I.O.S.

WAVE MEASUREMENT FOR JAGUAR SEA TRIALS
AT OREGRUND   SWEDEN

17/18th June 1983

by

J.A.Ewing & K.G.Birch

Internal Document No. 188

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Institute of Oceanographic Sciences,
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Jaguar Sea Trials

Report on wave measurements made by the Institute of Oceanographic

Sciences, Wormley during the period 17-18 June 1983, at the request of

Burness, Corlett & Partners Ltd.

1. Introduction

The purpose of the work was to obtain estimates of the directional

wave spectrum in conjunction with sea trials of "Jaguar".

The system employed to obtain the above information was the

pitch-roll buoy of the I.O.S. The buoy, which measures 1.2 m diameter,

and which weighs approximately 70 kg, was deployed from the lifeboat

"K.A. Wallenberg". Measurements taken in the buoy were transmitted

along a buoyant cable to the lifeboat, thus enabling a continuous

monitoring of the data on the "K.A. Wallenberg".

Six measurements were made during the period 17-18 June 1983. The

results from these measurements, together with the method of analysis,

are discussed in the following sections.

2. Measurements

The pitch-roll buoy is a surface-following wave buoy which

measures the vertical acceleration of the surface together with the

pitch and roll angle of the surface using a gyroscope. Additionally, a

magnetic compass is used to transform the pitch and roll signals to

axes referred to true North-East axes. Thus, after transformation to

true North, three signals are obtained, namely the vertical

acceleration and two orthogonal components of surface slope. This

information is required in the analysis.

The sensors in the buoy were calibrated in the laboratory before

the trials and the calibrations are accurate to within $\pm 2\%$. Linearity

of sensors is better than $\pm\frac{1}{2}\%$.

Data from the buoy were digitized at 0.5 sec intervals and each

recording lasted 35 mins to allow accurate estimates of the wave

parameters. The data were stored on magnetic tape ready for analysis

in the laboratory after the trials.

During the deployment of the buoy, care was taken to ensure that

the buoyant cable to the boat was at all times slack. Furthermore,

situations where the boat might shield the waves to the buoy or reflect

waves onto the buoy were avoided by careful positioning of

"K.A. Wallenberg".

All measurements were made at a fixed station $60^\circ 8'N$, $19^\circ 4'E$.

Magnetic variation was taken as 7° East. Water depth was 100 m.

Six records were taken on 17 and 18 June 1983. Table 1 gives

details of the times of these records (all times are Swedish Summer

Time) together with visual estimates of the wave characteristics and

wind speed and direction.

Table 1

Record number	Day (June 1983)	Time at start of record	Wind speed and direction	Visual wave height and direction (from)
1	17	1427	15 m/s, 350°	$1\frac{1}{2}$ m, 350°
2	17	1605	12 m/s, 330°	$<1\frac{1}{2}$ m, 350°
3	17	1806	11 m/s, 330°	$1-1\frac{1}{2}$ m, 350°
4	18	0940	3-5 m/s, 330°	$\frac{1}{2}$ m, 350°
5	18	1504	1-2 m/s, 170°	$<\frac{1}{4}$ m, 350°
6	18	1620	<1 m/s, 320°	10 cm, 350°

3.   Theory and analysis of the pitch-roll buoy system

The method of analysis for obtaining wave directional spectra from

the pitch-roll buoy system has been described by Longuet-Higgins,

Cartwright and Smith (1963). Let the subscript 1 denote the series of

vertical acceleration (in units of 'g'). And let subscripts 2 and 3

denote the two components of surface slope in the North and East directions respectively. (The pitch, roll and compass channels are used to derive the components of surface slope). Then, it can be shown that the six cross-spectra derived from this system are given by

$$C_{11}(f) = \int_O^{2\pi} (2\pi f)^4 F(f,\theta) d\theta,$$

$$C_{22}(f) = \int_O^{2\pi} k^2 \cos^2\theta \, F(f,\theta) d\theta,$$

$$C_{33}(f) = \int_O^{2\pi} k^2 \sin^2\theta \, F(f,\theta) d\theta,$$

$$Q_{12}(f) = \int_O^{2\pi} k(2\pi f)^2 \cos\theta \, F(f,\theta) d\theta,$$

$$Q_{13}(f) = \int_O^{2\pi} k(2\pi f)^2 \sin\theta \, F(f,\theta) d\theta,$$

$$C_{23}(f) = \int_O^{2\pi} k^2 \cos\theta \, F(f,\theta) d\theta,$$

where C_{ij} and Q_{ij} are co- and quad spectra of series i with j respectively. $F(f,\theta)$ is the directional wave spectrum with respect to frequency f and direction of propagation θ. k is the wave number. Only five of the cross-spectra are independent. This allows estimation of the five Fourier coefficients in the expansion of $F(f,\theta)$, namely,

$$a_n + ib_n = \frac{1}{\pi} \int_O^{2\pi} e^{in\theta} F(f,\theta) d\theta \quad : \quad n = 0,1,2$$

In the calculations, it is convenient to compute the normalized angular harmonics $A_1 = a_1/a_O$ etc. a_O is the one-dimensional spectrum obtained by integrating $F(f,\theta)$ over all directions. Thus,

$$A_1 = \frac{Q_{12}}{\sqrt{[C_{11}(C_{22} + C_{33})]}} \qquad B_1 = \frac{Q_{13}}{\sqrt{[C_{11}(C_{22} + C_{33})]}}$$

$$A_2 = \frac{C_{22} - C_{33}}{C_{22} + C_{33}} \qquad B_2 = \frac{2C_{23}}{C_{22} + C_{33}}$$

In the above, use is made of the relation

$$\sqrt{\frac{C_{11}}{C_{22} + C_{33}}} = \frac{(2\pi f)^2}{gk} = \tanh kh. \tag{1}$$

Equation (1) is, in effect, the dispersion relation for waves of small amplitude in water of depth h. It provides a check on the correct functioning of the system and on the analysis. This normalization of the angular harmonics removes the dependence on the wave number k which occurs in the derivation of the cross-spectra.

The cross-spectral analysis of the vertical acceleration and two components of surface slope were made using the Fast Fourier Transform (FFT). Each signal of length 2000 s was digitized at 0.5 s interval and transformed using the FFT. The resulting cross-spectra were then averaged over 20 successive harmonics to produce smoothed cross-spectra defined at 0.01 Hz interval with 40 degrees of freedom. The wave height spectrum was obtained by dividing the acceleration spectrum by (frequency)^4 before smoothing over successive harmonics. The above procedure was adopted for records 3-6.

For records 1 and 2 it was found that the accelerometer signals occasionally went off scale. This was subsequently found to be due to condensation in the instrument compartment. Erroneous parts of records 1 and 2 were readily identified and by-passed using a computer program which was based on an ensemble-averaging scheme using sections of length 128 sec. The results for records 1 and 2 therefore have a resolution of 1/128 Hz with degrees of freedom of 26 and 22 respectively.

If we assume a unimodal directional distribution of the form

$$\cos^{2s}\tfrac{1}{2}(\theta - \overline{\theta}) \tag{2}$$

then a number of statistical parameters may be derived (Cartwright, 1963).

These parameters, which are displayed in the computer print-out, are:-

(a) the mean wave direction θ_1 (= TH1) from the first-order angular harmonics (direction <u>towards</u> which the waves are travelling),

(b) the mean wave direction θ_{12} (= TH12) from the second-order angular harmonics (θ_{12} is ambiguous to 180°). Direction <u>towards</u> which the waves are travelling.

