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UNIVERSITY OF SOUTHAMPTON

DEPARTMENT OF SHIP SCIENCE

FACULTY OF ENGINEERING AND APPLIED SCIENCE

GRAPHICS VISUALIZATIONS OF SEAKEEPING DATA

by

P.A. Wilson

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The Use of Graphics in Seakeeping

P.A.Wilson

1) The new graphics program is an extension of the original program with the extra capabilities of being able to plot out results from the total motions program module, and the choice of the output constant for any particular graph between ship speed, wave encounter angle and sea state.

2) The first input is the generic file name used to describe the whole process of the calculation of the ship motions suite of programs. The program then checks what data has been calculated for this particular ship and stored in computer files. The program outputs to the screen the number of ship speeds, wave angles and sea spectra. This is vital data when there are multiple choices presented later on as to which type of variable to plot. The program then checks to see if there is a file of total motions output that can be plotted. A message is displayed if there have been no total motions data calculated.

3) The title of the graphs can now be input. This need not be the generic file name, as in earlier versions of the program, but can be up to twenty characters.

4) The first choice presented, if there are total motions values to plot, is either centre of gravity results or total motions, as the type of data to be plotted.

5) If, the centre of gravity results are chosen then, the next choice is whether the regular responses at the centre of gravity (heave, pitch, roll, sway or yaw values for each wave frequency, whichever has been calculated) or the statistical values of the rigid body modes of motion are plotted.

6) If the regular results are chosen then the next choice is the form that these results are to be plotted i.e. dimensional or non-dimensional. The next choice is between which variable, either ship speed or wave angle, is kept constant on the graph. Thus, if you have only calculated the responses for one ship speed and 9 wave angles then there is only one choice, ship speed, otherwise nine plottings will be given for each ship mode of response.

When that choice is satisfied then the user is prompted to put paper in the plotter.

7) If the choice in 4) above, is irregular then the next question is which of three variables is the constant for the graph. These are wave angle, ship speed and sea state. Here the choice is critical since if you have only calculated for two (2) ship speeds then this is not going to be a good choice for an x-axis of ship speed against heave r.m.s, since for each sea state and wave angle there will be only two points on the curve!

However, whichever of the three is chosen as the graph constant there will now be choice presented for the x-axis variable between the remaining two variables. If, the graph constant is sea state and the x-axis variable is ship speed then there could be a number of lines on the same graph for each calculated wave angle response for the rigid body mode response.

Once the chosen values are given there is then a choice as to whether the sea state variable should be significant wave heights or sea state number. If sea state number is chosen, then the user is prompted to indicate which significant wave height is associated with each sea state number.

The program user is then prompted as to whether the actual sea spectra should be plotted or not.

The final two choices allow the statistical result to be presented in either root mean square values, significant values or one tenth together with either amplitudes or heights (double amplitudes).

8) The graphs are annotated with all details of which variable is being plotted, the graph constant, and x-axis variable together with the lines on each graph. Examples are given in the appendix.

9) If in 3) above the choice is total motions then similar questions are posed as in the sections above when irregular responses were chosen.

The choice is again between wave angle, ship speed and sea state for the graph constant. Then, the x-axis is chosen from the remaining pair. Since the total motions program calculates for each ship speed, wave angle and sea state, up to a total of nine responses, the next question is the choice of which one of the following nine:

Absolute Vertical Displacement, Velocity or Acceleration,
Relative Vertical Displacement, Velocity or Acceleration,

Lateral Displacement, Velocity or Acceleration.

The next choice is which position number is plotted from those input to the total motions program. The actual positions where the calculations were performed will already have been listed. The next choice is whether to plot the sea spectra or not. As before, the final choices are as to the type of statistic to be plotted between root mean square, significant or one tenth, coupled with either amplitudes or heights (double amplitudes). The user is then prompted to place some paper in the plotter.

10) After the complete set of graphs have been plotted to repeat some other plottings requires the program to be re-run. A data file is written that is the calculated data of the graphs. This is found on file generic.TAB. This is printed out in the normal manner, e.g. TYPE generic.TAB >prn.

11) As a general note the style of all the graphs is the same. All curves have symbols placed on them. These symbols are at the calculated points. The continuous curve that joins all these plotted (symbol) points together is a spline passing through all points. The algorithm generates a spline with ten points betwen each calculated pair of values.

APPENDIX A

Fig 1 Graph constant Ship speed. C.G. regular results, non-dimensional.

Fig 2 Graph constant Ship speed. C.G. regular results, dimensional.

Fig 3 Graph constant Wave angle. C.G. regular results, non-dimensional.

Fig 4 Spectral plottings.

Fig 5 Graph constant Ship speed. C.G. irregular results vs. wave angle.

Fig 6 Graph constant Ship speed. C.G. irregular results vs. wave height.

Fig 7 Graph constant Wave angle. C.G. irregular results vs. Ship speed.

Fig 8 Graph constant Wave angle. C.G. irregular results vs. Wave height.

Fig 9 Graph constant Wave angle. Relative vertical displacement vs. wave height.

Fig 10 Graph constant Ship speed. Relative vertical acceleration vs. wave angle.

