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ONLINE SEAKEEPING CALCULATIONS

by P.A. Wilson

June 1983

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CONTENTS

SEAKEEPING PROGRAMS

1. INTRODUCTION

With the introduction of an interactive service on a mainframe University computer it became quickly apparent that the department's ability to perform seakeeping calculations quickly and succinctly was lacking. To rectify this deficiency the two suites of programs (refs 1,2) have been implemented on the Honeywell 6080.

Both of these programs require extensive input data where mistakes are easily made. To overcome this problem a pre-processing program has been written which asks for all the data by questions on the visual display unit (V.D.U.). This program also generates the data files for the lateral and the vertical motion program modules.

Also with the department's acquirement of graphics terminals and Hewlett Packard plotters that are able to plot on-line from the Honeywell 6080, there was an obvious need for a graphics program. This program is capable of being run by the pre-processing program or alone.

A further module has been written that allows the total motion and relative total motion to the wave system at any point in or outside the ship. This module is also capable of being run by the pre-processing program or alone.

In all these program modules the user does not have to know anything about the Honeywell operating system. All data files are automatically generated as is the printing of the output files. It is hoped that the programs have been written in a way that makes the user at ease with the system and not battling to understand the computer.

2. PROGRAM MODULES

There are five program modules in the seakeeping suite.

A) Generate.

This is the main control program that generates data files from the input data that the user types at the V.D.U. It also allows modification of most of this input data once the data files have been created.

The other main role of this program is to control the data flow between the other four program modules.

Most questions concerning the input of data concern a choice. The questions are answered by typing a number. Since all the programs are written in FORTRAN, a distinction between number types is required. For example if the ship displacement is required a value of 10000 tonnes may be required. This value must be input with a decimal place i.e. as 10000.0 not 10000.

Where the answers to questions are required, an integer is required, for example a one, then that value is typed as 1 not as 1.0.

The number with a decimal is called a <u>real</u> number, the number without a decimal is called an <u>integer</u>. It is important to acknowledge this difference since it can have drastic effects especially when a real number is to be input when an integer is actually input. At the end of the report a list of the input data is given which types every input variable.

B) <u>Vertical Plane Motions (Heave and Pitch)</u>.

This program is run automatically by module (A). It takes as input a data file generated by (A) and calculates all the two dimensional hydrodynamic properties that are required to solve the frequency equations of motion. It also performs simple spectral calculations on the two rigid body motions either allowing long crested seas or short crested seas.

If the user has specified weight as input, the module also calculates the vertical bending moments and shear forces, at the user chosen points.

One final capability of the program is the calculation of performance of a design in head seas by a probabilistic approach to the relative motion, wetness and acceleration. This enables the designer the capability of determining a limiting speed envelope for a given sea state.

C) Lateral Plane Motions (Roll, Sway and Yaw)

This program is run automatically by module (A) taking as input a data file also generated by module (A). It calculates the two dimensional properties of the ship sections for use in the frequency analysis of the ships response to wave. With the user specified spectral composition, it is possible to determine preliminary statistical ship responses either in long or short crested seas.

D) Graphical Output

This program module allows the response curves to be plotted on the Hewlett Packard 7470A A4 plotter. The results are always plotted as non-dimensional values. The heave, and sway are non-dimensionalised with respect to wave amplitude. The angular motions, pitch, roll and yaw with respect to wave slope. The wave slope is the wave amplitude divided by wave length, either in degrees or radians.

There is a choice as to which variable is used as the constant factor, either heading or ship speed. The resulting curves are presented two graphs per side of A4. Thus heave and pitch appear on one sheet, roll, sway on another, with the yaw graph on one sheet of A4.

The actual spectra that have been used in the program are also plotted on the HP7470A plotter.

E) Total Motions

This program module is of use in the calculation of the coupled motion, velocity and acceleration at any point within the ship. The module allows the vertical and lateral plane responses to be added in the correct vector sense. Absolute vertical and lateral responses are calculated as well as the relative motion in the vertical plane with respect to the wave system.

All the responses are dealt with on a statistical basis allowing long crested as well as short crest seaways to be considered.

It is normal only to calculate the responses of a ship from following seas to head seas and not bother with the symmetrical responses past head seas and back to following seas. The need for the responses in the other half of the polar diagram is important when coupling the responses, particularly when the point is off the centre line. In this case the module calculates an equivalent point off the centreline on the other side of the centreline.

3. RUNNING THE PROGRAMS

A flow chart of the basis data highways between the different modules is given in figure 1. It will be noticed that the GENERATE program controls the whole suite of programs. It is equally possible to run any one of these program modules as a 'stand alone program'. All the programs are in uncompiled form on the Honeywell 6080 under user identity SII001. Each program is in uncompiled FORTRAN, so each run of the module has the overhead in time of the compilation of the source code. This has not proved to be a handicap, even at the most severely congested times.

Details of the running of the program is found in Appendix A.

Of the five modules of program two may be chosen to be run at subsequent times to the generation of the particular data files. The graphics package may be one, because of the length of time required for plotting each A4 graph is of the order of 5-10 minutes, depending upon the machine's state of readiness. This is sometimes inconvenient because the plotter pen may be left in the down position, leading to an ink blob on the graph. Thus it is often more convenient to choose to graph plot on the HP7470 at a later time.

The other module that may be utilised at a later date is the TOTAL motions package. This is because there is a limit of only 10 positions along the length that the motions can be calculated at. Thus for instance if twenty positions' motions are required then two separate runs are required. The first ten positions would be run during the initial run of GENERATE, followed by a later run with the second set of ten values.

Typical run times are dependent upon the particular combination of headings, speeds and spectra chosen. There is in both modules B, and C a constant calculation time for generation of the two dimensional hydrodynamic properties. The times for the lateral motions calculation are much longer because of the need to calculate a significant roll angle amplitude to calculate the damping (see ref. 1). A quicker method of calculation of the optimum value has now been programmed.

The calculation time for the mode TOTAL is short, of the order of one minute for one speed, nine headings and one speed.

Input to the programs are summarised in the appendices. Typical output from the programs are also listed together with a typical graph plot.

4. References

1. Theory and Computer Program for Calculation of the Lateral Motion of a Ship, P.A. Wilson, SSSU 6/81, April 1981.

2. Users Manual of Program AEW2 Prediction of Vertical Ship Motions in Regular and Irregular Waves, P.A. Wilson, Ship Science Report No. 2, 1976.

3. Roll Stabilization Investigation for the Guided Missile Frigate FFG-7, DTNSRDC Ship Prediction Department Report SPD 495 1976.

5 List of Figures

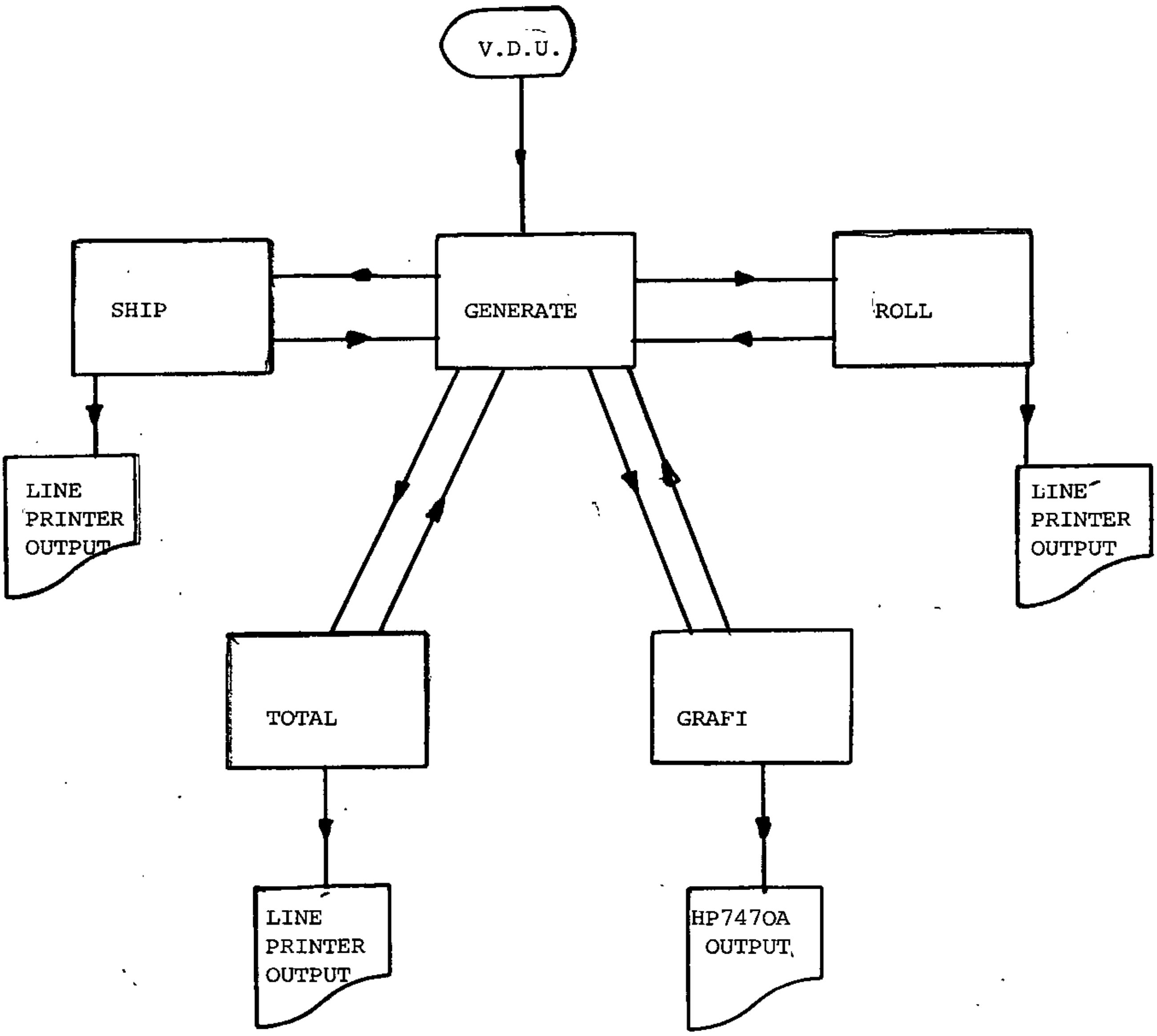

V.D.U.
SHIP
GENERATE
ROLL
LINE PRINTER OUTPUT
LINE PRINTER OUTPUT
TOTAL
GRAFI
LINE PRINTER OUTPUT
HP7470A OUTPUT

FIGURE 1

FIGURE 2

VERTICAL PLANE RESPONSES

SPEED = 4.0 KNOTS WAVE ANGLE = 0. DEG.