(c) spread parameters S_1 (= SP1) and S_2 (=SP2) from the first and second order angular harmonics.

(d) spread parameter θ_2 (=TH2) which for a narrow directional distribution, is equal to the root-mean-square angular spread.

$$(e) \quad \text{Ratio} = \frac{1}{\tanh\ kh}\ \left[\frac{C_{11}}{C_{22} + C_{33}}\right]^{\frac{1}{2}}.$$

From (1), the expected value of RATIO is thus unity.

4. Results

The main results from the analysis are contained in the computer listings at the end of this report. The print-out gives the one-dimensional wave spectrum, E(f), the angular harmonics A_n, B_n and statistical parameters which may be used for interpreting the results. We suggest an appropriate directional distribution function of the form (2) may be used with s = $\frac{1}{2}(s_1 + s_2)$ and $\bar{\theta} = \theta_1$.

Table 2 sets out some of the reduced statistics obtained from the analysis of the six wave buoy records. The significant wave height was defined as 4 x(variance)$^{\frac{1}{2}}$ over the range of frequencies 0.09 Hz to 0.50 Hz. Mean zero-crossing period was obtained from evaluating the second moment of the spectrum over the same range of frequencies.

Table 2

Record number	Sig. wave height (m)	Mean zero-crossing period (sec)	Spectral peak period (sec)	Direction of propagation at spectral peak period
1	0.97	5.1	8.0	186°
2	0.98	5.5	7.5	196°
3	0.76	5.1	8.0	197°
4	0.45	4.5	5.4	200°
5	0.21	3.7	4.7	195°
6	0.16	3.7	4.4	197°

Statistical errors associated with the analysis of these data are summarized in Table 3; the standard deviation of the parameters were obtained using the work of Long (1980).

Table 3

Standard deviation of

Record number	Sig. wave ht. (m)	θ_1 at spectral peak (deg)	s_1, s_2
1	)	3	35% of s
2	)	3	38% of s
3	) 3% of sig.	3	
4	) wave ht.	3	
5	)	3	30% of s
6	)	3	

Institute of Oceanographic
Sciences, Wormley,
Surrey, England,
9th August 1983.

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Cartwright, D.E. "The use of directional spectra in studying the output of a wave recorder on a moving ship". In Ocean Wave Spectra, Prentice-Hall, 203-218, 1963.

Long, R.B. "The statistical evaluation of directional spectrum estimates derived from pitch/roll buoy data". J. Phys. Oceanogr., 9, 373-381, 1979.

Longuet-Higgins, M.S., D.E. Cartwright and N.D. Smith. "Observations of the directional spectrum of sea waves using the motions of a floating buoy". In Ocean Wave Spectra, Prentice-Hall, 111-136, 1963.

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                          WALLENBERG              IOS PITCH-ROLL BUOY RECORD NO.  W1
        FREQ      E            A1          B1          A2          B2          RATIO       TH1  TH12  TH2   SP1  SP2
        HZ      M*M/HZ                                                                     DEG  DEG   DEG