Fig 11 Graph constant Sea State No. Absolute vertical acceleration vs. wave angle.

Fig 12 Graph constant Ship speed. Absolute vertical displacement vs. wave height.

Fig 13 Graph constant Wave angle. Relative vertical velocity vs. Ship speed.

Fig 14 Graph constant Ship speed. Absolute vertical velocity vs. Wave angle.

Fig 1

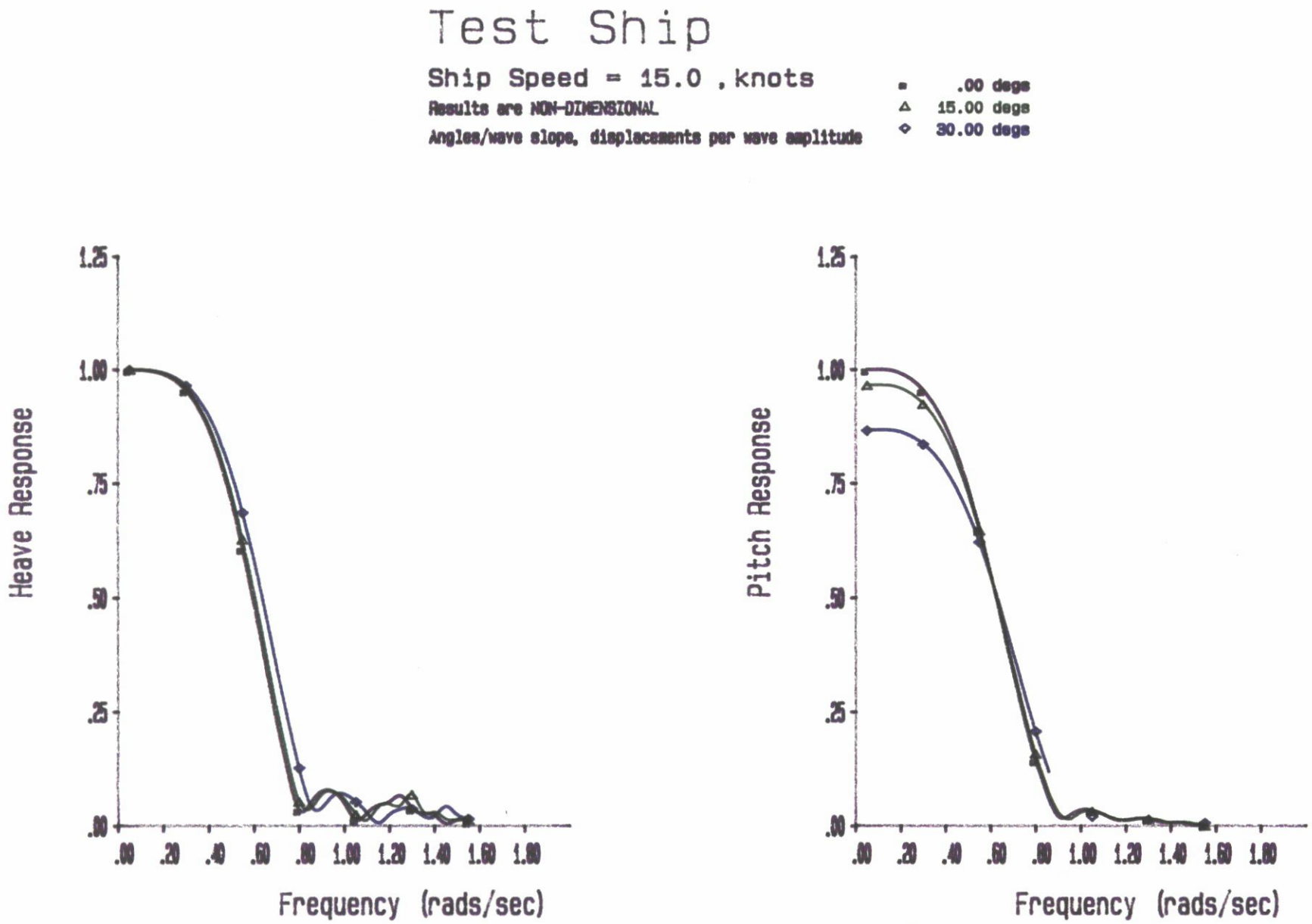

Test Ship
Ship Speed = 15.0 , knots
Results are NON-DIMENSIONAL
Angles/wave slope, displacements per wave amplitude
.00 degs
15.00 degs
30.00 degs
Heave Response
Pitch Response
Frequency (rads/sec)
Frequency (rads/sec)

