ISSN 0140 3818
SSSU 28

SEAKEEPING CALCULATIONS BY MICROCOMPUTER

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Ship Science Report No. 28

April 1987

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SEAKEEPING CALCULATIONS BY MICROCOMPUTER

This suite of computer programmes that is used to calculate various seakeeping responses and criteria of surface ships under the action of random seaways has been developed over a period of fourteen years by the Department of Ship Science at the University of Southampton and A.R.E. (H) at Haslar.

The programmes initially were developed to run using the language FORTRAN IV for use on various mainframe computers such as Prime, ICL, Honeywell, DEC and more recently IBM. Now the same suite of programmes have been transferred to a range of microcomputers. The operating system that is necessary to run these programmes is MSDOS or PCDOS. The language implementation has changed to FORTRAN 77, and in particular to that offered by Microsoft version 3.20. This compiler of this implementation of the language allows many different ways for the programme to run on the microcomputer.

The preferred method of use is to allow the programme to use the co-processor chip to handle the scientific calculations such as sine, exponentials etc. If the co-processor is not resident in the machine then the compiler mimics the scientific hardware but in software. It must be appreciated that the difference between the hardware and software versions is a factor of 3 in run times. If the software version is not invoked then the standard version of the progrmame is another factor of 3 to 4 times slower in terms of run times. Thus the hardware implementation can be up to 12 times quicker to run than a standard compilation of the programme.

The programmes are usually run from a menu that requires the user to select a single letter to run a particular module of the suite of programmes. Equally as with all MSDOS or PCDOS programmes it is possible to run a compiled programme by just typing the programme name. The actual programme names are given in the descriptions below. An advantage that the menu driven method has is that it returns to the menu after each module has been run.

All the programmes have been written to use the MSDOS method of accessing files i.e. a filename together with a three letter extension. An example might be FRED.EXA, note the use of the full stop (.) to link the filename to its extension. In the seakeeping suite of programmes the filename for a particular ship design will be called SHIPA for the rest of this manual. In each module the filename is termed the GENERIC filename. This means that when a directory of all files that exist on a particular disk is listed then a list of files with SHIPA together with up to 12 different file extensions will be found. Each module will require in general a set of files with a particular set of file extensions.

In each programme module a list of filenames is listed together with information about the form of each file. With this information it is possible to choose to list the file at the printer or monitor. Also it allows the interested programme user the ability to see the stages at which files are created. Files that can be printed or viewed on the monitor have been of the type FORMATTED denoted by F in the list. Files can also be UNFORMATTED, denoted by U in the file list in this manual. The need for different files is to save storage space on discs. Basically unformatted files occupy less storage space than formatted files.

Also included in the information about the files is either O for files that are OLD i.e. created in another module or N for NEW i.e. created in the module. Another letter is used to indicate where the data file is expected to be or expected to be written. S is used to indicate the SOURCE drive letter, T is used to indicate theTARGET drive letter. There is no real need for these drive names to be different.

Running the Programmes

The programmes are run from a series of batch files that are selected from a menu. The menu is loaded for the first time by typing MOTIONS, this is also a batch file i.e. the file extension name is .BAT. On subsequent occasions the menu reappears after a module has been completed. In the suite of programs there are eight different modules, each of which is described below. In each case a target drive letter is required as is a source drive letter. Usually the floppy disc drives A and B are sufficient.

MODULE A Data Input and Editing

This programme allows through a series of questions and answers, the generation of the two main data files that are required for the vertical motion and lateral motion modules. The module can be used to edit existing basic data files or to enter a totally new ship design. The type of information required of this module is the basic hydrostatic shape particulars together with if necessary, appendage information. The programme works logically through all the data for the modules, that has been selected. The quantity of data that is required is given in every detail in Ship Science report number 2/83 (5), including the type of variable since FORTRAN 77 requires the user of the programme to distinguish between data types Real and Integer.

The need to change data after a particular run is also catered for by this module, because it is possible to modify for example, the number of ship speeds, the wave angles and the spectral types. The major use of this facility is to take advantage in a re-run of data that has already been calculated i.e. the added mass and damping of the ship sections. These are termed the two dimensional properties (TDP's) of the ship. For the lateral motions the TDP's are calculated using the Frank Close Fit technique, which is fairly time consuming, but once calculated the results are stored in a file that can be read by the micro-computer on any number of subsequent occasions.

Thus users of the suite of programmes are strongly advised to take advantage of this reduction in run times whenever possible. It should be noted that if the vertical centre of gravity is changed for the lateral motions module, then the TDP's must be re-calculated. This module takes account of this fact and issues a message saying so on the monitor.

Data Filenames

SHIPA.DAT	F	N/O S	for vertical motions module
SHIPA.VER	F	N/O S	for vertical motions module
SHIPA.LAT	F	N/O S	for lateral motions module

For the inexperienced user of MSDOS and of this programme suite it can be easier to edit the data files using either a line editor such as EDLIN or a screen editor such as STEED. Great care should be taken if this approach is adopted. Details are given in appendix D .

Programme Name

GEN.EXE

MODULE B Vertical Motion

The theory that this module is based upon is given in all details in Ship Science Report Number 2 (1976) (9). The programme is strip theory based, in detail it is similar to SCORES(1). The original mainframe programme consisted of one module, this has now been split into three separate parts, each with a distinctly different role. Module B automatically runs all three sub-programmes for the user.

The first sub-module calculates the TDP's for the heave and pitch of the ship sections using Lewis forms. If previously these values have been calculated the values are read from the appropriate file and are then written to a file for the two subsequent modules to use.

The second sub-module calculates the response that are often termed the response amplitude operators (RAO's). These are calculated assuming a co-sinusoidal wave at midships for the range of wave frequencies, wave headings and ship speeds. The programmes uses the TDP's that have been previously calculated, for interpolation purposes. The TDP's have been calculated for a fixed set of non-dimensional wave encounter frequencies. The second module uses this data for its subsequent calculations.

The third sub-module calculates using the RAO's the statistical response of the ship in a set of user chosen spectra. The output of this module is typically the significant heave, and pitch always at the ship centre of gravity, for all combinations of ships heading and wave angles.

Data Filenames

SHIPA.DAT	F	O	S	Data file
SHIPA.TDP	U	N/O	T	TDP file
SHIPA.RES	U	N	T	Results for use for sub-modules
SHIPA.OUT	U	N	T	Regular wave response results (not for printing)
SHIPA.VRM	F	N	T	Irregular response statistics
SHIPA.GVT	U	N	T	Results for modules E, F
SHIPA.VIR	U	N	T	Not in use
SHIPA.VRS	F	N	T	Results file for printing .

The user at the start of module B has the choice of whether to print the results on a printer immediately or not. The results of the calculation are always sent to the computer monitor. Thus to have a subsequent hard copy of the irregular responses for example is done by typing

```
TYPE SHIPA.VRM > PRN
TYPE SHIPA.VRS > PRN
```

Programme Names

SHORT0.EXE
SHORT1.EXE
SHORT2.EXE

MODULE C Subjective Motion Calculation

This module is only applicable in head seas and this does not require that the data from the lateral motion programme module. Before running this module, module B must have been completed.

The subjective motion index (SM) is calculated using the statistic used in Andrew and Lloyd (2). Before using this module for high speed runs the article by Wilson (3) should be consulted.

The module allows the choice of the SM's being calculated at all the input stations or at specified points along the ship length. The longitudinal distance is always referred to in terms of stations, for instance a point may be a third of the way between stations 3/4 and 1.0.

Data filename

SHIPA.RES U O S results from module B

Programme name

SHORT4.EXE

MODULE D Lateral Motions

This programme calculates the three lateral plane responses of roll, sway and yaw together with any user chosen rudder or active fin motion. Note that there is no coupling of fin or rudder motion with the vertical plane responses. The theory behind this programme is described in detail in Ship Science Report Number 6/81 (10) and is based upon the work of Schmitke (4) and Salveson et al (11) . The damping of the lateral plane responses is taken into account via the bilge keels, skeg rudder and fins. The fins can either be passive or active. It is also possible to specify tanks to damp the rolling motion.

The programme calculates or reads from a file the TDP's then calculates the RAO's and finally computes the spectral statistics.

At the start of the module the user is allowed to chose to allow the calculation to iterate to a final solution or not.

The reason behind this choice is that some of the roll damping methods that have been programmed require the significant roll amplitude to be known at the start of the calculation.

The programme provides its own start up value for significant roll that is based on previous experience. After the RAO's have been calculated using the start up value of significant roll amplitude the actual amplitude can now be found in the standard manner. It is thus possible to compare the start up value with the calculated value, it is at this point the result of the users choice of answer is invoked. Thus if iteration is chosen then the calculated value is used for the roll damping calculations, the RAO's are re-calculated and a new significant roll amplitude is found. This process continues until the old and newly calculated values are within 2% of each other.

The error in the RAO's is estimated to not more than 10% in the worst case and is often far less. Thus it is usually sufficient to let the programme not iterate.

The basic data file has the long wave approximation for the method of approximation of the wave forces on the ship hull . It is recommended that this method is used if only for the simple expediency of speed of calculation ,since the long wave approximation is five times quicker than the total solution method . For further details see reference (10).

Data Filenames

SHIPA.LAT	F	O	S	Basic input data
SHIPA.LRS	F	N	T	Lateral results
SHIPA.LTP	U	N/O	T	Lateral TDP's
SHIPA.GLT	U	N	T	Results for modules E, F
SHIPA.LIR	U	N	T	Unused at present

Programme name

ONE.EXE

MODULE E Total Motion at a Point

Both modules B and D calculate the main ship responses at the ship's centre of gravity. To allow the calculation of the coupled motion at any other point in the ship requires the vector sum of the lateral and vertical motion to be calculated. The theory behind this module is given in Ship Science Report Number 29 (6) .

The programme user is allowed to input up to 10 points anywhere relative to the ship's centre of gravity. The point is referenced in stations for the longitudinal measure, in metres for the lateral measure relative to the fore/aft ship centre line and also in metres for the vertical measure from the underside of the keel (USK) .

Output from the programme is in spectral form i.e. root mean square values. The coupled vertical and lateral displacement, velocity and acceleration are calculated. Also the relative vertical displacement, velocity and acceleration of the ship to the random sea-way are also calculated and output. The use of these latter quantities is to allow the calculation of propeller emergence and deck wetness using a probabilistic method.

The programme also calculates the response of the coupled motion at a symmetric point in the ship to that input by the user. This point is symmetric with respect to the fore/aft ship centreline. In head or following seas the response of this point is identical to that of the input value. For any other heading the coupled responses will be different. The need to perform this calculation is only apparent if it is required that the coupled response at some point off the ship fore/aft centreline is required at all angles from head sea to following seas and the back to head seas. The normal calculations are only required from head to following seas the other wave directions on the other ship side will produce the same response of the ship centre of gravity. As already detailed above if the point is off the centreline then the symmetric value must also be calculated.

For details see Ship Science Report Number 31 (8) .

Thus if the results are output for a ship at 10 knots in waves from 0 degs to 180 degs at 30 degs intervals then the symmetric output values can be used for the wave angle range 360 degs to 180 deg in 30 deg steps. For example the response at 150 degs symmetric value is the response of the actual input point but at wave angle 210 degs and vice-versa.

The programme is also used to generate data for the time series module if the user prescribes that choice.

Data Filenames

SHIPA.GVT	U	O	S	Vertical responses
SHIPA.GLT	U	O	S	Lateral responses
SHIPA.OTT	F	N	T	Total motion results
SHIPA.TOT	U	N	T	Time series data file

Programme name

TOTAL.EXE

MODULE F Plotting Programme

This programme allows the user to plot various selected responses from previously calculated results onto a Hewlett Packard HP7470 or equivalent A4 or A3 plotter. The programme user is given information concerning the number of wave angles ship speeds and sea spectra that were used in the calculations. This information is necessary so that the user can choose the best method of plotting the results for any particular application.

The programme user is prompted to give an output filename . If there is a plotter attached to the serial port of the micro-computer then the device name of this port is the filename . In the case of RM NIMBUS the port name is COMB , in the case of IBM of equivalent machines it is likely to be COM1 or COM2 .

The user is then asked to decide which responses to plot, the choice is all the RAO's the spectral responses or both of these. Since it is likely that many ship speeds and wave headings results have been calculated the user is then asked to choose which variable ship speed or wave angle is to be kept constant. Thus for example the RAO's may have been selected for plotting together with ship speed as the graph constant. Thus the heave response curves will be produced in either dimensional or non-dimensional form so that the responses in heave will be superimposed for the range of wave angles. If there are more than four wave angles the programme splits the groupings into graphs with at most four lines. Thus for example the heave responses to the wave angles of 0, 30, 60 would be on one graph and 90, 120, 150, and 180 on a second graph.