WAVE FREQUENCIES	ENCOUNTER FREQUENCIES	WAVE LENGTH	WAVE/SHIP LENGTH	HEAVE AMPL	HEAVE PHASE	PITCH AMPL	PITCH PHASE	VERTICAL AMPLITUDE	BEND.MT. PHASE
0.20000	0.19161	1540.425	11.4496	0.9903	179.9	0.2333	-89.6	0.	0.
0.25000	0.23689	985.872	7.3277	0.9767	179.8	0.3615	-89.5	0.	0.
0.30000	0.28111	684.633	5.0887	0.9521	179.5	0.5125	-89.2	0.	0.
0.35000	0.32430	502.996	3.7386	0.9121	179.2	0.6793	-89.0	0.	0.
0.40000	0.36643	385.106	2.8624	0.8523	178.7	0.8508	-88.7	0.	0.
0.45000	0.40751	304.281	2.2616	0.7688	178.0	1.0114	-88.4	0.	0.
0.50000	0.44754	246.468	1.8319	0.6596	176.9	1.1405	-88.1	0.	0.
0.55000	0.48652	203.693	1.5140	0.5254	175.4	1.2147	-87.7	0.	0.
0.60000	0.52446	171.158	1.2722	0.3714	172.8	1.2102	-87.2	0.	0.
0.65000	0.56134	145.839	1.0840	0.2081	167.1	1.1088	-86.4	0.	0.
0.70000	0.59718	125.749	0.9347	0.0580	136.7	0.9045	-84.9	0.	0.
0.75000	0.63197	109.541	0.8142	0.0973	15.6	0.6107	-81.5	0.	0.
0.80000	0.66571	96.277	0.7156	0.1862	2.5	0.2722	-69.0	0.	0.
0.85000	0.69839	85.283	0.6339	0.2175	-2.9	0.1345	41.9	0.	0.
0.90000	0.73003	76.070	0.5654	0.1842	-7.1	0.3665	75.6	0.	0.
0.95000	0.76062	68.274	0.5075	0.0975	-11.4	0.4816	82.3	0.	0.
1.00000	0.79017	61.617	0.4580	0.0131	150.2	0.4255	88.4	0.	0.
1.05000	0.81866	55.888	0.4154	0.1026	153.0	0.2379	106.1	0.	0.
1.10000	0.84610	50.923	0.3785	0.1304	144.2	0.1519	-171.3	0.	0.
1.15000	0.87249	46.591	0.3463	0.0834	133.0	0.2876	-133.2	0.	0.
1.20000	0.89784	42.790	0.3180	0.0030	-3.4	0.2997	-121.8	0.	0.
1.25000	0.92213	39.435	0.2931	0.0597	-64.3	0.1755	-100.1	0.	0.
1.30000	0.94538	36.460	0.2710	0.0569	-74.2	0.1210	-20.9	0.	0.
1.35000	0.96758	33.809	0.2513	0.0126	-63.9	0.1814	17.2	0.	0.
1.40000	0.98872	31.437	0.2337	0.0268	77.7	0.1418	38.6	0.	0.
1.45000	1.00882	29.307	0.2178	0.0284	83.5	0.0696	100.4	0.	0.
1.50000	1.02787	27.385	0.2035	0.0084	129.7	0.0976	165.1	0.	0.
1.55000	1.04587	25.647	0.1906	0.0172	-132.3	0.0799	-167.5	0.	0.
1.60000	1.06282	24.069	0.1789	0.0157	-117.2	0.0374	-91.7	0.	0.

SIG. WAVE HT. = 5.80, MEAN PERIOD = 7.72

SWAY AMP IS NON-DIMENSIONALISED BY WAVE AMP,ROLL AND YAW AMPS BY WAVE SLOPE. FIGURE 3

FIN/TANK AMPLITUDES ARE IN DEGS

			SWAY		ROLL		YAW		RUDDER		FIN(TANK
W	WE	W.L./L	AMP	PHASE	AMP	PHASE	AMP	PHASE	AMP	PHASE	AMP
0.200	0.194	11.459	0.714	90.316	0.776	92.502	0.117	-43.601	0.000	0.	0.
0.250	0.241	7.334	0.707	90.562	0.830	93.861	0.099	-31.173	0.000	0.	0.
0.300	0.287	5.093	0.694	90.830	0.906	95.663	0.091	-22.558	0.000	0.	0.
0.350	0.332	3.742	0.674	91.108	1.021	97.729	0.088	-16.926	0.000	0.	0.
0.400	0.376	2.865	0.646	91.380	1.206	99.907	0.085	-13.504	0.000	0.	0.
0.450	0.420	2.263	0.610	91.587	1.545	101.869	0.083	-11.696	0.000	0.	0.
0.500	0.463	1.833	0.566	91.733	2.367	102.267	0.079	-11.465	0.000	0.	0.
0.550	0.505	1.515	0.536	90.046	6.800	85.516	0.074	-15.703	0.000	0.	0.
0.600	0.547	1.273	0.396	89.224	3.675	-40.763	0.064	-8.046	0.000	0.	0.
0.650	0.587	1.085	0.331	89.924	1.240	-45.832	0.058	-10.768	0.000	0.	0.
0.700	0.627	0.935	0.250	88.615	0.614	-41.310	0.049	-13.196	0.000	0.	0.
0.750	0.667	0.815	0.166	85.513	0.331	-32.572	0.040	-15.987	0.000	0.	0.
0.800	0.705	0.716	0.087	76.707	0.178	-16.542	0.029	-19.469	0.000	0.	0.
0.850	0.743	0.634	0.024	25.711	0.100	16.223	0.020	-23.460	0.000	0.	0.
0.900	0.780	0.566	0.046	-56.786	0.089	58.918	0.011	-28.811	0.000	0.	0.
0.950	0.816	0.508	0.073	-80.800	0.103	82.043	0.004	-42.568	0.000	0.	0.
1.000	0.852	0.458	0.078	-86.802	0.112	91.483	0.002	-168.925	0.000	0.	0.
1.050	0.886	0.416	0.060	-91.676	0.107	94.668	0.004	158.359	0.000	0.	0.
1.100	0.920	0.379	0.029	-96.760	0.090	94.106	0.004	150.147	0.000	0.	0.
1.150	0.954	0.347	0.006	93.203	0.067	90.579	0.004	143.483	0.000	0.	0.
1.200	0.986	0.318	0.033	78.809	0.042	83.986	0.002	135.407	0.000	0.	0.
1.250	1.018	0.293	0.045	73.473	0.019	66.045	0.000	99.023	0.000	0.	0.
1.300	1.049	0.271	0.039	67.001	0.008	-13.259	0.001	-33.957	0.000	0.	0.
1.350	1.080	0.251	0.019	55.286	0.014	-69.210	0.002	-46.167	0.000	0.	0.
1.400	1.109	0.234	0.007	-83.730	0.017	-87.299	0.001	-55.756	0.000	0.	0.
1.450	1.138	0.218	0.025	-114.210	0.015	-102.305	0.001	-72.960	0.000	0.	0.
1.500	1.166	0.204	0.030	-126.505	0.010	-123.548	0.000	-164.527	0.000	0.	0.
1.550	1.194	0.191	0.021	-144.483	0.006	-165.737	0.001	136.160	0.000	0.	0.
1.600	1.220	0.179	0.009	149.448	0.005	133.166	0.001	117.369	0.000	0.	0.

	ROLL AND YAW DISPLACEMENT DEG	VELOCITY DEG/SEC	ACCELERATION DEG/SEC**2
ROLL	7.349	3.922	2.113
YAW	0.053	0.031	0.019
RUDDER	0.000	0.000	0.000