Fig 2

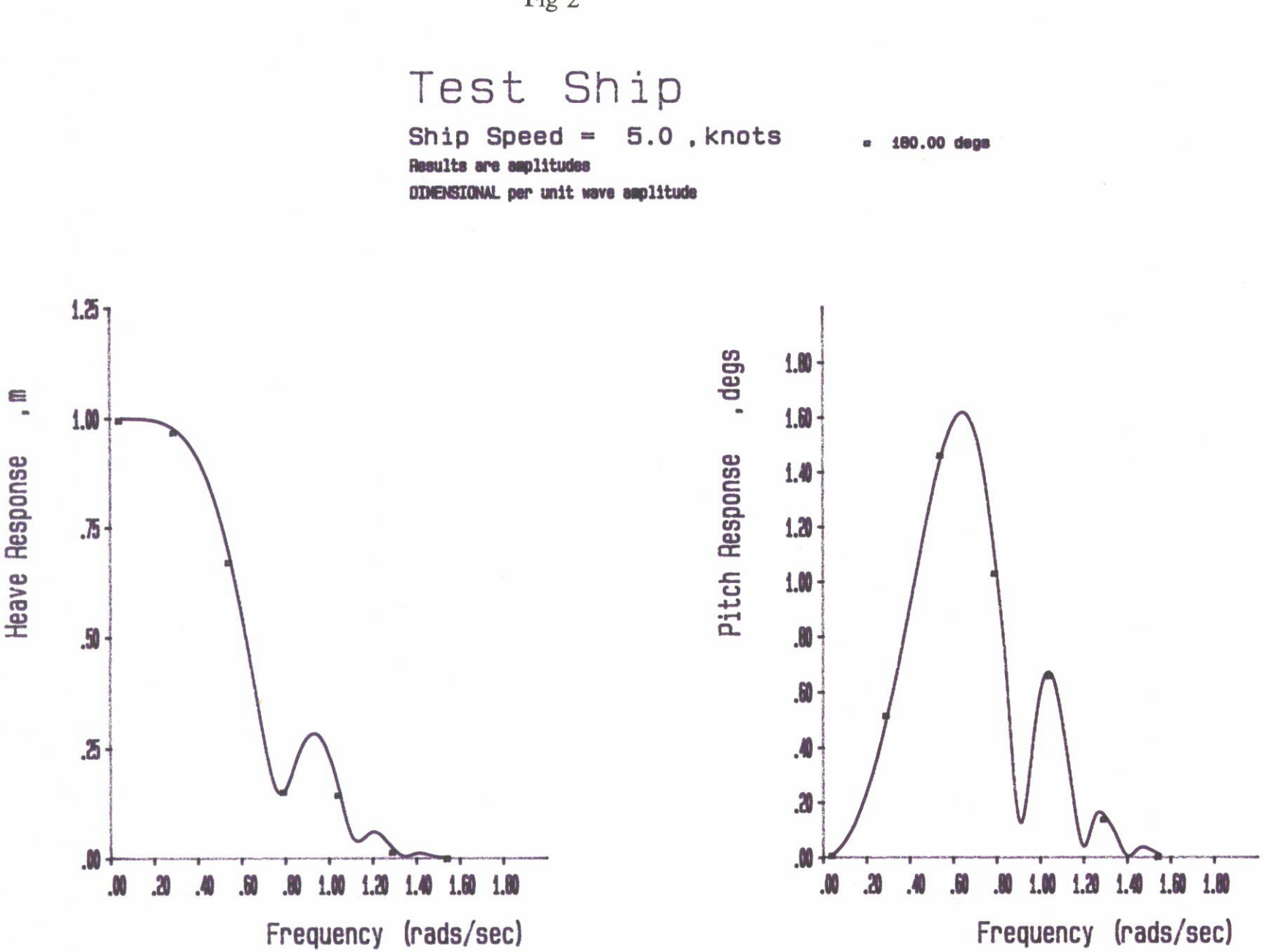

Test Ship
Ship Speed = 5.0 ,knots
= 180.00 degs
Results are amplitudes
DIMENSIONAL per unit wave amplitude
Heave Response ,m
1.25
1.00
.75
.50
.25
.00
.00 .20 .40 .60 .80 1.00 1.20 1.40 1.60 1.80
Frequency (rads/sec)
Pitch Response ,degs
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
.20
.00
.00 .20 .40 .60 .80 1.00 1.20 1.40 1.60 1.80
Frequency (rads/sec)

