SEAKEEPING CALCULATIONS BY MICROCOMPUTER

by P.A. Wilson

Ship Science Report No. 28

April 1987
CONTENTS

MODULE DESCRIPTIONS

MODULE A Data Generation and Editing

MODULE B Vertical Motions

MODULE C Subjective Motions

MODULE D Lateral Motions

MODULE E Total Motions

MODULE F Plotting Programme

MODULE G Time Series

MODULE H Sustained Ship Speed

APPENDIX A References

APPENDIX B Power Spectral Density Functions

APPENDIX C Programme Running Styles

APPENDIX D Generating Data and Editing

APPENDIX E Lateral Data (bilge keels and active fins)

APPENDIX F Lateral Data (bilge keels only)

APPENDIX G Lateral Data (active fins only)

APPENDIX H Lateral Data (no bilge keels or active fins)

APPENDIX I Vertical Data Files (VER type)

APPENDIX J Vertical Data File (DAT type)

APPENDIX K Sample Output
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 programme 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 the TARGET 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 Filemames

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**

<table>
<thead>
<tr>
<th>File</th>
<th>Type</th>
<th>User</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHIPA.DAT</td>
<td>F</td>
<td>O</td>
<td>S Data file</td>
</tr>
<tr>
<td>SHIPA.TDP</td>
<td>U</td>
<td>N/O</td>
<td>T TDP file</td>
</tr>
<tr>
<td>SHIPA.RES</td>
<td>U</td>
<td>N</td>
<td>T Results for use for sub-modules</td>
</tr>
<tr>
<td>SHIPA.OUT</td>
<td>U</td>
<td>N</td>
<td>T Regular wave response results (not for printing)</td>
</tr>
<tr>
<td>SHIPA.VRM</td>
<td>F</td>
<td>N</td>
<td>T Irregular response statistics</td>
</tr>
<tr>
<td>SHIPA.GVT</td>
<td>U</td>
<td>N</td>
<td>T Results for modules E, F</td>
</tr>
<tr>
<td>SHIPA.VIR</td>
<td>U</td>
<td>N</td>
<td>T Not in use</td>
</tr>
<tr>
<td>SHIPA.VRS</td>
<td>F</td>
<td>N</td>
<td>T Results file for printing</td>
</tr>
</tbody>
</table>

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 user's 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 File Names

SHIP.A.GVT U O S Vertical responses
SHIP.A.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 output from this module gives the time period when the mutual limit values have not been exceeded in two forms, which are sometimes called Quiescent periods the second method lists the actual quiescent periods.
Data Filename

SHIP.A.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.

\[ P( x>x_0 ) = e^{-x_0^2/2m_0} \]

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,

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

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 probabilities 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 position 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 interpolate 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


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


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,

\[ S(\omega) = \frac{A}{\omega^5} e^{-B/\omega^4} \]  \hspace{1cm} (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

\[ \frac{dS}{d\omega} = 0 \]

\[ \therefore - \frac{5A}{\omega^6} e^{-B/\omega^4} + \frac{A}{\omega^5} \left( \frac{4B}{\omega^4} e^{-B/\omega^4} \right) = 0 \]

\[ \therefore \omega^4 = \frac{4B}{5} \]

Thus the peak frequency \( \omega_p \) is

\[ \omega_p = \sqrt[4]{0.8B} \] \hspace{1cm} (2)

The peak period \( T_p \) is thus

\[ T_p = \frac{2\pi}{\omega_p} = \frac{2\pi}{\sqrt[4]{0.8B}} \] \hspace{1cm} (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 \( m_0 \).
\[ m_0 = \int_0^\infty S(\omega) \, d\omega = \left[ \frac{-A}{4B} \, e^{-B/\omega} \right]_0^\infty = \frac{A}{4B} \]

Thus \[ m_0 = \frac{A}{4B} \]  \quad (4)

Another definition of \( m_0 \) is found from the significant wave height \( h_{1/3} \) viz:

\[ m_0 = \frac{h_{1/3}^2}{16} \]

\[ \therefore \quad \frac{A}{B} = 0.25 \, h_{1/3}^2 \]  \quad (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

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

i.e.

\[ B = \frac{3.11}{2} \frac{1}{h_{1/3}} \]  \quad \text{in metric units}

or

\[ \frac{33.43}{2} \frac{1}{h_{1/3}} \]  \quad \text{in imperial units}

Thus for P-M spectra

\[ A = 0.081 \, g^2 \]  \quad (6)

\[ B = \frac{3.11}{2} \frac{1}{h_{1/3}} \]  \quad \text{in metric units}  \quad (7)
For the ITTC spectral family the following analysis defines, A and B.

The nth moment of the spectral density function is

\[ m_0 = \int_0^\infty \omega^n S(\omega) \, d\omega \]  \hspace{1cm} (8)

\[ m_n = A \int_0^\infty \omega^{n-5} e^{-B\omega^4} \, d\omega \]  \hspace{1cm} (9)

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

\[ m_n = \frac{A}{4B} B^{n/4} \int_0^\infty e^{-u} u^{-n/4} \, du \]  \hspace{1cm} (10)

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

\[ \Gamma(n) = \int_0^\infty e^{-u} u^{n-1} \, du \]

\[ \therefore \quad m_n = \frac{A}{4} B^{n/4-1} \Gamma(1-n/4) \]  \hspace{1cm} (11)

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

\[ \omega_o^2 = \frac{m_2}{m_0} = \left(\frac{2\pi}{T_0}\right)^2 \]  \hspace{1cm} (12)

\[ \omega_1 = \frac{m_1}{m_0} = \frac{2\pi}{T_1} \]  \hspace{1cm} (13)
Thus using (11) in (13) gives

\[
\frac{2\pi}{T_1} = B^{1/4} \frac{\Gamma(3/4)}{r(3/4)}
\]

\[
\therefore B = \left(\frac{2\pi}{T_1} \frac{1}{r(3/4)}\right)^4
\]

(14)

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

\[
\therefore \quad B = \frac{691.16}{T_1^4}
\]

Therefore

\[A = 0.25 h_1^2 B\]

(15)

\[B = \left(\frac{2\pi}{T_1} 0.816\right)^4\]

(16)

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

Often \(T_0\) 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.

\(T_0\) is called the zero crossing period.

From (12)

\[
\left(\frac{2\pi}{T_0}\right)^2 = \Gamma(\frac{1}{2})B^{\frac{1}{2}}
\]

\[\Gamma(\frac{1}{2}) = \sqrt{\pi}
\]

\[
\therefore \quad \left(\frac{2\pi}{T_0}\right)^2 = \sqrt{\pi}B
\]

Thus using (16) to redefine \(B\) gives a relationship between \(T_0\) and \(T_1\):

i.e.

\[T_0 = T_1 \frac{\Gamma(3/4)}{\sqrt{\Gamma(\frac{1}{2})}}\]
\[ T_1 = 1.08643 \, T_0 \]  \hspace{1cm} (17)

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

\[ T_p = 1.2957 T_1 \]  \hspace{1cm} (18)

\[ T_p = 1.40769 T_0 \]  \hspace{1cm} (19)

**SUMMARY**

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

P-M type spectra

\[ A = 0.0081 \, g^2 \]

\[ B = \frac{3.11}{h^{1/3}} \]  \hspace{1cm} (in metric units)

ITTC type spectra

\[ A = 0.25 \, h^{2/3} \]

\[ B = (0.816 \frac{2\pi}{1})^4 \]
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

   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 con-trà-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 Hc x 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

SHIP.A LAT SHIP.A VER SHIP.A 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 SHIP.A 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 separately.

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 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 BRETSCHEIDER 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 BRETSCHEIDER 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 bcg fluid GM roll roll yaw
relative natural radius radius
to Lwl frequency gyration gyration
+ve upwards /beam /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 6.4000 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

10.0000 15.0000

1 number of frequencies, first frequency, last frequency (rads/sec)
41 .05000 2.05000

wave frequencies information

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
<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Data 1</th>
<th>Data 2</th>
<th>Data 3</th>
<th>Data 4</th>
<th>Data 5</th>
<th>Data 6</th>
<th>Data 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0000</td>
<td>4.0000</td>
<td>sea spectrum 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.0000</td>
<td>12.0000</td>
<td>sea spectrum 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

First is the significant height in metres, second is the modal period in seconds.

"Number of stations used in the calculation. This can be 19, 20 or 21 see the Manual."
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
skew information
the first is the station where the skew starts the second is the breadth of the skew 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 coefficients in the order of amplitude velocity and acceleration. The next three are the demanded control coefficients in the same order and the last three are the servo control coefficients 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 the slope of the lift curve (a 0 means let the programme calculate a value) the eighth is the dihedral 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 dihedral angle needed)

  .000  .000  .000  1.000  .000  .000  1.000  .000  .000
First three are the autopilot yaw gain control coefficients in the order amplitude velocity and accelerations followed by three for the demanded control coefficients the final three are the rudder servo control coefficients

  .000  .000  .000  1.000  .000  .000
The first three are the rudder control gains again in the order amplitude velocity acceleration the last three are the demanded angle coefficients

  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 tdp but print out tdp
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 tdp 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 0 20
The fourth indicates the spectral type 2 means PM, a 3 means BRETSCHNEIDER, a 4 means JONSWAP. The fifth means type of calculation 2 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 0 means no spectral spreading. The seventh indicates the tdp a -1 means calculate the tdp and do not print out the values, a 0 means calculate the tdp 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.