       0.09375  0.4059E-01  -0.2917E 00  -0.1480E 00   0.1860E 00   0.3513E 00   0.3516E 00   207.  31.  66.   0.5  4.0
       0.10156  0.1430E 00  -0.1918E 00   0.6684E-01   0.3841E 00  -0.1597E 00   0.6311E 00   161. 349.  72.   0.3  4.2
       0.10938  0.4901E 00  -0.7656E 00  -0.7907E-01   0.7723E 00   0.1043E 00   0.8271E 00   186.   4.  39.   3.3 15.6
       0.11719  0.8788E 00  -0.9192E 00  -0.9540E-01   0.8595E 00   0.2030E 00   0.8232F 00   186.   7.  22.  12.2 31.7
       0.12500  0.8914E 00  -0.9103E 00  -0.9154E-01   0.8269E 00   0.2162E 00   0.8087E 00   186.   7.  24.  10.7 25.0
       0.13281  0.7028E 00  -0.8487E 00  -0.1609E 00   0.7133E 00   0.3711E 00   0.8671E 00   191.  14.  30.   6.4 17.9
       0.14063  0.5459E 00  -0.8551E 00  -0.2418E 00   0.6451E 00   0.4888E 00   0.8567E 00   196.  19.  27.   8.0 18.4
       0.14844  0.4769E 00  -0.8167E 00  -0.2949E 00   0.5011E 00   0.4390E 00   0.9548E 00   200.  19.  29.   6.6 11.3
       0.15625  0.2038E 00  -0.7070E 00  -0.2685E 00   0.3843E 00   0.3620E 00   0.9899E 00   201.  22.  40.   3.1  5.9
       0.16406  0.1610E 00  -0.8381E 00  -0.2705E-01   0.7088E 00   0.4417E-01   0.8287E 00   182.   2.  33.   5.2 11.2
       0.17188  0.2006E 00  -0.8534E 00  -0.9110E-01   0.6763E 00   0.1438E 00   0.8812E 00   186.   6.  31.   6.1 10.4
       0.17969  0.2690E 00  -0.8810E 00  -0.2565E 00   0.6915E 00   0.4146E 00   0.8778E 00   196.  15.  23.  11.1 18.1
       0.18750  0.1117E 00  -0.7702E 00  -0.2801E 00   0.4431E 00   0.3678E 00   0.7582E 00   200.  20.  34.   4.6  6.8
       0.19531  0.1402E 00  -0.8129E 00  -0.1774E 00   0.5775E 00   0.2757E 00   0.8093E 00   192.  13.  33.   5.0  8.5
       0.20313  0.1404E 00  -0.8114E 00  -0.1978E 00   0.5820E 00   0.3205E 00   0.8162E 00   194.  15.  33.   5.1  9.4
       0.21094  0.1523E 00  -0.8808E 00  -0.2030E 00   0.6843E 00   0.4082E 00   0.8426E 00   193.  15.  25.   9.4 17.1
       0.21875  0.9490E-01  -0.8102E 00  -0.3579E-01   0.4739E 00   0.1188E 00   0.8257E 00   183.   7.  35.   4.3  5.2
       0.22656  0.1464E 00  -0.8594E 00   0.2156E-01   0.6152E 00  -0.2049E-01   0.8137E 00   179. 359.  30.   6.1  7.8
       0.23438  0.1551E 00  -0.8728E 00   0.8021E-02   0.5937E 00  -0.1105E-01   0.7577E 00   179. 359.  29.   6.9  7.3
       0.24219  0.1446E 00  -0.8809E 00   0.8894E-01   0.6412E 00  -0.1765E-01   0.8233E 00   174. 352.  27.   7.7  9.4
       0.25000  0.1208E 00  -0.8961E 00   0.5845E-01   0.7218E 00  -0.8253E-01   0.8206E 00   176. 357.  26.   8.8 12.1
       0.25781  0.1210E 00  -0.8639E 00   0.1943E 00   0.6281E 00  -0.3392E 00   0.8798E 00   167. 346.  27.   7.7 11.4
       0.26563  0.1193E 00  -0.8486E 00   0.1504E 00   0.5973E 00  -0.1876E 00   0.7879E 00   170. 351.  30.   6.2  8.1
       0.27344  0.9100E-01  -0.8415E 00   0.1480E 00   0.5524E 00  -0.1362E 00   0.7410E 00   170. 353.  31.   5.9  6.7
       0.28125  0.1001E 00  -0.8220E 00   0.1548E 00   0.5170E 00  -0.1971E 00   0.7897E 00   169. 350.  33.   5.1  6.3
       0.28906  0.1740E 00  -0.8805E 00   0.2080E 00   0.6685E 00  -0.3597E 00   0.8600E 00   167. 346.  25.   9.5 14.1
       0.29688  0.1404E 00  -0.8234E 00   0.2352E 00   0.4632E 00  -0.3967E 00   0.8503E 00   164. 340.  31.   6.0  7.7
       0.30469  0.9076E-01  -0.7844E 00   0.2593E 00   0.3791E 00  -0.3359E 00   0.8063E 00   162. 339.  34.   4.8  5.5
       0.31250  0.6999E-01  -0.7997E 00   0.1432E 00   0.4587E 00  -0.1806E 00   0.8613E 00   170. 349.  35.   4.3  5.3
       0.32031  0.7652E-01  -0.8025E 00   0.2215E 00   0.4560E 00  -0.2625E 00   0.8032E 00   165. 345.  33.   5.0  5.8
       0.32813  0.5056E-01  -0.7444E 00   0.2282E 00   0.2436E 00  -0.2985E 00   0.8084E 00   163. 335.  38.   3.5  3.8
       0.33594  0.4092E-01  -0.7663E 00   0.3055E 00   0.3896E 00  -0.4106E 00   0.8581E 00   158. 337.  34.   4.7  6.6
       0.34375  0.3485E-01  -0.6254E 00   0.3382E 00   0.6320E-01  -0.3449E 00   0.7289E 00   152. 320.  44.   2.5  3.5
       0.35156  0.1940E-01  -0.4728E 00   0.3020E 00  -0.9041E-01  -0.7345E-01   0.6326E 00   147. 290.  54.   1.3  1.7
       0.35938  0.1688E-01  -0.5621E 00   0.1616E 00   0.1633E 00  -0.1661E 00   0.6393E 00   164. 337.  52.   1.4  2.5
       0.36719  0.2347E-01  -0.6372E 00   0.2538E 00   0.1105E 00  -0.5235E 00   0.8343E 00   158. 321.  45.   2.2  6.0
       0.37500  0.3002E-01  -0.7000E 00   0.2665E 00   0.2202E 00  -0.3282E 00   0.9032E 00   159. 332.  41.   3.0  3.9
       0.38281  0.2241E-01  -0.5862E 00   0.2091E 00   0.9499E-01  -0.1312E 00   0.8257E 00   160. 333.  50.   1.6  2.0
       0.39063  0.1273E-01  -0.6122E 00   0.6908E-01   0.1313E 00   0.1153E 00   0.6858E 00   174.  21.  50.   1.6  2.1