Fig 3

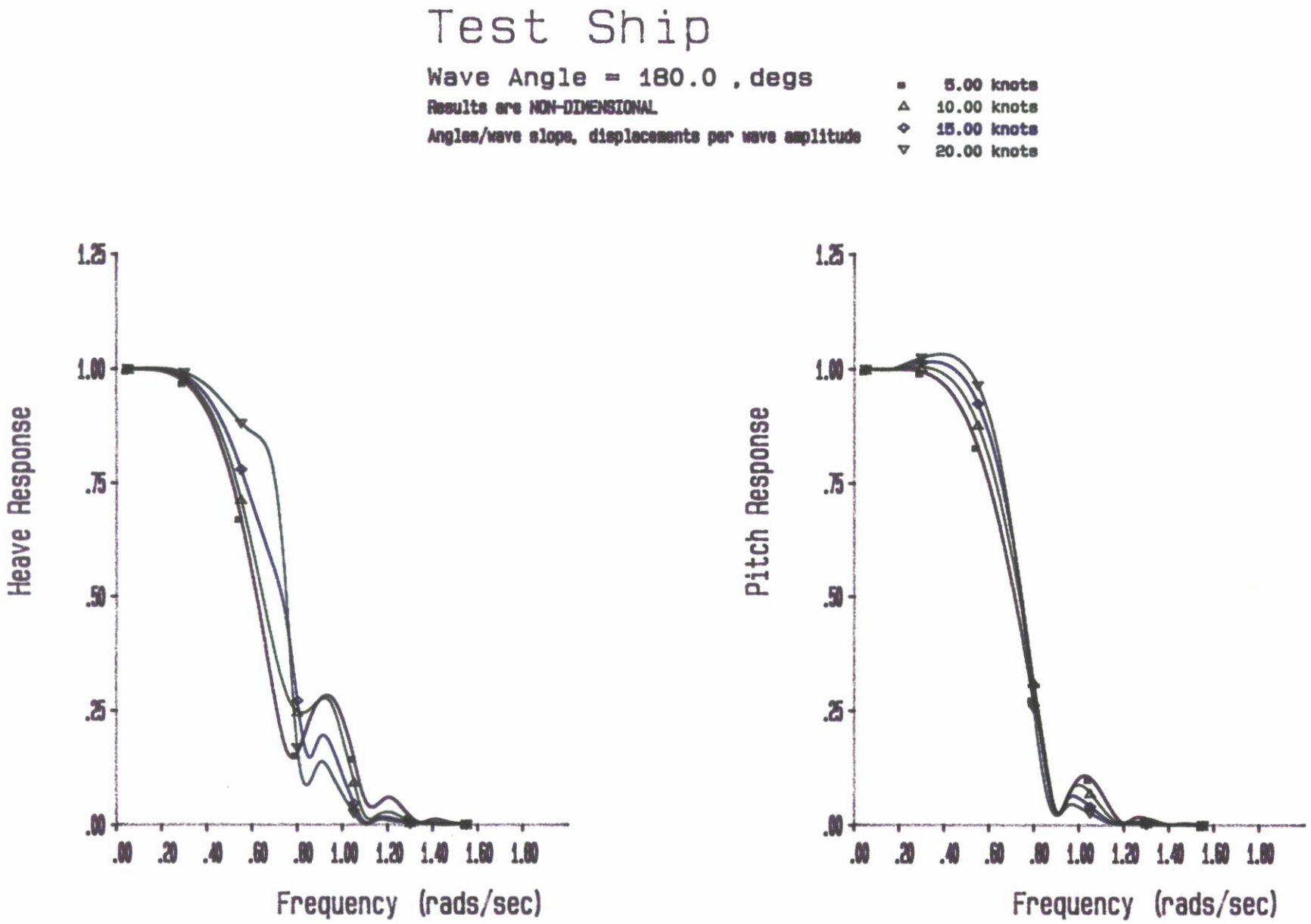

Test Ship
Wave Angle = 180.0 , degs
Results are NON-DIMENSIONAL
Angles/wave slope, displacements per wave amplitude
5.00 knots
10.00 knots
15.00 knots
20.00 knots
Heave Response
1.25
1.00
.75
.50
.25
.00
.00 .20 .40 .60 .80 1.00 1.20 1.40 1.60 1.80
Frequency (rads/sec)
Pitch Response
1.25
1.00
.75
.50
.25
.00
.00 .20 .40 .60 .80 1.00 1.20 1.40 1.60 1.80
Frequency (rads/sec)