<table>
<thead>
<tr>
<th>ship length (metres)</th>
<th>ship displacement (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>133.00000 1.02500</td>
<td>9.80665 7104.720</td>
</tr>
<tr>
<td>.0000 .0000 .0000 .0000</td>
<td>sectional data starting at FP</td>
</tr>
<tr>
<td>2.5650 5.5168 5.4528 .0000</td>
<td></td>
</tr>
<tr>
<td>5.0040 5.1118 6.4000 .0000</td>
<td></td>
</tr>
<tr>
<td>7.5600 5.5566 6.4000 .0000</td>
<td></td>
</tr>
<tr>
<td>10.0890 5.8700 6.4000 .0000</td>
<td></td>
</tr>
<tr>
<td>12.2550 6.2600 6.4000 .0000</td>
<td></td>
</tr>
<tr>
<td>14.0700 6.7670 6.4000 .0000</td>
<td></td>
</tr>
<tr>
<td>15.4350 7.2270 6.4000 .0000</td>
<td></td>
</tr>
<tr>
<td>16.3620 7.6666 6.4000 .0000</td>
<td></td>
</tr>
<tr>
<td>16.9380 7.9100 6.4000 .0000</td>
<td></td>
</tr>
<tr>
<td>17.2770 8.0400 6.4000 .0000</td>
<td></td>
</tr>
<tr>
<td>17.6310 8.0010 6.4000 .0000</td>
<td></td>
</tr>
<tr>
<td>17.4540 7.8180 6.4000 .0000</td>
<td></td>
</tr>
<tr>
<td>17.2890 7.4450 6.4000 .0000</td>
<td></td>
</tr>
<tr>
<td>16.8840 6.9260 6.4000 .0000</td>
<td></td>
</tr>
<tr>
<td>16.2960 6.2200 6.4000 .0000</td>
<td></td>
</tr>
<tr>
<td>15.4200 5.2710 6.4000 .0000</td>
<td></td>
</tr>
<tr>
<td>14.2290 6.1780 3.9328 .0000</td>
<td></td>
</tr>
<tr>
<td>12.7530 6.8310 2.1936 .0000</td>
<td></td>
</tr>
<tr>
<td>10.7310 7.1350 1.3920 .0000</td>
<td></td>
</tr>
<tr>
<td>.0000 .0000 .0000 .0000</td>
<td>finishing with AP</td>
</tr>
</tbody>
</table>

full area beam coefficient
33.2500 -2.1700

longitudinal lcg
(O)gyradius relative
(metres) to midships

(metres +ve fwd.)
11 11 1
1.0000 0.0500 2.0500 0.0500

wave frequencies
initial final increment (rads/sec)
1
2 (number of ship speeds——)
10.00 15.00 (ship speed in knots)
wave angles

<table>
<thead>
<tr>
<th>initial</th>
<th>final</th>
<th>increment</th>
<th>(degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

2.0010.00 (significant wave heights (metres))
4.0012.00 (modal period (seconds))

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 0 0 2 0
The fourth is the spectral indicator a 2 means PM a 3 means BRETSCHEIDER, a 4 means JONSWAP.
The fifth indicates 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) displacement (tonnes)

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

.0000 .0000 .0000 .0000 sectional data strating at FP

<table>
<thead>
<tr>
<th>full</th>
<th>area coefficient</th>
<th>draught</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5650</td>
<td>.5168</td>
<td>5.4528 .0000</td>
</tr>
<tr>
<td>5.0040</td>
<td>.5118</td>
<td>6.4000 .0000</td>
</tr>
<tr>
<td>7.5600</td>
<td>.5556</td>
<td>6.4000 .0000</td>
</tr>
<tr>
<td>10.0890</td>
<td>.5870</td>
<td>6.4000 .0000</td>
</tr>
<tr>
<td>12.2550</td>
<td>.6260</td>
<td>6.4000 .0000</td>
</tr>
<tr>
<td>14.0700</td>
<td>.6767</td>
<td>6.4000 .0000</td>
</tr>
<tr>
<td>15.4350</td>
<td>.7227</td>
<td>6.4000 .0000</td>
</tr>
<tr>
<td>16.3620</td>
<td>.7666</td>
<td>6.4000 .0000</td>
</tr>
<tr>
<td>16.9380</td>
<td>.7910</td>
<td>6.4000 .0000</td>
</tr>
<tr>
<td>17.2770</td>
<td>.8040</td>
<td>6.4000 .0000</td>
</tr>
<tr>
<td>17.6310</td>
<td>.8001</td>
<td>6.4000 .0000</td>
</tr>
<tr>
<td>17.4540</td>
<td>.7818</td>
<td>6.4000 .0000</td>
</tr>
<tr>
<td>17.2890</td>
<td>.7445</td>
<td>6.4000 .0000</td>
</tr>
<tr>
<td>16.8840</td>
<td>.6926</td>
<td>6.4000 .0000</td>
</tr>
<tr>
<td>16.2960</td>
<td>.6220</td>
<td>6.4000 .0000</td>
</tr>
<tr>
<td>15.4200</td>
<td>.5271</td>
<td>6.4000 .0000</td>
</tr>
<tr>
<td>14.2290</td>
<td>.6178</td>
<td>3.9328 .0000</td>
</tr>
<tr>
<td>12.7530</td>
<td>.6831</td>
<td>2.1936 .0000</td>
</tr>
<tr>
<td>10.7310</td>
<td>.7135</td>
<td>1.3920 .0000</td>
</tr>
<tr>
<td>.0000</td>
<td>.0000</td>
<td>.0000 .0000 finishing at AP</td>
</tr>
<tr>
<td>33.2500</td>
<td>-2.1700</td>
<td></td>
</tr>
</tbody>
</table>

radius lcg (relative to mid-ships +ve forwards)
<table>
<thead>
<tr>
<th>Gyration</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.05</td>
<td>2.05</td>
<td>0.05</td>
</tr>
<tr>
<td>first</td>
<td>last</td>
<td></td>
<td></td>
</tr>
<tr>
<td>frequencies (rads/sec)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>(number of ship speeds)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.00</td>
<td>15.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ship speeds in knots)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90.0000</td>
<td>180.0000</td>
<td>15.0000</td>
<td></td>
</tr>
<tr>
<td>first</td>
<td>last</td>
<td></td>
<td>increment</td>
</tr>
<tr>
<td>2</td>
<td>(number of sea spectra)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.0010.00</td>
<td></td>
<td></td>
<td>(significant wave heights (metres))</td>
</tr>
<tr>
<td>4.0012.00</td>
<td></td>
<td></td>
<td>(modal periods (seconds))</td>
</tr>
</tbody>
</table>
## APPENDIX E
### EXAMPLE WITH BILGE KEELS AND FINS

**Example**

<table>
<thead>
<tr>
<th>0</th>
<th>0</th>
<th>.00000</th>
<th>.30480</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>133.0000</td>
<td>.9440</td>
<td>1.6000</td>
<td>.0000</td>
</tr>
<tr>
<td>90.0000</td>
<td>180.0000</td>
<td>15.0000</td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>5.4528</td>
<td>6.4000</td>
<td>6.4000</td>
</tr>
<tr>
<td>6.4000</td>
<td>3.9328</td>
<td>2.1936</td>
<td>1.3920</td>
</tr>
<tr>
<td>10.0000</td>
<td>15.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>.05000</td>
<td>2.05000</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.0000</td>
<td>4.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.0000</td>
<td>12.0000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>19</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>.9472</td>
</tr>
<tr>
<td>3.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>4.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>5.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>6.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>7.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>8.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>9.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>10.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>11.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>12.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>13.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>14.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>15.000</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>16.000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>17.000</td>
</tr>
<tr>
<td>.0000</td>
</tr>
<tr>
<td>18.000</td>
</tr>
<tr>
<td>2.4672</td>
</tr>
<tr>
<td>19.000</td>
</tr>
<tr>
<td>4.2064</td>
</tr>
<tr>
<td>20.000</td>
</tr>
<tr>
<td>5.0080</td>
</tr>
</tbody>
</table>

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

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   |
| 19.650 | 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  1.000  .000  .000