       0.39844  0.1103E-01  -0.6778E 00   0.1391E 00   0.2682E 00  -0.4426E-01   0.7501E 00   168. 355.  45.   2.2  2.8
       0.40625  0.1926E-01  -0.6949E 00   0.3042E 00   0.2132E 00  -0.3429E 00   0.7492E 00   156. 331.  40.   3.1  4.0
       0.41406  0.1536E-01  -0.6542E 00   0.3497E 00   0.9799E-01  -0.3710E 00   0.7360E 00   151. 322.  43.   2.6  3.8
       0.42188  0.1977E-01  -0.7485E 00   0.2616E 00   0.3320E 00  -0.3105E 00   0.7965E 00   161. 338.  37.   3.8  4.7
       0.42969  0.1725E-01  -0.8553E 00   0.1454E 00   0.5789E 00  -0.2150E 00   0.8033E 00   170. 350.  32.   5.6  7.9
       0.43750  0.9851E-02  -0.6537E 00   0.2210E 00   0.2314E 00  -0.2145E 00   0.8455E 00   161. 339.  45.   2.2  3.1
       0.44531  0.6129E-02  -0.4613E 00   0.2986E 00   0.8202E-01  -0.1512E 00   0.7124E 00   147. 329.  54.   1.2  2.0
       0.45313  0.6365E-02  -0.6233E 00   0.6576E-01   0.2798E 00   0.1338E 00   0.5917E 00   174.  13.  50.   1.7  3.1
       0.46094  0.9460E-02  -0.5787E 00   0.2096E 00   0.1122E 00  -0.8432E-01   0.8701E 00   160. 342.  50.   1.6  1.8
       0.46875  0.1184E-01  -0.6658E 00   0.2386E 00   0.3141E 00  -0.3623E 00   0.1030E 01   160. 335.  44.   2.4  5.0
       0.47656  0.7729E-02  -0.6050E 00   0.2271E 00   0.3330E 00  -0.1742E 00   0.9069E 00   159. 346.  48.   1.8  3.7
       0.48438  0.3636E-02  -0.3798E 00   0.1986E 00   0.1741E-01   0.1117E 00   0.7056E 00   152.  41.  61.   0.7  1.7
       0.49219  0.2627E-02  -0.4322E 00  -0.3852E-01   0.5266E-01   0.3448E 00   0.5391E 00   185.  41.  61.   0.8  3.5
       0.50000  0.6156E-02  -0.6888E 00  -0.4526E-01   0.4123E 00   0.8919E-01   0.8172E 00   184.   6.  45.   2.2  4.3
```

FREQ HZ	E M*M/HZ	A1	B1	A2	B2	RATIO	TH1 DEG	TH12 DEG	TH2 DEG	SP1	SP2
0.09375	0.1505E 00	-0.2496E 00	-0.2350E 00	0.1930E 00	0.7743E-01	0.6815E 00	223.	11.	66.	0.5	2.3
0.10156	0.1743E 00	-0.3676E 00	-0.2308E 00	0.3614E 00	0.3616E 00	0.6633E 00	212.	23.	61.	0.8	5.6
0.10938	0.4077E 00	-0.7419E 00	-0.2276E 00	0.6719E 00	0.3680E 00	0.7399E 00	197.	14.	38.	3.5	14.6
0.11719	0.9443E 00	-0.8490E 00	-0.2555E 00	0.6450E 00	0.3950E 00	0.8252E 00	197.	16.	27.	7.8	13.9
0.12500	0.1039E 01	-0.8847E 00	-0.2642E 00	0.6884E 00	0.4052E 00	0.8012E 00	197.	15.	22.	12.0	17.3
0.13281	0.1069E 01	-0.8983E 00	-0.2601E 00	0.7317E 00	0.4578E 00	0.8481E 00	196.	16.	21.	14.4	26.7
0.14063	0.7144E 00	-0.8450E 00	-0.2918E 00	0.6130E 00	0.5820E 00	0.8954E 00	199.	22.	26.	8.4	23.3
0.14844	0.4462E 00	-0.8086E 00	-0.2113E 00	0.6275E 00	0.4436E 00	0.8070E 00	195.	18.	33.	5.1	14.7
0.15625	0.3242E 00	-0.8012E 00	-0.2132E 00	0.6223E 00	0.3654E 00	0.8384E 00	195.	15.	33.	4.9	11.8
0.16406	0.3538E 00	-0.8480E 00	-0.2929E 00	0.6592E 00	0.5102E 00	0.7991E 00	199.	19.	26.	8.7	22.0
0.17188	0.1364E 00	-0.7652E 00	-0.1930E 00	0.5401E 00	0.4204E 00	0.7263E 00	194.	19.	37.	3.7	10.1
0.17969	0.4138E-01	-0.5729E 00	0.8290E-01	0.4087E 00	0.1225E-01	0.6315E 00	172.	1.	53.	1.4	4.1
0.18750	0.8545E-01	-0.8162E 00	-0.1522E 00	0.6048E 00	0.3204E 00	0.7048E 00	191.	14.	33.	4.9	10.1
0.19531	0.9031E-01	-0.8357E 00	-0.1501E 00	0.5365E 00	0.2510E 00	0.7556E 00	190.	13.	31.	5.6	7.2
0.20313	0.9876E-01	-0.8494E 00	-0.1754E 00	0.5783E 00	0.2510E 00	0.7557E 00	192.	12.	30.	6.5	8.2
0.21094	0.1417E 00	-0.8725E 00	-0.1368E 00	0.6482E 00	0.1737E 00	0.7602E 00	189.	7.	28.	7.6	9.6
0.21875	0.1683E 00	-0.9026E 00	-0.1770E 00	0.7362E 00	0.3119E 00	0.7903E 00	191.	11.	23.	11.5	17.4
0.22656	0.8222E-01	-0.8293E 00	-0.7592E-01	0.5576E 00	0.1590E 00	0.7103E 00	185.	8.	33.	5.0	6.9
0.23438	0.9414E-01	-0.8765E 00	-0.1967E-01	0.6374E 00	0.8467E-01	0.7266E 00	181.	4.	28.	7.1	8.6
0.24219	0.7954E-01	-0.8826E 00	-0.1380E 00	0.6950E 00	0.2377E 00	0.7525E 00	189.	9.	26.	8.4	12.5
0.25000	0.9943E-01	-0.9240E 00	-0.1102E 00	0.8251E 00	0.1518E 00	0.7482E 00	187.	5.	21.	13.4	22.3
0.25781	0.9426E-01	-0.9112E 00	-0.1202E 00	0.7892E 00	0.1652E 00	0.7594E 00	188.	6.	23.	11.4	18.1
0.26563	0.7286E-01	-0.8897E 00	-0.1741E 00	0.7243E 00	0.2666E 00	0.8131E 00	191.	10.	25.	9.7	15.0
0.27344	0.8143E-01	-0.8822E 00	0.2564E-01	0.6306E 00	-0.7006E-01	0.7612E 00	178.	357.	28.	7.5	8.4
0.28125	0.7344E-01	-0.8912E 00	0.6682E-01	0.6844E 00	-0.1498E 00	0.7486E 00	176.	354.	26.	8.4	10.8
0.28906	0.4571E-01	-0.8755E 00	0.3509E-01	0.7642E 00	-0.7154E-01	0.8157E 00	178.	357.	29.	7.1	14.7
0.29688	0.5224E-01	-0.8873E 00	-0.7875E-01	0.8303E 00	0.1509E 00	0.8126E 00	185.	5.	27.	8.2	23.1
0.30469	0.5791E-01	-0.8798E 00	-0.6722E-01	0.7567E 00	0.4709E-01	0.8673E 00	186.	2.	28.	7.6	14.0
0.31250	0.4484E-01	-0.8425E 00	0.5963E-01	0.5840E 00	-0.2163E 00	0.8097E 00	176.	350.	32.	5.4	8.0