Fig 4

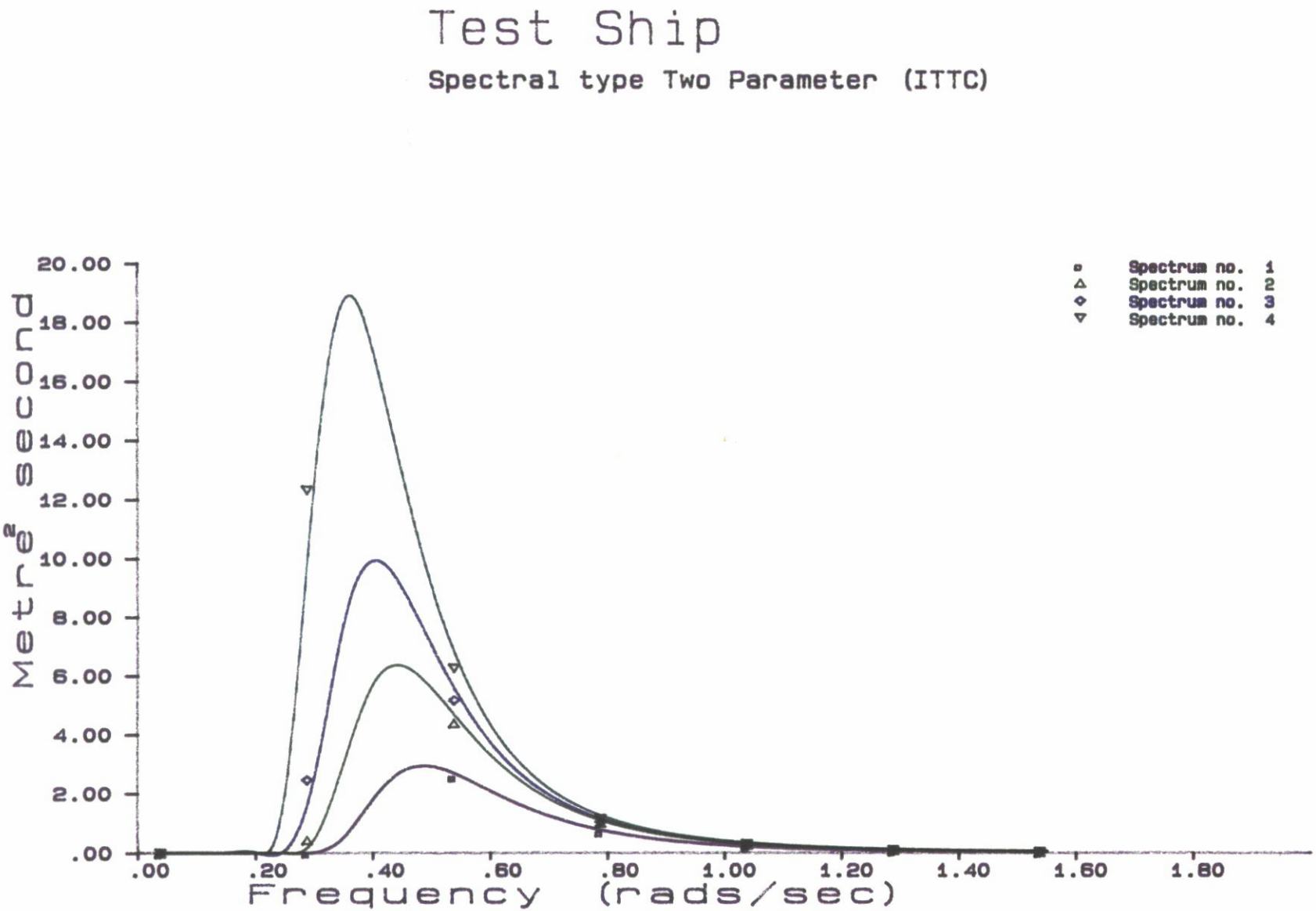

Test Ship
Spectral type Two Parameter (ITTC)
Spectrum no. 1
Spectrum no. 2
Spectrum no. 3
Spectrum no. 4
Metre² second
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
.00
.00
.20
.40
.60
.80
1.00
1.20
1.40
1.60
1.80
Frequency (rads/sec)