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

1

-1 1

-1
## Appendix F

**Example with Bilge Keels Only**

### Example

<table>
<thead>
<tr>
<th>0</th>
<th>0.0000</th>
<th>0.30480</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0</td>
<td>0.2</td>
</tr>
<tr>
<td>133.000</td>
<td>0.9440</td>
<td>1.6000</td>
</tr>
<tr>
<td>2</td>
<td>90.0000</td>
<td>180.0000</td>
</tr>
<tr>
<td>0.0000</td>
<td>5.4528</td>
<td>6.4000</td>
</tr>
<tr>
<td>6.4000</td>
<td>3.9328</td>
<td>2.1936</td>
</tr>
<tr>
<td>10.0000</td>
<td>15.0000</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>0.05000</td>
<td>2.05000</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>2.0000</td>
<td>4.0000</td>
<td></td>
</tr>
<tr>
<td>10.0000</td>
<td>12.0000</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>2.0000</td>
<td>1</td>
</tr>
<tr>
<td>0.0000</td>
<td>0.2610</td>
<td>0.4875</td>
</tr>
<tr>
<td>0.9472</td>
<td>1.7760</td>
<td>2.8224</td>
</tr>
<tr>
<td>3.0000</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>0.0000</td>
<td>0.4785</td>
<td>0.9075</td>
</tr>
<tr>
<td>0.0000</td>
<td>1.0880</td>
<td>2.1856</td>
</tr>
<tr>
<td>4.0000</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>0.0000</td>
<td>0.7545</td>
<td>1.2465</td>
</tr>
<tr>
<td>0.0000</td>
<td>0.8192</td>
<td>1.6192</td>
</tr>
<tr>
<td>5.0000</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>0.0000</td>
<td>1.0695</td>
<td>1.8105</td>
</tr>
<tr>
<td>0.0000</td>
<td>0.8416</td>
<td>1.6080</td>
</tr>
<tr>
<td>6.0000</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>0.0000</td>
<td>1.3635</td>
<td>2.2305</td>
</tr>
<tr>
<td>0.0000</td>
<td>0.6288</td>
<td>1.4864</td>
</tr>
<tr>
<td>7.0000</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>0.0000</td>
<td>1.4070</td>
<td>2.4120</td>
</tr>
<tr>
<td>0.0000</td>
<td>0.3792</td>
<td>0.8800</td>
</tr>
<tr>
<td>8.0000</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>0.0000</td>
<td>1.5270</td>
<td>3.7965</td>
</tr>
<tr>
<td>0.0000</td>
<td>0.1792</td>
<td>1.1312</td>
</tr>
<tr>
<td>9.0000</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>0.0000</td>
<td>2.2350</td>
<td>3.2895</td>
</tr>
<tr>
<td>0.0000</td>
<td>0.1712</td>
<td>0.4816</td>
</tr>
<tr>
<td>10.0000</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>0.0000</td>
<td>2.7315</td>
<td>4.6140</td>
</tr>
<tr>
<td>0.0000</td>
<td>0.1936</td>
<td>0.8832</td>
</tr>
<tr>
<td>11.0000</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>0.0000</td>
<td>4.0005</td>
<td>4.8225</td>
</tr>
<tr>
<td>0.0000</td>
<td>0.4864</td>
<td>0.8160</td>
</tr>
<tr>
<td>12.0000</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>0.0000</td>
<td>3.5925</td>
<td>5.2875</td>
</tr>
<tr>
<td>0.0000</td>
<td>0.3168</td>
<td>1.0160</td>
</tr>
<tr>
<td>13.0000</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>0.0000</td>
<td>1.8300</td>
<td>3.2655</td>
</tr>
<tr>
<td>0.0000</td>
<td>0.0896</td>
<td>0.3680</td>
</tr>
<tr>
<td>14.0000</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>0.0000</td>
<td>1.9425</td>
<td>3.7035</td>
</tr>
<tr>
<td>0.0000</td>
<td>0.2064</td>
<td>0.8000</td>
</tr>
<tr>
<td>15.0000</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>2.4015</td>
</tr>
<tr>
<td>------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>16.000</td>
<td>0.0000</td>
<td>1.5345</td>
</tr>
<tr>
<td>17.000</td>
<td>0.0000</td>
<td>0.7312</td>
</tr>
<tr>
<td>18.000</td>
<td>0.0000</td>
<td>0.6690</td>
</tr>
<tr>
<td>19.000</td>
<td>0.0000</td>
<td>0.8576</td>
</tr>
<tr>
<td>20.000</td>
<td>0.0000</td>
<td>0.4455</td>
</tr>
<tr>
<td>2.4072</td>
<td>2.6688</td>
<td>3.0672</td>
</tr>
<tr>
<td>19.000</td>
<td>0.0000</td>
<td>0.5805</td>
</tr>
<tr>
<td>4.2064</td>
<td>4.2848</td>
<td>4.4432</td>
</tr>
<tr>
<td>5.0080</td>
<td>5.0624</td>
<td>5.1872</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>8</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.7000</td>
<td>2.7860</td>
<td>1.5000</td>
</tr>
<tr>
<td></td>
<td>6.3620</td>
<td>2.6340</td>
<td>1.5000</td>
</tr>
<tr>
<td></td>
<td>6.3090</td>
<td>2.0460</td>
<td>1.5000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>0.0000</th>
<th>0.0000</th>
<th>0.0000</th>
<th>1.0000</th>
<th>0.0000</th>
<th>1.0000</th>
<th>0.0000</th>
<th>0.0000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>19.6300</td>
<td>3.7990</td>
<td>4.1090</td>
<td>1.8100</td>
<td>0.5200</td>
<td>0.5200</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td></td>
<td>19.6300</td>
<td>2.1630</td>
<td>3.7310</td>
<td>1.5200</td>
<td>0.7500</td>
<td>0.5200</td>
<td>0.0000</td>
<td>62.5000</td>
</tr>
<tr>
<td></td>
<td>20.3700</td>
<td>2.0630</td>
<td>5.3120</td>
<td>2.7900</td>
<td>2.2740</td>
<td>1.6220</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>1.0000</td>
<td>0.0000</td>
<td>1.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>1.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

1

-1 1

-1
### APPENDIX G

#### EXAMPLE WITH FINS ONLY

<table>
<thead>
<tr>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>0</th>
<th>0</th>
<th>.00000</th>
<th>.30480</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>133.000</td>
<td></td>
<td>.9440</td>
<td>1.6000</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>90.000</td>
<td>180.000</td>
<td>15.0000</td>
<td>.0000</td>
</tr>
<tr>
<td>6.4000</td>
<td>3.9328</td>
<td>2.1936</td>
<td>1.3920</td>
</tr>
<tr>
<td>10.000</td>
<td>15.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>.05000</td>
<td>2.05000</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>2.0000</td>
<td>4.0000</td>
</tr>
<tr>
<td>10.000</td>
<td>12.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.0000</td>
<td>1</td>
<td>.2610</td>
<td>.4875</td>
</tr>
<tr>
<td>.9472</td>
<td>1.7760</td>
<td>2.8224</td>
<td>4.0000</td>
</tr>
<tr>
<td>3.000</td>
<td>1</td>
<td>.4785</td>
<td>.9075</td>
</tr>
<tr>
<td>.0000</td>
<td>1.0880</td>
<td>2.1856</td>
<td>3.6464</td>
</tr>
<tr>
<td>4.000</td>
<td>1</td>
<td>.7545</td>
<td>1.2465</td>
</tr>
<tr>
<td>.0000</td>
<td>.8192</td>
<td>1.6192</td>
<td>2.8816</td>
</tr>
<tr>
<td>5.000</td>
<td>1</td>
<td>.10695</td>
<td>1.8105</td>
</tr>
<tr>
<td>.0000</td>
<td>.8416</td>
<td>1.6080</td>
<td>2.2640</td>
</tr>
<tr>
<td>6.000</td>
<td>1</td>
<td>.3635</td>
<td>2.2305</td>
</tr>
<tr>
<td>.0000</td>
<td>.6288</td>
<td>1.4864</td>
<td>2.2640</td>
</tr>
<tr>
<td>7.000</td>
<td>1</td>
<td>.14070</td>
<td>2.4120</td>
</tr>
<tr>
<td>.0000</td>
<td>.3792</td>
<td>.8800</td>
<td>1.7104</td>
</tr>
<tr>
<td>8.000</td>
<td>0</td>
<td>.5270</td>
<td>3.7965</td>
</tr>
<tr>
<td>.0000</td>
<td>.1792</td>
<td>1.1312</td>
<td>1.9616</td>
</tr>
<tr>
<td>9.000</td>
<td>0</td>
<td>.2350</td>
<td>3.2895</td>
</tr>
<tr>
<td>.0000</td>
<td>.1712</td>
<td>.4816</td>
<td>1.5424</td>
</tr>
<tr>
<td>.0000</td>
<td>.1936</td>
<td>.8832</td>
<td>2.0464</td>
</tr>
<tr>
<td>11.000</td>
<td>3</td>
<td>.0005</td>
<td>4.8225</td>
</tr>
<tr>
<td>.0000</td>
<td>.4864</td>
<td>.8160</td>
<td>2.0176</td>
</tr>
<tr>
<td>12.000</td>
<td>3</td>
<td>.5925</td>
<td>5.2875</td>
</tr>
<tr>
<td>.0000</td>
<td>.3168</td>
<td>1.0160</td>
<td>2.4432</td>
</tr>
<tr>
<td>13.000</td>
<td>3</td>
<td>.8300</td>
<td>3.2655</td>
</tr>
<tr>
<td>.0000</td>
<td>.0896</td>
<td>.3680</td>
<td>1.3472</td>
</tr>
<tr>
<td>14.000</td>
<td>3</td>
<td>.9425</td>
<td>3.7035</td>
</tr>
<tr>
<td>.0000</td>
<td>.2064</td>
<td>.8000</td>
<td>1.8208</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>15,000</td>
<td>0</td>
<td>.0000</td>
<td>2.4015</td>
</tr>
<tr>
<td></td>
<td>.0000</td>
<td>.6624</td>
<td>1.8192</td>
</tr>
<tr>
<td>16,000</td>
<td>0</td>
<td>.0000</td>
<td>1.5345</td>
</tr>
<tr>
<td></td>
<td>.0000</td>
<td>.7312</td>
<td>1.1344</td>
</tr>
<tr>
<td>17,000</td>
<td>0</td>
<td>.0000</td>
<td>0.6690</td>
</tr>
<tr>
<td></td>
<td>.0000</td>
<td>.8576</td>
<td>1.4080</td>
</tr>
<tr>
<td>18,000</td>
<td>0</td>
<td>.0000</td>
<td>0.4455</td>
</tr>
<tr>
<td></td>
<td>.0000</td>
<td>.5805</td>
<td>1.3740</td>
</tr>
<tr>
<td>19,000</td>
<td>0</td>
<td>.0000</td>
<td>0.9345</td>
</tr>
<tr>
<td></td>
<td>.0000</td>
<td>5.0624</td>
<td>5.1872</td>
</tr>
<tr>
<td>0</td>
<td></td>
<td>.0000</td>
<td>.0000</td>
</tr>
<tr>
<td>1</td>
<td>.0000</td>
<td>.0000</td>
<td>.0000</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11,000</td>
<td>6.986</td>
<td>2.472</td>
<td>1.605</td>
</tr>
<tr>
<td>19,630</td>
<td>3.799</td>
<td>4.109</td>
<td>1.810</td>
</tr>
<tr>
<td>19,630</td>
<td>2.163</td>
<td>3.731</td>
<td>1.520</td>
</tr>
<tr>
<td>20,370</td>
<td>2.063</td>
<td>5.312</td>
<td>2.790</td>
</tr>
<tr>
<td></td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>10,000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>-1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## APPENDIX H

