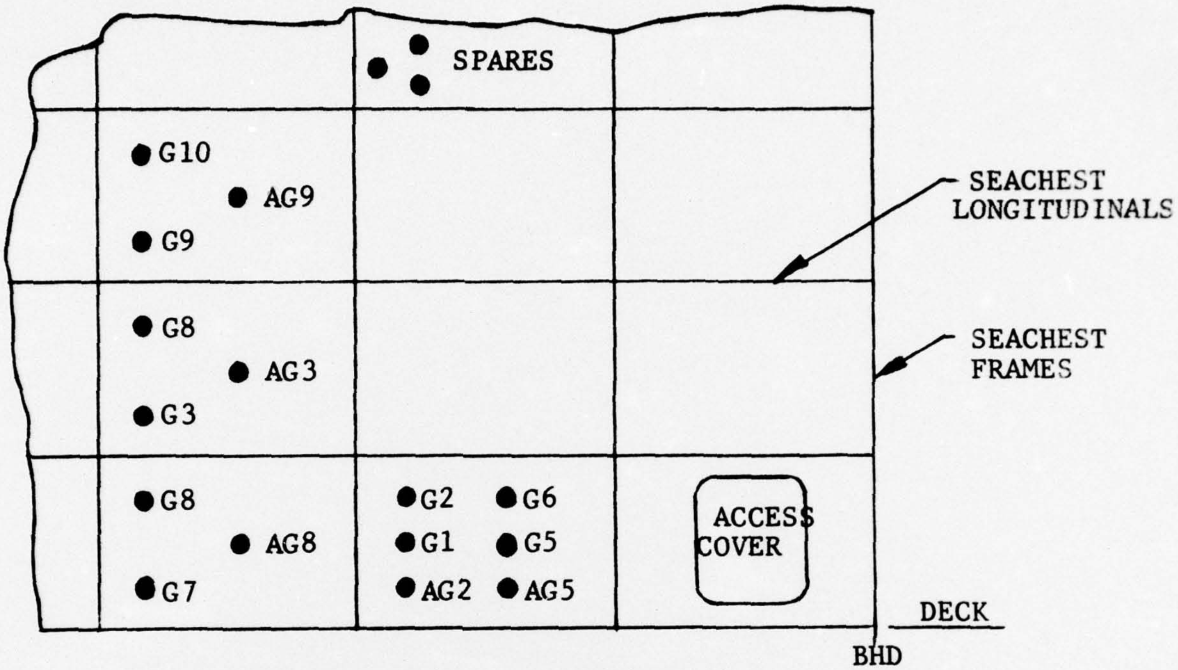
| Element No. | Nominal Thickness | Actual Thickness |
|---|---|---|
| D1 | 9/16" | 1 5/32" |
| D2 | 1 1/8" | 1 47/64" |
| D3 | 2 1/4" | 2 51/64" |
| D4 | 4 1/2" | 4 59/64" |
| D5 | 1/4" | 5/8" |
| D6 | 9/16" | 13/16" |
| D7 | 1 1/8" | 1 23/32" |
| D8 | 2 1/4" | 2 25/32" |
| D9 | 4 1/2" | 5 1/32" |
| D10 | 1/4" | 59/64" |

3. The Hydrophone (LC-57) in the sonar dome (T-1) was located 39 inches aft of leading edge of dome, 23 inches to port of center-line and 43 1/2 inches below keel bottom. The dome interface was 1 1/2 degrees off transversely.

4. The overside calibration stations measured as follows:
   a) Dim Z is the height above keel to the base plate that the lower sleeve sits on.
   b) Dim. Y is the distance off center-line of ship to the center-line of the sleeve.