0.32031	0.2606E-01	-0.7953E 00	-0.2894E-01	0.4305E 00	-0.8745E-01	0.8126E 00	182.	354.	37.	3.9	4.5
0.32813	0.2814E-01	-0.8095E 00	0.5934E-01	0.5268E 00	-0.2564E 00	0.7318E 00	176.	347.	35.	4.3	7.1
0.33594	0.4311E-01	-0.8564E 00	0.6311E-01	0.6480E 00	-0.1961E 00	0.7727E 00	176.	352.	30.	6.1	9.8
0.34375	0.3939E-01	-0.8341E 00	-0.5830E-01	0.6198E 00	0.8002E-01	0.8269E 00	184.	4.	33.	5.1	8.1
0.35156	0.3603E-01	-0.8361E 00	0.8264E-01	0.5854E 00	-0.1132E 00	0.8139E 00	174.	355.	32.	5.3	7.3
0.35938	0.2638E-01	-0.7329E 00	0.1360E 00	0.3013E 00	-0.2224E 00	0.7761E 00	169.	342.	41.	2.9	3.7
0.36719	0.2275E-01	-0.7742E 00	0.1635E 00	0.4666E 00	-0.2890E 00	0.8419E 00	168.	344.	37.	3.8	6.3
0.37500	0.2310E-01	-0.7650E 00	0.1082E 00	0.4427E 00	-0.1170E 00	0.8445E 00	172.	353.	39.	3.4	4.7
0.38281	0.1724E-01	-0.8203E 00	-0.8488E-01	0.7222E 00	0.1071E 00	0.7753E 00	186.	4.	34.	4.7	12.3
0.39063	0.1655E-01	-0.6823E 00	0.4553E-01	0.4087E 00	-0.1591E-01	0.8143E 00	176.	359.	46.	2.2	4.1
0.39844	0.1671E-01	-0.7074E 00	-0.5938E-01	0.4188E 00	0.1472E 00	0.9426E 00	185.	10.	44.	2.4	4.5
0.40625	0.1429E-01	-0.6797E 00	0.1262E 00	0.4031E 00	-0.2009E 00	0.8654E 00	169.	347.	45.	2.2	4.6
0.41406	0.1261E-01	-0.7300E 00	0.8460E-01	0.5475E 00	0.1007E-01	0.8229E 00	173.	1.	42.	2.8	6.2
0.42188	0.1533E-01	-0.6726E 00	-0.2281E-01	0.3849E 00	0.1313E 00	0.9105E 00	182.	9.	46.	2.1	4.1
0.42969	0.1191E-01	-0.7288E 00	0.2821E-01	0.3947E 00	-0.1977E 00	0.8965E 00	178.	347.	42.	2.7	4.5
0.43750	0.8520E-02	-0.8063E 00	-0.1517E 00	0.5780E 00	0.2014E 00	0.8481E 00	191.	10.	34.	4.6	7.7
0.44531	0.1045E-01	-0.7214E 00	-0.2308E-01	0.3177E 00	0.2099E 00	0.7626E 00	182.	17.	43.	2.6	3.8
0.45313	0.6728E-02	-0.6509E 00	0.4605E-01	0.2251E 00	0.3273E 00	0.6366E 00	176.	28.	49.	1.7	4.0
0.46094	0.1121E-01	-0.7604E 00	0.1624E 00	0.4891E 00	-0.8292E-01	0.7563E 00	168.	355.	38.	3.5	5.3
0.46875	0.1081E-01	-0.8093E 00	0.1308E 00	0.5736E 00	-0.2176E 00	0.8388E 00	171.	350.	34.	4.5	7.8
0.47656	0.1188E-01	-0.7842E 00	0.2100E 00	0.5223E 00	-0.2372E 00	0.9232E 00	165.	348.	35.	4.3	6.8
0.48438	0.9165E-02	-0.7546E 00	0.2473E 00	0.4680E 00	-0.2892E 00	0.8762E 00	162.	344.	37.	3.9	6.3
0.49219	0.6064E-02	-0.7161E 00	0.3571E 00	0.3745E 00	-0.5211E 00	0.8614E 00	153.	333.	36.	4.0	8.6
0.50000	0.5717E-02	-0.6598E 00	0.3997E 00	0.1184E 00	-0.4183E 00	0.7695E 00	149.	323.	39.	3.4	4.4

FREQ HZ	E M*M/HZ	A1	B1	A2	B2	RATIO	TH1 DEG	TH12 DEG	TH2 DEG	SP1	SP2
0.09525	0.5174E-01	-0.2402E 00	-0.3285E 00	-0.2307E 00	0.3876E 00	0.6588E 00	234.	60.	62.	0.7	4.6
0.10525	0.1126E 00	-0.6658E 00	-0.2978E 00	0.3436E 00	0.5261E 00	0.7561E 00	204.	28.	42.	2.7	8.2
0.11525	0.4005E 00	-0.8709E 00	-0.1941E 00	0.6545E 00	0.3436E 00	0.7762E 00	193.	14.	27.	8.3	12.8
0.12525	0.6594E 00	-0.8608E 00	-0.2710E 00	0.6729E 00	0.4534E 00	0.9380E 00	197.	17.	23.	11.8	18.7
0.13525	0.3830E 00	-0.8234E 00	-0.2061E 00	0.5915E 00	0.3591E 00	0.9131E 00	194.	16.	32.	5.6	10.4
0.14525	0.3741E 00	-0.8372E 00	-0.1900E 00	0.7052E 00	0.2554E 00	0.8721E 00	193.	10.	30.	6.1	13.5
0.15525	0.2136E 00	-0.8224E 00	-0.2445E 00	0.6026E 00	0.3602E 00	0.8004E 00	197.	15.	31.	6.0	10.9
0.16525	0.1005E 00	-0.7851E 00	-0.1970E 00	0.5677E 00	0.2977E 00	0.7911E 00	194.	14.	35.	4.2	8.6
0.17525	0.9724E-01	-0.8135E 00	-0.1024E 00	0.6053E 00	0.1556E 00	0.7767E 00	187.	7.	34.	4.6	8.1
0.18525	0.1015E 00	-0.8408E 00	-0.2046E 00	0.6310E 00	0.3140E 00	0.8538E 00	194.	13.	30.	6.4	11.0
0.19525	0.8737E-01	-0.8350E 00	-0.2517E 00	0.6028E 00	0.4502E 00	0.7871E 00	197.	18.	29.	6.8	13.6
0.20525	0.1042E 00	-0.8455E 00	-0.2358E 00	0.6975E 00	0.3131E 00	0.8344E 00	196.	12.	28.	7.2	14.4
0.21525	0.9393E-01	-0.7892E 00	-0.2858E 00	0.5467E 00	0.4652E 00	0.8772E 00	200.	20.	32.	5.2	11.6
0.22525	0.7032E-01	-0.8280E 00	-0.2502E 00	0.5863E 00	0.3815E 00	0.7834E 00	197.	17.	30.	6.4	10.7
0.23525	0.6474E-01	-0.8134E 00	-0.2785E 00	0.5934E 00	0.3962E 00	0.7943E 00	199.	17.	30.	6.1	11.4
0.24525	0.8363E-01	-0.8247E 00	-0.1812E 00	0.6551E 00	0.3259E 00	0.8625E 00	192.	14.	32.	5.4	11.4
0.25525	0.6178E-01	-0.8261E 00	-0.2064E 00	0.6802E 00	0.3492E 00	0.8573E 00	194.	14.	31.	5.7	14.4
0.26525	0.5761E-01	-0.7971E 00	-0.1095E 00	0.7244E 00	0.2301E 00	0.8908E 00	188.	9.	36.	4.1	14.1
0.27525	0.6144E-01	-0.7605E 00	-0.4284E-01	0.6136E 00	0.8680E-01	0.9869E 00	183.	4.	40.	3.2	7.9
0.28525	0.4560E-01	-0.7703E 00	-0.1242E 00	0.6862E 00	0.3525E 00	0.7069E 00	189.	14.	38.	3.6	15.0
0.29525	0.4981E-01	-0.6543E 00	-0.1153E 00	0.5582E 00	0.1383E 00	0.8907E 00	190.	7.	47.	2.0	6.8
0.30525	0.3432E-01	-0.7141E 00	0.1520E-01	0.5465E 00	0.6863E-01	0.9039E 00	179.	4.	43.	2.5	6.3
0.31525	0.3169E-01	-0.7375E 00	-0.8513E-01	0.5558E 00	0.5168E-01	0.7875E 00	187.	3.	41.	2.9	6.4