### EXAMPLE WITH NO FINS AND NO BILGE KEELS

<table>
<thead>
<tr>
<th>Example</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0000</td>
<td>0.30480</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>133.000</td>
<td>0.9440</td>
<td>1.6000</td>
</tr>
<tr>
<td>2</td>
<td>90.000</td>
<td>180.000</td>
<td>15.0000</td>
<td>0.0000</td>
<td>5.4528</td>
<td>6.4000</td>
</tr>
<tr>
<td></td>
<td>6.4000</td>
<td>3.9328</td>
<td>2.1936</td>
<td>1.3920</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>10.0000</td>
<td>15.0000</td>
<td>41</td>
<td>0.05000</td>
<td>2.05000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>0</td>
<td></td>
<td>2.0000</td>
<td>4.0000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.0000</td>
<td>12.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>2.0000</td>
<td>1</td>
<td></td>
<td>0.0000</td>
<td>0.2610</td>
<td>0.4875</td>
</tr>
<tr>
<td></td>
<td>0.9472</td>
<td>1.7760</td>
<td>2.8224</td>
<td>4.0000</td>
<td>4.5696</td>
<td>4.8000</td>
</tr>
<tr>
<td>3</td>
<td>0.0000</td>
<td>0.4785</td>
<td>0.9075</td>
<td>1.4415</td>
<td>1.5735</td>
<td>1.9200</td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>1.0880</td>
<td>2.1856</td>
<td>3.6464</td>
<td>4.0000</td>
<td>4.9248</td>
</tr>
<tr>
<td>4</td>
<td>0.0000</td>
<td>0.7545</td>
<td>1.2465</td>
<td>1.9995</td>
<td>2.5755</td>
<td>3.2265</td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>0.8192</td>
<td>1.6192</td>
<td>2.8816</td>
<td>3.9904</td>
<td>5.2864</td>
</tr>
<tr>
<td>5</td>
<td>0.0000</td>
<td>1.0695</td>
<td>1.8105</td>
<td>2.8140</td>
<td>3.6960</td>
<td>4.3110</td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>0.8416</td>
<td>1.6080</td>
<td>2.2640</td>
<td>4.0000</td>
<td>5.0192</td>
</tr>
<tr>
<td>6</td>
<td>0.0000</td>
<td>1.3635</td>
<td>2.2305</td>
<td>3.2760</td>
<td>4.2150</td>
<td>4.7445</td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>0.6288</td>
<td>1.4864</td>
<td>2.2640</td>
<td>3.2912</td>
<td>4.0000</td>
</tr>
<tr>
<td>7</td>
<td>0.0000</td>
<td>1.4070</td>
<td>2.4120</td>
<td>3.6480</td>
<td>4.5795</td>
<td>5.7915</td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>0.3792</td>
<td>0.8800</td>
<td>1.7104</td>
<td>2.5456</td>
<td>4.0000</td>
</tr>
<tr>
<td>8</td>
<td>0.0000</td>
<td>1.5270</td>
<td>3.7965</td>
<td>4.8510</td>
<td>5.7000</td>
<td>6.5745</td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>0.1792</td>
<td>1.1312</td>
<td>1.9616</td>
<td>2.7856</td>
<td>4.0000</td>
</tr>
<tr>
<td>9</td>
<td>0.0000</td>
<td>2.2350</td>
<td>3.2895</td>
<td>5.1795</td>
<td>6.3615</td>
<td>7.2735</td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>0.1712</td>
<td>0.4816</td>
<td>1.5424</td>
<td>2.6336</td>
<td>4.0000</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>0.0000</td>
<td>2.7315</td>
<td>4.6140</td>
<td>6.3090</td>
<td>6.8025</td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>0.1936</td>
<td>0.8832</td>
<td>2.0464</td>
<td>2.5840</td>
<td>4.0000</td>
</tr>
<tr>
<td>11</td>
<td>3</td>
<td>0.0000</td>
<td>4.0005</td>
<td>4.8225</td>
<td>6.6000</td>
<td>6.9835</td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>0.4864</td>
<td>0.8160</td>
<td>2.0176</td>
<td>2.4720</td>
<td>4.0000</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>0.0000</td>
<td>3.5925</td>
<td>5.2875</td>
<td>7.0215</td>
<td>7.5390</td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>0.3168</td>
<td>1.0160</td>
<td>2.4432</td>
<td>3.1248</td>
<td>4.0000</td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>0.0000</td>
<td>1.8300</td>
<td>3.2655</td>
<td>5.4645</td>
<td>6.9690</td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>0.0896</td>
<td>0.3680</td>
<td>1.3472</td>
<td>2.6400</td>
<td>4.0000</td>
</tr>
<tr>
<td>14</td>
<td>3</td>
<td>0.0000</td>
<td>1.9425</td>
<td>3.7035</td>
<td>5.6535</td>
<td>6.8505</td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>0.2064</td>
<td>0.8000</td>
<td>1.8208</td>
<td>2.9536</td>
<td>4.0000</td>
</tr>
</tbody>
</table>
APPENDIX I

EXAMPLE OF VERTICAL MOTIONS VER FILES

EXAMPLE

8 APR 87
Test of stretch factor programme

1 0 1 3 1 0 0 1 0 0 0 0 0 0 0 0 0 20
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 .7918 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

-1.0000

1 1
1 1 1

1

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

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>First Motion</th>
<th>Second Motion</th>
<th>Third Motion</th>
<th>Fourth Motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>133.0000</td>
<td>1.0250</td>
<td>9.8067</td>
<td>7104.7200</td>
<td>0.0000</td>
</tr>
<tr>
<td>2.5650</td>
<td>5.168</td>
<td>5.4528</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>5.0040</td>
<td>5.118</td>
<td>6.4000</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>7.5600</td>
<td>5.566</td>
<td>6.4000</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>10.0890</td>
<td>5.870</td>
<td>6.4000</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>12.2550</td>
<td>6.260</td>
<td>6.4000</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>14.0700</td>
<td>6.767</td>
<td>6.4000</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>15.4350</td>
<td>7.227</td>
<td>6.4000</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>16.3620</td>
<td>7.666</td>
<td>6.4000</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>16.9380</td>
<td>7.910</td>
<td>6.4000</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>17.2770</td>
<td>8.040</td>
<td>6.4000</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>17.6310</td>
<td>8.001</td>
<td>6.4000</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>17.4540</td>
<td>7.818</td>
<td>6.4000</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>17.2890</td>
<td>7.445</td>
<td>6.4000</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>16.8840</td>
<td>6.926</td>
<td>6.4000</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>16.2960</td>
<td>6.220</td>
<td>6.4000</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>15.4200</td>
<td>5.271</td>
<td>6.4000</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>14.2290</td>
<td>6.178</td>
<td>3.9328</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>12.7530</td>
<td>6.831</td>
<td>2.1936</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>10.7130</td>
<td>7.135</td>
<td>1.3920</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>33.2500</td>
<td>-2.1700</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0500</td>
<td>2.0500</td>
<td>0.5000</td>
<td></td>
</tr>
</tbody>
</table>