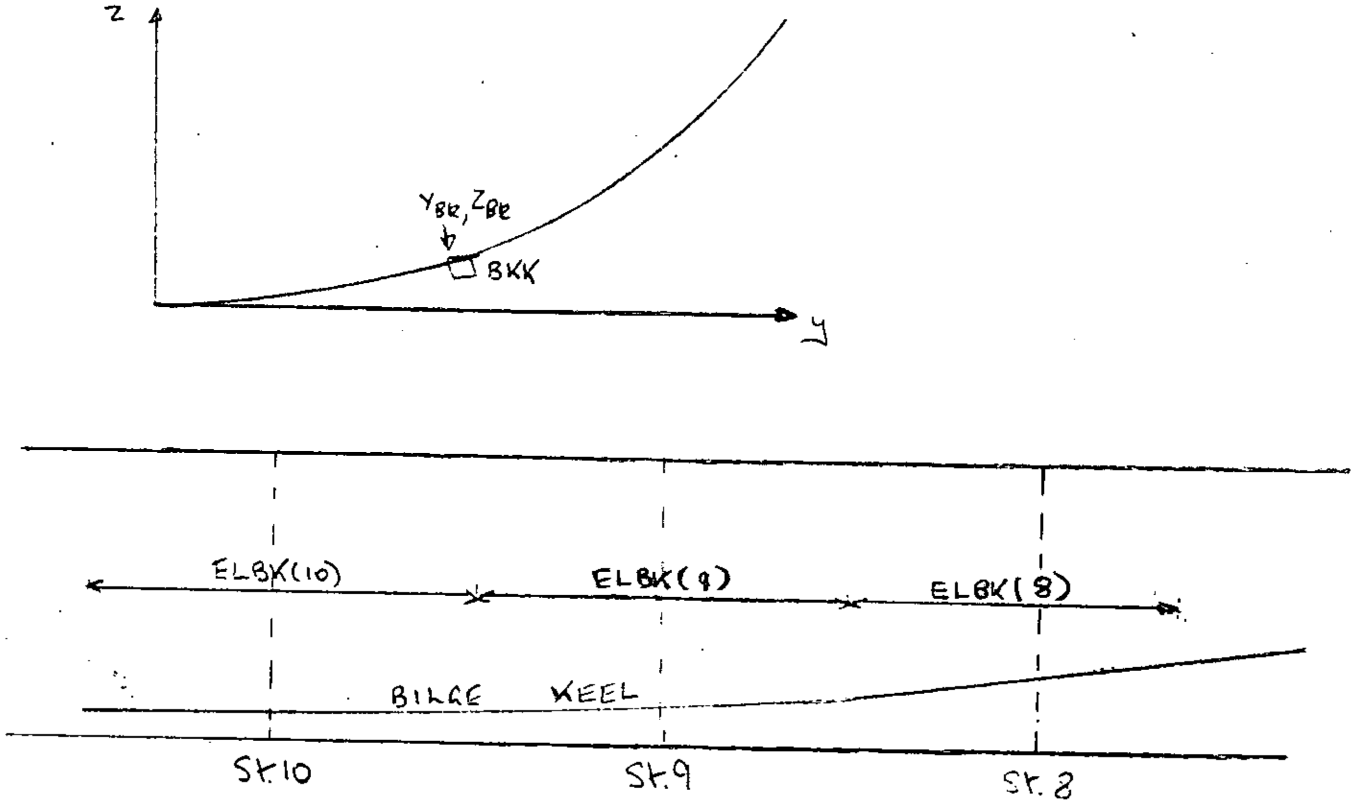


Fig. 4 Bilge Keel Inputs

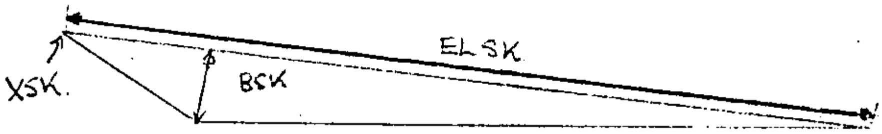


Fig. 5: Skeg Inputs

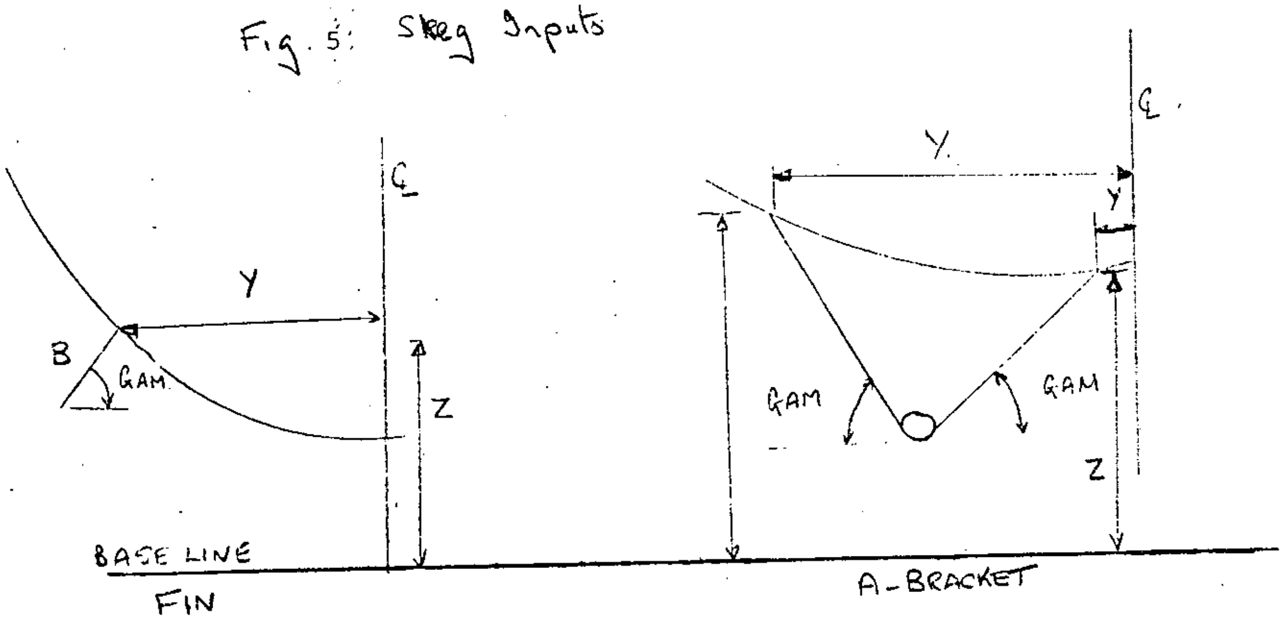


Fig 6 Foil Inputs

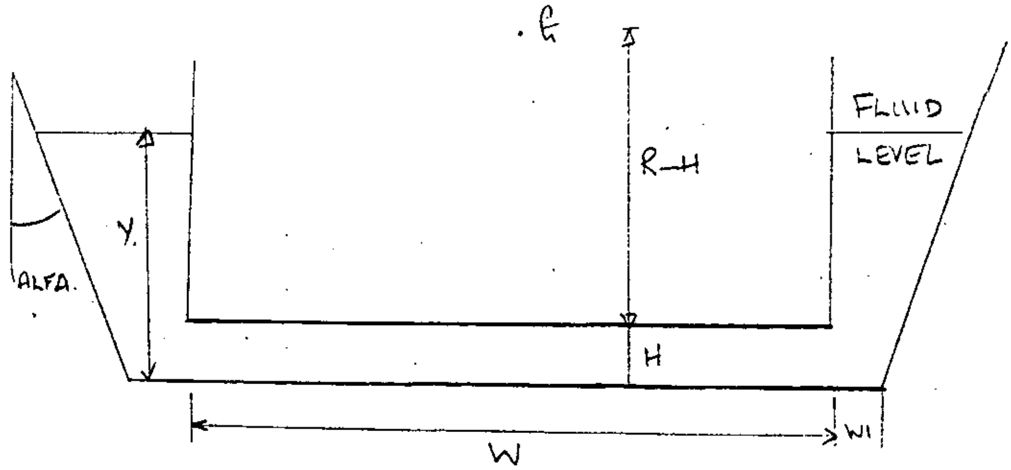


Fig 7. Tank Inputs.

FIGURE 8

LOCATION NO. 2

R.M.S. R E S P O N S E S

WAVE SPECTRUM	VERTICAL ABSOLUTE			VERTICAL RELATIVE			LATERA	
	DISPL	VEL	ACCEL	DISPL	VEL	ACCEL	DISPL	
1	0.652E 00	0.349E 00	0.195E 00	0.103E 01	0.726E 00	0.548E 00	0.113E-03	0.69
2	0.161E 01	0.770E 00	0.382E 00	0.148E 01	0.102E 01	0.762E 00	0.207E-03	0.11

LOCATION NO. 3

R.M.S. R E S P O N S E S

WAVE SPECTRUM	VERTICAL ABSOLUTE			VERTICAL RELATIVE			LATERA	
	DISPL	VEL	ACCEL	DISPL	VEL	ACCEL	DISPL	
1	0.534E 00	0.282E 00	0.156E 00	0.115E 01	0.783E 00	0.573E 00	0.653E-04	0.40
2	0.143E 01	0.671E 00	0.329E 00	0.167E 01	0.111E 01	0.799E 00	0.121E-03	0.65

LOCATION NO. 4

R.M.S. R E S P O N S E S

WAVE SPECTRUM	VERTICAL ABSOLUTE			VERTICAL RELATIVE			LATERA	
	DISPL	VEL	ACCEL	DISPL	VEL	ACCEL	DISPL	
1	0.445E 00	0.231E 00	0.126E 00	0.123E 01	0.820E 00	0.587E 00	0.250E-04	0.15
2	0.130E 01	0.602E 00	0.290E 00	0.180E 01	0.116E 01	0.819E 00	0.488E-04	0.25

LOCATION NO. 5

R.M.S. R E S P O N S E S

WAVE SPECTRUM	VERTICAL ABSOLUTE			VERTICAL RELATIVE			LATERA	
	DISPL	VEL	ACCEL	DISPL	VEL	ACCEL	DISPL	
1	0.445E 00	0.231E 00	0.126E 00	0.123E 01	0.820E 00	0.587E 00	0.307E-04	0.18
2	0.130E 01	0.602E 00	0.290E 00	0.180E 01	0.116E 01	0.819E 00	0.587E-04	0.31

LOCATION NO. 6

R.M.S. R E S P O N S E S

WAVE SPECTRUM	VERTICAL ABSOLUTE			VERTICAL RELATIVE			LATERA	
	DISPL	VEL	ACCEL	DISPL	VEL	ACCEL	DISPL	
1	0.445E 00	0.231E 00	0.126E 00	0.123E 01	0.820E 00	0.587E 00	0.369E-04	0.22
2	0.130E 01	0.602E 00	0.290E 00	0.180E 01	0.116E 01	0.819E 00	0.697E-04	0.37

LOCATION NO. 7

R.M.S. R E S P O N S E S

WAVE SPECTRUM	VERTICAL ABSOLUTE			VERTICAL RELATIVE			LATERA	
	DISPL	VEL	ACCEL	DISPL	VEL	ACCEL	DISPL	
1	0.445E 00	0.231E 00	0.126E 00	0.123E 01	0.820E 00	0.587E 00	0.434E-04	0.26
2	0.130E 01	0.602E 00	0.290E 00	0.180E 01	0.116E 01	0.819E 00	0.814E-04	0.44