Each A4 sheet of paper contains in the case of vertical motions heave and pitch graphs and for lateral motions roll and sway together with a second sheet which only contains the yaw response.

For the irregular response the abscissae are either ship speed or wave angle. For the regular responses the abscissae are wave frequency for all the graphs .

Data Filenames

SHIPA.GVT	U	O	S	Vertical responses
SHIPA.GLT	U	O	S	Lateral responses

Programme name

PLOTTING.EXE

MODULE G Time Series

The theory that this programme is based upon is described in Ship Science Report Number 30 (7). The programme requires that the total motion module is run first.
The user of the programme is allowed to choose which set of vertical motions are going to provide the limit condition to the performance of that particular part of the ship.

The theory outlined elsewhere produces from the RAO's of the point of interest the time series of that point in the sea spectra that have been used in the other calculations. The results of this calculation are the absolute vertical displacement, absolute vertical velocity and the absolute vertical acceleration time histories at the point.

There may be operational limitations on the performance of the ship in terms of any combination of any or all these three values. One particular use might be the operational envelope of performance of a helicopter landing on the flight deck whilst the ship is under way. It might be that the limitation to landing are the velocity and acceleration.

The user can input up to a maximum of five combinations of the three limits.

More details on the method and data required are found in the aforementioned Ship Science report.

The ouput from this module gives the time period when the mutual limit values have not been exceeded in two forms, which are sometimes called Quiescient periods the second method lists the actual quiescent periods.

Data Filename

SHIPA.OTT U O S Output from the Total motions module

Programme name

TIMES.EXE

MODULE H SUSTAINED SHIP SPEED

This module can be run only for head sea since the theory is based upon experiments performed in head seas .

The programme generates the variances at user specified points along the ships length that are then used to determine the probability of slamming , deck wetness or propeller emergence ,acceleration . The theory that this part of the calculation is based upon is Rayleighian i.e.

$$P(\ x>x0\ ) = e^{-x_o^2/2m_o}$$

The probability of slamming is based upon the work of Ochi . This requires the determination of a threshold velocity .The threshold velocity is used to calculate an impact pressure . In this version of the theory of Ochi the velocity is determined from the shape at a station one quarter of the ships LBP aft of the F.P.

The half beam of this station is used to compute the slamming pressure from the following formula ,

$$\text{pressure} = 0.0196\ \text{Beam/Beam}\ (@1/4)\ \sqrt{G\ \text{LBP}}$$

where Beam is the ships full beam

Beam(@1/4) is the half beam at 1/4 LBP from F.P.

G is gravitational constant

LBP is the ships length

The input to the programme is

1) Full beam
2) Number of places where the probablities are to be evaluated
3) Co-ordinates of these points
4) Freeboard of these points .
5) Half beam at 1/4 Lbp from F.P.
6) Acceleration level in m/sec/sec
7) Number of Probability combinations
8) Probability of slamming
9) Probability of wetness
10) Probability of acceleration exceedance

Output from the programme is grouped into four headings ,after the variance data has been calculated .

1) Slamming Limits

For each wave spectrum the maximum speed that the ship can sustain with the input level of slamming probability and at which postion this limit applies .

2) Wetness Limits

For each wave spectrum the maximum speed that the ship can sustain with the level of wetness probability and also at which station this limit applies .

3) Motion Limits

For each wave spectrum the maximum speed that the ship can sustain with the level of acceleration probability and also at which station this limit applies .

4) Overall Limits

From the three headings given above the summary of the lowest sustainable maximum ship speed is given for each wave spectrum and at which station this overall limit is applying.

It is necessary to have a wide range of ship speeds so that the programme can interploate the variance data with a high degree of accuracy . Thus it is suggested that the range of ship speeds at which the variance data is calculated should include a low value of say 1 knot .

Data Filenames

SHIPA.RES U O S Results file from Module B

Programme Name

SPEED.EXE

APPENDIX A

1. Raff, Programme SCORES Ship Structural Response in Waves SSC , 1972.

2. Lloyd, A.R.J.M. and Andrew R.N. Criteria for Ship Speed in Rough Weather 18th ATTC U.S. Naval Academy, 1967.

3. Wilson, P.A. The Effect of Truncation of Spectra on the Calculation of Subjective Motions, January 1981.

4. Schmitke,R.T. Swaying, Rolling and Yawing of Surface Ships S.N.A.M.E. 1978 ,28

5. Wilson, P.A. Online Seakeeping Calculations Ship Science Report number 2/83 June 1983

6. Wilson, P.A. Total Motions Programme Ship Science Report number 29 , April 1987

7. Wilson, P.A. Time Series Programme Ship Science Report number 30 , April 1987

8. Wilson, P.A. The Use of Symmetry in Seakeeping Calculations Ship Science Report number 31 , April 1987

9. Wilson, P.A. Prediction of Ship Motions in Regular and Irregular Waves Ship Science report 2 1976

10. Wilson, P.A. Theory and Computer Programme for the Calculation of the Lateral Motion of a ship Ship Science Report Number 6/81 April 1981

11. Salveson N.,Tuck E.O.,Faltinsen O., Ship Motions and Sea Loads SNAME 1970

APPENDIX B

POWER SPECTRAL DENSITY FUNCTION

In both the vertical and lateral plane modules the power spectral density function that is used to represent random long crested seaway is of the form,

$$S(\omega) = \frac{A}{\omega^5} e^{-B/\omega^4} \qquad (1)$$

Various values of A, and B are used to represent different spectral families. This Appendix seeks to show the relationship between A and B, together with the relationships between the different time periods used in the spectral formulations.

The peak of the spectrum is found from

$$\frac{dS}{d\omega} = 0$$

$$\therefore \quad -\frac{5A}{\omega^6} e^{-B/\omega^4} + \frac{A}{\omega^5} \frac{4B}{\omega^5} e^{-B/\omega^4} = 0$$

$$\therefore \quad \omega^4 = 4B/5$$

Thus the peak frequency ω_p is

$$\omega_p = \sqrt[4]{0.8B} \qquad (2)$$

The peak period Tp is thus

$$Tp = \frac{2\pi}{\omega_p} = \frac{2\pi}{\sqrt[4]{0.8B}} \qquad (3)$$

The value of the power spectral density function is

$$S(\omega p) = \frac{5A}{4B} \frac{e^{-5/4}}{\sqrt[4]{0.8B}}$$

The area under the spectral curve is called the variance or zeroth moment and is given the symbol m_0.

$$m_o = \int_o^\infty S(\omega)\, d\omega = \left| \frac{-A}{4B} e^{-B/\omega^4} \right|_o^\infty = \frac{A}{4B}$$

Thus $$m_o = \frac{A}{4B} \qquad (4)$$

Another definition of m_o is found from the significant wave height $h_{1/3}$ viz:

$$m_o = \frac{h_{1/3}^2}{16}$$

$$\therefore \qquad \frac{A}{B} = 0.25\, h_{1/3}^2 \qquad (5)$$

Equation (5) is true for all spectral types.

For the Pierson-Moskowitz spectrum

$$A = 0.081\, g^2$$

g is the gravitational constant
0.0081 is termed Phillip's constant

$$\therefore \quad \text{from (5)} \qquad B = 0.0081 \frac{g^2 \times 4}{h_{1/3}^2}$$

i.e. $$B = \frac{3.11}{h_{1/3}^2} \quad \text{in metric units}$$

$$\text{or} \quad \frac{33.43}{h_{1/3}^2} \quad \text{in imperial units}$$

Thus for P-M spectra

$$A = 0.081\, g^2 \qquad (6)$$

$$B = \frac{3.11}{h_{1/3}^2} \quad \text{in metric units} \qquad (7)$$

For the ITTC spectral family the following analysis defines, A and B.

The nth moment of the spectral density function is

$$m_o = \int_o^\infty \omega^n \, S(\omega) \, d\omega \qquad (8)$$

$$m_n = A \int_o^\infty \omega^{n-5} \, e^{-B\omega^{-4}} \, d\omega \qquad (9)$$

Putting $\omega^4 = B/u$ into (9)

$$m_n = \frac{A}{4B} \, B^{n/4} \int_o^\infty e^{-u} \, u^{-n/4} \, du \qquad (10)$$

The definition of the Gamma Function $\Gamma(n)$ is

$$\Gamma(n) = \int_o^\infty e^{-u} \, u^{n-1} \, du$$

$$\therefore \quad m_n = \frac{A}{4} \, B^{n/4-1} \, \Gamma(1-n/4) \qquad (11)$$

The definition of various times with respect to the nth moment can now be given

$$\omega_o^2 = \frac{m_2}{m_o} = \left(\frac{2\pi}{T_o}\right)^2 \qquad (12)$$

$$\omega_1 = \frac{m_1}{m_o} = \frac{2\pi}{T_1} \qquad (13)$$

Thus using (11) in (13) gives

$$\frac{2\pi}{T_1} = B^{1/4}\,\Gamma(3/4)$$

$$\therefore \qquad B = \left|\frac{2\pi}{T_1}\;\frac{1}{\Gamma(3/4)}\right|^4 \qquad (14)$$

with $\Gamma(3/4) = 1.2254167024$ (see Abramowitz and Stegun)

$$\therefore \qquad B = \frac{691.16}{T_1{}^4}$$

Therefore

$$A = 0.25\, h_{1/3}^2\; B \qquad (15)$$

$$B = \left|\frac{2\pi}{T_1}\; 0.816\right|^4 \qquad (16)$$

are the definitions of the parameters A, B for the ITTC spectral family.

Often T_o, and T_p are used instead of T_1.

T_1 is called the average period corresponding to the 'observed period' of the random seaway.

T_o is called the zero crossing period.

From (12)

$$\left(\frac{2\pi}{T_o}\right)^2 = \Gamma(\tfrac{1}{2})B^{\frac{1}{2}}$$

$$\Gamma(\tfrac{1}{2}) = \sqrt{\pi}$$

$$\therefore \qquad \left(\frac{2\pi}{T_o}\right)^2 = \sqrt{\pi B}$$

Thus using (16) to redefine B gives a relationship between T_o, and T_1.

i.e. $$T_o = T_1 \frac{\Gamma(3/4)}{\sqrt{\Gamma(\frac{1}{2})}}$$

$$\therefore \qquad T_1 = 1.08643\ T_o \qquad (17)$$

for this spectra using (16) for B in (3)

$$T_p = 1.2957T_1 \qquad (18)$$

$$\therefore \qquad T_p = 1.40769T_o \qquad (19)$$

SUMMARY

$$S(\omega) = \frac{A}{\omega^5} \quad e^{-B/\omega^4}$$

P-M type spectra

$$A = 0.0081\ g^2$$

$$B = \frac{3.11}{h_{1/3}^2} \qquad \text{(in metric units)}$$

ITTC type spectra

$$A = 0.25\ h_{1/3}^2$$

$$B = (0.816\ \frac{2\pi}{T_1})^4$$

APPENDIX C

Programme Running Styles

The logical sequence of running the programme suite falls into one of three categories :

1) Vertical Motions

The correct sequence of running the programmes is to run

a) Module A the editor programme to make sure the data files are correct

b) Module B the vertical response amplitudes are calculated for the given range of ship speed(s) ,wave angle(s), and sea spectra (spectrum) that have been chosen in Module A .

c) Choose now whether to plot the regular and irregular RAOS and spectral statistics using Module F.

After these have been run the disc contains the data files that are used as input to the following four Modules

i) Module C The subjective motion calculation method of assessment of the ships performance .

ii) Module E The total motion at any point within the body of the ship .

iii) Module H The sustained ship speed programme that calculates the probability of the ship slamming or shipping green water on the ship deck or exceeding a set of acceleration levels .

iv) Module G The time series simulation programme that produces a histogram of quiescent periods of up to three ship motions for any one of the 21 combinations that are available .

Each of the four above programmes can be run and re-run without re-running Module B . This is in contra-distinction to the mode of operation of the main frame series of programmes .

2 Lateral and Vertical Motions

The correct order of running the programmes is

a) Module A
b) Module B
c) Module C The module calculates the lateral response amplitude operators
d) Then as above choose whether to plot the regular or irregular responses using Module F .

Then all the programmes that are in the Vertical section above listed as i) to iv) can be run and re-run with out re-course to re-running Modules B and C again . If the ship speed range or the wave angle range or the sea spectra are changed in any way then a) to d) must be repeated . This also applies if the ship Hcg is changed because of its effects in running the Module E

3) Lateral Motions

The correct order is ;

a) Module A
b) Module C
c) Module D if so chosen

The sustained speed and subjective motion modules cannot be run if this combination has been chosen because these two modules are only connected with Vertical motions.