0.32525	0.2036E-01	-0.7439E 00	-0.2655E-01	0.4771E 00	0.5137E-01	0.8312E 00	182.	3.	41.	2.9	5.1
0.33525	0.2179E-01	-0.7043E 00	-0.1332E 00	0.4268E 00	0.2294E 00	0.9676E 00	191.	14.	43.	2.5	5.1
0.34525	0.2158E-01	-0.7174E 00	0.6528E-01	0.4157E 00	-0.9399E-01	0.8129E 00	175.	354.	43.	2.6	4.3
0.35525	0.3031E-01	-0.8132E 00	0.5739E-01	0.6859E 00	-0.5762E-01	0.9533E 00	176.	358.	35.	4.4	10.3
0.36525	0.2141E-01	-0.7441E 00	-0.4841E-01	0.4383E 00	0.2536E-01	0.8694E 00	184.	2.	41.	2.9	4.5
0.37525	0.1691E-01	-0.7568E 00	-0.1765E-01	0.4554E 00	0.4917E-01	0.8997E 00	181.	3.	40.	3.1	4.7
0.38525	0.1772E-01	-0.6882E 00	0.1644E 00	0.3738E 00	-0.2405E 00	0.1037E 01	167.	344.	44.	2.4	4.6
0.39525	0.9047E-02	-0.7500E 00	0.4526E-01	0.6054E 00	-0.1411E 00	0.6961E 00	177.	353.	40.	3.0	8.0
0.40525	0.1792E-01	-0.6850E 00	0.8641E-01	0.2583E 00	-0.1673E 00	0.8750E 00	173.	344.	45.	2.2	3.1
0.41525	0.1475E-01	-0.7252E 00	0.2174E 00	0.3896E 00	-0.4012E 00	0.8599E 00	163.	337.	40.	3.1	6.5
0.42525	0.1542E-01	-0.6135E 00	0.6605E-01	0.2593E 00	-0.8591E-01	0.9145E 00	174.	351.	50.	1.6	2.8
0.43525	0.1146E-01	-0.7231E 00	0.1997E 00	0.3452E 00	-0.2353E 00	0.9394E 00	165.	343.	41.	3.0	4.2
0.44525	0.6525E-02	-0.7067E 00	0.1066E 00	0.5287E 00	-0.1680E 00	0.7570E 00	171.	351.	43.	2.5	6.4
0.45525	0.8103E-02	-0.6567E 00	0.1870E 00	0.2405E 00	-0.1335E 00	0.9458E 00	164.	345.	46.	2.2	2.8
0.46525	0.6521E-02	-0.5738E 00	0.1037E 00	0.1598E 00	-0.1986E 00	0.9092E 00	170.	334.	52.	1.4	2.6
0.47525	0.6734E-02	-0.6330E 00	0.1840E 00	0.4000E 00	-0.1694E 00	0.8010E 00	164.	349.	47.	1.9	4.4
0.48525	0.5916E-02	-0.6450E 00	0.2586E 00	0.3233E 00	-0.2918E 00	0.8934E 00	158.	339.	45.	2.3	4.4
0.49525	0.7726E-02	-0.6755E 00	0.2387E 00	0.4091E 00	-0.2537E 00	0.9596E 00	161.	344.	43.	2.5	5.1

FREQ HZ	E M*M/HZ	A1	B1	A2	B2	RATIO	TH1 DEG	TH12 DEG	TH2 DEG	SP1	SP2
0.09525	0.2619E 00	0.1068E 00	-0.1440E 00	0.4167E-01	-0.1490E 00	0.2773E 01	307.	323.	73.	0.2	1.9
0.10525	0.9582E-01	-0.6332E-01	0.2317E-01	-0.3493E-01	0.6319E-01	0.1765E 01	160.	59.	78.	0.1	1.4
0.11525	0.6670E-01	-0.1421F 00	-0.1107E 00	-0.1450E 00	-0.1816E 00	0.1836E 01	218.	296.	73.	0.2	2.5
0.12525	0.6518E-01	0.3607E-01	0.6683E-01	0.2253E 00	-0.2954E 00	0.2193E 01	62.	334.	78.	0.1	3.7
0.13525	0.2186E-01	-0.7951E-01	-0.1934E 00	-0.1014E 00	0.4777E-01	0.1600E 01	248.	77.	72.	0.3	1.7
0.14525	0.2357E-01	-0.5690E-01	-0.1397E 00	0.4093E-01	-0.1363E 00	0.1905E 01	248.	323.	75.	0.2	1.8
0.15525	0.2414E-01	-0.1252E 00	-0.4629E-01	0.2473E 00	0.3494E-01	0.1461E 01	200.	4.	75.	0.2	2.6
0.16525	0.1684E-01	-0.4676E 00	-0.4733E-01	0.7474E 00	0.2224E 00	0.8061E 00	186.	8.	59.	0.9	15.6
0.17525	0.6908E-01	-0.8163E 00	-0.1733E 00	0.6648E 00	0.3400E 00	0.9222E 00	192.	14.	33.	5.0	13.2
0.18525	0.8726E-01	-0.8387E 00	-0.3090E 00	0.6044E 00	0.5416E 00	0.9593E 00	200.	21.	26.	8.4	18.7
0.19525	0.5148E-01	-0.8365E 00	-0.2743E 00	0.6607E 00	0.5181E 00	0.8021E 00	198.	19.	28.	7.4	22.4
0.20525	0.6390E-01	-0.8433E 00	-0.1734E 00	0.7186E 00	0.3587E 00	0.9390E 00	192.	13.	30.	6.2	17.8
0.21525	0.5812E-01	-0.7972E 00	-0.2798E 00	0.5845E 00	0.5189E 00	0.1010E 01	199.	21.	32.	5.4	15.8
0.22525	0.3492E-01	-0.8205E 00	-0.2369E 00	0.6053E 00	0.5036E 00	0.8178E 00	196.	20.	31.	5.9	16.3
0.23525	0.3037E-01	-0.7967E 00	-0.2696E 00	0.6062E 00	0.3989E 00	0.8272E 00	199.	17.	32.	5.3	12.0
0.24525	0.2759E-01	-0.8218E 00	-0.1133E-01	0.6178E 00	0.1279E 00	0.8598E 00	181.	6.	34.	4.6	8.3
0.25525	0.2051E-01	-0.6705E 00	-0.1952E 00	0.4181E 00	0.3351E 00	0.9626E 00	196.	19.	45.	2.3	6.0
0.26525	0.1566E-01	-0.7354E 00	-0.1202E 00	0.4817E 00	0.3350E 00	0.9625E 00	189.	17.	41.	2.9	7.1
0.27525	0.1092E-01	-0.6972E 00	0.2803E-01	0.4719E 00	0.1781E 00	0.8518E 00	178.	10.	45.	2.3	5.4
0.28525	0.9566E-02	-0.6346E 00	-0.2332E 00	0.2850E 00	0.5389E 00	0.6865E 00	200.	31.	46.	2.1	7.7
0.29525	0.1075E-01	-0.6597E 00	-0.5205E-01	0.4771E 00	0.2835E 00	0.8061E 00	185.	15.	47.	2.0	6.4
0.30525	0.1276E-01	-0.7823E 00	-0.8505E-01	0.6343E 00	0.2973E 00	0.8072E 00	186.	13.	37.	3.7	10.8
0.31525	0.1796E-01	-0.7768E 00	0.6680E-01	0.5752E 00	-0.7288E-01	0.9577E 00	175.	356.	38.	3.5	6.9
0.32525	0.1808E-01	-0.7881E 00	0.6382E-02	0.4962E 00	0.1142E 00	0.9517E 00	180.	6.	37.	3.7	5.5
0.33525	0.1615E-01	-0.7621E 00	0.6382E-01	0.5760E 00	-0.3443E-03	0.8478E 00	175.	360.	39.	3.3	6.8
0.34525	0.1839E-01	-0.7824E 00	0.4759E-01	0.6314E 00	-0.1992E-01	0.8277E 00	177.	359.	38.	3.6	8.3
0.35525	0.1047E-01	-0.6922E 00	0.8017E-01	0.4227E 00	-0.4215E-01	0.7876E 00	173.	357.	45.	2.3	4.3
0.36525	0.1766E-01	-0.7488E 00	0.7442E-01	0.5248E 00	-0.6331E-01	0.9236E 00	174.	357.	40.	3.0	5.9
0.37525	0.1602E-01	-0.7996E 00	0.1571E 00	0.5820E 00	-0.1982E 00	0.9302E 00	169.	351.	35.	4.4	7.8