LOCATION NO. 8

R.M.S. R E S P O N S E S

WAVE SPECTRUM	VERTICAL ABSOLUTE			VERTICAL RELATIVE			LATERA	
	DISPL	VEL	ACCEL	DISPL	VEL	ACCEL	DISPL	
1	0.438E 00	0.226E 00	0.123E 00	0.124E 01	0.822E 00	0.587E 00	0.264E-04	0.15
2	0.129E 01	0.597E 00	0.287E 00	0.181E 01	0.117E 01	0.821E 00	0.512E-04	0.27

FIGURE 9

SHIP SPEED 15.0 Knots

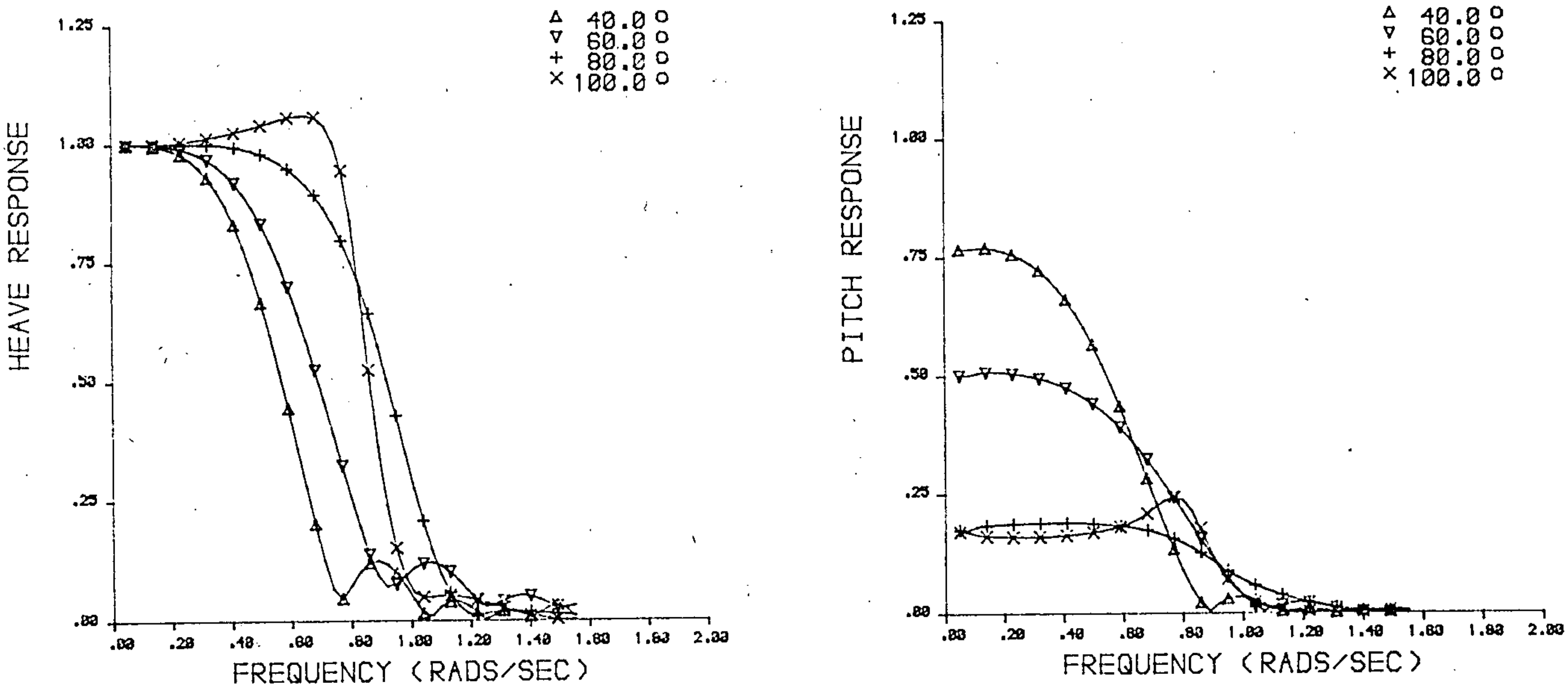


FIGURE 10

SHIP SPEED 15.0 Knots

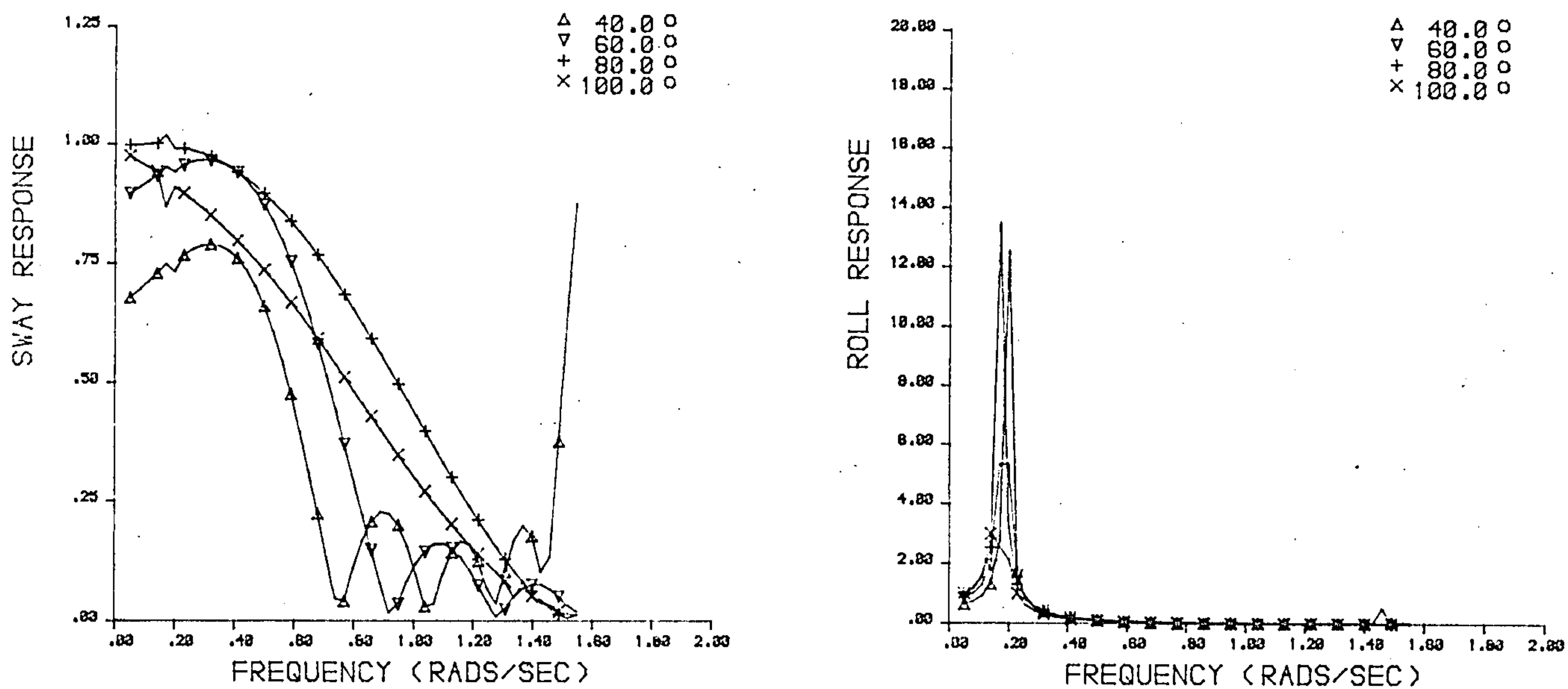
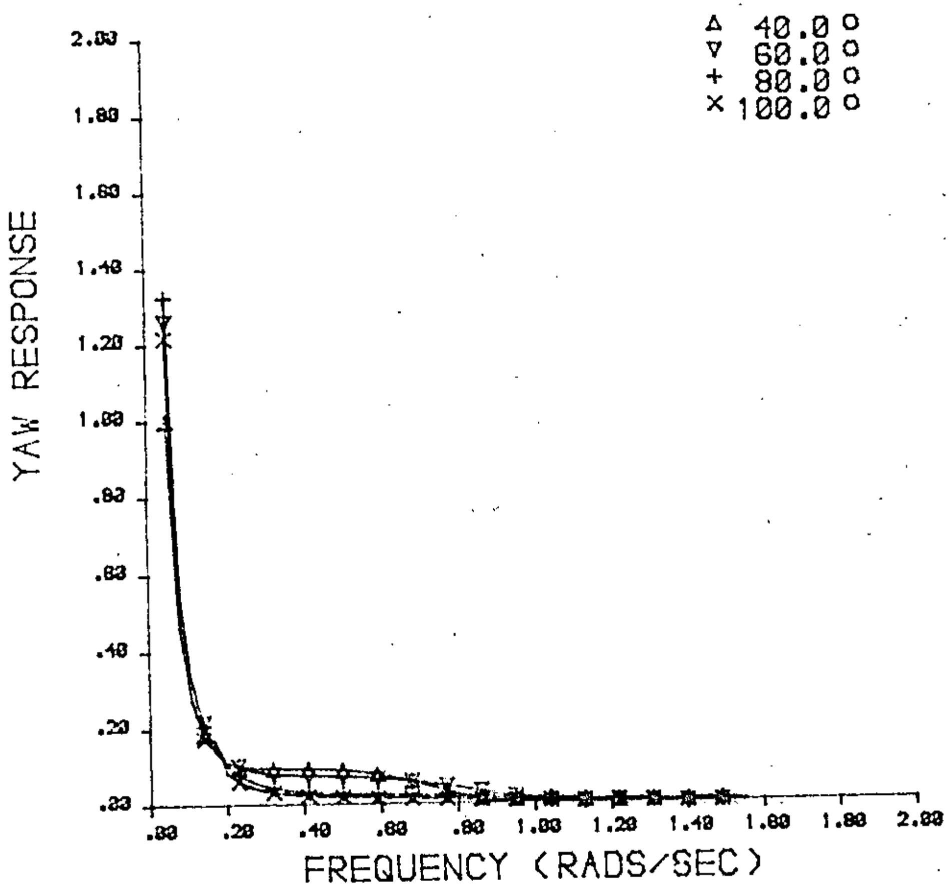


FIGURE 11

SHIP SPEED 15.0 Knots



APPENDIX A

All the computer statements, in capitals, must be followed by return.