Fig 5

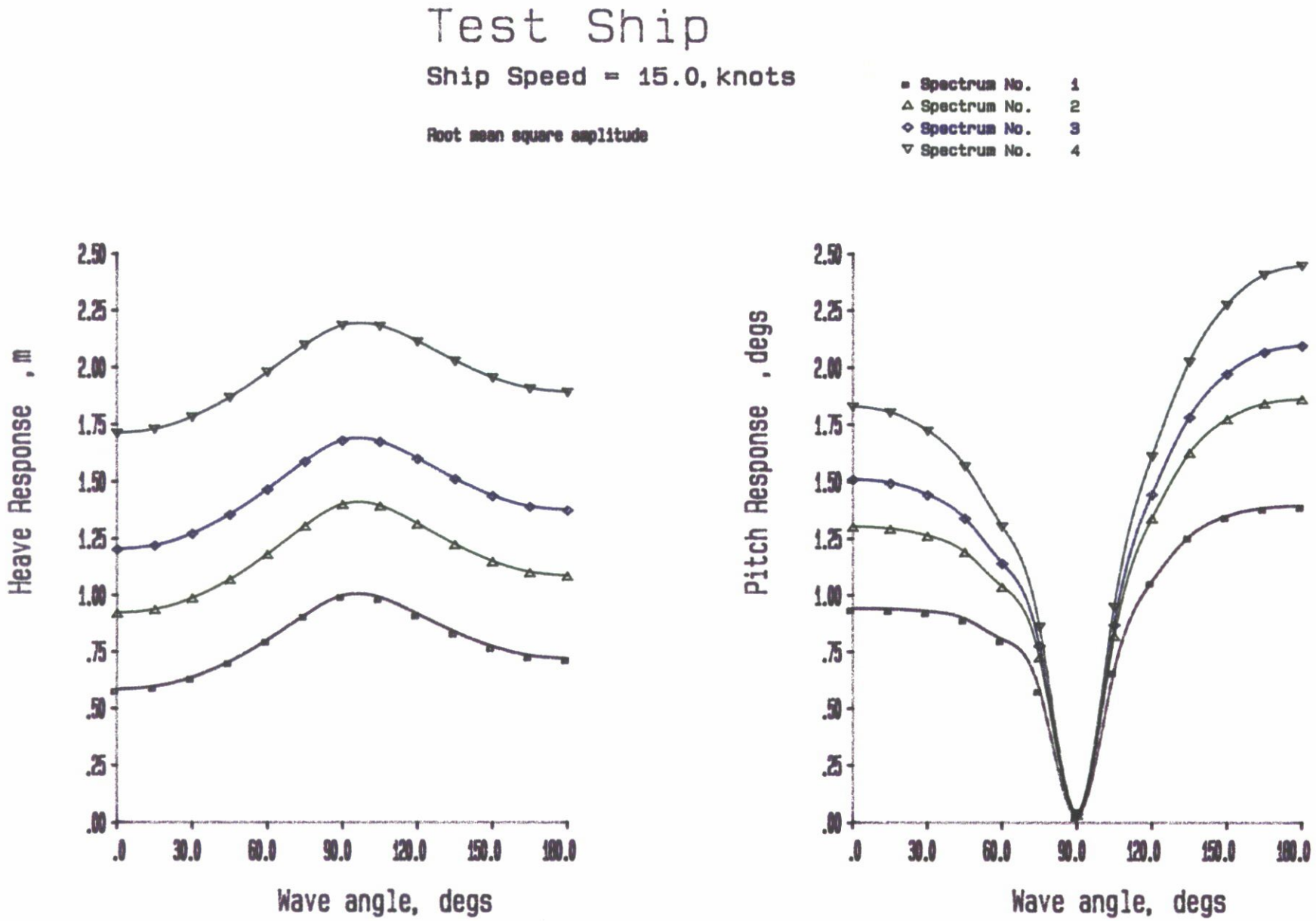
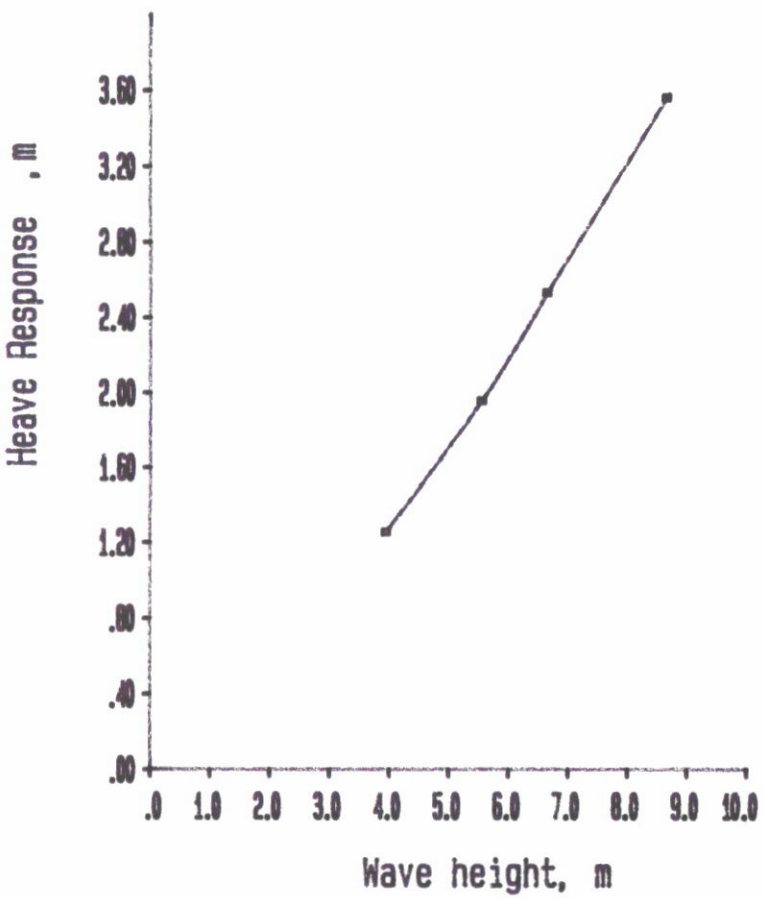

Test Ship
Ship Speed = 15.0, knots
Root mean square amplitude
Spectrum No. 1
Spectrum No. 2
Spectrum No. 3
Spectrum No. 4
Heave Response , m
2.50
2.25
2.00
1.75
1.50
1.25
1.00
.75
.50
.25
.00
.0
30.0
60.0
90.0
120.0
150.0
180.0
Wave angle, degs
Pitch Response , degs
2.50
2.25
2.00
1.75
1.50
1.25
1.00
.75
.50
.25
.00
.0
30.0
60.0
90.0
120.0
150.0
180.0
Wave angle, degs