0.38525	0.1656E-01	-0.8146E 00	0.1431E 00	0.6058E 00	-0.1714E 00	0.1021E 01	170.	352.	34.	4.8	8.2
0.39525	0.1130E-01	-0.7577E 00	0.1480E 00	0.6546E 00	-0.2817E 00	0.8917E 00	169.	348.	39.	3.4	11.4
0.40525	0.7253E-02	-0.7251E 00	0.6243E-01	0.6545E 00	-0.1237E 00	0.8619E 00	175.	355.	42.	2.7	9.4
0.41525	0.1026E-01	-0.7910E 00	0.1119E 00	0.5951E 00	-0.1823E 00	0.8577E 00	172.	351.	36.	4.0	8.0
0.42525	0.9923E-02	-0.8029E 00	0.2183E 00	0.6758E 00	-0.2423E 00	0.8699E 00	165.	350.	33.	5.0	11.6
0.43525	0.9924E-02	-0.7680E 00	0.2317E 00	0.5995E 00	-0.2578E 00	0.9417E 00	163.	348.	36.	4.1	8.9
0.44525	0.6105E-02	-0.7307E 00	0.1480E 00	0.5377E 00	-0.1978E 00	0.8372E 00	169.	350.	41.	2.9	6.8
0.45525	0.6043E-02	-0.6902E 00	0.2651E 00	0.4747E 00	-0.3627E 00	0.8487E 00	159.	341.	41.	2.8	7.3
0.46525	0.7210E-02	-0.7124E 00	0.3009E 00	0.4569E 00	-0.4002E 00	0.9544E 00	157.	339.	39.	3.4	7.6
0.47525	0.4504E-02	-0.6514F 00	0.2686E 00	0.3903E 00	-0.2030E 00	0.9139E 00	158.	346.	44.	2.4	4.5
0.48525	0.6581E-02	-0.7341E 00	0.2355E 00	0.5444E 00	-0.2302E 00	0.1065E 01	162.	349.	39.	3.4	7.2
0.49525	0.3703E-02	-0.6405E 00	0.2350E 00	0.2958E 00	-0.2491E-01	0.1023E 01	160.	358.	46.	2.1	3.0

FREQ HZ	E M*M/HZ	A1	B1	A2	B2	RATIO	TH1 DEG	TH12 DEG	TH2 DEG	SP1	SP2
0.09525	0.1131E-03	-0.1402E 00	0.5726E-01	0.5492E 00	-0.5242E 00	0.7983E-01	158.	338.	75.	0.2	14.1
0.10525	0.1196E-03	-0.9530E-01	-0.7920E-02	0.3807E 00	-0.4915E 00	0.9966E-01	185.	334.	77.	0.1	8.0
0.11525	0.1826E-03	-0.5287E-01	-0.1289E 00	0.4630E 00	-0.4690E-01	0.1975E 00	248.	357.	75.	0.2	4.8
0.12525	0.4809E-03	-0.3383E 00	0.1751E-02	0.5880E 00	-0.4387E 00	0.3223E 00	180.	342.	66.	0.5	12.5
0.13525	0.1231E-02	-0.3878E 00	-0.2970E 00	0.3803E 00	0.1098E 00	0.6603E 00	217.	8.	58.	1.0	4.0
0.14525	0.2927E-02	-0.6072E 00	-0.2104E 00	0.5654E 00	-0.8303E-02	0.9766E 00	199.	360.	48.	1.8	6.6
0.15525	0.1803E-02	-0.5247E 00	-0.8740E-01	0.1849E 00	-0.1631E 00	0.8716E 00	189.	339.	55.	1.1	2.6
0.16525	0.1453E-02	-0.6139E 00	-0.2532E 00	0.5465E 00	0.1300E 00	0.7635E 00	202.	7.	47.	2.0	6.5
0.17525	0.1979E-02	-0.7435E 00	-0.5103E-01	0.6757E 00	0.6050E-01	0.8994E 00	184.	3.	41.	2.9	9.9
0.18525	0.1044E-01	-0.7640E 00	-0.3083E 00	0.6733E 00	0.3670E 00	0.1102E 01	202.	14.	34.	4.7	14.6
0.19525	0.1157E-01	-0.7470E 00	-0.2409E 00	0.6444E 00	0.1549E 00	0.9347E 00	198.	7.	38.	3.6	9.3
0.20525	0.1593E-01	-0.7893E 00	-0.6125E-01	0.7309E 00	-0.4516E-01	0.1012E 01	184.	358.	37.	3.8	12.4
0.21525	0.2992E-01	-0.8515E 00	-0.2268E 00	0.7141E 00	0.3663E 00	0.9660E 00	195.	14.	28.	7.4	17.7
0.22525	0.1704E-01	-0.7459E 00	-0.1427E 00	0.6688E 00	0.7742E-01	0.8681E 00	191.	3.	40.	3.2	9.7
0.23525	0.2131E-01	-0.7944E 00	-0.2113E 00	0.6635E 00	0.3062E 00	0.1124E 01	195.	12.	34.	4.6	12.3
0.24525	0.1577E-01	-0.5915E 00	-0.2995E 00	0.4872E 00	0.3515E 00	0.1049E 01	207.	18.	47.	2.0	7.4
0.25525	0.1387E-01	-0.4091E 00	-0.4308E 00	0.3257E 00	0.1598E 00	0.9430E 00	226.	13.	52.	1.5	3.6
0.26525	0.2273E-01	0.1138E 00	-0.1840E 00	0.7689E 00	0.7828E-01	0.8161E 00	302.	3.	72.	0.3	15.1
0.27525	0.1803E-01	-0.5627E 00	-0.3179E 00	0.5908E 00	0.1983E 00	0.1072E 01	209.	9.	48.	1.8	8.0
0.28525	0.9975E-02	-0.6863E 00	-0.1797E 00	0.5420E 00	0.1321E 00	0.1021E 01	195.	7.	44.	2.4	6.4
0.29525	0.1243E-01	-0.7833E 00	-0.1449E 00	0.6213E 00	0.5486E-01	0.1045E 01	190.	3.	37.	3.9	8.0
0.30525	0.9111E-02	-0.6493E 00	-0.8674E-01	0.5105E 00	0.1591E 00	0.1145E 01	188.	9.	48.	1.9	6.0
0.31525	0.7061E-02	-0.6593E 00	-0.2385E 00	0.4519E 00	0.5793E 00	0.1110E 01	200.	26.	44.	2.3	12.5
0.32525	0.2610E-02	-0.6622E 00	-0.3536E-01	0.2908E 00	0.6793E-01	0.8317E 00	183.	7.	47.	2.0	3.0
0.33525	0.3455E-02	-0.6459E 00	-0.9754E-01	0.5218E 00	0.2959E-01	0.9181E 00	189.	2.	48.	1.9	5.8
0.34525	0.3305E-02	-0.7394E 00	-0.7866E-01	0.5842E 00	-0.1067E-01	0.9136E 00	186.	359.	41.	2.9	7.0
0.35525	0.4237E-02	-0.7993E 00	-0.1795E 00	0.5774E 00	0.3246E 00	0.1045E 01	193.	15.	34.	4.5	9.3
0.36525	0.4196E-02	-0.8321E 00	-0.1384E 00	0.6813E 00	0.2371E 00	0.1100E 01	189.	10.	32.	5.4	11.8
0.37525	0.2468E-02	-0.6244E 00	-0.2641E 00	0.4079E 00	0.2706E 00	0.1014E 01	203.	17.	46.	2.1	5.2
0.38525	0.2044E-02	-0.7134E 00	-0.1694E 00	0.4925E 00	0.2358E 00	0.8341E 00	193.	13.	42.	2.7	6.2
0.39525	0.2557E-02	-0.7233E 00	-0.2144E 00	0.3224E 00	0.2900E 00	0.1191E 01	197.	21.	40.	3.1	4.4
0.40525	0.1779E-02	-0.6086E 00	-0.1309E 00	0.3302E 00	0.2063E 00	0.9356E 00	192.	16.	50.	1.6	3.9
0.41525	0.1084E-02	-0.4296E 00	-0.1733E 00	-0.6265E-01	0.2352E-01	0.7881E 00	202.	80.	59.	0.9	1.4
0.42525	0.1733E-02	-0.4272E 00	-0.1898E 00	0.1102E 00	0.1586E 00	0.1038E 01	204.	28.	59.	0.9	2.2
0.43525	0.1748E-02	-0.6007E 00	-0.9604E-01	0.4570E 00	-0.4968E-02	0.9607E 00	189.	360.	51.	1.6	4.7