1) Running the general program GENERATE, type

```
FRNH GENERATE
```

2) To run the total motions package alone type

```
FRNH TOTAL = (NWARN)
```

3) To run the graphics package type

```
FRNH GRAF1 = (NWARN,ULIB)LIBRARY/GINOGRAF;LIBRARY/GINO-F
```

4) To run the vertical motions package

```
FRNH SHIP = (NWARN)
```

5) To run the laterals motions package

```
FRNH ROLL = (NWARN).
```

APPENDIX B

Remember the difference between real and integer numbers

Real numbers require a decimal point

Integer numbers no decimal point

Where there is a limit on a number of conditions, say speeds, if the user specifies more than the maximum, then the program proceeds to ask for the data again until the number chosen by the user is equal to or less than the maximum.

With all the program input, wait until the = sign appears after the phrase before inputting the number or variable. After typing the number press the return key.

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
1	Title used to identify ship files, called generic file name (6 characters)	Alpha Numeric	Yes	Yes	
2	Control variable allowing re-use of ship already defined on file	Integer	Yes	Yes	New ship or old (if old got to input no 125)
3	Title, That is printed on output (80 characters max)	Alpha Numeric	Yes	Yes	
4	Date, This is output at top of each output page 12 characters	Alpha Numeric	Yes	Yes	
5	Units, Either metric units (tonnes,metre,sec) or Imperial (tons, feet,secs)	Integer	Yes	Yes	
6	Displacement (Tonnes, Tons)	Real	Yes	Yes	
7	Length (m or ft) Waterline length	Real	Yes	Yes	
8	Calculation Type Vertical only (0) Lateral only (2) Both (1)	Integer	Yes	Yes	
9	VCG about waterline (m)	Real	No	Yes	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
10	Roll radius of gyration ÷ beam	Real	No	Yes	see input 12
11	Yaw radius of gyration ÷ LWL	Real	No	Yes	If unknown use 0.25
12	Roll natural frequency (rad/sec)	Real	No	Yes	either 10 or 12 is specified the other is zero. Also the added moments of inertia is lumped with ship inertia
13	Metacentric height (m or ft)	Real	No	Yes	If not calculated prog. calculates from section data. Not corrected for internal surfaces.
14	Longitudinal radius of gyration ÷ LWL	Real	Yes	No	lateral only go to input 23
15	Display output results in dimensional or non-dimensional form	Integer	Yes	No	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
16	Calculation Type; Heave and Pitch only, using summary conditions of mass distribution, or from input mass distribution or heave, pitch, bending moment and shear force from mass distribution.	Integer	Yes	No	
17	Number of stations (only if vertical motions being calculated)	Integer	Yes	No	Only if input 8 is O
18	Beam — for each of the sections the beam draft, sectional area coefficient are required at <u>equal</u> intervals from the F.P. (number 1) to the aft perpendicular (number 21)	Real	Yes	No	Only if input 8 is O
19	Draft	Real	Yes	No	
20	Sectional area coefficient	Real	Yes	No	
21	sectional, mass — only if the bending moments and shear force are required	Real	Yes	No	Only if input 16 is not O
22	Long term statistics package and control of output when spectra are used.	Integer	Yes	No	
23	Number of Stations — 21 equally spaced stations, 1 is F.P., 21 is aft 19 is no bulb, no cruiser stern 20 bulb <u>or</u> cruiser stern 21 bulb <u>and</u> cruiser stern	Integer	Yes	Yes	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
24	EDDY making characteristics of each station 0 if section not liable to produce eddies as ship rolls 1 for V or U usually far forward 2 for triangular shapes aft on cruiser sterns 3 for very full sections	INTEGER	NO	YES	
25	horizontal (m or ft) :	REAL	YES	YES	only required for vertical if input 8 is 1.
26	waterline (m or ft) above baseline for each section at 8 points, up to load waterline	REAL	YES	YES	
27	LCG from midships (m or ft)	REAL	YES	YES	only if input 21 is 0
28	wave force calculation type for lateral motions either a long wave approximation or the total solution	INTEGER	NO	YES	if total is selected calc-ulation time is doubled
29	Printout of the two dimensional hydrodynamic properties (0) or not (-1)	INTEGER	YES	YES	
30	Number of ship speeds (maximum 10)	INTEGER	YES	YES	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
31	Speed in knots (for each of input 30) start at lowest, work in ascending order to highest	real	Yes	Yes	
32	Initial wave angle in degrees	real	Yes	Yes	
33	Final wave angle in degrees	Real	Yes	Yes	
34	Increment that is used to get from input 32 to input 33 (N.B. a total of 25 wave angles only are allowed).	Real	Yes	Yes	If 32 = 33 then this is ignored
35	Number of wave frequencies (max of 51)	Integer	Yes	Yes	
36	Initial wave frequency (RAD/SEC)	Real	Yes	Yes	work from lowest wave frequency to
37	Final wave frequency (RAD/SEC)	Real	Yes	Yes	highest wave freq-uency
38	Control mechanisms (in lateral motions only) type 0 No water tanks or fins 1 Fins only, 2 tanks only	Integer	No	Yes	
39	Sectral Type, 1, Pierson-Moskowitz 2, ITTC Two Parameter, 3 JONSWAP (ISSC Approx)	Integer	Yes	Yes	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
40	Number of spectra (Maximum of 10)	Integer	Yes	Yes	
41	Significant wave height (m or ft) for each specified spectra	Real	Yes	Yes	
42	Mean wave period (T_o)	Real	Yes	Yes	If input 39 is 2 or 3 only
43	Wave spreading of the spectra Cosine Spreading Power (even)	Integer	Yes	Yes	Go to input 99 if vertical only
44	Number of bilge keel parts	Integer	No	Yes	maximum of 5
45	First station spanned by bilge keel I	Integer	No	Yes	
46	Number of stations spanned by bilge keel I	Integer	No	Yes	
47	Offset of each bilge keel point at each station I	Real	No	Yes	See fig. 2 for
48	Waterline of each bilge keel point at each station I	Real	No	Yes	for clarification
49	bilge keel breadth at this station I	Real	No	Yes	also 47,48 must
50	bilge keel length at this station I	Real	No	Yes	be included in the values 25,26 at that station.
51	X co-ordinate of skeg point meeting hull (in station)	Real	No	Yes	see fig. 3 for clarification if no skeg put zeros

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
52	Skeg breadth (m, or ft)	Real	No	Yes	see fig. 3 for clarification, if no skeg put zeros
53	Skeg length (m, or ft)	Real	No	Yes	
54	Number of fin pairs	Integer	No	Yes	if input 38 is not 1 go to input
55	Normal fin angle used for bilge fin interference	Real	No	Yes	
56		Real	No	Yes	
	For each of the fins the following control coefficients				
57	Roll amplitude gain (deg/deg)	Real	No	Yes	
58	Roll velocity gain (deg/deg.s)	Real	No	Yes	
59	Roll acceleration gain (deg/deg.s^2)	Real	No	Yes	
60	Demand amplitude gain (deg/deg)	Real	No	Yes	
61	Demand velocity gain (deg/deg.s)	Real	No	Yes	
62	Demand acceleration gain (deg/deg.s^2)	Real	No	Yes	
63	Servo angle coefficient (deg/deg)	Real	No	Yes	
64	Servo velocity coefficient (deg/deg.s)	Real	No	Yes	
65	Servo acceleration coefficient (deg/(deg.s^2))	Real	No	Yes	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
66	X co-ordinate of foil number I (stations)	Real	No	Yes	
67	Y co-ordinate of foil number I (m or ft)	Real	No	Yes	if lift curve slope is unknown a value is calculated in the program
68	Z co-ordinate of foil number I (m or ft)	Real	No	Yes	
69	Span of foil I (m or ft)	Real	No	Yes	
70	Root chord of foil I (m or ft)	Real	No	Yes	
71	Tip chord of foil I (m or ft)	Real	No	Yes	
72	Lift curve slope of foil I (rad^{-1})	Real	No	Yes	figure 4 typifies the arrangement
73	Dihedral angle of foil I (deg)	Real	No	Yes	
74	Number of propeller shafts (Max 2)	Integer	No	Yes	
75	X coordinate of shaft bracket (stns)	Real	No	Yes	
76	Y coordinate of shaft bracket (m or ft)	Real	No	Yes	As figure 4 if the shaft brackets outboard is input first
77	Z coordinate of shaft bracket (m or ft)	Real	No	Yes	
78	Span of shaft bracket (m or ft)	Real	No	Yes	
79	Root chord of shaft bracket (m or ft)	Real	No	Yes	
80	Tip chord of shaft bracket (m or ft)	Real	No	Yes	
81	Lift curve slope of shaft bracket (rad^{-1})	Real	No	Yes	
82	Dihedral angle of shaft bracket (deg)	Real	No	Yes	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
83	X coordinate of rudder stock (stns)	Real	No	Yes	if Y=O then single
84	Y coordinate of rudder stock (m or ft)	Real	No	Yes	rudder
85	Z coordinate of rudder stock (m or ft)	Real	No	Yes	otherwise program
86	Rudder span (m or ft)	Real	No	Yes	assumes twin rudders
87	Rudder Root chord (m or ft)	Real	No	Yes	
88	Rudder Tip Chord (m or ft)	Real	No	Yes	
89	Rudder lift curve slope (rad^{-1})	Real	No	Yes	
90	longitudinal length of anti-rolling tank (m or ft)	Real	No	Yes	if IFT is not equal to 2 go to
91	Width of tank connection duct (m or ft)	Real	No	Yes	input number 98
92	Bottom width of tank vertical leg (m or ft)	Real	No	Yes	
93	Average fluid depth in tank vertical leg (m or ft)	Real	No	Yes	See figure 5 for clarification
94	Inclination of outside wall of tank vertical leg (m or ft)	Real	No	Yes	
95	Height of tank connecting duct (m or ft)	Real	No	Yes	
96	X co-ordinate of tank (stns)	Real	No	Yes	
97	Tank fluid density ($tonnes/m^3$ or $tons/ft^3$)	Real	No	Yes	
98	Tank valve resistance coefficient	Real	No	Yes	see ref (3) fig. 8