APPENDIX D

Generating Data and Editing

There are eight programmes in the micro-version of the seakeeping suite of programmes . It is possible to use all the programmes from the menu that is displayed before and after every programme starts and finishes . It is recommended that you do not input data from scratch using the first module unless you are a very experienced user of the suite .Thus it is recommended that new data files are created using a full screen editor such as STEED or a word processing package that is capable of producing A.S.C.I.I files e.g. WORDSTAR . A full screen editor is far superior and is usually quicker to use and easily assimilated .

When the data files have been created it is then worthwhile processing the new data files through Module A .

This allows a secondary check that the data files are correct , since most input data can be displayed for possible changing by this Module .When only small amounts of data are to be modified it is also recommended that Module A is used to change the data values . A typical minor modification might be to increase the number of ship speeds or to decrease the number of wave angles ,or to change the spectral formulations . Although these can easily be performed using a screen editor it makes sense to have the data checked by Module A .

To take advantage of this method three data files are stored on the ship motions directory under the names

SHIPA.LAT SHIPA.VER SHIPA.DAT

It is suggested that you choose your new file name , say SHIPC , and then copy these three data files onto your working disc drive which may be on a floppy disc or a hard disc drive as follows

COPY P:SHIPA.* A:SHIPC.*

where P is the directory that contains the example data
A is the directory that is your working directory disc drive

In the examples and explanations that follow in other appendices four different versions of SHIPA.LAT are listed

APPENDIX E) Contains fins and bilge keels
APPENDIX F) Contains fins and no bilge keels
APPENDIX G) Contains no fins and bilge keels
APPENDIX H) Contains no fins and no bilge keels

The example data is that from APPENDIX E

As you will see there are two ship speeds in these data sets . If you require more than this they are easily added to the data line but with one simple proviso that the distance between the decimal points of the extra ship speeds is the same as in the example . Real FORTRAN variables require decimal points and in the correct place in the data field .

The same applies for the number of sea spectra , keep the distance between the decimal points a constant .

The bilge keel information give the offset and waterline of the point of the bilge keel as in crosses the ship sections . This data point must be one of the eight (8) the section data points .Thus in the example data section 8 is the first section of the bilge keel and the data point is also found on the sectional data values .

The same is true for all the root of the bilge keel points the data point must be one of the 8 data values that define the ship sections .

The data for the 'A' brackets is furnished as follows . If there is one propeller shaft then the 'A' bracket is considered to be symmetrical so only one side of the 'A' bracket is needed the programme doubles the effect of the other half . Each 'A' bracket is considered to be a solid foil

If there are more than one propeller shaft then the 'A' brackets no longer are probably symmetric and the outboard and inboard parts need specifying seperately .

The data is specified in the order
largest 'A' bracket outboard
smaller 'A' bracket outboard
largest 'A' bracket inboard
smallest 'A' bracket inboard

If the ship has active foils and 'A' brackets

The foil data is input first followed by the 'A' bracket information and then followed by the rudder information .

The following data file taken from APPENDIX E has been annotated so that each piece of data that can be modified .

The comments are given in small typeface

EXAMPLE
Title of this data set
0
0
0 .00000 .30480
3 0 2 1

the first indicates which type of spectra a 1 is P.M. a 2 is JONSWAP a 3 is BRETSCHNEIDER a 4 is own specified spectra the second indicates the power of the cosine spreading function a 0 indicates no spreading the third also indicates the spectral type 1 is PM 3 is JONSWAP 2 is BRETSCHNEIDER 4 is own spectral type .The fourth indicates what type of motion calculation a 0 means vertical only a 1 means vertical and lateral a 2 means lateral only .

133.0000	.9440	1.6000	.0000	.3800	.2500
ship length	hcg realtive to Lwl +ve upwards	fluid GM	roll natural frequency	roll radius gyration /beam	yaw radius gyration /length

2 number of ship speeds (maximum of 10 speeds)
90.0000 180.0000 15.0000 wave angles
initial final increment (degrees)

.0000	5.4528	6.4000	6.4000	6.4000	6.400	6.4000	6.4000
6.4000	6.4000	6.4000	6.4000	6.4000	6.4000	6.4000	6.4000
6.4000	3.9328	2.1936	1.3920	.0000			

sectional draught list first is FP last is AP .There must be 21 stations
10.0000 15.0000 ship speeds in knots
41 .05000 2.05000 wave frequencies information
number of frequencies , first frequency , last frequency (rads/sec)
1
This indicates whether the ship has fins of any sort i.e. active foils or 'A' brackets when given a value of 1 , when no foils and no 'A' brackets then a value 0

```
 2   0   first is number of sea spectra ,   second is always zero
    2.0000      4.0000     sea spectrum 1
   10.0000     12.0000     sea spectrum 2

first is the significant height in metres , second is the modal period in seconds
 19
number of stations used in the calculation .This can be 19 20 or 21 see the Manual
      2.000   1
station number referenced from the BOW    followed by the eddy type  0 1 2 or 3
      .0000      .2610      .4875      .7140      .8370      .9150     1.0770     1.2825
section offsets measured from vertical centreline up to load waterline (must be 8 in number)
      .9472     1.7760     2.8224     4.0000     4.5696     4.8000     5.6000     6.4000
section waterlines measured from keel line (must be eight in number)
      3.000   1
      .0000      .4785      .9075     1.4415     1.5735     1.9200     2.1870     2.5020
      .0000     1.0880     2.1856     3.6464     4.0000     4.9248     5.6000     6.4000
      4.000   1
      .0000      .7545     1.2465     1.9995     2.5755     3.2265     3.3825     3.7800
      .0000      .8192     1.6192     2.8816     3.9904     5.2864     5.6000     6.4000
      5.000   1
      .0000     1.0695     1.8105     2.8140     3.6960     4.3110     4.6335     5.0445
      .0000      .8416     1.6080     2.2640     4.0000     5.0192     5.6000     6.4000
      6.000   1
      .0000     1.3635     2.2305     3.2760     4.2150     4.7445     5.7450     6.1275
      .0000      .6288     1.4864     2.2640     3.2912     4.0000     5.6000     6.4000
      7.000   1
      .0000     1.4070     2.4120     3.6480     4.5795     5.7915     6.7095     7.0350
      .0000      .3792      .8800     1.7104     2.5456     4.0000     5.6000     6.4000
      8.000   0
      .0000     1.5270     3.7965     4.8510     5.7000     6.5745     7.4325     7.7175
      .0000      .1792     1.1312     1.9616     2.7856     4.0000     5.6000     6.4000
      9.000   0
      .0000     2.2350     3.2895     5.1795     6.3615     7.2735     7.9305     8.1810
      .0000      .1712      .4816     1.5424     2.6336     4.0000     5.6000     6.4000
     10.000   3
      .0000     2.7315     4.6140     6.3090     6.8025     7.6920     8.2800     8.4690
      .0000      .1936      .8832     2.0464     2.5840     4.0000     5.6000     6.4000
     11.000   3
      .0000     4.0005     4.8225     6.6000     6.9855     7.9080     8.4450     8.6385
      .0000      .4864      .8160     2.0176     2.4720     4.0000     5.6000     6.4000
     12.000   3
      .0000     3.5925     5.2875     7.0215     7.5390     8.0415     8.6430     8.8155
      .0000      .3168     1.0160     2.4432     3.1248     4.0000     5.6000     6.4000
     13.000   3
      .0000     1.8300     3.2655     5.4645     6.9690     7.9005     8.5125     8.7270
      .0000      .0896      .3680     1.3472     2.6400     4.0000     5.6000     6.4000
     14.000   3
      .0000     1.9425     3.7035     5.6535     6.8505     7.5840     8.3685     8.6445
      .0000      .2064      .8000     1.8208     2.9536     4.0000     5.6000     6.4000
     15.000   0
      .0000     2.4015     4.6935     5.7255     6.5175     7.1610     8.1165     8.4420
      .0000      .6624     1.8192     2.5456     3.2240     4.0000     5.6000     6.4000
     16.000   0
      .0000     1.5345     2.1750     3.8010     4.6095     6.5910     7.7610     8.1480
      .0000      .7312     1.1344     2.0784     2.5856     4.0000     5.6000     6.4000
     17.000   0
      .0000      .6690     1.0290     2.2770     3.7800     5.7555     7.2585     7.7100
      .0000      .8576     1.4080     2.2496     2.9280     4.0000     5.6000     6.4000
     18.000   0
      .0000      .4455     1.3905     3.0840     4.0200     5.7960     6.5370     7.1145
```

2.4672	2.6688	3.0672	3.6736	4.0000	4.8688	5.6000	6.4000
19.000	0						
.0000	.5805	1.3740	2.4765	3.6735	4.6230	5.5200	6.3765
4.2064	4.2848	4.4432	4.6416	4.8928	5.1216	5.6000	6.4000
20.000	0						
.0000	.9345	1.7955	2.8245	3.7320	3.9600	4.6305	5.3670
5.0080	5.0624	5.1872	5.3344	5.5248	5.6000	5.8640	6.4000

1

Number of bilge keel parts

8 3

start of bilge keel (nearest section number)

number of stations spanned by this bilge keel , thus this one bilge keel starts near section 8 and ends near section 10 . The word near is used because the actual length of each part of each bilge keel is given in the following data sets .

5.700 2.786 1.500 5.320

offset of point where bilge keel crosses this section (8 in this case)

waterline of this point followed by the bilge keel outreach and then the length of the bilge keel at this station

6.362 2.634 1.500 6.650

as above but for the next station that the bilge keel crosses (section 9 in this case)

6.309 2.046 1.500 7.980

as above but for section 10

.0000 .0000 .0000

skeg information

the first is the station where the skeg starts the second is the breadth of the skeg the third is the length in metres

1 .000 .000 .000 1.000 .000 .000 1.000 .000 .000

the first is the number of active foil pairs (1 in this example)

the next three are the roll control coefficents in the order of amplitude velocity and acceleration .The next three are the demanded control coefficents in the same order and the last three are the servo control coefficents again in the same order

1 2

The first is the number of Propeller shafts , the second is the number of 'A' brackets per shaft

11.000 6.986 2.472 1.605 2.960 2.190 .000 45.000

First is the station where the active foil is , the second is the offset of this point ,the third is the waterline of this point the fourth is the foil span the fifth is the root chord the sixth is the tip chord the seventh is slope of the lift curve (a 0 means let the programme calculate a value) the eighth is the di-hedral angle .

19.630 3.799 4.109 1.810 .520 .520 .000 .000

this is the same as above for the larger of the two 'A' brackets

19.630 2.163 3.731 1.520 .750 .520 .000 62.500

this is the smaller 'A' bracket information

20.370 2.063 5.312 2.790 2.274 1.622 .000

this is the rudder information (note no di-hedral angle needed)

.000 .000 .000 1.000 .000 .000 1.000 .000 .000

First three are the autopilot yaw gain control coefficents in the order amplitude velocity and accelerations followed by three for the demanded control coefficents the final three are the rudder servo control coefficents

.000 .000 .000 1.000 .000 .000

The first three are the rudder controll gains again in the order amplitude velocity acceleration the last three are the demanded angle coefficents

10.000 .000

the first is the nominal fin angle (10 degrees is recommended) the second is the fractional lift increment due to flap deflection

these two data are not required if there are no active foils

1 (this is the marker for total solution (0) or long wave approx (1)

-1 1

the first is the marker for the tdps calculation

-1 means calculate the tdps and no printout

0 means calculate the tdps but print out tdps
1 means read back the tdp file with no print out
2 means read back the tdp file with print out of values
the second is a marker that is always 1 **(remember that if you change hcg in any way the tdps must be re-calculated)**
-1

The following is the vertical data file with extension VER with annotations .

EXAMPLE (main title)
0
8 APR 87 (date of this run)
Test of stretch factor programme (secondary title)
1 0 1 3 1 0-1 0 1 0 0 0 0 020

The fourth indicates the spectral type a 2 means PM ,a 3 means BRETSCHNEIDER , a 4 means JONSWAP. The fifth means type of calculation a 0 means vertical only , a 1 means vertical and lateral , a 2 means lateral only . The sixth means spreading power of the cosine function note a o means no spectral spreading . The seventh indicates the tdps a -1 means calculate the tdps and do not print out the values , a 0 means calculate the tdps and print out their values , a 1 means read back previously calculated values for this ship and do not print out their values , a 2 means read back the tdp file and print out their values .