2

10.00 15.00

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Value 1</th>
<th>Value 2</th>
<th>Value 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>90.0000</td>
<td>180.0000</td>
<td>15.0000</td>
<td></td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>WAVELENGTH (MTRS)</th>
<th>FREQUENCIES (RAD/SEC)</th>
<th>HEAVE (MTRS)</th>
<th>PHASE (DEG)</th>
<th>PITCH (DEG)</th>
<th>NON-D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2464.92</td>
<td>.05</td>
<td>1.0000</td>
<td>180.0</td>
<td>.0000</td>
<td>-13.5</td>
</tr>
<tr>
<td>6161.73</td>
<td>.10</td>
<td>1.0001</td>
<td>180.0</td>
<td>.0001</td>
<td>-58.6</td>
</tr>
<tr>
<td>2738.55</td>
<td>.15</td>
<td>1.0004</td>
<td>180.0</td>
<td>.0006</td>
<td>-72.2</td>
</tr>
<tr>
<td>1540.43</td>
<td>.20</td>
<td>1.0011</td>
<td>179.9</td>
<td>.0012</td>
<td>-75.4</td>
</tr>
<tr>
<td>985.88</td>
<td>.25</td>
<td>1.0022</td>
<td>179.8</td>
<td>.0021</td>
<td>-78.3</td>
</tr>
<tr>
<td>684.64</td>
<td>.30</td>
<td>1.0038</td>
<td>179.7</td>
<td>.0033</td>
<td>-80.8</td>
</tr>
<tr>
<td>503.00</td>
<td>.35</td>
<td>1.0059</td>
<td>179.4</td>
<td>.0048</td>
<td>-83.0</td>
</tr>
<tr>
<td>385.11</td>
<td>.40</td>
<td>1.0084</td>
<td>179.0</td>
<td>.0067</td>
<td>-84.9</td>
</tr>
<tr>
<td>304.28</td>
<td>.45</td>
<td>1.0112</td>
<td>178.5</td>
<td>.0089</td>
<td>-86.8</td>
</tr>
<tr>
<td>246.47</td>
<td>.50</td>
<td>1.0142</td>
<td>177.8</td>
<td>.0115</td>
<td>-88.3</td>
</tr>
<tr>
<td>203.69</td>
<td>.55</td>
<td>1.0172</td>
<td>176.9</td>
<td>.0145</td>
<td>-89.6</td>
</tr>
<tr>
<td>171.16</td>
<td>.60</td>
<td>1.0200</td>
<td>175.7</td>
<td>.0178</td>
<td>-90.6</td>
</tr>
<tr>
<td>145.84</td>
<td>.65</td>
<td>1.0222</td>
<td>174.2</td>
<td>.0215</td>
<td>-91.3</td>
</tr>
<tr>
<td>125.75</td>
<td>.70</td>
<td>1.0243</td>
<td>172.4</td>
<td>.0257</td>
<td>-91.5</td>
</tr>
<tr>
<td>109.54</td>
<td>.75</td>
<td>1.0264</td>
<td>170.2</td>
<td>.0306</td>
<td>-91.6</td>
</tr>
<tr>
<td>96.28</td>
<td>.80</td>
<td>1.0286</td>
<td>167.4</td>
<td>.0355</td>
<td>-91.5</td>
</tr>
<tr>
<td>85.28</td>
<td>.85</td>
<td>1.0303</td>
<td>164.0</td>
<td>.0436</td>
<td>-91.6</td>
</tr>
<tr>
<td>76.07</td>
<td>.90</td>
<td>1.0320</td>
<td>159.9</td>
<td>.0526</td>
<td>-92.5</td>
</tr>
<tr>
<td>68.27</td>
<td>.95</td>
<td>1.0336</td>
<td>154.8</td>
<td>.0637</td>
<td>-94.4</td>
</tr>
<tr>
<td>61.62</td>
<td>1.00</td>
<td>1.0352</td>
<td>148.5</td>
<td>.0770</td>
<td>-98.4</td>
</tr>
<tr>
<td>55.89</td>
<td>1.05</td>
<td>1.0368</td>
<td>141.0</td>
<td>.0921</td>
<td>-104.2</td>
</tr>
<tr>
<td>50.92</td>
<td>1.10</td>
<td>1.0384</td>
<td>132.4</td>
<td>.1061</td>
<td>-112.3</td>
</tr>
<tr>
<td>46.59</td>
<td>1.15</td>
<td>1.0400</td>
<td>122.9</td>
<td>.1176</td>
<td>-122.1</td>
</tr>
<tr>
<td>42.79</td>
<td>1.20</td>
<td>1.0416</td>
<td>113.5</td>
<td>.1219</td>
<td>-132.3</td>
</tr>
<tr>
<td>39.44</td>
<td>1.25</td>
<td>1.0432</td>
<td>104.9</td>
<td>.1205</td>
<td>-141.8</td>
</tr>
<tr>
<td>36.46</td>
<td>1.30</td>
<td>1.0448</td>
<td>97.9</td>
<td>.1139</td>
<td>-148.9</td>
</tr>
<tr>
<td>33.81</td>
<td>1.35</td>
<td>1.0464</td>
<td>89.7</td>
<td>.1046</td>
<td>-154.5</td>
</tr>
<tr>
<td>31.44</td>
<td>1.40</td>
<td>1.0480</td>
<td>81.5</td>
<td>.0935</td>
<td>-158.6</td>
</tr>
<tr>
<td>29.31</td>
<td>1.45</td>
<td>1.0496</td>
<td>72.2</td>
<td>.0839</td>
<td>-160.6</td>
</tr>
<tr>
<td>27.39</td>
<td>1.50</td>
<td>1.0512</td>
<td>62.9</td>
<td>.0754</td>
<td>-161.4</td>
</tr>
<tr>
<td>25.65</td>
<td>1.55</td>
<td>1.0528</td>
<td>53.7</td>
<td>.0664</td>
<td>-161.6</td>
</tr>
<tr>
<td>24.07</td>
<td>1.60</td>
<td>1.0544</td>
<td>44.5</td>
<td>.0573</td>
<td>-160.5</td>
</tr>
<tr>
<td>22.63</td>
<td>1.65</td>
<td>1.0560</td>
<td>35.3</td>
<td>.0482</td>
<td>-158.6</td>
</tr>
<tr>
<td>21.22</td>
<td>1.70</td>
<td>1.0576</td>
<td>26.1</td>
<td>.0401</td>
<td>-156.2</td>
</tr>
<tr>
<td>20.01</td>
<td>1.75</td>
<td>1.0592</td>
<td>16.9</td>
<td>.0328</td>
<td>-152.8</td>
</tr>
<tr>
<td>19.02</td>
<td>1.80</td>
<td>1.0608</td>
<td>8.7</td>
<td>.0258</td>
<td>-149.1</td>
</tr>
<tr>
<td>18.00</td>
<td>1.85</td>
<td>1.0624</td>
<td>0.5</td>
<td>.0188</td>
<td>-144.7</td>
</tr>
<tr>
<td>17.07</td>
<td>1.90</td>
<td>1.0640</td>
<td>0.0</td>
<td>.0118</td>
<td>-139.7</td>
</tr>
<tr>
<td>16.20</td>
<td>1.95</td>
<td>1.0656</td>
<td>0.0</td>
<td>.0049</td>
<td>-133.9</td>
</tr>
<tr>
<td>15.40</td>
<td>2.00</td>
<td>1.0672</td>
<td>0.0</td>
<td>.0064</td>
<td>-127.3</td>
</tr>
<tr>
<td>14.66</td>
<td>2.05</td>
<td>1.0688</td>
<td>0.0</td>
<td>.0069</td>
<td>-120.0</td>
</tr>
</tbody>
</table>