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
99	First station for bending moment calculations	Integer	Yes	No	only if record 16 is none zero
100	Last station for bending moment calculations	Integer	Yes	No	
101	Increment for range of input 99 to input 100	Integer	Yes	No	
102	Long term statistics package 0 gives no call, 1 allow calculation of motions due to heave and pitch alone at up to 21 stations 2 calls the long term statistics package	Integer	Yes	No	if this is zero go to input number 116
103	Number of stations for motions calculations	Integer	Yes	No	
104	Station numbers for each of (103) stations	Integer	Yes	No	
105	Number of stations for slamming assessment package	Integer	Yes	No	only if (102)=2
106	Station numbers for each of (105) stations (all these must be in list (04)	Integer	Yes	No	
107	Number of probability values (I)	Integer	Yes	No	MAX of 10
108	Probability of slamming I	Real	Yes	No	
109	Probability of wetness I	Real	Yes	No	
110	Probability of acceleration I	Real	Yes	No	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
111	Sinkage at speed number I	Real	Yes	No	one for each
112	Trim at speed number I	Real	Yes	No	ship speed
113	Freeboard at station I	Real	Yes	No	for each of input (105) see equation on page 1 appendix B
114	Pressure for slamming pressure calculation at station I	Real	Yes	No	
115	Acceleration level at station I for assessment of	Real	Yes	No	
116	Total motion calculations positions maximum of 10 points	Integer	Yes	No	if zero go to input (120)
117	X coordinate of position I (stn)	Real	Yes	Yes	see figure 5
118	Y coordinate of position I (m or ft)	Real	Yes	Yes	for direction
119	Z coordinate of position I (m or ft)	Real	Yes	Yes	
120	Time series calculation 0 for no call 1 to call	Integer	Yes	Yes	N.B. not operative yet
121	Plot the output results (1) or not (0)	Integer	Yes	Yes	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
122	Save the two dimensional properties (1) or not (O). N.B. it is recommended that you save these results as it saves considerable time, especially in the lateral mode when re-running ship data	Integer	Yes	Yes	END OF DATA
123	Modify any data	Integer	Yes	Yes	if no; no more data! Program now runs your data!
	In all the questions that follow, the program will automatically print out the present values of the variables, and then pose the question as to whether you wish to change these values. If the variable is to be changed then the new values follow those when previously input.				
124	Change date	Integer	Yes	Yes	only if
125	Change title	Integer	Yes	Yes	123 is YES
126	Change speeds	Integer	Yes	Yes	
127	Change wave headings	Integer	Yes	Yes	
128	Change wave frequencies	Integer	Yes	Yes	
129	Change displacement	Integer	Yes	Yes	
130	Change LCB	Integer	Yes	Yes	
131	Change waterlines and offsets by section	Integer	Yes	Yes	
132	Change spectrum type	Integer	Yes	Yes	
133	Change number of spectra	Integer	Yes	Yes	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
134	Change spectral definition	Integer	Yes	Yes	
135	Change spectral spreading function	Integer	Yes	Yes	
136	Change HCG,Roll natural frequency, yaw natural frequency, roll radius of gyration and minimum GM	Integer	Yes	Yes	
137	Change the printout option of the two dimensional properties	Integer	Yes	Yes	
138	Change the number of positions where total motions are calculated	Integer	Yes	Yes	
139	Graphical output	Integer	Yes	Yes	
140	Calculation type, vertical; vertical and lateral; lateral	Integer	Yes	Yes	
141	If new two dimensional properties are being calculated; save the output files or not	Integer	Yes	Yes	
142	Time series simulation	Integer	Yes	Yes	Not implemented yet

APPENDIX C

The following files are generated by the various programs.

If the generic file name is XXXXXX

REGEN

No.	Filename	Program	
11	XXXXXXLD	ROLL	(Lateral)
12	XXXXXXVD	SHIP	(Vertical)
21	XXXXXXLT	ROLL	(Lateral)
22	XXXXXXVT	SHIP	(Vertical)
31	XXXXXXGL	ROLL	(Lateral)
32	XXXXXXGV	SHIP	(Vertical)
33	regular response results	ROLL	(Lateral)
34	regular response results	SHIP	(Vertical)
37	statistical responses from TOTAL	TOTAL	
38	XXXXXXTO	TOTAL	
7	Dummy channel	GRAF	

Channels 33,34,37 are used to write the data to which has been generated by the various modules. These data files are output to the line printer. Thus the user requires no knowledge of how to print files. These three files are dummy files and are only generated at runtime. They are removed from the users catalogue at the end of the job.

APPENDIX D

Module Total

This program can take the data positions as specified when building the data file or have new values input. There is a minimum of data required.

1) Generic file name (6 characters) as used before.

2) Change the positions? (integer)

If this is zero it uses the values input from GENERATE

If you want to change these values, then put the value of new position you require (e.g. 7) up to a maximum of 10.

The computer then asks for the X,Y,Z values as defined in the input to GENERATE.

Typical output is shown in figure 8.

Appendix E

<u>GRAF</u>

The graphics module requires only four input values.

1) The generic filename (6 characters).
2) Whether to plot with speed or wave heading as a constant.
3) The output device type, either the Tektronix type graphics terminal or the HP7470A plotter.
4) If the output device is the HP7470A, then the terminal will print a message concerning channel 7. When the word <u>FUNCTION ? appears, press the return key</u>.

The output from this program is in pairs of responses, e.g. Pitch and Heave, Sway and Roll, with Yaw alone.

When one pair, or the Yaw is finished, the terminal will display a message to press any key when the plotter has had a new piece of paper inserted. A typical output is given in figures 9, 10 and 11.

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BY P.A. WILSON

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SEAKEEPING PROGRAMS

1. INTRODUCTION

With the introduction of an interactive service on a mainframe University computer it became quickly apparent that the department's ability to perform seakeeping calculations quickly and succinctly was lacking. To rectify this deficiency the two suites of programs (refs 1,2) have been implemented on the Honeywell 6080.

Both of these programs require extensive input data where mistakes are easily made. To overcome this problem a pre-processing program has been written which asks for all the data by questions on the visual display unit (V.D.U.). This program also generates the data files for the lateral and the vertical motion program modules.

Also with the department acquirement of graphics terminals and Hewlett Packard plotters that are able to plot on-line from the Honeywell 6080, there was an obvious need for a graphics program. This program is capable of being run by the pre-processing program or alone.

A further module has been written that allows the total motion and relative total motion to the waye system at any point in or outside the ship. This module is also capable of being run by the pre-processing program or alone.

In all these program modules the user does not have to know anything about the HOneywell operating system. All data files are automatically generated as is the printing of the output files. It is hoped that the programs have been written in a way that makes the user at ease with the system and not battling to understand the computer.

2. PROGRAM MODULES

There are five program modules in the seakeeping suite.

A) Generate.

This is the main control program that generates data files from the input data that the user types at the V.D.U. It also allows modification of most of this input data once the data files have been created.

The other main role of this program is to control the data flow between the other four program modules.

Most questions concerning the input of data concern a choice. The questions are answered by typing a number. Since all the programs are written in FORTRAN, a distinction between number types is required. For example if the ship displacement is required a value of 10000 tonnes may be required. This value must be input with a decimal place i.e. as 1000000nnotl00000.

Where the answers to questions are required, a number is required, for example a one, then that value is typed as 1 not as 1.0.

The number with a decimal is called a real number, the number without a decimal is called an integer. It is important to acknowledge this difference since it can have drastic effects especially when a real number is to be input when an integer is actually input. At the end of the report a list of the input data is given which types every input variable.

B) Vertical Plane Motions (Heave and Pitch).

This program is run automatically by module (a). It takes as input a data file generated by (a) and calculates all the two dimensional hydrodynamic properties that are required to solve the frequency equations of motion. It also performs single spectral calculations on the two rigid body motions either allowing long crested seas or short crested seas.

If the user has specified weight as input, the module also calculates the vertical bending moments and shear forces, at the user chosen points.

One final capability of the program is the calculation performance of a design in head seas by a probabilistic approach to the relative motion, wetness and acceleration. This enables the designer the capability of determining a limiting speed envelope for a given sea state.

C) <u>Lateral Plane Motions (Roll, Sway and Yaw)</u>

This program is run automatically by module (a) taking as input a data file also generated by module (a). It calculates the two dimensional properties of the ship sections for use in the frequency analysis of the ships response to wave. With the user specified spectral composition, it is possible to determine preliminary statistical ship responses either in long or short crested seas.

D) <u>Graphical Output</u>

This program module allows the response curves of the plotted on the Hewlett Packard 7470A A4 plotter. The results are always plotted as non-dimensional values. The heave, and sway are non-dimensionalised with respect to wave amplitude. The angular motions, pitch, roll and yaw with respect to wave slope. The wave slope is the wave amplitude divided by wave length, either in degrees or radians.