133.00000 1.02500 9.80665 7104.720
ship length(metres) ship displacment (tonnes)

.0000	.0000	.0000	.0000	sectional data starting at FP
2.5650	.5168	5.4528	.0000	
5.0040	.5118	6.4000	.0000	
7.5600	.5566	6.4000	.0000	
10.0890	.5870	6.4000	.0000	
12.2550	.6260	6.4000	.0000	
14.0700	.6767	6.4000	.0000	
15.4350	.7227	6.4000	.0000	
16.3620	.7666	6.4000	.0000	
16.9380	.7910	6.4000	.0000	
17.2770	.8040	6.4000	.0000	
17.6310	.8001	6.4000	.0000	
17.4540	.7818	6.4000	.0000	
17.2890	.7445	6.4000	.0000	
16.8840	.6926	6.4000	.0000	
16.2960	.6220	6.4000	.0000	
15.4200	.5271	6.4000	.0000	
14.2290	.6178	3.9328	.0000	
12.7530	.6831	2.1936	.0000	
10.7310	.7135	1.3920	.0000	
.0000	.0000	.0000	.0000	finishing with AP
fulll beam	area coefficent	draught		

33.2500 -2.1700
longitudinal gyradius (metres)   lcg relative to midships (metres +ve fwd.)

11 11 1
1.0000 .0500 2.0500 .0500
wave frequencies initial final increment (rads/sec)
1
2 (number of ship speeds–)
10.00 15.00 (ship speed in knots)

90.0000 180.0000 15.0000
wave angles
initial final increment (degrees)
2 (number of spectra)
2.0010.00 (significant wave heights (metres))
4.0012.00 (modal period (seconds))
0
0
-1.0000

The following is the vertical data file with annotation .DAT . It is necessary to modify both the vertical data files even with the duplication of the data .

1 0 1 3 1 0-1 1 020
The fourth is the spectral indicator a 2 means PM a 3 means BRETSCHNEIDER , a 4 means JONSWAP .The fifth inducates the type of calculation a 0 means vertical only , a 1 means vertical and lateral , a 2 means lateral only . The sixth means the power of the spectral spreading function , note that a 0 means no spectral spreading . The seventh means the tdps indicator a -1 means calculate the tdps and no printout of their values a 0 means calculate the tdps and print out their values , a 1 means read back from a previously calculated set of tdps and donot print out their values a 2 means read back previous tdps and printout their values .

133.0000 1.0250 9.8067 7104.7200

ship length (metres) displacment (tonnes)

the following is the section data starting at the BOW and finsihing at the STERN in a total of 21 equally spaced stations .

full beam	area coefficient	draught		
.0000	.0000	.0000	.0000	sectional data strating at FP
2.5650	.5168	5.4528	.0000	
5.0040	.5118	6.4000	.0000	
7.5600	.5566	6.4000	.0000	
10.0890	.5870	6.4000	.0000	
12.2550	.6260	6.4000	.0000	
14.0700	.6767	6.4000	.0000	
15.4350	.7227	6.4000	.0000	
16.3620	.7666	6.4000	.0000	
16.9380	.7910	6.4000	.0000	
17.2770	.8040	6.4000	.0000	
17.6310	.8001	6.4000	.0000	
17.4540	.7818	6.4000	.0000	
17.2890	.7445	6.4000	.0000	
16.8840	.6926	6.4000	.0000	
16.2960	.6220	6.4000	.0000	
15.4200	.5271	6.4000	.0000	
14.2290	.6178	3.9328	.0000	
12.7530	.6831	2.1936	.0000	
10.7310	.7135	1.3920	.0000	
.0000	.0000	.0000	.0000	finishing at AP

33.2500 -2.1700
radius of lcg (relative to mid-ships +ve forwards)

gyration

```
    .0500      2.0500      .0500
    first      last        increment
       frequencies (rads/sec)
 2       (number of ship speeds )
  10.00     15.00   (ship speeds in knots )
  90.0000   180.0000   15.0000
  first     last          increment        wave angles (degrees)
2       number of sea spectra
2.0010.00   (significant wave heights (metres) )
4.0012.00   (modal periods (seconds)
```

APPENDIX E

EXAMPLE WITH BILGE KEELS AND FINS

```
EXAMPLE
  0
  0
     0      .00000      .30480
  3   0   2   1
  133.0000       .9440      1.6000       .0000        .3800       .2500
  2
    90.0000   180.0000    15.0000
      .0000     5.4528      6.4000      6.4000      6.4000      6.4000      6.4000      6.4000
     6.4000     6.4000      6.4000      6.4000      6.4000      6.4000      6.4000      6.4000
     6.4000     3.9328      2.1936      1.3920       .0000
    10.0000    15.0000
    41       .05000     2.05000
  1
  2   0
     2.0000     4.0000
    10.0000    12.0000
 19
      2.000   1
      .0000      .2610       .4875       .7140       .8370       .9150      1.0770      1.2825
      .9472     1.7760      2.8224      4.0000      4.5696      4.8000      5.6000      6.4000
      3.000   1
      .0000      .4785       .9075      1.4415      1.5735      1.9200      2.1870      2.5020
      .0000     1.0880      2.1856      3.6464      4.0000      4.9248      5.6000      6.4000
      4.000   1
      .0000      .7545      1.2465      1.9995      2.5755      3.2265      3.3825      3.7800
      .0000      .8192      1.6192      2.8816      3.9904      5.2864      5.6000      6.4000
      5.000   1
      .0000     1.0695      1.8105      2.8140      3.6960      4.3110      4.6335      5.0445
      .0000      .8416      1.6080      2.2640      4.0000      5.0192      5.6000      6.4000
      6.000   1
      .0000     1.3635      2.2305      3.2760      4.2150      4.7445      5.7450      6.1275
      .0000      .6288      1.4864      2.2640      3.2912      4.0000      5.6000      6.4000
      7.000   1
      .0000     1.4070      2.4120      3.6480      4.5795      5.7915      6.7095      7.0350
      .0000      .3792       .8800      1.7104      2.5456      4.0000      5.6000      6.4000
      8.000   0
      .0000     1.5270      3.7965      4.8510      5.7000      6.5745      7.4325      7.7175
      .0000      .1792      1.1312      1.9616      2.7856      4.0000      5.6000      6.4000
      9.000   0
      .0000     2.2350      3.2895      5.1795      6.3615      7.2735      7.9305      8.1810
      .0000      .1712       .4816      1.5424      2.6336      4.0000      5.6000      6.4000
     10.000   3
      .0000     2.7315      4.6140      6.3090      6.8025      7.6920      8.2800      8.4690
      .0000      .1936       .8832      2.0464      2.5840      4.0000      5.6000      6.4000
     11.000   3
      .0000     4.0005      4.8225      6.6000      6.9855      7.9080      8.4450      8.6385
      .0000      .4864       .8160      2.0176      2.4720      4.0000      5.6000      6.4000
     12.000   3
      .0000     3.5925      5.2875      7.0215      7.5390      8.0415      8.6430      8.8155
      .0000      .3168      1.0160      2.4432      3.1248      4.0000      5.6000      6.4000
     13.000   3
      .0000     1.8300      3.2655      5.4645      6.9690      7.9005      8.5125      8.7270
      .0000      .0896       .3680      1.3472      2.6400      4.0000      5.6000      6.4000
     14.000   3
      .0000     1.9425      3.7035      5.6535      6.8505      7.5840      8.3685      8.6445
      .0000      .2064       .8000      1.8208      2.9536      4.0000      5.6000      6.4000
```

```
   15.000    0
    .0000     2.4015     4.6935     5.7255     6.5175     7.1610     8.1165     8.4420
    .0000      .6624     1.8192     2.5456     3.2240     4.0000     5.6000     6.4000
   16.000    0
    .0000     1.5345     2.1750     3.8010     4.6095     6.5910     7.7610     8.1480
    .0000      .7312     1.1344     2.0784     2.5856     4.0000     5.6000     6.4000
   17.000    0
    .0000      .6690     1.0290     2.2770     3.7800     5.7555     7.2585     7.7100
    .0000      .8576     1.4080     2.2496     2.9280     4.0000     5.6000     6.4000
   18.000    0
    .0000      .4455     1.3905     3.0840     4.0200     5.7960     6.5370     7.1145
   2.4672     2.6688     3.0672     3.6736     4.0000     4.8688     5.6000     6.4000
   19.000    0
    .0000      .5805     1.3740     2.4765     3.6735     4.6230     5.5200     6.3765
   4.2064     4.2848     4.4432     4.6416     4.8928     5.1216     5.6000     6.4000
   20.000    0
    .0000      .9345     1.7955     2.8245     3.7320     3.9600     4.6305     5.3670
   5.0080     5.0624     5.1872     5.3344     5.5248     5.6000     5.8640     6.4000
1
8   3
    5.700      2.786      1.500      5.320
    6.362      2.634      1.500      6.650
    6.309      2.046      1.500      7.980
    .0000      .0000      .0000
1     .000       .000       .000    1.000      .000       .000    1.000      .000      .000
1   2
11.000    6.986    2.472    1.605    2.960    2.190     .000   45.000
19.630    3.799    4.109    1.810     .520     .520     .000     .000
19.630    2.163    3.731    1.520     .750     .520     .000   62.500
20.370    2.063    5.312    2.790    2.274    1.622     .000
   .000     .000     .000    1.000     .000     .000    1.000     .000     .000
   .000     .000     .000    1.000     .000     .000
      .000        .000
1
–1   1
–1
```

APPENDIX F
EXAMPLE WITH BILGE KEELS ONLY

```
EXAMPLE
  0
  0
    0      .00000      .30480
  3   0   2   1
 133.0000       .9440     1.6000      .0000       .3800       .2500
  2
   90.0000  180.0000   15.0000
     .0000     5.4528     6.4000     6.4000     6.4000     6.4000     6.4000     6.4000
    6.4000     6.4000     6.4000     6.4000     6.4000     6.4000     6.4000     6.4000
    6.4000     3.9328     2.1936     1.3920      .0000
   10.0000    15.0000
   41     .05000    2.05000
  1
  2   0
    2.0000     4.0000
   10.0000    12.0000
 19
     2.000   1
     .0000      .2610      .4875      .7140      .8370      .9150     1.0770     1.2825
     .9472     1.7760     2.8224     4.0000     4.5696     4.8000     5.6000     6.4000
     3.000   1
     .0000      .4785      .9075     1.4415     1.5735     1.9200     2.1870     2.5020
     .0000     1.0880     2.1856     3.6464     4.0000     4.9248     5.6000     6.4000
     4.000   1
     .0000      .7545     1.2465     1.9995     2.5755     3.2265     3.3825     3.7800
     .0000      .8192     1.6192     2.8816     3.9904     5.2864     5.6000     6.4000
     5.000   1
     .0000     1.0695     1.8105     2.8140     3.6960     4.3110     4.6335     5.0445
     .0000      .8416     1.6080     2.2640     4.0000     5.0192     5.6000     6.4000
     6.000   1
     .0000     1.3635     2.2305     3.2760     4.2150     4.7445     5.7450     6.1275
     .0000      .6288     1.4864     2.2640     3.2912     4.0000     5.6000     6.4000
     7.000   1
     .0000     1.4070     2.4120     3.6480     4.5795     5.7915     6.7095     7.0350
     .0000      .3792      .8800     1.7104     2.5456     4.0000     5.6000     6.4000
     8.000   0
     .0000     1.5270     3.7965     4.8510     5.7000     6.5745     7.4325     7.7175
     .0000      .1792     1.1312     1.9616     2.7856     4.0000     5.6000     6.4000
     9.000   0
     .0000     2.2350     3.2895     5.1795     6.3615     7.2735     7.9305     8.1810
     .0000      .1712      .4816     1.5424     2.6336     4.0000     5.6000     6.4000
    10.000   3
     .0000     2.7315     4.6140     6.3090     6.8025     7.6920     8.2800     8.4690
     .0000      .1936      .8832     2.0464     2.5840     4.0000     5.6000     6.4000
    11.000   3
     .0000     4.0005     4.8225     6.6000     6.9855     7.9080     8.4450     8.6385
     .0000      .4864      .8160     2.0176     2.4720     4.0000     5.6000     6.4000
    12.000   3
     .0000     3.5925     5.2875     7.0215     7.5390     8.0415     8.6430     8.8155
     .0000      .3168     1.0160     2.4432     3.1248     4.0000     5.6000     6.4000
    13.000   3
     .0000     1.8300     3.2655     5.4645     6.9690     7.9005     8.5125     8.7270
     .0000      .0896      .3680     1.3472     2.6400     4.0000     5.6000     6.4000
    14.000   3
     .0000     1.9425     3.7035     5.6535     6.8505     7.5840     8.3685     8.6445
     .0000      .2064      .8000     1.8208     2.9536     4.0000     5.6000     6.4000
    15.000   0
```

```
    .0000    2.4015    4.6935    5.7255    6.5175    7.1610    8.1165    8.4420
    .0000     .6624    1.8192    2.5456    3.2240    4.0000    5.6000    6.4000
  16.000  0
    .0000    1.5345    2.1750    3.8010    4.6095    6.5910    7.7610    8.1480
    .0000     .7312    1.1344    2.0784    2.5856    4.0000    5.6000    6.4000
  17.000  0
    .0000     .6690    1.0290    2.2770    3.7800    5.7555    7.2585    7.7100
    .0000     .8576    1.4080    2.2496    2.9280    4.0000    5.6000    6.4000
  18.000  0
    .0000     .4455    1.3905    3.0840    4.0200    5.7960    6.5370    7.1145
  2.4672    2.6688    3.0672    3.6736    4.0000    4.8688    5.6000    6.4000
  19.000  0
    .0000     .5805    1.3740    2.4765    3.6735    4.6230    5.5200    6.3765
  4.2064    4.2848    4.4432    4.6416    4.8928    5.1216    5.6000    6.4000
  20.000  0
    .0000     .9345    1.7955    2.8245    3.7320    3.9600    4.6305    5.3670
  5.0080    5.0624    5.1872    5.3344    5.5248    5.6000    5.8640    6.4000
1
8   3
    5.700     2.786     1.500     5.320
    6.362     2.634     1.500     6.650
    6.309     2.046     1.500     7.980
    .0000     .0000     .0000
0     .000     .000     .000    1.000     .000     .000    1.000     .000     .000
1   2
19.630   3.799   4.109   1.810    .520    .520    .000    .000
19.630   2.163   3.731   1.520    .750    .520    .000  62.500
20.370   2.063   5.312   2.790   2.274   1.622    .000
   .000    .000    .000   1.000    .000    .000   1.000    .000    .000
   .000    .000    .000   1.000    .000    .000
1
-1   1
-1
```