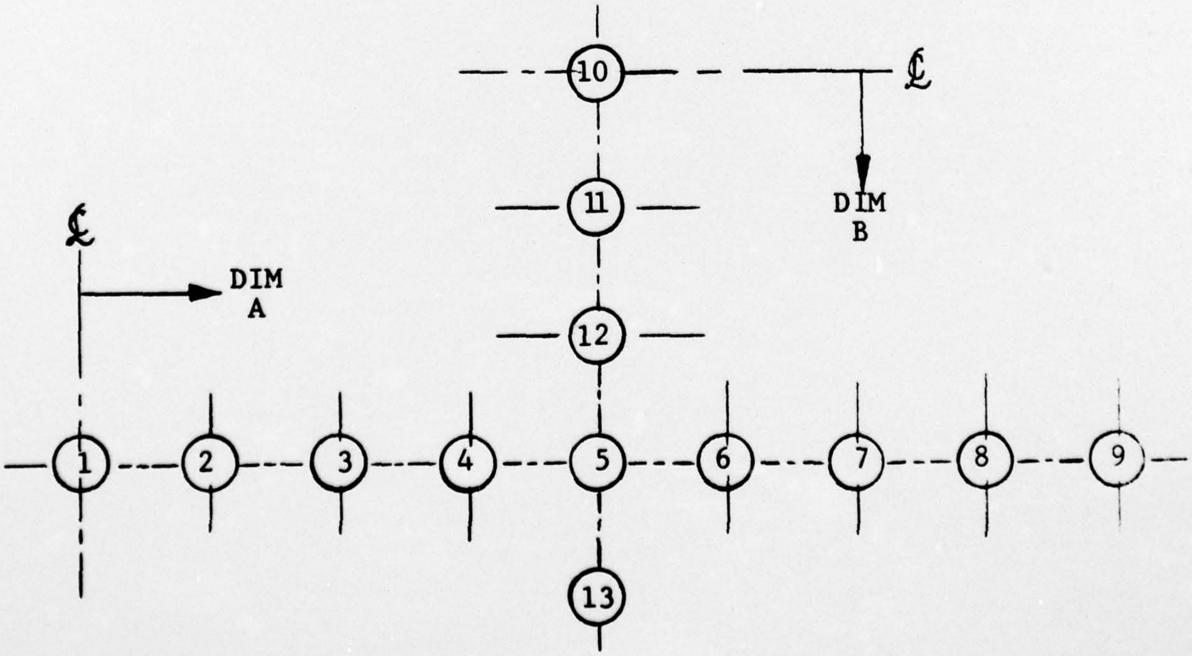
| Calibration Station No. | DIM Z | DIM Y | Distance from Frame (Approx.) |
|---|---|---|---|
| 1 | 26'-7$\frac{1}{2}$" | 11"-6" | 6" Fwd. of Fr. 18 |
| 2 | 26'-3" | 12'-10$\frac{1}{2}$" | 6" Fwd. of Fr. 23 |
| 3 | 23'-7" | 17'-6" | 10" Fwd. of Fr. 49 |
| 4 | 22'-7$\frac{1}{2}$" | 18'-2$\frac{1}{4}$" | |
| 5 | 20'-10$\frac{1}{2}$" | 19'-11" | 10" Fwd. of Fr. 81 |

5. Stuffing tube locations in No. II window



INBOARD VIEW LOOKING OUT

Distances of element from reference line, measured along hull surface:



## High Frequency Array

| ELEMENT | DIM A | DIM B |
|---|---|---|
| HF 1 | 0 (REF DIM) | |
| 2 | 0'-11$\frac{3}{4}$" | 2'-11$\frac{3}{8}$" |
| 3 | 1'-9$\frac{5}{8}$" | " " |
| 4 | 2'-8$\frac{5}{8}$" | " " |
| 5 | 3'-6$\frac{3}{4}$" | 2'-11$\frac{3}{8}$" |
| 6 | 4'-6$\frac{1}{8}$" | " " |
| 7 | 5'-4$\frac{1}{8}$" | " " |
| 8 | 6'-3$\frac{3}{8}$" | " " |
| 9 | 7'-1$\frac{1}{8}$" | " " |
| 10 | 3'-6$\frac{3}{4}$" | 0 (REF DIM) |
| 11 | " " | 1'-0" |
| 12 | " " | 1'-10$\frac{1}{4}$" |
| 13 | " " | 4'- $\frac{1}{4}$" |

## LOW FREQUENCY ARRAY

Horizontal Row Only.

| Element | DIM A |
|---|---|
| LF - 1 | 0 (REF DIM) |
| 2 | 2'-6" |
| 3 | 5'-3" |
| STRUT | 7'-9" |
| 4 | 10'-5$\frac{3}{4}$" |
| 5 | 13'-0" |
| 6 | 15'-9$\frac{1}{8}$" |
| 7 | 18'-2$\frac{3}{8}$" |
| 8 | 20'-11$\frac{3}{4}$" |

C.I.C. RETRACTABLE STRUT
3'- $\frac{1}{4}$" OFF ℄ of SHIP
STRAIGHT LINE MEASUREMENT

The following is a measurement of transmission path giving the distance from the element to transmitter.

From (T-4) to H5 = 15'-9"
" " " H6 = 11'-2"
" " " H7 = 8'-7"
" " " H8 = 13'-7"
" " " H9 = 5'-1$\frac{1}{2}$"
" " " H10 = 5'-1"

A check of the painted grid lines showed that their W.L. locations are not to print. A more extensive check could be accomplished by a three man team with aid of shipyard staging or ladders and per proper measuring tools.