There is a choice as to which variable is used as the constant factor, either heading or ship speed. The resulting curves are presented two graphs per side of A4. Thus heave and pitch appear on one sheet, roll, sway on another, with the yaw graph on one sheet of A4.

The actual spectra that have been used in the program are also plotted on the HP7470A plotter.

E) Total Motions

This program module is of use in the calculation of the coupled motion, velocity and acceleration at any point within the ship. The module allows the vertical and lateral plane responses to be added in the correct vector sense. Absolute vertical and lateral responses are calculated as well as the relative motion in the vertical plane with respect to the wave system.

All the responses are dealt with on a statistical basis allowing long crested as well as short crest seaways to be considered.

It is normal only to calculate the responses of a ship from following seas to head seas and not bother with the symmetrical responses past head seas and back to following seas. The need for the responses in ~~this~~ the other half of the polar diagram is important when coupling the responses, particularly when the point is off the centre line. In this case the module calculates an equivalent point off the centreline on the other side of the centreline.

3. RUNNING THE PROGRAMS

A flow chart of the basis data highways between the different modules is given in figure 1. It will be noticed that the ~~regen~~ GENERATE program controls the whole suite of programs. It issequally possible to run any one of these program modules as a 'stand alone program'. All the programs are in uncompiled form on the Honeywell 6080 under user identity SII001. Each program is in uncompiled FORTRAN, seaeach run of the module has the overhead in time of the compilation of the source code. This has not proved to be a handicap, even at the most severely congested times.

Details of the running of the program is found in Appendix A.

Of the five modules of program two may be chosen to be run at subsequent times to the generation of the parficular data files. The graphics package may be one, because of the length of time required for plotting each A4 graph is of the order of 5-10 minutes, depending upon the machine's state of readiness. This is sometimes inconvenient because the plotter pen may be left in the down position, leading to an ink blob on the graph. Thus it is often more convenient to choose to graphy plot on the HP7470 at a later time.

The other module that may be utilised at a later date is the TOTAL motions package. This is because there is a limit of only 10 positions along the length that the motions can be calculated at. Thus for instance if twenty positions motions are required then two separate runs are required. The first ten positions would be run during the initial run of REGEN, followed by a later run with the second set of ten values.

Typical run times are dependent upon the particular combination of headings, speeds and spectra chosen. There is in both modules b, and c a constant calculation time for ~~calculation~~ generation of the two dimensional hydrodynamic properties. The times for the lateral motions calculation are much longer because of the need to calculate a significant roll angle amplitude to calculate the damping (see ref. 1). A quicker method of calculation is the optimum value has now been programmed.

The calculation time for the mode TOTAL is short, of the order of one minute for one speed, Nine headings and one spped.

Input to the programs are summarised in the appendices. Typical output from the programs are also listed together with a typical graph plot.

4 References

1. Theory and Computer Program for Calculation of the Lateral Motion of a Ship, P.A. Wilson, SSSU 6/81, April 1981.

2. Users Manual of Program AEW2
   Prediction of Vertical Ship Motions in Regular and Irregular Waves, P.A. Wilson, Ship Science Report No. 2, 1976.

3. Roll Stabilization Investigation for the Guided Missile Frigate FFG-7, DTNSRDC Ship Prediction Department Report SPD 495 1976.

5 List of Figures

APPENDIX A

All 1900 computer statements, in capitals, must be followed by return

1) Running the general program ~~REGEN~~, type GENERATE

GENERATE tab → FRNH ~~REGEN~~ ~~followed by return.~~

2) To run the total motionsppackage alone type

FRNH TOTAL = (NWARN) ~~followed by return.~~

3) To run the graphics package type

1 FRNH GRAF~~X~~ = (NWARN,ULIB)LIBRARY/GENOGRAF;LIBRARY/GINO-F

4) To run the vertical motions package

FRNH SHIP = (NWARN)

5) To run the laterals motions package

H FRN~~X~~ ROLL = (NWARN).

APPENDIX B

Remember the difference between real and integer numbers

Real numbers reqquire a decimal poinnt

Integer numbers no decimal point

Where there is a limit on a number of conditions, say speeds, ôf the user specifies more than the maximum, then the program proceeds to ask for theddata again until the number chosen by the user is equal to or less than the maximum.

underline

With all the program input, wait until the = sign appears after the phrase before inputting the number or variable.

After typing the number press the return key

Swap these two around

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
2	Control variable allowing re-use of ship already defined on file	Integer	Yes	Yes	New ship or old (if old got to input no 125)
1	Title used to identify ship files, called generic file name (6 characters)	Alpha Numeric	Yes	Yes	
3	Title, That is printed on outppt (80 characters) max	Alpha Numeric	Yes	Yes	
4	Date, This is output at top of each output page 12 characters	Alpha Numeric	Yes	Yes	
5	Units, Either metric units (tonees,metre,sec) or Imperial (tons, feet,secs)	Integer	Yes	Yes	
6	Displacement (Tonnes, Tons)	Real	Yes	Yes	
7	Length ~~(M,FT)~~ Small Waterline length	Real	Yes	Yes	
8	Calcuation Type Vertical only (0) Lateral only (2) Both (1)	Integer	Yes	Yes	
9	VCG about waterline (m)	Real	No	Yes	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
10	Roll radius of gyration ÷ beam	Real	No	Yes	see input 12
11	Yaw radius of gyration ÷ LWL	Raal	No	Yes	If unknown use 0.25
12	Roll natural frequency ~~(HZ)~~ (rad/s)	Real	No	Yes	either 10 or 12 is specified the other is aero. Also the added moments of inertia is lumped with ship inertia
13	Metacentric height (~~m~~ or ft)	Real	No	Yes	X → If not calculated prog. calculates from section data. Not corrected for internal surfaces.
14	Longitudinal radius of gyration ÷ LWL	Real	Yes	No	go to lateral only got o input 23
15	Display output results in dimensional or non-dimensional form	Integer	Yes	No	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
16	Calculation Type, Heave and Pitch only, using summary conditions of mass distribution, or from input mass distribution or heave, pitch, bending moment and shear force from mass distribution.	Integer	Yes	No	
17	Number of stations (only if vertical motions being calculated)	Integer	Yes	No	Only if input 8 is 0
18	BEAM (Small) — for each of the sections the beam draft, sectional area coefficient are required at equal intervals from the F.P. (number 1) to the aft perpendicular (number 21)	Real	Yes	No	Only if input 8 is 0
19	DRAFT	Real	Yes	NO	
20	Sectional area coefficient	Real	Yes	NO	
21	sectional, mass — only if the bending moments and shear force are required	Real	Yes	NO	Only if input 16 is not 0
22	Long term statistics package and control of output when spectra are used.	Integer	Yes	No	
23 X	Number of Stations — 21 equally spaced stations, 1 is F.P., 21 is aft 19 is no bulb, no cruiser stern 20 bulb or cruiser stern 21 bulb and cruiser stern CAP	Integer	Yes	Yes	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
24	EDDY making characteristics of each station 0 if section not liable to produce eddies as ship rolls 1 for V or U usually for forward 2 for triangular shapes aft on cruiser sterns 3 for very full sections	INTEGER	NO	YES	
25	horizontal (m); or ft	REAL	YES	YES	only required for vertical if input 8 is 1.
26	waterline (m) or ft above baseline for each section at 8 points, up to load waterline	REAL	YES	YES	
27	LCG from midships (m) or ft	REAL	YES	YES	only if input 21 is 0
28	wave force calculation type for lateral motions either a long wave approximation or the total solution	INTEGER	NO	YES	if total is selected calculation time is doubled
29	Printout of the two dimensional hydrodynamic properties (0) or not (-1)	INTEGER	YES	YES	
30	Number of ship speeds (maximum 10)	INTEGER	YES	YES	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
31	Speed in knots (for each of input 30) start at lowest, work in ascending order to highest	real	Yes	Yes	
32	Initial wave angle in degrees	real	Yes	Yes	
33	Final wave angle in degrees	Real	Yes	Yes	
34	Increment that is used to get from input 32 to input 33 (N.B. a total of 25 wave angles only are allowed).	Real	Yes	Yes	If 32 = 33 then this is ignored
35	Number of wave frequencies (max of 51)	Integer	Yes	Yes	
36	Initial wave frequency (~~HZ~~ RAD/SEC)	Real	Yes	Yes	work from lowest wave frequency to
37	Final wave frequency (~~HZ~~ RAD/SEC)	Real	Yes	Yes	highest wave freq-uency
38	Control mechanisms (in lateral motions only) type 0 No water tanks or fins 1 Fins only, 2 tanks only	Integer	No	Yes	
39	Sectral Type, 1, Pierson-Moskowitz 2, ITTC ~~Tow~~ Two Parameter, 3 JONSWAP (ISSC Approx)	Integer	Yes	Yes	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
40	Number of spectra (Maximum of 10)	Integer	Yes	Yes	
41	Significant wave height (m or ft) for each specified spectra	Real	Yes	Yes	If input (BG) is 2 or 3 only
42	Mean wave period (T_0)	Real	Yes	Yes	If input (BG) 39 is 2 or 3 only
43	Wave spreading of the spectra Cosine Spreading Power (even)	Integer	Yes	Yes	GOTO INPUT 99 if vertical only
44	Number of bilge keel parts	Integer	No	Yes	maximum of 5
45	First station spanned by bilge keel I	Integer	No	Yes	
46	Number of stations spanned by bilge keel I	Integer	No	Yes	
47	Offset of each bilge keel point at each station I	Real	No	Yes	See fig. 2 for
48	Waterline of each bilge keel point at each station I	Real	No	Yes	for clarification
49	bilge keel breadth at this station I	Real	No	Yes	about47,48 must
50	bilge keel length at this station I	Real	No	Yes	be included in the values 25,26 at that station.
51	X co-ordinate of skeg point meeting hull (in station)	Real	No	Yes	see fig. 3 for clarification if no skeg put zeros