**Note:** The table above represents the sample output from SHIPC.VRS, showing wave lengths, frequencies, heave, phase, and pitch values. The non-dimensional values likely represent a normalized or transformed data point, often used in naval architectural computations to assess wave conditions during ship design.
<table>
<thead>
<tr>
<th>WAVELENGTH</th>
<th>FREQUENCIES</th>
<th>HEAVE</th>
<th>PHASE</th>
<th>PITCH</th>
<th>PHASE</th>
<th>PITCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTRS</td>
<td>RAD/SEC</td>
<td>MTRS</td>
<td>DEG</td>
<td>DEG</td>
<td>DEG</td>
<td>NON--D.</td>
</tr>
<tr>
<td>2464.92</td>
<td>.05</td>
<td>.05</td>
<td>1.0000</td>
<td>180.0</td>
<td>.0038</td>
<td>89.7</td>
</tr>
<tr>
<td>616.57</td>
<td>.10</td>
<td>.10</td>
<td>1.0002</td>
<td>180.0</td>
<td>.0150</td>
<td>89.5</td>
</tr>
<tr>
<td>2738.55</td>
<td>.15</td>
<td>.15</td>
<td>1.0007</td>
<td>180.0</td>
<td>.0236</td>
<td>89.3</td>
</tr>
<tr>
<td>1540.43</td>
<td>.20</td>
<td>.21</td>
<td>1.0015</td>
<td>179.9</td>
<td>.0598</td>
<td>89.2</td>
</tr>
<tr>
<td>985.88</td>
<td>.25</td>
<td>.26</td>
<td>1.0028</td>
<td>179.8</td>
<td>.0939</td>
<td>88.9</td>
</tr>
<tr>
<td>684.64</td>
<td>.30</td>
<td>.31</td>
<td>1.0045</td>
<td>179.7</td>
<td>.1361</td>
<td>88.5</td>
</tr>
<tr>
<td>503.00</td>
<td>.35</td>
<td>.37</td>
<td>1.0065</td>
<td>179.4</td>
<td>.1868</td>
<td>87.9</td>
</tr>
<tr>
<td>385.11</td>
<td>.40</td>
<td>.42</td>
<td>1.0084</td>
<td>179.0</td>
<td>.2467</td>
<td>87.1</td>
</tr>
<tr>
<td>304.28</td>
<td>.45</td>
<td>.48</td>
<td>1.0099</td>
<td>178.5</td>
<td>.3163</td>
<td>86.1</td>
</tr>
<tr>
<td>246.47</td>
<td>.50</td>
<td>.53</td>
<td>1.0108</td>
<td>177.8</td>
<td>.3964</td>
<td>84.7</td>
</tr>
<tr>
<td>203.69</td>
<td>.55</td>
<td>.59</td>
<td>1.0106</td>
<td>176.9</td>
<td>.4878</td>
<td>82.9</td>
</tr>
<tr>
<td>171.16</td>
<td>.60</td>
<td>.65</td>
<td>1.0092</td>
<td>175.7</td>
<td>.5910</td>
<td>80.6</td>
</tr>
<tr>
<td>145.84</td>
<td>.65</td>
<td>.71</td>
<td>1.0064</td>
<td>174.3</td>
<td>.7063</td>
<td>77.6</td>
</tr>
<tr>
<td>125.75</td>
<td>.70</td>
<td>.77</td>
<td>1.0025</td>
<td>172.6</td>
<td>.8335</td>
<td>73.9</td>
</tr>
<tr>
<td>109.54</td>
<td>.75</td>
<td>.83</td>
<td>.9982</td>
<td>170.3</td>
<td>.9706</td>
<td>69.2</td>
</tr>
<tr>
<td>96.28</td>
<td>.80</td>
<td>.89</td>
<td>.9938</td>
<td>167.4</td>
<td>1.1130</td>
<td>63.3</td>
</tr>
<tr>
<td>85.28</td>
<td>.85</td>
<td>.95</td>
<td>.9903</td>
<td>163.4</td>
<td>1.2504</td>
<td>55.8</td>
</tr>
<tr>
<td>76.07</td>
<td>.90</td>
<td>1.01</td>
<td>.9815</td>
<td>157.5</td>
<td>1.3630</td>
<td>46.7</td>
</tr>
<tr>
<td>68.27</td>
<td>.95</td>
<td>1.07</td>
<td>.9541</td>
<td>149.0</td>
<td>1.4231</td>
<td>36.0</td>
</tr>
<tr>
<td>61.62</td>
<td>1.00</td>
<td>1.14</td>
<td>.8806</td>
<td>137.5</td>
<td>1.4022</td>
<td>24.2</td>
</tr>
<tr>
<td>55.89</td>
<td>1.05</td>
<td>1.20</td>
<td>.7420</td>
<td>124.2</td>
<td>1.2897</td>
<td>12.5</td>
</tr>
<tr>
<td>50.92</td>
<td>1.10</td>
<td>1.26</td>
<td>.5658</td>
<td>111.5</td>
<td>1.1161</td>
<td>1.8</td>
</tr>
<tr>
<td>46.59</td>
<td>1.15</td>
<td>1.33</td>
<td>.3906</td>
<td>101.4</td>
<td>.9174</td>
<td>6.9</td>
</tr>
<tr>
<td>42.79</td>
<td>1.20</td>
<td>1.40</td>
<td>.2425</td>
<td>95.9</td>
<td>.7271</td>
<td>13.6</td>
</tr>
<tr>
<td>39.44</td>
<td>1.25</td>
<td>1.46</td>
<td>.1399</td>
<td>95.9</td>
<td>.5568</td>
<td>13.6</td>
</tr>
<tr>
<td>36.46</td>
<td>1.30</td>
<td>1.53</td>
<td>.0745</td>
<td>105.9</td>
<td>.4135</td>
<td>21.2</td>
</tr>
<tr>
<td>33.81</td>
<td>1.35</td>
<td>1.60</td>
<td>.0401</td>
<td>114.4</td>
<td>.2969</td>
<td>21.9</td>
</tr>
<tr>
<td>31.44</td>
<td>1.40</td>
<td>1.67</td>
<td>.0333</td>
<td>127.2</td>
<td>.2071</td>
<td>20.5</td>
</tr>
<tr>
<td>29.31</td>
<td>1.45</td>
<td>1.74</td>
<td>.0348</td>
<td>165.5</td>
<td>.1386</td>
<td>16.2</td>
</tr>
<tr>
<td>27.39</td>
<td>1.50</td>
<td>1.81</td>
<td>.0346</td>
<td>153.5</td>
<td>.0994</td>
<td>8.4</td>
</tr>
<tr>
<td>25.65</td>
<td>1.55</td>
<td>1.88</td>
<td>.0316</td>
<td>145.4</td>
<td>.0582</td>
<td>4.2</td>
</tr>
<tr>
<td>24.07</td>
<td>1.60</td>
<td>1.95</td>
<td>.0269</td>
<td>137.3</td>
<td>.0380</td>
<td>21.0</td>
</tr>
<tr>
<td>22.63</td>
<td>1.65</td>
<td>2.02</td>
<td>.0219</td>
<td>128.1</td>
<td>.0256</td>
<td>4.1</td>
</tr>
<tr>
<td>21.32</td>
<td>1.70</td>
<td>2.09</td>
<td>.0174</td>
<td>117.1</td>
<td>.0169</td>
<td>63.9</td>
</tr>
<tr>
<td>20.12</td>
<td>1.75</td>
<td>2.17</td>
<td>.0139</td>
<td>104.7</td>
<td>.0106</td>
<td>97.1</td>
</tr>
<tr>
<td>19.02</td>
<td>1.80</td>
<td>2.24</td>
<td>.0111</td>
<td>91.9</td>
<td>.0090</td>
<td>148.9</td>
</tr>
<tr>
<td>18.00</td>
<td>1.85</td>
<td>2.31</td>
<td>.0090</td>
<td>80.6</td>
<td>.0125</td>
<td>174.7</td>
</tr>
<tr>
<td>17.07</td>
<td>1.90</td>
<td>2.39</td>
<td>.0070</td>
<td>71.8</td>
<td>.0166</td>
<td>158.6</td>
</tr>
<tr>
<td>16.20</td>
<td>1.95</td>
<td>2.47</td>
<td>.0050</td>
<td>66.5</td>
<td>.0192</td>
<td>153.1</td>
</tr>
<tr>
<td>15.40</td>
<td>2.00</td>
<td>2.54</td>
<td>.0029</td>
<td>63.9</td>
<td>.0197</td>
<td>151.8</td>
</tr>
<tr>
<td>14.66</td>
<td>2.05</td>
<td>2.62</td>
<td>.0010</td>
<td>69.1</td>
<td>.0182</td>
<td>153.6</td>
</tr>
</tbody>
</table>
**SAMPLE OUTPUT FROM SHIPC.VRM**

**SHIP TITLE IS SHIPC**

**WAVE SPECTRAL DENSITY TWO PARAMETER, ISSC 1967 SPECTRA**

**SPECTRA**

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
</table>

**INPUT VALUES OF SPECTRAL PARAMETERS**

<table>
<thead>
<tr>
<th>SIG.HT. MTRS</th>
<th>2.00</th>
<th>10.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN.PER. SECS</td>
<td>4.00</td>
<td>12.00</td>
</tr>
</tbody>
</table>

**CALCULATED VALUES FROM FREQUENCY RANGE**

<table>
<thead>
<tr>
<th>SIG.HT. MTRS</th>
<th>1.85</th>
<th>9.99</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN.PER. SECS</td>
<td>4.57</td>
<td>12.08</td>
</tr>
</tbody>
</table>