JHK:aek
Joseph H. Koestner

Distribution: W. Graham, W. Landauer, J. Kotik, A. Raff, G. Sammis,
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# APPENDIX G

## REDUCTION OF FLOW NOISE BY A COVERING LAYER

We review briefly the basic points relevant to the question of noise reduction by a layer.* At a given frequency, three contributions to the noise on a large flush element (radius $R_o$, $\omega R_o/U_\infty >> \pi$) are distinguished. The first two are due directly to pressure fluctuations associated with the turbulent boundary layer (TBL). Of these, the first is a high-wave number part ($K > \omega/U_\infty$) which is the only kind that would be present if the pressure were generated by "frozen" eddies convected downstream at velocities not exceeding the ship speed ($U_\infty$). This part varies with radius as $R_o^{-3}$. Any additional pressure fluctuations due to surface roughnesses are expected also to be of this high-wavenumber character. The second is a low-wavenumber component ($K \lesssim 2\pi R_o^{-1}$); the amplitude of this component is no doubt much smaller than that of the former, but it is more heavily weighted in the average pressure on the element, since its contribution is much less reduced by area averaging. The third contribution to noise is understood to include all other sources; it is presumed to have the character of a radiated sound field (modified by interaction with the flow-bounding hull and including any sound due to compressibility of the fluid of the TBL).

Shielding the given element by a layer of depth L is expected to have the following effects on the three contributions. The first (high wavenumber) part will be reduced to negligibility provided roughly $L >> U_\infty/\omega$ and the lateral dimensions of the layer are large compared to the element diameter (and perhaps larger than the wave length $\lambda (= 2\pi c/\omega)$ of sound in the layer material. In some parameter regime, more specifically, this part is reduced

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*The explicit mathematical analysis that has been done pertains to a fluid, not a solid, layer. We expect, subject to experimental test, that an elastic solid behaves similarly provided the transverse sound velocity is of the order of the sound velocity for the fluid analog and large compared to the ship speed.

rather as though averaged, not over the element area, but over the lateral area of the layer. The second (low-wavenumber TBL) part will be reduced to an extent depending mainly on the ratios $R_o/\lambda$ and $R_o/L$. For example, if the wavenumber spectrum of the TBL pressure at frequency $\omega$ is constant* in the range in question (whence this part of the average-pressure spectrum for the flush element would vary as $R_o^{-2}$), this part for the shielded element is reduced as if averaged, not over the element area, but over an area $\pi R_e^2$, if $R_e \gtrsim R_o$, where:

$$R_e^{-2} = (\pi/\lambda)^2 + 1/8L^2$$

i.e., roughly over an area of radius equal to the smaller of three times the layer thickness or one third the sound wave length in the material; if $R_e \lesssim R_o$, however, (as becomes true at sufficiently high frequency) this part is not appreciably reduced. The third (radiative) part will not be substantially reduced for any L, except that if the material is such as to introduce an acoustic impedance mismatch with respect to the water outside, both a signal and this part of the noise will be reduced similarly (such mismatch is thus not desired).

The reductions of these contributions to the effective noise on an array (as opposed to a single element) depend also on their correlation properties and have been similarly analyzed. Some further discussion and numerical estimates for the type of array in question are contained in an appended section of a document generated at TRG in the ONR-supported flow-noise work.

For practical reasons it would be desirable that the covering layer not have to be integral across the periphery of the element face. If it is instead cut along this line, i.e., if the element has a boot (in addition to any it has for flush installation) and the adjacent hull has a separate contiguous boot

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*i.e., when averaged over wave-vector direction in the boundary, constant per unit area in two-dimensional wave-vector space.

of the same thickness, the noise reduction may well be much the same as for an integral layer, provided normal stresses are freely transmitted across the cut between boot edges. Possibly, adequate transmission of normal stress would occur even if the adjoining boots are not in contact, by virtue of the thin layer of water between them.

## REFERENCES

1. TRG Document No. 023-TM-66-17 PURVIS I Sea Trials Data Acquisition and Analysis Equipment.
2. TRG Report No. 023-TN-66-20 Data Conversion System Description.
3. TRG Report No. 023-TM-66-19 (CONFIDENTIAL) Interim Report on PURVIS I Acoustic Tests (U)
4. D. Chase, TRG-011-TN-65-8 (23rd Navy Symposium on Underwater Acoustics, Washington, D.C., 1965)