0.44525	0.1472E-02	-0.4551E 00	-0.4187E-01	0.4600E 00	0.3543E-01	0.9300E 00	185.	2.	60.	0.8	4.8
0.45525	0.1607E-02	-0.5124E 00	-0.2207E 00	0.2229E 00	0.2868E 00	0.1064E 01	203.	26.	54.	1.3	3.6
0.46525	0.1801E-02	-0.6919E 00	-0.3917E-01	0.4170E 00	-0.3955E-01	0.1115E 01	183.	357.	45.	2.3	4.2
0.47525	0.1129E-02	-0.4962E 00	-0.1056E 00	0.1655E 00	0.3443E 00	0.1020E 01	192.	32.	57.	1.0	3.8
0.48525	0.1263E-02	-0.5740E 00	-0.5681E-01	0.1428E 00	0.2982E 00	0.9653E 00	186.	32.	53.	1.4	3.3
0.49525	0.8958E-03	-0.5503E 00	0.5300E-02	0.3392E 00	0.5127E-01	0.9218E 00	179.	4.	56.	1.1	3.4

WALLENBERG   IOS PITCH-ROLL BUOY RECORD NO. W6

FREQ HZ	E M*M/HZ	A1	B1	A2	B2	RATIO	TH1 DEG	TH12 DEG	TH2 DEG	SP1	SP2
0.09525	0.7641E-03	-0.9954E-01	0.8889E-01	0.2198E 00	-0.3534E 00	0.4808E 00	138.	331.	75.	0.2	4.2
0.10525	0.4829E-03	0.4097E-02	-0.5455E-01	0.7870E-01	-0.2937E-01	0.4440E 00	274.	350.	79.	0.1	1.5
0.11525	0.4280E-03	-0.2032E 00	-0.3236E-01	0.9927E-01	0.1081E 00	0.4850E 00	189.	24.	72.	0.3	1.9
0.12525	0.4104E-03	-0.2628E 00	-0.1318E 00	0.3306E 00	0.1256E 00	0.5747E 00	207.	10.	68.	0.4	3.5
0.13525	0.1174E-02	-0.5630E 00	-0.2090E 00	0.4350E 00	0.2856E 00	0.8062E 00	200.	17.	51.	1.5	5.7
0.14525	0.1320E-02	-0.6767E 00	-0.2103E 00	0.3906E 00	0.1351E 00	0.8226E 00	197.	10.	44.	2.4	4.2
0.15525	0.1969E-02	-0.6591E 00	-0.2860E 00	0.4719E 00	0.1490E 00	0.9063E 00	203.	9.	43.	2.6	5.3
0.16525	0.1500E-02	-0.6938E 00	-0.2025E 00	0.6299E 00	0.1117E 00	0.8788E 00	196.	5.	43.	2.6	8.5
0.17525	0.1468E-02	-0.6584E 00	-0.3303E 00	0.5282E 00	0.3937E 00	0.9266E 00	207.	18.	42.	2.8	9.1
0.18525	0.2275E-02	-0.7287E 00	-0.1999E 00	0.6633E 00	0.9005E-01	0.8913E 00	195.	4.	40.	3.1	9.5
0.19525	0.4251E-02	-0.6525E 00	-0.3430E 00	0.6478E 00	0.3674E 00	0.1047E 01	208.	15.	42.	2.8	13.1
0.20525	0.6893E-02	-0.7910E 00	-0.2519E 00	0.6943E 00	0.4557E 00	0.8759E 00	198.	17.	33.	4.9	21.1
0.21525	0.1459E-01	-0.8657E 00	-0.2726E 00	0.7098E 00	0.3905E 00	0.9229E 00	197.	14.	25.	9.8	18.5
0.22525	0.2195E-01	-0.9009E 00	-0.1758E 00	0.7705E 00	0.2921E 00	0.9741E 00	191.	10.	23.	11.2	20.2
0.23525	0.1636E-01	-0.8061E 00	-0.2999E 00	0.4640E 00	0.4206E 00	0.9542E 00	200.	21.	30.	6.1	8.1
0.24525	0.1654E-01	-0.9227E 00	-0.1075E 00	0.8272E 00	0.2007E 00	0.1008E 01	187.	7.	22.	13.1	24.4
0.25525	0.9928E-02	-0.8933E 00	-0.2045E 00	0.7819E 00	0.3040E 00	0.9029E 00	193.	11.	23.	11.0	22.3
0.26525	0.1139E-01	-0.8955E 00	-0.8565E-01	0.7317E 00	0.1270E 00	0.8951E 00	185.	5.	26.	9.0	13.0
0.27525	0.9701E-02	-0.9011E 00	-0.1343E 00	0.7556E 00	0.2803E 00	0.9289E 00	188.	10.	24.	10.2	18.1
0.28525	0.5654E-02	-0.8554E 00	-0.1154E 00	0.6679E 00	0.1976E 00	0.8368E 00	188.	8.	30.	6.3	10.6
0.29525	0.5481E-02	-0.8102E 00	-0.7823E-01	0.5655E 00	0.1156E 00	0.1089E 01	186.	6.	35.	4.4	6.9
0.30525	0.6112E-02	-0.8459E 00	-0.1175E 00	0.8159E 00	0.2196E 00	0.9591E 00	188.	8.	31.	5.9	23.3
0.31525	0.3996E-02	-0.7570E 00	-0.1256E 00	0.6714E 00	0.2212E 00	0.9903E 00	189.	9.	39.	3.3	11.1
0.32525	0.2892E-02	-0.7590E 00	-0.2087E 00	0.6405E 00	0.3634E 00	0.9124E 00	195.	15.	37.	3.7	12.6
0.33525	0.4638E-02	-0.8477E 00	-0.1382E 00	0.6881E 00	0.1677E 00	0.1017E 01	189.	7.	30.	6.1	11.1
0.34525	0.2989E-02	-0.7879E 00	-0.1478E 00	0.5506E 00	0.7854E-01	0.9792E 00	191.	4.	36.	4.0	6.4
0.35525	0.2297E-02	-0.8174E 00	-0.8689E-01	0.6628E 00	0.1691E 00	0.8937E 00	186.	7.	34.	4.6	10.1
0.36525	0.1401E-02	-0.7595E 00	-0.1335E 00	0.6026E 00	0.1572E 00	0.8930E 00	190.	7.	39.	3.4	8.0
0.37525	0.2512E-02	-0.8536E 00	-0.9849E-01	0.6486E 00	0.2150E 00	0.1063E 01	187.	9.	30.	6.1	10.1
0.38525	0.1462E-02	-0.7611E 00	-0.1490E 00	0.5793E 00	0.3577E 00	0.8551E 00	191.	16.	38.	3.5	10.0
0.39525	0.1035E-02	-0.7135E 00	-0.1826E 00	0.5780E 00	0.3207E 00	0.8766E 00	194.	15.	42.	2.8	9.2
0.40525	0.4854E-03	-0.7509E 00	0.5582E-01	0.5653E 00	-0.4019E-02	0.7013E 00	176.	360.	40.	3.0	6.6
0.41525	0.1135E-02	-0.6728E 00	-0.8384E-01	0.4466E 00	0.1240E 00	0.9586E 00	187.	8.	46.	2.1	4.8
0.42525	0.6723E-03	-0.6361E 00	-0.2175E 00	0.5312E 00	0.3326E 00	0.9453E 00	199.	16.	46.	2.1	8.1
0.43525	0.8752E-03	-0.7111E 00	-0.2516E 00	0.5690E 00	0.3268E 00	0.9139E 00	199.	15.	40.	3.1	9.1
0.44525	0.9625E-03	-0.7012E 00	-0.5040E-01	0.5288E 00	0.1447E 00	0.9534E 00	184.	8.	44.	2.4	6.2
0.45525	0.3906E-03	-0.5668E 00	0.1701E-01	0.3118E 00	0.6417E-01	0.7246E 00	178.	6.	53.	1.3	3.2
0.46525	0.3852E-03	-0.5835E 00	0.2014E-02	0.5099E 00	0.2248E 00	0.9761E 00	180.	12.	52.	1.4	6.4
0.47525	0.2879E-03	-0.5550E 00	-0.1437E 00	0.3717E 00	0.2507E 00	0.8682E 00	195.	17.	53.	1.3	4.6
0.48525	0.5481E-03	-0.5190E 00	-0.2293E-01	0.3690E 00	0.3243E 00	0.9353E 00	183.	21.	56.	1.1	5.2
0.49525	0.4522E-03	-0.6790E 00	0.2093E 00	0.4629E 00	-0.2330E 00	0.9007E 00	163.	347.	44.	2.5	5.7