**WAVE**

<p>| FREQ. |
|-------|-------|
| .05   | .00   |
| .10   | .00   |
| .15   | .00   |
| .20   | .00   |
| .25   | .00   |
| .30   | .00   |
| .35   | .00   |
| .40   | .00   |
| .45   | .00   |
| .50   | .00   |
| .55   | .00   |
| .60   | .00   |
| .65   | .00   |
| .70   | .00   |
| .75   | .00   |
| .80   | .00   |
| .85   | .00   |
| .90   | .00   |
| .95   | .00   |
| 1.00  | .00   |
| 1.05  | .00   |
| 1.10  | .00   |
| 1.15  | .00   |
| 1.20  | .00   |
| 1.25  | .00   |
| 1.30  | .00   |
| 1.35  | .00   |
| 1.40  | .00   |
| 1.45  | .00   |
| 1.50  | .00   |
| 1.55  | .00   |
| 1.60  | .00   |
| 1.65  | .00   |
| 1.70  | .00   |
| 1.75  | .00   |
| 1.80  | .00   |
| 1.85  | .00   |
| 1.90  | .00   |
| 1.95  | .00   |
| 2.00  | .00   |
| 2.05  | .00   |</p>
<table>
<thead>
<tr>
<th>Ship Speed</th>
<th>Wave Height</th>
<th>Mean Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.00 Knots</td>
<td>2.00 MTRS</td>
<td>4.00 SECS</td>
</tr>
<tr>
<td>MNSQ: 0.642 MTRs</td>
<td>RMS: 0.255 MTRs</td>
<td>AVG: 0.368 MTRs</td>
</tr>
<tr>
<td>HEAVE</td>
<td>PITCH</td>
<td></td>
</tr>
<tr>
<td>0.0017 DEG</td>
<td>0.0411 DEG</td>
<td></td>
</tr>
<tr>
<td>0.034 DEG</td>
<td>0.0822 DEG</td>
<td></td>
</tr>
<tr>
<td>0.1049 DEG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.00 Knots</td>
<td>10.00 MTRs</td>
<td>12.00 SECS</td>
</tr>
<tr>
<td>MNSQ: 6.2882 MTRs</td>
<td>RMS: 2.5076 MTRs</td>
<td>AVG: 3.3345 MTRs</td>
</tr>
<tr>
<td>HEAVE</td>
<td>PITCH</td>
<td></td>
</tr>
<tr>
<td>0.0036 DEG</td>
<td>0.0603 DEG</td>
<td></td>
</tr>
<tr>
<td>0.0754 DEG</td>
<td>0.1206 DEG</td>
<td></td>
</tr>
<tr>
<td>0.1538 DEG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.00 Knots</td>
<td>10.00 MTRs</td>
<td>12.00 SECS</td>
</tr>
<tr>
<td>MNSQ: 6.3683 MTRs</td>
<td>RMS: 2.4836 MTRs</td>
<td>AVG: 3.1045 MTRs</td>
</tr>
<tr>
<td>HEAVE</td>
<td>PITCH</td>
<td></td>
</tr>
<tr>
<td>1.7695 DEG</td>
<td>1.3302 DEG</td>
<td></td>
</tr>
<tr>
<td>1.6628 DEG</td>
<td>2.6605 DEG</td>
<td></td>
</tr>
<tr>
<td>3.3921 DEG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.00 Knots</td>
<td>10.00 MTRs</td>
<td>12.00 SECS</td>
</tr>
<tr>
<td>MNSQ: 5.4907 MTRs</td>
<td>RMS: 2.3432 MTRs</td>
<td>AVG: 2.9290 MTRs</td>
</tr>
<tr>
<td>HEAVE</td>
<td>PITCH</td>
<td></td>
</tr>
<tr>
<td>4.8687 DEG</td>
<td>2.2065 DEG</td>
<td></td>
</tr>
<tr>
<td>2.7581 DEG</td>
<td>4.4130 DEG</td>
<td></td>
</tr>
<tr>
<td>5.6266 DEG</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SAMPLE OUTPUT FROM SHIPC.LRS

<table>
<thead>
<tr>
<th>L.B.P.</th>
<th>HCG</th>
<th>GMN</th>
<th>RNF</th>
<th>RRG/B</th>
<th>YRG/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>133.0000</td>
<td>.9440</td>
<td>1.6000</td>
<td>.0000</td>
<td>.3800</td>
<td>.2500</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>.050</th>
<th>.000</th>
<th>.000</th>
</tr>
</thead>
<tbody>
<tr>
<td>.100</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>.150</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>.200</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>.250</td>
<td>.000</td>
<td>.162</td>
</tr>
<tr>
<td>.300</td>
<td>.000</td>
<td>5.517</td>
</tr>
<tr>
<td>.350</td>
<td>.000</td>
<td>17.113</td>
</tr>
<tr>
<td>.400</td>
<td>.000</td>
<td>22.101</td>
</tr>
<tr>
<td>.450</td>
<td>.000</td>
<td>20.049</td>
</tr>
<tr>
<td>.500</td>
<td>.000</td>
<td>15.678</td>
</tr>
<tr>
<td>.550</td>
<td>.000</td>
<td>11.537</td>
</tr>
<tr>
<td>.600</td>
<td>.000</td>
<td>8.315</td>
</tr>
<tr>
<td>.650</td>
<td>.000</td>
<td>5.981</td>
</tr>
<tr>
<td>.700</td>
<td>.000</td>
<td>4.333</td>
</tr>
<tr>
<td>.750</td>
<td>.002</td>
<td>3.174</td>
</tr>
<tr>
<td>.800</td>
<td>.011</td>
<td>2.354</td>
</tr>
<tr>
<td>.850</td>
<td>.034</td>
<td>1.770</td>
</tr>
<tr>
<td>.900</td>
<td>.074</td>
<td>1.347</td>
</tr>
<tr>
<td>.950</td>
<td>.125</td>
<td>1.038</td>
</tr>
<tr>
<td>1.000</td>
<td>.180</td>
<td>.810</td>
</tr>
<tr>
<td>1.050</td>
<td>.228</td>
<td>.638</td>
</tr>
<tr>
<td>1.100</td>
<td>.264</td>
<td>.508</td>
</tr>
<tr>
<td>1.150</td>
<td>.286</td>
<td>.408</td>
</tr>
<tr>
<td>1.200</td>
<td>.295</td>
<td>.331</td>
</tr>
<tr>
<td>1.250</td>
<td>.293</td>
<td>.271</td>
</tr>
<tr>
<td>1.300</td>
<td>.283</td>
<td>.223</td>
</tr>
<tr>
<td>1.350</td>
<td>.267</td>
<td>.185</td>
</tr>
<tr>
<td>1.400</td>
<td>.249</td>
<td>.154</td>
</tr>
<tr>
<td>1.450</td>
<td>.229</td>
<td>.130</td>
</tr>
<tr>
<td>1.500</td>
<td>.209</td>
<td>.110</td>
</tr>
<tr>
<td>1.550</td>
<td>.190</td>
<td>.093</td>
</tr>
<tr>
<td>1.600</td>
<td>.171</td>
<td>.079</td>
</tr>
<tr>
<td>1.650</td>
<td>.154</td>
<td>.068</td>
</tr>
<tr>
<td>1.700</td>
<td>.138</td>
<td>.059</td>
</tr>
<tr>
<td>1.750</td>
<td>.124</td>
<td>.051</td>
</tr>
<tr>
<td>1.800</td>
<td>.111</td>
<td>.044</td>
</tr>
<tr>
<td>1.850</td>
<td>.099</td>
<td>.039</td>
</tr>
<tr>
<td>1.900</td>
<td>.089</td>
<td>.034</td>
</tr>
<tr>
<td>1.950</td>
<td>.080</td>
<td>.030</td>
</tr>
<tr>
<td>STATION</td>
<td>OFFSET DISTANCE FROM CENTRELINE</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>-------------------------------</td>
<td></td>
</tr>
<tr>
<td>2.00</td>
<td>IEDDY= 1</td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>.2040 .6875 .3400 .7970 .9350 1.0770 1.2825</td>
<td></td>
</tr>
<tr>
<td>DISTANCES FROM KEEL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.0472</td>
<td>1.7760 2.8224 4.0000 4.5966 4.8000 5.6000 6.4000</td>
<td></td>
</tr>
<tr>
<td>3.00</td>
<td>IEDDY= 1</td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>.4785 .9075 1.4415 1.5735 1.9200 2.1870 2.5020</td>
<td></td>
</tr>
<tr>
<td>DISTANCES FROM KEEL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>1.0880 2.1856 3.6464 4.0000 4.9248 5.6000 6.4000</td>
<td></td>
</tr>
<tr>
<td>4.00</td>
<td>IEDDY= 1</td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>.7545 1.2465 1.9995 2.5755 3.2265 3.3825 3.7800</td>
<td></td>
</tr>
<tr>
<td>DISTANCES FROM KEEL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>.8192 1.6192 2.8816 3.9904 5.2864 5.6000 6.4000</td>
<td></td>
</tr>
<tr>
<td>5.00</td>
<td>IEDDY= 1</td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>1.0695 1.8105 2.8140 3.6960 4.3110 4.6335 5.0445</td>
<td></td>
</tr>
<tr>
<td>DISTANCES FROM KEEL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>.8410 1.6080 2.2640 4.0000 5.0192 5.6000 6.4000</td>
<td></td>
</tr>
<tr>
<td>6.00</td>
<td>IEDDY= 1</td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>1.3635 2.2305 3.2760 4.2150 4.7445 5.7450 6.1275</td>
<td></td>
</tr>
<tr>
<td>DISTANCES FROM KEEL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>.6288 1.4864 2.2640 3.2912 4.0000 5.6000 6.4000</td>
<td></td>
</tr>
<tr>
<td>7.00</td>
<td>IEDDY= 1</td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>1.4070 2.4120 3.6480 4.5795 5.7915 6.7095 7.0350</td>
<td></td>
</tr>
<tr>
<td>DISTANCES FROM KEEL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>.3792 .8800 1.7104 2.5456 4.0000 5.6000 6.4000</td>
<td></td>
</tr>
<tr>
<td>8.00</td>
<td>IEDDY= 0</td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>1.5270 3.7965 4.8310 5.7000 6.5745 7.4325 7.7175</td>
<td></td>
</tr>
<tr>
<td>DISTANCES FROM KEEL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>.7921 1.3312 1.9656 2.7856 4.0000 5.6000 6.4000</td>
<td></td>
</tr>
<tr>
<td>9.00</td>
<td>IEDDY= 0</td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>2.2350 3.2895 5.1955 6.3615 7.2735 7.9305 8.1810</td>
<td></td>
</tr>
<tr>
<td>DISTANCES FROM KEEL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>.1712 .4816 1.5424 2.6336 4.0000 5.6000 6.4000</td>
<td></td>
</tr>
<tr>
<td>10.00</td>
<td>IEDDY= 3</td>
<td></td>
</tr>
<tr>
<td>DISTANCES FROM KEEL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>.1936 .8832 2.0464 2.5840 4.0000 5.6000 6.4000</td>
<td></td>
</tr>
<tr>
<td>11.00</td>
<td>IEDDY= 3</td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>4.0005 4.8225 6.6000 6.9855 7.9080 8.4450 8.6385</td>
<td></td>
</tr>
<tr>
<td>DISTANCES FROM KEEL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.0000</td>
<td>.4864 .8160 2.0176 2.4720 4.0000 5.6000 6.4000</td>
<td></td>
</tr>
<tr>
<td>STATION</td>
<td>IEDDY=</td>
<td>OFFSET DISTANCE FROM CENTRELINE</td>
</tr>
<tr>
<td>---------</td>
<td>--------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7107.088 11.3661 .4613 17.6310 6.4000</td>
</tr>
</tbody>
</table>