Fig 6

Test Ship

Ship Speed = 5.0, knots * Wave Angle No. 1

Significant amplitude



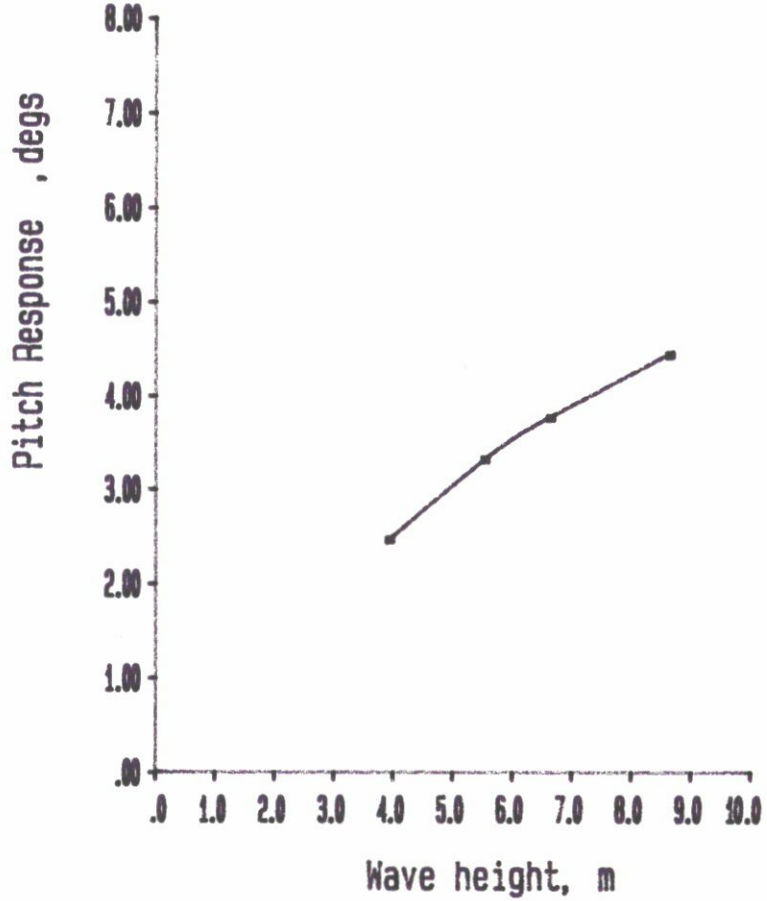


Fig 7

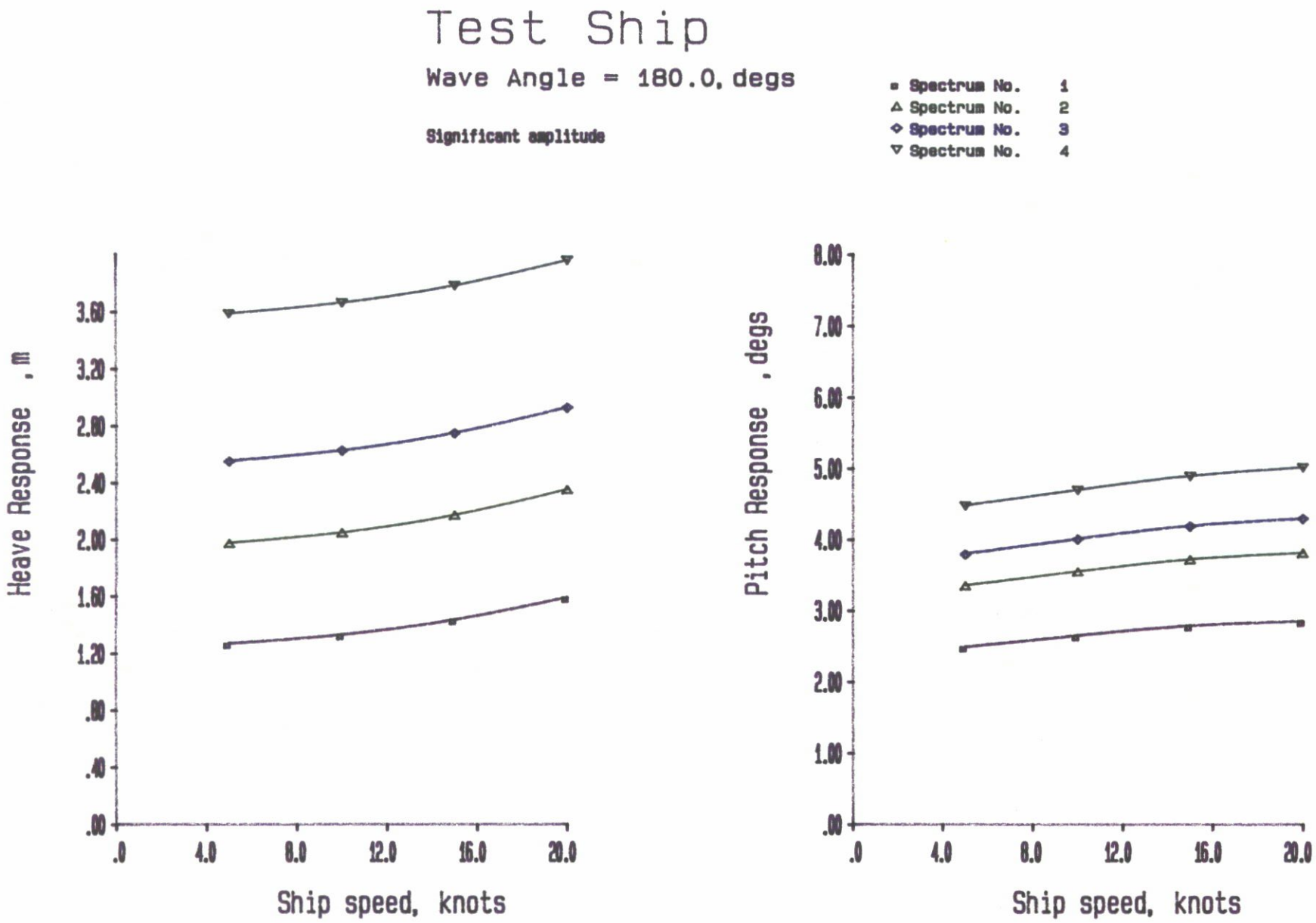

Test Ship
Wave Angle = 180.0, degs
Significant amplitude
Spectrum No. 1
Spectrum No. 2
Spectrum No. 3
Spectrum No. 4
Heave Response , m
3.60
3.20
2.80
2.40
2.00
1.60
1.20
.80
.40
.00
.0
4.0
8.0
12.0
16.0
20.0
Ship speed, knots
Pitch Response , degs
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
.00
.0
4.0
8.0