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
52	Skeg breadth (m, or ft)	Real	No	Yes	see fig. 3 for clarification, if no skeg put zeros
53	Skeg length (m, or ft)	Real	No	Yes	
54	Number of fin pairs	Integer	No	Yes	if input 38 is not 1 go to input
55	Normal fin angle used for bilge fin interference	Real	No	Yes	
56		Real	No	Yes	
	For each of the fins the following control coefficients				
57	Rollaamplitude gain (deg/deg)	Real	No	Yes	
58	Roll velocity gain (deg/degs)	Real	No	Yes	
59	Roll acceleration gain (deg/degs^2)	Real	No	Yes	
60	Demand amplitude gain (deg/deg)	Real	No	Yes	
61	Demand velocity gain (deg/degs)	Real	No	Yes	
62	Demand acceleration gain (deg/degs^2)	Real	No	Yes	
63	Servo angle coefficient (deg/deg)	Real	No	Yes	
64	Servo velocity coefficient (deg/degs)	Real	No	Yes	
	Servo acceleration coefficient (deg/(degs^2))	Real	No	Yes	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
66	X co-ordinate of foil number I (stations)	Real	No	Yes	
67	Y co-ordinate of foild number I (m or ft)	Real	No	Yes	if lift curve slope is unknown a value is calculated in the program.
68	Z co-ordinate of foild number I (m or ft)	Real	No	Yes	
69	Span of foil I (m or ft)	Real	No	Yes	
70	Root chord of foil I (m or ft)	Real	No	Yes	
71	Tip chord of foil I (m or ft)	Real	No	Yes	
72	Lift curve slope of foil I (rad^{-1})	REAL	No	Yes	figure 14 typifies the arrangement
73	Dihedral angle of foil I (deg)	Real	No	Yes	
74	Number of propeller shafts (Max 2)	Integer	No	Yes	
75	X coordinate of shaft bracket (stns)	Real	No	Yes	
76	Y coordinate of shaft bracket (m or ft)	Real	No	Yes	As figure 4 if the shaft brackets outboard is input first
77	Z coordinate of shaft bracket (m or ft)	Real	No	Yes	
78	Span of shaft bracket (m or ft)	Real	No	Yes	
79	Root chord of shaft bracket (m or ft)	Real	No	Yes	
80	Tip chord of shaft bracket (m or ft)	Real	No	Yes	
81	Lift curve slope of shaft bracket (rad^{-1})	Real	No	Yes	
	Dihedral angle of shaft bracket (deg)	Real	No	Yes	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
83	X coordinate of rudder stock (stns)	Real	No	Yes	if Y=O then single
84	Y coordinate of rudder stock (m or ft)	Real	No	Yes	rudder
85	Z coordinate of rudder stock (m or ft)	Real	No	Yes	otherwise program
86	Rudder span (m or ft)	Real	No	Yes	assumes twin rudders
87	Rudder Root chord (m or ft)	Real	No	Yes	
88	Rudder Tip Chord (m or ft)	Real	No	Yes	
89	Rudder lift curve slope (rad^{-1})	Real	No	Yes	
90	longitudinal length of anti-rolling tank (m or ft)	Real	No	Yes	if IFT is not equal to 2 goto input number 98
91	Width of tank connection duct (m or ft)	Real	No	Yes	
92	Bottom width of tank vertical leg (m or ft)	Real	No	Yes	
93	Average fluid depth in tank vertical leg (m or ft)	Real	No	Yes	See figure ~~four~~ 5 for clarfication
94	Inclination of outside wall of tank vertical leg (m or ft)	Real	No	Yes	
95	Height of tank connecting duct (m or ft)	Real	No	Yes	
96	X co-ordinate of tank (stns)	Real	No	Yes	
97	Tank fluid density ($tonnes/m^3$ or $tons/ft^3$)	Real	No	Yes	
98	Tank valve resistance coefficient	Real	NNo	Yes	see ref (3) fig. 8

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
99	First station for bending moment calculations	Integer	Yes	No	only if record 16 is none zero
100	Last station for bending moment calculations	Integer	Yes	No	
101	Increment for range of input 99 ~~100~~ to input 100	Integer	Yes	No	
102	Long term statistics package 0 gives no call, 1 allow calculation of motions due to heave and pitch alone at up to 21 stations 2 calls the long term statistics package	Integer	Yes	No	if this is zero goto input number 116
103	Number of stations for motions calculations	Integer	Yes	No	
104	Station numbers for each of (103) stations	Integer	Yes	No	
105	Number of stations for slamming assessment package	Integer	Yes	No	only if (102)=2
106	Station numbers for each of (105) stations (all these must be in list (04)	Integer	Yes	No	
107	Number of probability values (I)	Integer	Yes	No	MAX of 10
108	Probability of slamming I	Real	Yes	No	
109	Probability of wetness I	Real	Yes	No	
110	Probability of acceleration I	Real	Yes	No	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
111	Sinkage at speed number I	Real	Yes	No	one for each
112	Trim at speed number I	Real	Yes	No	ship speed
113	Freeboard at station I	Real	Yes	No	for each of input (105)
114	Pressure for slamming pressure calculation at station I	Real	Yes	No	see equation on page 1 appendix B
115	Acceleration level at station I for assessment of	Real	Yes	No	
116	Total motion calculations positions maximum of 10 points	Integer	Yes	No	if zero go to input (120)
117	X coordinate of position I (stn)	Real	Yes	Yes	see figure 5
118	Y coordinate of position I (m or ft)	Real	Yes	Yes	for direction
119	Z coordinate of position I (m or ft)	Real	Yes	Yes	
120	Time series calculation 0 for no call 1 to call	Integer	Yes	Yes	N.B. not operative yet
121	Plot the output results (1) or not (0)	Integer	Yes	Yes	

INPUT NO.	DESCRIPTION	VARIABLE TYPE	VERTICAL	LATERAL	COMMENTS
122	Save the two dimensional properties (1) or not (O) N.B. it is recommended that you save these results as it saves considerable time, especially in the lateral mode when re-running ship data	Integer	Yes	Yes	END OF DATA
123	Modify any data	Integer	Yes	Yes	if no; normore data! PROGRAM NOW RUNS YOUR DATA!
	In all the questions that follow, the program will automatically print out the present values of the variables, and then pose the question as to whether you wish to change these values. If the variable is to be changed then the new values follow those when previously input.				
124	Change date	Integer	Yes	Yes	only if 123 is YES
125	Change title	Integer	Yes	Yes	
126	Change speeds	Integer	Yes	Yes	
127	Change wave headings	Integer	Yes	Yes	
128	Change wave frequencies	Integer	Yes	Yes	
129	Change displacement	Integer	Yes	Yes	
130	Change LCB	Integer	Yes	Yes	
131	Change waterlines and offsets by section	Integer	Yes	Yes	
132	Change spectrum type	Integer	Yes	Yes	
133	Change number of spectra	Integer	Yes	Yes	

INPUT NO.	DESCRIPTION	VARIABLE type	VERTICAL	LATERAL	COMMENTS
134	Change spectral definition	Integer	Yes	Yes	
135	Change spectral spreading function	Integer	Yes	Yes	
136	Change HCG,Roll natural frequency, yaw natural frequency, roll radius of gyration and minimum GM	Integer	Yes	Yes	
137	Change the printout option of the two dimensional properties	Integer	Yes	Yes	
138	Change the number of positions where total motions are calculated	Integer	Yes	Yes	
139	Graphical output	Integer	Yes	Yes	
140	Calculation type, vertical; vertical and lateral; lateral	Integer	Yes	Yes	
141	If new two dimensional properties are being calculated; save the output files or not	Integer	Yes	Yes	
142	Time series simulation	Integer	Yes	Yes	Not implemented yet

APPENDIX C

The following files are generated by the various programs.

If the generic file name is XXXXXX

<u>REGEN</u>

No.	Filename	Program	[redacted]
11	XXXXXXLD	ROLL	(Lateral)
12	XXXXXXVD	SHIP	(Vertical)
21	XXXXXXLT	ROLL	(Lateral)
22	XXXXXXVT	SHIP	(Vertical)
31	XXXXXXGL	ROLL	(Lateral)
32	XXXXXXGV	SHIP	(Vertical)
33	regular response results	ROLL	(Lateral)
34	regular response results	SHIP	(Vertical)
37	statistical responses from TOTAL	TOTAL	
38	XXXXXXTO	TOTAL	
7	Dummy channel	GRAF	

Channels 33,34,37 are used to write the data to which ~~is~~ has been generated by the various modules. These data files are output to the line printer. Thus the user requires no knowledge of how to print files. These three files are dummy files and are only generated at runtime. They are removed from the users catalogue at the end of the job.

APPENDIX D

Module Total

This program can take the data positions as specified when building the data file or have new values input. There is a minimum of data required.

1) Generic file name (6 characters) as used before.

2) Change the positions? (integer)

If this is zero it uses the values input from ~~REGEN~~. GENERATE

If you want to change these values, then put the value of new positions you require (e.g. 7) up to a maximum of 10.

The computer then asks for the X,Y,Z values as defined in the input to ~~REGEN.~~ GENERATE

Typical output is shown in figure 1.

Appendix E

GRAF

The graphics module requires only four input values.

1) The generic filename (6 characters).
2) Whether to plot with speed or wave heading as a constant.
3) The output device type, either the Tektronix type graphics terminal or the HP7470A plotter.
4) If the output device is the HP7470A, then the terminal will print a message concerning channel 7. When the word FUNCTION ? appears, press the return key.

The output from this program is in pairs of responses, e.g. Pitch and Heave, Sway and Roll, with Yaw alone.

When one pair, or the Yaw is finished, the terminal will display a message to press any key when the plotter has ~~had~~ had a new piece of paper inserted. A typical output is given in figures ~~2,3 and 4.~~ ~~6 7~~

9 10 11