APPENDIX G

EXAMPLE WITH FINS ONLY

```
EXAMPLE
  0
  0
    0      .00000      .30480
  3   0   2   1
  133.0000       .9440     1.6000       .0000       .3800       .2500
  2
   90.0000  180.0000    15.0000
     .0000     5.4528     6.4000     6.4000     6.4000     6.4000     6.4000     6.4000
    6.4000     6.4000     6.4000     6.4000     6.4000     6.4000     6.4000     6.4000
    6.4000     3.9328     2.1936     1.3920      .0000
   10.0000    15.0000
   41      .05000    2.05000
  1
  2   0
    2.0000     4.0000
   10.0000    12.0000
 19
     2.000   1
     .0000      .2610      .4875      .7140      .8370      .9150     1.0770     1.2825
     .9472     1.7760     2.8224     4.0000     4.5696     4.8000     5.6000     6.4000
     3.000   1
     .0000      .4785      .9075     1.4415     1.5735     1.9200     2.1870     2.5020
     .0000     1.0880     2.1856     3.6464     4.0000     4.9248     5.6000     6.4000
     4.000   1
     .0000      .7545     1.2465     1.9995     2.5755     3.2265     3.3825     3.7800
     .0000      .8192     1.6192     2.8816     3.9904     5.2864     5.6000     6.4000
     5.000   1
     .0000     1.0695     1.8105     2.8140     3.6960     4.3110     4.6335     5.0445
     .0000      .8416     1.6080     2.2640     4.0000     5.0192     5.6000     6.4000
     6.000   1
     .0000     1.3635     2.2305     3.2760     4.2150     4.7445     5.7450     6.1275
     .0000      .6288     1.4864     2.2640     3.2912     4.0000     5.6000     6.4000
     7.000   1
     .0000     1.4070     2.4120     3.6480     4.5795     5.7915     6.7095     7.0350
     .0000      .3792      .8800     1.7104     2.5456     4.0000     5.6000     6.4000
     8.000   0
     .0000     1.5270     3.7965     4.8510     5.7000     6.5745     7.4325     7.7175
     .0000      .1792     1.1312     1.9616     2.7856     4.0000     5.6000     6.4000
     9.000   0
     .0000     2.2350     3.2895     5.1795     6.3615     7.2735     7.9305     8.1810
     .0000      .1712      .4816     1.5424     2.6336     4.0000     5.6000     6.4000
    10.000   3
     .0000     2.7315     4.6140     6.3090     6.8025     7.6920     8.2800     8.4690
     .0000      .1936      .8832     2.0464     2.5840     4.0000     5.6000     6.4000
    11.000   3
     .0000     4.0005     4.8225     6.6000     6.9855     7.9080     8.4450     8.6385
     .0000      .4864      .8160     2.0176     2.4720     4.0000     5.6000     6.4000
    12.000   3
     .0000     3.5925     5.2875     7.0215     7.5390     8.0415     8.6430     8.8155
     .0000      .3168     1.0160     2.4432     3.1248     4.0000     5.6000     6.4000
    13.000   3
     .0000     1.8300     3.2655     5.4645     6.9690     7.9005     8.5125     8.7270
     .0000      .0896      .3680     1.3472     2.6400     4.0000     5.6000     6.4000
    14.000   3
     .0000     1.9425     3.7035     5.6535     6.8505     7.5840     8.3685     8.6445
     .0000      .2064      .8000     1.8208     2.9536     4.0000     5.6000     6.4000
```

```
    15.000  0
      .0000    2.4015    4.6935    5.7255    6.5175    7.1610    8.1165    8.4420
      .0000     .6624    1.8192    2.5456    3.2240    4.0000    5.6000    6.4000
    16.000  0
      .0000    1.5345    2.1750    3.8010    4.6095    6.5910    7.7610    8.1480
      .0000     .7312    1.1344    2.0784    2.5856    4.0000    5.6000    6.4000
    17.000  0
      .0000     .6690    1.0290    2.2770    3.7800    5.7555    7.2585    7.7100
      .0000     .8576    1.4080    2.2496    2.9280    4.0000    5.6000    6.4000
    18.000  0
      .0000     .4455    1.3905    3.0840    4.0200    5.7960    6.5370    7.1145
    2.4672    2.6688    3.0672    3.6736    4.0000    4.8688    5.6000    6.4000
    19.000  0
      .0000     .5805    1.3740    2.4765    3.6735    4.6230    5.5200    6.3765
    4.2064    4.2848    4.4432    4.6416    4.8928    5.1216    5.6000    6.4000
    20.000  0
      .0000     .9345    1.7955    2.8245    3.7320    3.9600    4.6305    5.3670
    5.0080    5.0624    5.1872    5.3344    5.5248    5.6000    5.8640    6.4000
  0
      .0000     .0000     .0000
  1     .000     .000     .000   1.000     .000     .000   1.000     .000     .000
  1  2
  11.000   6.986   2.472   1.605   2.960   2.190    .000  45.000
  19.630   3.799   4.109   1.810    .520    .520    .000    .000
  19.630   2.163   3.731   1.520    .750    .520    .000  62.500
  20.370   2.063   5.312   2.790   2.274   1.622    .000
     .000    .000    .000   1.000    .000    .000   1.000    .000    .000
     .000    .000    .000   1.000    .000    .000
    10.000       .000
  1
 -1  1
 -1
0
```

APPENDIX H

EXAMPLE WITH NO FINS AND NO BILGE KEELS

```
EXAMPLE
 0
 0
   0      .00000      .30480
 3   0   2   1
 133.0000        .9440      1.6000        .0000        .3800        .2500
 2
   90.0000   180.0000    15.0000
      .0000      5.4528      6.4000      6.4000      6.4000      6.4000      6.4000      6.4000
     6.4000      6.4000      6.4000      6.4000      6.4000      6.4000      6.4000      6.4000
     6.4000      3.9328      2.1936      1.3920       .0000
   10.0000    15.0000
   41       .05000    2.05000
 1
 2   0
     2.0000      4.0000
   10.0000    12.0000
19
       2.000   1
       .0000        .2610        .4875        .7140        .8370        .9150      1.0770      1.2825
       .9472      1.7760      2.8224      4.0000      4.5696      4.8000      5.6000      6.4000
       3.000   1
       .0000        .4785        .9075      1.4415      1.5735      1.9200      2.1870      2.5020
       .0000      1.0880      2.1856      3.6464      4.0000      4.9248      5.6000      6.4000
       4.000   1
       .0000        .7545      1.2465      1.9995      2.5755      3.2265      3.3825      3.7800
       .0000        .8192      1.6192      2.8816      3.9904      5.2864      5.6000      6.4000
       5.000   1
       .0000      1.0695      1.8105      2.8140      3.6960      4.3110      4.6335      5.0445
       .0000        .8416      1.6080      2.2640      4.0000      5.0192      5.6000      6.4000
       6.000   1
       .0000      1.3635      2.2305      3.2760      4.2150      4.7445      5.7450      6.1275
       .0000        .6288      1.4864      2.2640      3.2912      4.0000      5.6000      6.4000
       7.000   1
       .0000      1.4070      2.4120      3.6480      4.5795      5.7915      6.7095      7.0350
       .0000        .3792        .8800      1.7104      2.5456      4.0000      5.6000      6.4000
       8.000   0
       .0000      1.5270      3.7965      4.8510      5.7000      6.5745      7.4325      7.7175
       .0000        .1792      1.1312      1.9616      2.7856      4.0000      5.6000      6.4000
       9.000   0
       .0000      2.2350      3.2895      5.1795      6.3615      7.2735      7.9305      8.1810
       .0000        .1712        .4816      1.5424      2.6336      4.0000      5.6000      6.4000
     10.000   3
       .0000      2.7315      4.6140      6.3090      6.8025      7.6920      8.2800      8.4690
       .0000        .1936        .8832      2.0464      2.5840      4.0000      5.6000      6.4000
     11.000   3
       .0000      4.0005      4.8225      6.6000      6.9855      7.9080      8.4450      8.6385
       .0000        .4864        .8160      2.0176      2.4720      4.0000      5.6000      6.4000
     12.000   3
       .0000      3.5925      5.2875      7.0215      7.5390      8.0415      8.6430      8.8155
       .0000        .3168      1.0160      2.4432      3.1248      4.0000      5.6000      6.4000
     13.000   3
       .0000      1.8300      3.2655      5.4645      6.9690      7.9005      8.5125      8.7270
       .0000        .0896        .3680      1.3472      2.6400      4.0000      5.6000      6.4000
     14.000   3
       .0000      1.9425      3.7035      5.6535      6.8505      7.5840      8.3685      8.6445
       .0000        .2064        .8000      1.8208      2.9536      4.0000      5.6000      6.4000
```

```
  15.000   0
    .0000    2.4015    4.6935    5.7255    6.5175    7.1610    8.1165    8.4420
    .0000     .6624    1.8192    2.5456    3.2240    4.0000    5.6000    6.4000
  16.000   0
    .0000    1.5345    2.1750    3.8010    4.6095    6.5910    7.7610    8.1480
    .0000     .7312    1.1344    2.0784    2.5856    4.0000    5.6000    6.4000
  17.000   0
    .0000     .6690    1.0290    2.2770    3.7800    5.7555    7.2585    7.7100
    .0000     .8576    1.4080    2.2496    2.9280    4.0000    5.6000    6.4000
  18.000   0
    .0000     .4455    1.3905    3.0840    4.0200    5.7960    6.5370    7.1145
   2.4672    2.6688    3.0672    3.6736    4.0000    4.8688    5.6000    6.4000
  19.000   0
    .0000     .5805    1.3740    2.4765    3.6735    4.6230    5.5200    6.3765
   4.2064    4.2848    4.4432    4.6416    4.8928    5.1216    5.6000    6.4000
  20.000   0
    .0000     .9345    1.7955    2.8245    3.7320    3.9600    4.6305    5.3670
   5.0080    5.0624    5.1872    5.3344    5.5248    5.6000    5.8640    6.4000
0
    .0000     .0000     .0000
0    .000    .000    .000   1.000    .000    .000   1.000    .000    .000
1  2
19.630   3.799   4.109   1.810    .520    .520    .000    .000
19.630   2.163   3.731   1.520    .750    .520    .000  62.500
20.370   2.063   5.312   2.790   2.274   1.622    .000
   .000    .000    .000   1.000    .000    .000   1.000    .000    .000
   .000    .000    .000   1.000    .000    .000
1
-1  1
-1
```