**BILGE KEEL INFORMATION**

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

<table>
<thead>
<tr>
<th>Bilge keel number 1</th>
<th>Station</th>
<th>Offset</th>
<th>Waterline</th>
<th>Outreach</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>5.7000</td>
<td>2.7860</td>
<td>1.5000</td>
<td>5.3200</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>6.3620</td>
<td>2.6340</td>
<td>1.5000</td>
<td>6.6500</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>6.3090</td>
<td>2.0460</td>
<td>1.5000</td>
<td>7.9800</td>
<td></td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Station</th>
<th>Offset</th>
<th>Waterline</th>
<th>Outreach</th>
<th>Root Chord</th>
<th>Tip Chord</th>
<th>Di-hedral</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.00</td>
<td>6.99</td>
<td>2.47</td>
<td>1.61</td>
<td>2.96</td>
<td>2.19</td>
<td>45.00</td>
</tr>
</tbody>
</table>

PROPELLER SHAFT BRACKET INFORMATION

<table>
<thead>
<tr>
<th>Station</th>
<th>Offset</th>
<th>Waterline</th>
<th>Outreach</th>
<th>Root Chord</th>
<th>Tip Chord</th>
<th>Di-hed ral</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.63</td>
<td>3.80</td>
<td>4.11</td>
<td>1.81</td>
<td>.52</td>
<td>.52</td>
<td>.00</td>
</tr>
<tr>
<td>19.63</td>
<td>2.16</td>
<td>3.73</td>
<td>1.52</td>
<td>.75</td>
<td>.52</td>
<td>62.50</td>
</tr>
</tbody>
</table>

RUDDER INFORMATION

<table>
<thead>
<tr>
<th>Station</th>
<th>Offset</th>
<th>Waterline</th>
<th>Outreach</th>
<th>Root chord</th>
<th>Tip Chord</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.37</td>
<td>2.06</td>
<td>5.31</td>
<td>2.79</td>
<td>2.27</td>
<td>1.62</td>
</tr>
</tbody>
</table>

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

| W  | WE  | WL/L | AMP PHASE | AMP PHASE | AMP PHASE | AMP PHASE | AMP PHASE | AMP PHASE |
|----|-----|------|-----------|-----------|-----------|-----------|-----------|
| .05| .05 | 185.46| 1.038 | .773 | 84. | 5.144 | -79. | .000 | -93. | .013 | 0. |
| .10| .10 | 46.37 | 1.030 | .790 | 85. | 2.011 | -71. | .000 | -94. | .003 | 0. |
| .15| .15 | 20.61 | 1.038 | .806 | 86. | 1.062 | -72. | .000 | 91. | .001 | 0. |
| .20| .20 | 11.59 | 1.007 | .836 | 86. | .643 | -75. | .000 | 105. | .001 | 0. |
| .25| .25 | 7.42  | .995  | 86. | .885 | 86. | .425 | -77. | .000 | 90. | .001 | 0. |
| .30| .30 | 5.15  | .983  | 89. | .959 | 86. | .309 | -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 | 15. | .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   | .388  | 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| .13   | .260  | 87. | .015 | 74. | .004 | 16. | .000 | 0. | .000 | 0. |
| 1.90|1.90| .12   | .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 | 87. | .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

<table>
<thead>
<tr>
<th></th>
<th>SWAY</th>
<th>ROLL</th>
<th>YAW</th>
<th>RUDDER</th>
<th>FINS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISPLACEMENT</td>
<td>.2305</td>
<td>.4160</td>
<td>.0378</td>
<td>.0001</td>
<td>.0001</td>
</tr>
<tr>
<td>VELOCITY</td>
<td>.2885</td>
<td>.4842</td>
<td>.0535</td>
<td>.0001</td>
<td>.0001</td>
</tr>
<tr>
<td>ACCELERATION</td>
<td>.3384</td>
<td>.6058</td>
<td>.0804</td>
<td>.0002</td>
<td>.0002</td>
</tr>
</tbody>
</table>

SIG. WAVE HEIGHT 10.00 METRES
WAVE PERIOD 12.00 SECONDS

<table>
<thead>
<tr>
<th></th>
<th>SWAY</th>
<th>ROLL</th>
<th>YAW</th>
<th>RUDDER</th>
<th>FINS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISPLACEMENT</td>
<td>2.2693</td>
<td>12.1043</td>
<td>.4687</td>
<td>.0005</td>
<td>.0827</td>
</tr>
<tr>
<td>VELOCITY</td>
<td>1.1545</td>
<td>7.2434</td>
<td>.2417</td>
<td>.0003</td>
<td>.0333</td>
</tr>
<tr>
<td>ACCELERATION</td>
<td>.7342</td>
<td>4.4400</td>
<td>.1430</td>
<td>.0002</td>
<td>.0151</td>
</tr>
</tbody>
</table>
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 FROM THE CENTRELINE +VE TO STBD (M)
Z DISTANCES ARE MEASURED FROM USK POSITIVE UPWARDS (M)

POSITIONS ARE AS FOLLOWS

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th>NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0000</td>
<td>4.0000</td>
<td>6.0000</td>
<td>1</td>
</tr>
</tbody>
</table>

SPECTRUM NUMBER

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

SIG. WAVE HT. (M)  
MODAL WAVE PERIOD (SEC)  

R.M.S. VALUES

MOTION IN METRES

VELOCITY IN METRES/SEC

ACCELERATION IN METRES/SEC**2

MOTIONS IN LONG CRESTED IRREGULAR SEAS

<table>
<thead>
<tr>
<th></th>
<th>10.00 KNOTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEADING</td>
<td>90.00 DEGREES</td>
</tr>
</tbody>
</table>

LOCATION NO. 1  R.M.S. RESPONSES

| WAVE SPECT | VERTICAL | LATERAL |
|           | ABSOLUTE | ABSOLUTE |
|           | DISP | VEL | ACCEL | DISP | VEL | ACCEL | DISP | VEL | ACCEL |
| 1 | .25 | .27 | .31 | .37 | .57 | .92 | .23 | .30 | .40 |
| 2 | 2.23 | 1.21 | .79 | .85 | .65 | .72 | 1.98 | 1.03 | .68 |

SYMMETRIC VALUES

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.29</td>
<td>.33</td>
<td>.38</td>
<td>.57</td>
<td>.79</td>
<td>1.16</td>
</tr>
<tr>
<td>2</td>
<td>2.92</td>
<td>1.62</td>
<td>1.06</td>
<td>1.19</td>
<td>1.01</td>
<td>1.09</td>
</tr>
<tr>
<td>LOCATION NO.</td>
<td>SPEED</td>
<td>HEADING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>-------</td>
<td>---------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>10.00 KNOTS</td>
<td>105.00 DEGREES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>10.00 KNOTS</td>
<td>120.00 DEGREES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WAVE</th>
<th>VERTICAL</th>
<th>R.M.S. RESPONSES</th>
<th>LATERAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SPECT</td>
<td>ABSOLUTE</td>
<td>RELATIVE</td>
</tr>
<tr>
<td></td>
<td>DISP</td>
<td>VEL</td>
<td>ACCEL</td>
</tr>
<tr>
<td>1</td>
<td>.43</td>
<td>.52</td>
<td>.65</td>
</tr>
<tr>
<td>2</td>
<td>2.81</td>
<td>1.92</td>
<td>1.64</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SYMMETRIC VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>3.25</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1.58</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SPEED</th>
<th>HEADING</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.00 KNOTS</td>
<td>120.00 DEGREES</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WAVE</th>
<th>VERTICAL</th>
<th>R.M.S. RESPONSES</th>
<th>LATERAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SPECT</td>
<td>ABSOLUTE</td>
<td>RELATIVE</td>
</tr>
<tr>
<td></td>
<td>DISP</td>
<td>VEL</td>
<td>ACCEL</td>
</tr>
<tr>
<td>1</td>
<td>.28</td>
<td>.34</td>
<td>.42</td>
</tr>
<tr>
<td>2</td>
<td>3.46</td>
<td>2.40</td>
<td>2.12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SYMMETRIC VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>.27</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1.93</td>
</tr>
</tbody>
</table>
Ship Name: SHIPC
Ship Speed = 10.0 knots
Results are amplitudes and DIMENSIONAL per unit wave amplitude

**Heave Response**

- 90.00 degs
- 105.00 degs
- 120.00 degs

**Pitch Response**

- 90.00 degs
- 105.00 degs
- 120.00 degs
Ship Name : SHIPC
Ship Speed = 10.0 knots
Results are amplitudes and DIMENSIONAL per unit wave amplitude

Sway Response (m)

Roll Response (deg)

Frequency (rads/sec)