<u>APPENDIX I</u>

EXAMPLE OF VERTICAL MOTIONS VER FILES

```
EXAMPLE
 0
8 APR 87
Test of stretch factor programme
 1  0  1  3  1  0-1  0  1  0  0  0  0  020
                 133.00000    1.02500    9.80665   7104.720
      .0000        .0000        .0000      .0000
     2.5650        .5168       5.4528      .0000
     5.0040        .5118       6.4000      .0000
     7.5600        .5566       6.4000      .0000
    10.0890        .5870       6.4000      .0000
    12.2550        .6260       6.4000      .0000
    14.0700        .6767       6.4000      .0000
    15.4350        .7227       6.4000      .0000
    16.3620        .7666       6.4000      .0000
    16.9380        .7910       6.4000      .0000
    17.2770        .8040       6.4000      .0000
    17.6310        .8001       6.4000      .0000
    17.4540        .7818       6.4000      .0000
    17.2890        .7445       6.4000      .0000
    16.8840        .6926       6.4000      .0000
    16.2960        .6220       6.4000      .0000
    15.4200        .5271       6.4000      .0000
    14.2290        .6178       3.9328      .0000
    12.7530        .6831       2.1936      .0000
    10.7310        .7135       1.3920      .0000
      .0000        .0000        .0000      .0000
    33.2500      -2.1700
         11           11            1
     1.0000        .0500       2.0500      .0500
  1
  2
    10.00     15.00
    90.0000   180.0000     15.0000
  2
 2.0010.00
 4.0012.00
  0
 0
    -1.0000
```

APPENDIX J

EXAMPLE OF VERTICAL MOTIONS DAT FILE

```
1 0 1 3 1 0-1 1 020
 133.0000     1.0250     9.8067 7104.7200
    .0000      .0000      .0000      .0000
   2.5650      .5168     5.4528      .0000
   5.0040      .5118     6.4000      .0000
   7.5600      .5566     6.4000      .0000
  10.0890      .5870     6.4000      .0000
  12.2550      .6260     6.4000      .0000
  14.0700      .6767     6.4000      .0000
  15.4350      .7227     6.4000      .0000
  16.3620      .7666     6.4000      .0000
  16.9380      .7910     6.4000      .0000
  17.2770      .8040     6.4000      .0000
  17.6310      .8001     6.4000      .0000
  17.4540      .7818     6.4000      .0000
  17.2890      .7445     6.4000      .0000
  16.8840      .6926     6.4000      .0000
  16.2960      .6220     6.4000      .0000
  15.4200      .5271     6.4000      .0000
  14.2290      .6178     3.9328      .0000
  12.7530      .6831     2.1936      .0000
  10.7310      .7135     1.3920      .0000
    .0000      .0000      .0000      .0000
  33.2500    -2.1700
    .0500     2.0500      .0500
 2
  10.00    15.00
  90.0000  180.0000    15.0000
 2
 2.0010.00
 4.0012.00
0
```

APPENDIX K

SAMPLE OUTPUT FROM SHIPC.VRS

SHIP TITLE IS SHIPC

SPEED = 10.00 KNOTS WAVE ANGLE = 90.00 DEGS

WAVELENGTH MTRS	WAVE FREQUENCIES RAD/SEC	ENC. FREQUENCIES RAD/SEC	HEAVE MTRS	PHASE DEG	PITCH DEG	PHASE DEG	PITCH NON-D.
24646.92	.05	.05	1.0000	180.0	.0000	-13.5	.0011
6161.73	.10	.10	1.0001	180.0	.0001	-58.6	.0024
2738.55	.15	.15	1.0004	180.0	.0006	-72.2	.0047
1540.43	.20	.20	1.0011	179.9	.0012	-75.4	.0052
985.88	.25	.25	1.0022	179.8	.0021	-78.3	.0057
684.64	.30	.30	1.0038	179.7	.0033	-80.8	.0062
503.00	.35	.35	1.0059	179.4	.0048	-83.0	.0067
385.11	.40	.40	1.0084	179.0	.0067	-84.9	.0072
304.28	.45	.45	1.0112	178.5	.0089	-86.8	.0076
246.47	.50	.50	1.0142	177.8	.0115	-88.3	.0079
203.69	.55	.55	1.0172	176.9	.0145	-89.6	.0082
171.16	.60	.60	1.0200	175.7	.0178	-90.6	.0084
145.84	.65	.65	1.0222	174.2	.0215	-91.3	.0087
125.75	.70	.70	1.0238	172.4	.0257	-91.5	.0090
109.54	.75	.75	1.0243	170.2	.0306	-91.6	.0093
96.28	.80	.80	1.0232	167.4	.0365	-91.5	.0098
85.28	.85	.85	1.0193	164.0	.0436	-91.6	.0103
76.07	.90	.90	1.0107	159.9	.0526	-92.5	.0111
68.27	.95	.95	.9964	154.8	.0637	-94.4	.0121
61.62	1.00	1.00	.9691	148.5	.0770	-98.4	.0132
55.89	1.05	1.05	.9264	141.0	.0921	-104.2	.0143
50.92	1.10	1.10	.8579	132.4	.1061	-112.5	.0150
46.59	1.15	1.15	.7644	122.9	.1176	-122.1	.0152
42.79	1.20	1.20	.6491	113.5	.1219	-132.3	.0145
39.44	1.25	1.25	.5279	104.9	.1205	-141.8	.0132
36.46	1.30	1.30	.4169	97.9	.1139	-148.9	.0115
33.81	1.35	1.35	.3197	92.4	.1046	-154.5	.0098
31.44	1.40	1.40	.2358	88.5	.0935	-158.6	.0082
29.31	1.45	1.45	.1747	86.2	.0839	-160.6	.0068
27.39	1.50	1.50	.1285	85.3	.0754	-161.4	.0057
25.65	1.55	1.55	.0933	85.7	.0664	-161.6	.0047
24.07	1.60	1.60	.0680	86.7	.0593	-160.5	.0040
22.63	1.65	1.65	.0494	88.0	.0531	-158.6	.0033
21.32	1.70	1.70	.0357	89.1	.0476	-156.2	.0028
20.12	1.75	1.75	.0256	89.2	.0428	-152.8	.0024
19.02	1.80	1.80	.0181	87.4	.0383	-149.1	.0020
18.00	1.85	1.85	.0126	81.8	.0343	-144.7	.0017
17.07	1.90	1.90	.0089	70.0	.0307	-139.7	.0015
16.20	1.95	1.95	.0069	50.4	.0276	-133.9	.0012
15.40	2.00	2.00	.0064	28.2	.0250	-127.3	.0011
14.66	2.05	2.05	.0069	11.4	.0227	-120.0	.0009

SPEED = 10.00 KNOTS WAVE ANGLE = 105.00 DEGS

WAVELENGTH	WAVE	ENC.	HEAVE	PHASE	PITCH	PHASE	PITCH
	FREQUENCIES						
MTRS	RAD/SEC		MTRS	DEG	DEG	DEG	NON–D.
24646.92	.05	.05	1.0000	180.0	.0038	89.7	.2587
6161.73	.10	.10	1.0002	180.0	.0150	89.5	.2571
2738.55	.15	.15	1.0007	180.0	.0336	89.3	.2555
1540.43	.20	.21	1.0015	179.9	.0598	89.2	.2561
985.88	.25	.26	1.0028	179.8	.0939	88.9	.2572
684.64	.30	.31	1.0045	179.7	.1361	88.5	.2588
503.00	.35	.37	1.0065	179.4	.1868	87.9	.2610
385.11	.40	.42	1.0084	179.0	.2467	87.1	.2639
304.28	.45	.48	1.0099	178.5	.3163	86.1	.2674
246.47	.50	.53	1.0108	177.8	.3964	84.7	.2714
203.69	.55	.59	1.0106	176.9	.4878	82.9	.2760
171.16	.60	.65	1.0092	175.7	.5910	80.6	.2810
145.84	.65	.71	1.0064	174.3	.7063	77.6	.2861
125.75	.70	.77	1.0025	172.6	.8335	73.9	.2911
109.54	.75	.83	.9982	170.3	.9706	69.2	.2953
96.28	.80	.89	.9938	167.4	1.1130	63.3	.2977
85.28	.85	.95	.9903	163.4	1.2504	55.8	.2962
76.07	.90	1.01	.9815	157.5	1.3630	46.7	.2880
68.27	.95	1.07	.9541	149.0	1.4231	36.0	.2699
61.62	1.00	1.14	.8806	137.5	1.4022	24.2	.2400
55.89	1.05	1.20	.7420	124.2	1.2897	12.5	.2002
50.92	1.10	1.26	.5658	111.5	1.1161	1.8	.1579
46.59	1.15	1.33	.3906	101.4	.9174	−6.9	.1187
42.79	1.20	1.40	.2425	95.8	.7271	−13.6	.0864
39.44	1.25	1.46	.1399	95.9	.5568	−18.3	.0610
36.46	1.30	1.53	.0745	105.9	.4135	−21.2	.0419
33.81	1.35	1.60	.0401	134.4	.2969	−21.9	.0279
31.44	1.40	1.67	.0333	172.7	.2071	−20.5	.0181
29.31	1.45	1.74	.0348	−165.5	.1386	−16.2	.0113
27.39	1.50	1.81	.0346	−153.5	.0904	−8.4	.0069
25.65	1.55	1.88	.0316	−145.4	.0582	4.2	.0041
24.07	1.60	1.95	.0269	−137.3	.0380	21.0	.0025
22.63	1.65	2.02	.0219	−128.1	.0256	41.1	.0016
21.32	1.70	2.09	.0174	−117.1	.0169	63.9	.0010
20.12	1.75	2.17	.0139	−104.7	.0106	97.1	.0006
19.02	1.80	2.24	.0111	−91.9	.0090	148.9	.0005
18.00	1.85	2.31	.0090	−80.6	.0125	−174.7	.0006
17.07	1.90	2.39	.0070	−71.8	.0166	−158.6	.0008
16.20	1.95	2.47	.0050	−66.5	.0192	−153.1	.0009
15.40	2.00	2.54	.0029	−63.9	.0197	−151.8	.0008
14.66	2.05	2.62	.0010	−69.1	.0182	−153.6	.0007

SAMPLE OUTPUT FROM SHIPC.VRM

SHIP TITLE IS SHIPC
WAVE SPECTRAL DENSITY TWO PARAMETER, ISSC 1967 SPECTRA

	SPECTRA	
NUMBER	1	2
INPUT VALUES OF SPECTRAL PARAMETERS		
SIG.HT. MTRS	2.00	10.00
MN.PER. SECS	4.00	12.00
CALCULATED VALUES FROM FREQUENCY RANGE		
SIG.HT. MTRS	1.85	9.99
MN.PER. SECS	4.57	12.08
WAVE FREQ.		
.05	.00	.00
.10	.00	.00
.15	.00	.00
.20	.00	.00
.25	.00	.16
.30	.00	5.52
.35	.00	17.11
.40	.00	22.10
.45	.00	20.05
.50	.00	15.68
.55	.00	11.54
.60	.00	8.31
.65	.00	5.98
.70	.00	4.33
.75	.00	3.17
.80	.01	2.35
.85	.03	1.77
.90	.07	1.35
.95	.13	1.04
1.00	.18	.81
1.05	.23	.64
1.10	.26	.51
1.15	.29	.41
1.20	.29	.33
1.25	.29	.27
1.30	.28	.22
1.35	.27	.18
1.40	.25	.15
1.45	.23	.13
1.50	.21	.11
1.55	.19	.09
1.60	.17	.08
1.65	.15	.07
1.70	.14	.06
1.75	.12	.05
1.80	.11	.04
1.85	.10	.04
1.90	.09	.03
1.95	.08	.03
2.00	.07	.03
2.05	.06	.02

SHIP SPEED = 10.00 KNOTS WAVE ANGLE = 90.00 DEG. (AMPLITUDE)SPECTRA

SIG. WAVE HT. = 2.00 MTRS MEAN PERIOD = 4.00 SECS

	HEAVE	PITCH
MNSQ	.0642 MTRS↑2	.0017 DEG↑2
RMS.	.2535 MTRS	.0411 DEG
AVG.	.3168 MTRS	.0514 DEG
SIG.	.5069 MTRS	.0822 DEG
1/10	.6463 MTRS	.1049 DEG

SIG. WAVE HT. = 10.00 MTRS MEAN PERIOD = 12.00 SECS

	HEAVE	PITCH
MNSQ	6.2882 MTRS↑2	.0036 DEG↑2
RMS.	2.5076 MTRS	.0603 DEG
AVG.	3.1345 MTRS	.0754 DEG
SIG.	5.0153 MTRS	.1206 DEG
1/10	6.3945 MTRS	.1538 DEG

SHIP SPEED = 10.00 KNOTS WAVE ANGLE = 105.00 DEG. (AMPLITUDE)SPECTRA

SIG. WAVE HT. = 2.00 MTRS MEAN PERIOD = 4.00 SECS

	HEAVE	PITCH
MNSQ	.0326 MTRS↑2	.1049 DEG↑2
RMS.	.1805 MTRS	.3240 DEG
AVG.	.2256 MTRS	.4049 DEG
SIG.	.3609 MTRS	.6479 DEG
1/10	.4602 MTRS	.8261 DEG

SIG. WAVE HT. = 10.00 MTRS MEAN PERIOD = 12.00 SECS

	HEAVE	PITCH
MNSQ	6.1683 MTRS↑2	1.7695 DEG↑2
RMS.	2.4836 MTRS	1.3302 DEG
AVG.	3.1045 MTRS	1.6628 DEG
SIG.	4.9672 MTRS	2.6605 DEG
1/10	6.3332 MTRS	3.3921 DEG

SHIP SPEED = 10.00 KNOTS WAVE ANGLE = 120.00 DEG. (AMPLITUDE)SPECTRA

SIG. WAVE HT. = 2.00 MTRS MEAN PERIOD = 4.00 SECS

	HEAVE	PITCH
MNSQ	.0056 MTRS↑2	.0542 DEG↑2
RMS.	.0748 MTRS	.2329 DEG
AVG.	.0935 MTRS	.2911 DEG
SIG.	.1496 MTRS	.4658 DEG
1/10	.1907 MTRS	.5939 DEG

SIG. WAVE HT. = 10.00 MTRS MEAN PERIOD = 12.00 SECS

	HEAVE	PITCH
MNSQ	5.4907 MTRS↑2	4.8687 DEG↑2
RMS.	2.3432 MTRS	2.2065 DEG
AVG.	2.9290 MTRS	2.7581 DEG
SIG.	4.6864 MTRS	4.4130 DEG
1/10	5.9752 MTRS	5.6266 DEG

SAMPLE OUTPUT FROM SHIPC.LRS

L.B.P.	HCG	GMIN	RNF	RRG/B	YRG/L
133.0000	.9440	1.6000	.0000	.3800	.2500

WAVE SPECTRAL DENSITY, TWO PARAMETER ISSC 1967 SPECTRA

Wave frequencies in radians per second
Spectral units are metres * 2 * pi per second
Modal period in seconds
Significant wave height in metres

DERIVED RESULTS

SIG.HT.	1.852	9.991
MN.PER.	4.570	12.083

INPUT VALUES

SIG.HT.	2.000	10.000
MN.PER.	4.000	12.000

SPECTRA NO.	1	2
WAVE FREQ.		
.050	.000	.000
.100	.000	.000
.150	.000	.000
.200	.000	.000
.250	.000	.162
.300	.000	5.517
.350	.000	17.113
.400	.000	22.101
.450	.000	20.049
.500	.000	15.678
.550	.000	11.537
.600	.000	8.315
.650	.000	5.981
.700	.000	4.333
.750	.002	3.174
.800	.011	2.354
.850	.034	1.770
.900	.074	1.347
.950	.125	1.038
1.000	.180	.810
1.050	.228	.638
1.100	.264	.508
1.150	.286	.408
1.200	.295	.331
1.250	.293	.271
1.300	.283	.223
1.350	.267	.185
1.400	.249	.154
1.450	.229	.130
1.500	.209	.110
1.550	.190	.093
1.600	.171	.079
1.650	.154	.068
1.700	.138	.059
1.750	.124	.051
1.800	.111	.044
1.850	.099	.039
1.900	.089	.034
1.950	.080	.030

2.000	.072	.026
2.050	.064	.023

MN. SQ	.214	6.238
R.M.S.	.463	2.498
AVG.	.567	3.058
SIG.	.926	4.995
AV1/10	1.178	6.357

STATION 2.00 IEDDY= 1
OFFSET DISTANCE FROM CENTRELINE
.0000 .2610 .4875 .7140 .8370 .9150 1.0770 1.2825
DISTANCES FROM KEEL
.9472 1.7760 2.8224 4.0000 4.5696 4.8000 5.6000 6.4000
STATION 3.00 IEDDY= 1
OFFSET DISTANCE FROM CENTRELINE
.0000 .4785 .9075 1.4415 1.5735 1.9200 2.1870 2.5020
DISTANCES FROM KEEL
.0000 1.0880 2.1856 3.6464 4.0000 4.9248 5.6000 6.4000
STATION 4.00 IEDDY= 1
OFFSET DISTANCE FROM CENTRELINE
.0000 .7545 1.2465 1.9995 2.5755 3.2265 3.3825 3.7800
DISTANCES FROM KEEL
.0000 .8192 1.6192 2.8816 3.9904 5.2864 5.6000 6.4000
STATION 5.00 IEDDY= 1
OFFSET DISTANCE FROM CENTRELINE
.0000 1.0695 1.8105 2.8140 3.6960 4.3110 4.6335 5.0445
DISTANCES FROM KEEL
.0000 .8416 1.6080 2.2640 4.0000 5.0192 5.6000 6.4000
STATION 6.00 IEDDY= 1
OFFSET DISTANCE FROM CENTRELINE
.0000 1.3635 2.2305 3.2760 4.2150 4.7445 5.7450 6.1275
DISTANCES FROM KEEL
.0000 .6288 1.4864 2.2640 3.2912 4.0000 5.6000 6.4000
STATION 7.00 IEDDY= 1
OFFSET DISTANCE FROM CENTRELINE
.0000 1.4070 2.4120 3.6480 4.5795 5.7915 6.7095 7.0350
DISTANCES FROM KEEL
.0000 .3792 .8800 1.7104 2.5456 4.0000 5.6000 6.4000
STATION 8.00 IEDDY= 0
OFFSET DISTANCE FROM CENTRELINE
.0000 1.5270 3.7965 4.8510 5.7000 6.5745 7.4325 7.7175
DISTANCES FROM KEEL
.0000 .1792 1.1312 1.9616 2.7856 4.0000 5.6000 6.4000
STATION 9.00 IEDDY= 0
OFFSET DISTANCE FROM CENTRELINE
.0000 2.2350 3.2895 5.1795 6.3615 7.2735 7.9305 8.1810
DISTANCES FROM KEEL
.0000 .1712 .4816 1.5424 2.6336 4.0000 5.6000 6.4000
STATION 10.00 IEDDY= 3
OFFSET DISTANCE FROM CENTRELINE
.0000 2.7315 4.6140 6.3090 6.8025 7.6920 8.2800 8.4690
DISTANCES FROM KEEL
.0000 .1936 .8832 2.0464 2.5840 4.0000 5.6000 6.4000
STATION 11.00 IEDDY= 3
OFFSET DISTANCE FROM CENTRELINE
.0000 4.0005 4.8225 6.6000 6.9855 7.9080 8.4450 8.6385
DISTANCES FROM KEEL
.0000 .4864 .8160 2.0176 2.4720 4.0000 5.6000 6.4000

STATION 12.00 IEDDY= 3
OFFSET DISTANCE FROM CENTRELINE
.0000 3.5925 5.2875 7.0215 7.5390 8.0415 8.6430 8.8155
DISTANCES FROM KEEL
.0000 .3168 1.0160 2.4432 3.1248 4.0000 5.6000 6.4000
STATION 13.00 IEDDY= 3
OFFSET DISTANCE FROM CENTRELINE
.0000 1.8300 3.2655 5.4645 6.9690 7.9005 8.5125 8.7270
DISTANCES FROM KEEL
.0000 .0896 .3680 1.3472 2.6400 4.0000 5.6000 6.4000
STATION 14.00 IEDDY= 3
OFFSET DISTANCE FROM CENTRELINE
.0000 1.9425 3.7035 5.6535 6.8505 7.5840 8.3685 8.6445
DISTANCES FROM KEEL
.0000 .2064 .8000 1.8208 2.9536 4.0000 5.6000 6.4000
STATION 15.00 IEDDY= 0
OFFSET DISTANCE FROM CENTRELINE
.0000 2.4015 4.6935 5.7255 6.5175 7.1610 8.1165 8.4420
DISTANCES FROM KEEL
.0000 .6624 1.8192 2.5456 3.2240 4.0000 5.6000 6.4000
STATION 16.00 IEDDY= 0
OFFSET DISTANCE FROM CENTRELINE
.0000 1.5345 2.1750 3.8010 4.6095 6.5910 7.7610 8.1480
DISTANCES FROM KEEL
.0000 .7312 1.1344 2.0784 2.5856 4.0000 5.6000 6.4000
STATION 17.00 IEDDY= 0
OFFSET DISTANCE FROM CENTRELINE
.0000 .6690 1.0290 2.2770 3.7800 5.7555 7.2585 7.7100
DISTANCES FROM KEEL
.0000 .8576 1.4080 2.2496 2.9280 4.0000 5.6000 6.4000
STATION 18.00 IEDDY= 0
OFFSET DISTANCE FROM CENTRELINE
.0000 .4455 1.3905 3.0840 4.0200 5.7960 6.5370 7.1145
DISTANCES FROM KEEL
2.4672 2.6688 3.0672 3.6736 4.0000 4.8688 5.6000 6.4000
STATION 19.00 IEDDY= 0
OFFSET DISTANCE FROM CENTRELINE
.0000 .5805 1.3740 2.4765 3.6735 4.6230 5.5200 6.3765
DISTANCES FROM KEEL
4.2064 4.2848 4.4432 4.6416 4.8928 5.1216 5.6000 6.4000
STATION 20.00 IEDDY= 0
OFFSET DISTANCE FROM CENTRELINE
.0000 .9345 1.7955 2.8245 3.7320 3.9600 4.6305 5.3670
DISTANCES FROM KEEL
5.0080 5.0624 5.1872 5.3344 5.5248 5.6000 5.8640 6.4000

DISPLACEMENT	XCG	BLOCK	BEAM	DRAFT
7107.088	11.3661	.4613	17.6310	6.4000

BILGE KEEL INFORMATION
The Bilge keel is in 1 Part
Bilge keel number 1 Starts at station 8 and spans 3 stations

Bilge keel number 1

Station	Offset	Waterline	Outreach	Length
8	5.7000	2.7860	1.5000	5.3200
9	6.3620	2.6340	1.5000	6.6500
10	6.3090	2.0460	1.5000	7.9800

ANTI ROLLING FOIL ,A BRACKET AND RUDDER INFORMATION

This ship has 1 Foil
This ship has 1 Propeller shaft
with 2 A Brackets per shaft

ANTI-ROLLING FIN INFORMATION

Station	Offset	Waterline	Outreach	Root Chord	Tip Chord	Di-hedral
11.00	6.99	2.47	1.61	2.96	2.19	45.00

PROPELLER SHAFT BRACKET INFORMATION

Station	Offset	Waterline	Outreach	Root Chord	Tip Chord	Di-hed ral
19.63	3.80	4.11	1.81	.52	.52	.00
19.63	2.16	3.73	1.52	.75	.52	62.50

RUDDER INFORMATION

Station	Offset	Waterline	Outreach	Root chord	Tip Chord
20.37	2.06	5.31	2.79	2.27	1.62

CALCULATED GM (SOLID) IS 1.33 METRES

DATA GENERATED BY FCF METHOD

LONG WAVE APPROX

SHIP SPEED IS 10.0 KNOTS ,WAVE DIRECTION IS 90.0 DEGS

SWAY AMP IS NON-DIMENSIONALISED BY WAVE AMP,
ROLL AND YAW AMPS BY WAVE SLOPE. FIN/TANK AMPLITUDES ARE IN DEGS
FREQUENCY RESPONSE

SWAY

FINS

W	WE	WL/L	AMP	PHASE	AMP	PHASE	AMP	PHASE	AMP	PHASE	AMP	PHASE
.05	.05	185.46	1.038	88.	.773	84.	5.144	−79.	.000	−93.	.013	0.
.10	.10	46.37	1.030	88.	.790	85.	2.011	−71.	.000	−94.	.003	0.
.15	.15	20.61	1.018	88.	.806	86.	1.062	−72.	.000	91.	.001	0.
.20	.20	11.59	1.007	89.	.836	86.	.643	−75.	.000	105.	.001	0.
.25	.25	7.42	.995	89.	.885	86.	.425	−77.	.000	90.	.001	0.
.30	.30	5.15	.983	89.	.959	86.	.300	−78.	.000	−90.	.000	0.
.35	.35	3.78	.970	89.	1.060	85.	.223	−79.	.000	−2.	.000	0.
.40	.40	2.90	.957	89.	1.225	84.	.174	−80.	.000	0.	.000	0.
.45	.45	2.29	.944	89.	1.504	82.	.144	−81.	.000	0.	.000	0.
.50	.50	1.85	.933	89.	2.050	78.	.131	−84.	.000	0.	.000	0.
.55	.55	1.53	.929	88.	3.442	65.	.144	−94.	.000	0.	.000	0.
.60	.60	1.29	.872	83.	6.940	6.	.182	−151.	.000	0.	.000	0.
.65	.65	1.10	.801	89.	3.067	−58.	.046	145.	.000	0.	.000	0.
.70	.70	.95	.797	90.	1.537	−71.	.012	119.	.000	0.	.000	0.
.75	.75	.82	.782	90.	.958	−75.	.005	57.	.000	0.	.000	0.
.80	.80	.72	.763	90.	.664	−77.	.006	22.	.000	0.	.000	0.
.85	.85	.64	.742	90.	.489	−78.	.008	16.	.000	0.	.000	0.
.90	.90	.57	.719	90.	.375	−78.	.009	15.	.000	0.	.000	0.
.95	.95	.51	.696	90.	.296	−78.	.010	16.	.000	0.	.000	0.
1.00	1.00	.46	.672	90.	.238	−77.	.010	16.	.000	0.	.000	0.
1.05	1.05	.42	.647	90.	.196	−77.	.010	21.	.000	0.	.000	0.
1.10	1.10	.38	.621	90.	.161	−77.	.010	17.	.000	0.	.000	0.
1.15	1.15	.35	.596	90.	.135	−76.	.010	16.	.000	0.	.000	0.
1.20	1.20	.32	.569	90.	.114	−76.	.010	16.	.000	0.	.000	0.
1.25	1.25	.30	.543	89.	.097	−75.	.010	15.	.000	0.	.000	0.
1.30	1.30	.27	.517	89.	.082	−75.	.009	14.	.000	0.	.000	0.
1.35	1.35	.25	.490	89.	.071	−75.	.009	13.	.000	0.	.000	0.
1.40	1.40	.24	.464	89.	.061	−75.	.008	12.	.000	0.	.000	0.
1.45	1.45	.22	.439	88.	.052	−75.	.008	12.	.000	0.	.000	0.
1.50	1.50	.21	.413	88.	.045	−75.	.007	12.	.000	0.	.000	0.
1.55	1.55	.19	.389	88.	.038	−75.	.006	11.	.000	0.	.000	0.
1.60	1.60	.18	.365	88.	.033	−75.	.006	11.	.000	0.	.000	0.
1.65	1.65	.17	.342	88.	.028	−75.	.005	12.	.000	0.	.000	0.
1.70	1.70	.16	.320	87.	.024	−74.	.005	12.	.000	0.	.000	0.
1.75	1.75	.15	.299	87.	.021	−74.	.004	13.	.000	0.	.000	0.
1.80	1.80	.14	.279	87.	.017	−74.	.004	14.	.000	0.	.000	0.
1.85	1.85	.14	.260	87.	.015	−74.	.004	16.	.000	0.	.000	0.
1.90	1.90	.13	.242	87.	.012	−74.	.003	17.	.000	0.	.000	0.
1.95	1.95	.12	.225	86.	.010	−75.	.003	19.	.000	0.	.000	0.
2.00	2.00	.12	.209	87.	.009	−87.	.003	21.	.000	0.	.000	0.
2.05	2.05	.11	.193	87.	.007	−72.	.002	24.	.000	0.	.000	0.

SWAY IN METRIC UNITS , ALL ANGULAR MEASURES ARE IN DEGREES

SIG. WAVE HEIGHT 2.00 METRES
WAVE PERIOD 4.00 SECONDS

	R.M.S.				
	SWAY	ROLL	YAW	RUDDER	FINS
DISPLACEMENT	.2305	.4160	.0378	.0001	.0001
VELOCITY	.2885	.4842	.0535	.0001	.0001
ACCELERATION	.3884	.6058	.0804	.0002	.0002

SIG. WAVE HEIGHT 10.00 METRES
WAVE PERIOD 12.00 SECONDS

	R.M.S.				
	SWAY	ROLL	YAW	RUDDER	FINS
DISPLACEMENT	2.2693	12.1043	.4687	.0005	.0827
VELOCITY	1.1545	7.2434	.2417	.0003	.0333
ACCELERATION	.7342	4.4400	.1430	.0002	.0151

SAMPLE OUTPUT FROM SHIPC.OTT

COMBINATION OF VERTICAL AND LATERAL MOTIONS

TO GIVE TOTAL MOTIONS AT SPECIFIED POINTS

X IS POSITION IN STATIONS
Y DISTANCES ARE MEASURED FRIM THE CENTRELINE +VE TO STBD (M)
Z DISTANCES ARE MEASURED FROM USK POSITIVE UPWARDS (M)

POSITIONS ARE AS FOLLOWS

X	Y	Z	NUMBER
3.0000	4.0000	6.0000	1

SPECTRUM NUMBER	1	2
SIG. WAVE HT. (M)	2.00	10.00
MODAL WAVE PERIOD (SEC)	4.00	12.00

R.M.S. VALUES

MOTION IN METRES
VELOCITY IN METRES/SEC
ACCELERATION IN METRES/SEC**2

MOTIONS IN LONG CRESTED IRREGULAR SEAS

SPEED 10.00 KNOTS
HEADING 90.00 DEGREES

LOCATION NO. 1 R.M.S. R E S P O N S E S

WAVE SPECT	VERTICAL ABSOLUTE DISP	VEL	ACCEL	VERTICAL RELATIVE DISP	VEL	ACCEL	LATERAL ABSOLUTE DISP	VEL	ACCEL
1	.25	.27	.31	.37	.57	.92	.23	.30	.40
2	2.35	1.21	.79	.85	.65	.72	1.98	1.03	.68

SYMMETRIC VALUES

1	.29	.33	.38	.57	.79	1.16	.23	.30	.40
2	2.92	1.62	1.06	1.19	1.01	1.09	1.98	1.03	.68

SPEED 10.00 KNOTS
HEADING 105.00 DEGREES

LOCATION NO. 1 R.M.S. R E S P O N S E S

WAVE SPECT	VERTICAL ABSOLUTE DISP	VERTICAL ABSOLUTE VEL	VERTICAL ABSOLUTE ACCEL	VERTICAL RELATIVE DISP	VERTICAL RELATIVE VEL	VERTICAL RELATIVE ACCEL	LATERAL ABSOLUTE DISP	LATERAL ABSOLUTE VEL	LATERAL ABSOLUTE ACCEL
1	.43	.52	.65	.62	.96	1.66	.22	.30	.43
2	2.81	1.92	1.64	1.30	1.29	1.62	1.89	1.07	.80

SYMMETRIC VALUES

1	.40	.48	.60	.72	1.06	1.75	.22	.30	.43
2	3.25	2.02	1.58	1.71	1.63	1.92	1.89	1.07	.80

SPEED 10.00 KNOTS
HEADING 120.00 DEGREES

LOCATION NO. 1 R.M.S. R E S P O N S E S

WAVE SPECT	VERTICAL ABSOLUTE DISP	VERTICAL ABSOLUTE VEL	VERTICAL ABSOLUTE ACCEL	VERTICAL RELATIVE DISP	VERTICAL RELATIVE VEL	VERTICAL RELATIVE ACCEL	LATERAL ABSOLUTE DISP	LATERAL ABSOLUTE VEL	LATERAL ABSOLUTE ACCEL
1	.28	.34	.42	.62	1.06	2.15	.10	.13	.19
2	3.46	2.50	2.12	2.06	2.08	2.53	1.66	.96	.70

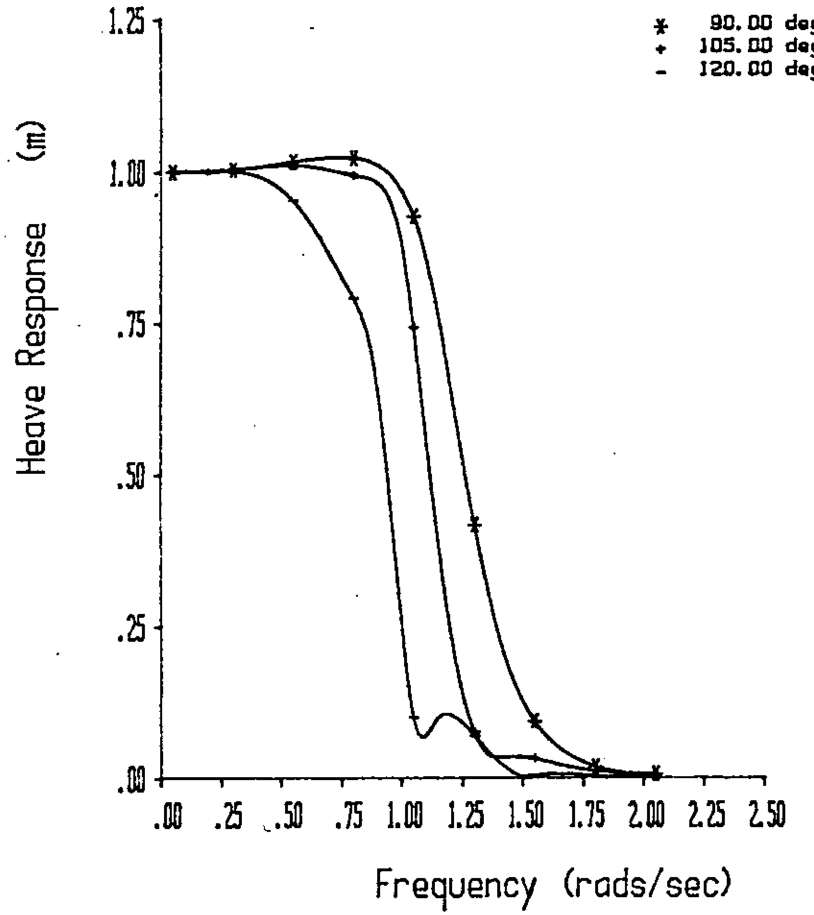
SYMMETRIC VALUES

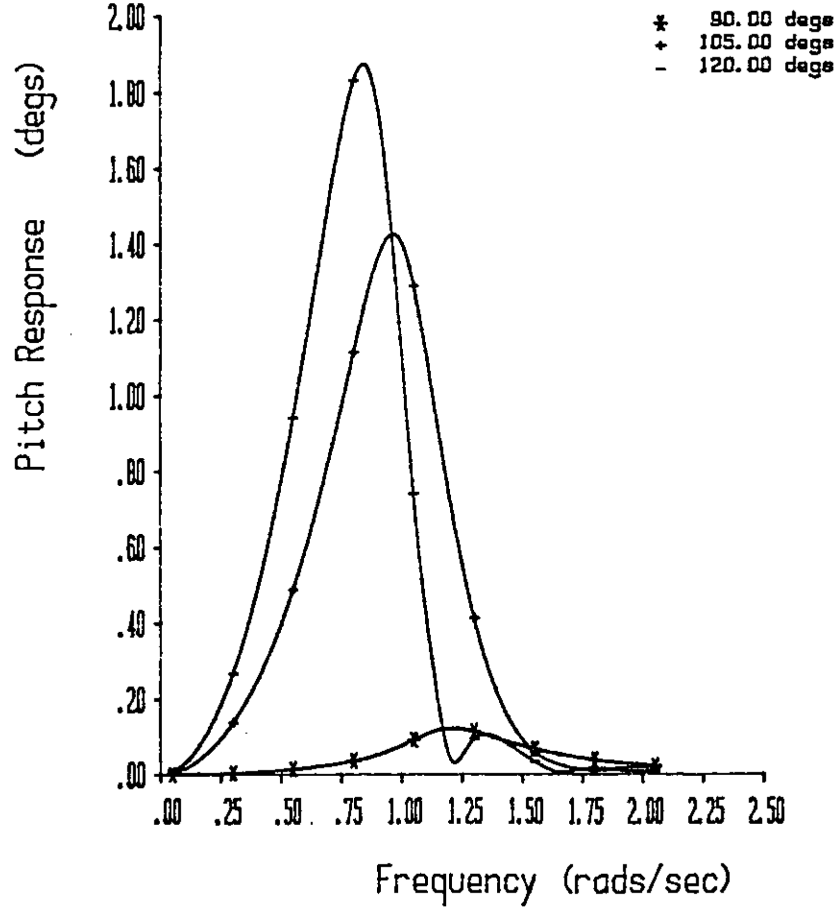
1	.27	.32	.40	.61	1.03	2.11	.10	.13	.19
2	3.53	2.36	1.93	2.31	2.22	2.60	1.66	.96	.70

Ship Name : SHIPC

Ship Speed = 10.0 knots

Results are amplitudes and DIMENSIONAL per unit wave amplitude





Ship Name : SHIPC

Ship Speed = 10.0 knots

Results are amplitudes and DIMENSIONAL per unit wave amplitude