12.0
16.0
20.0
Ship speed, knots

Fig 8

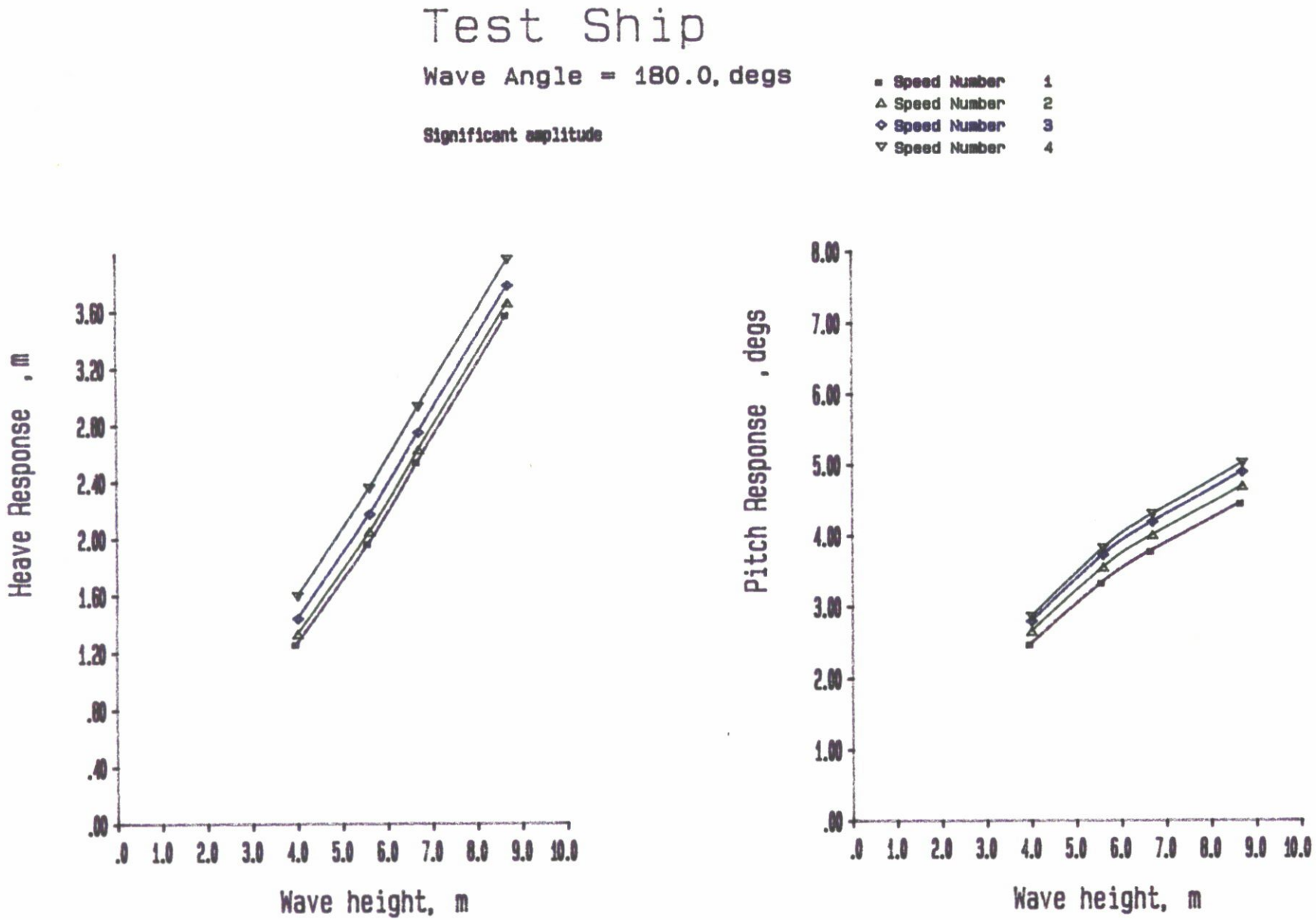

Test Ship
Wave Angle = 180.0, degs
Significant amplitude
Speed Number 1
Speed Number 2
Speed Number 3
Speed Number 4
Heave Response , m
3.60
3.20
2.80
2.40
2.00
1.60
1.20
.80
.40
.00
.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0
Wave height, m
Pitch Response , degs
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
.00
.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0
Wave height, m

Fig 9

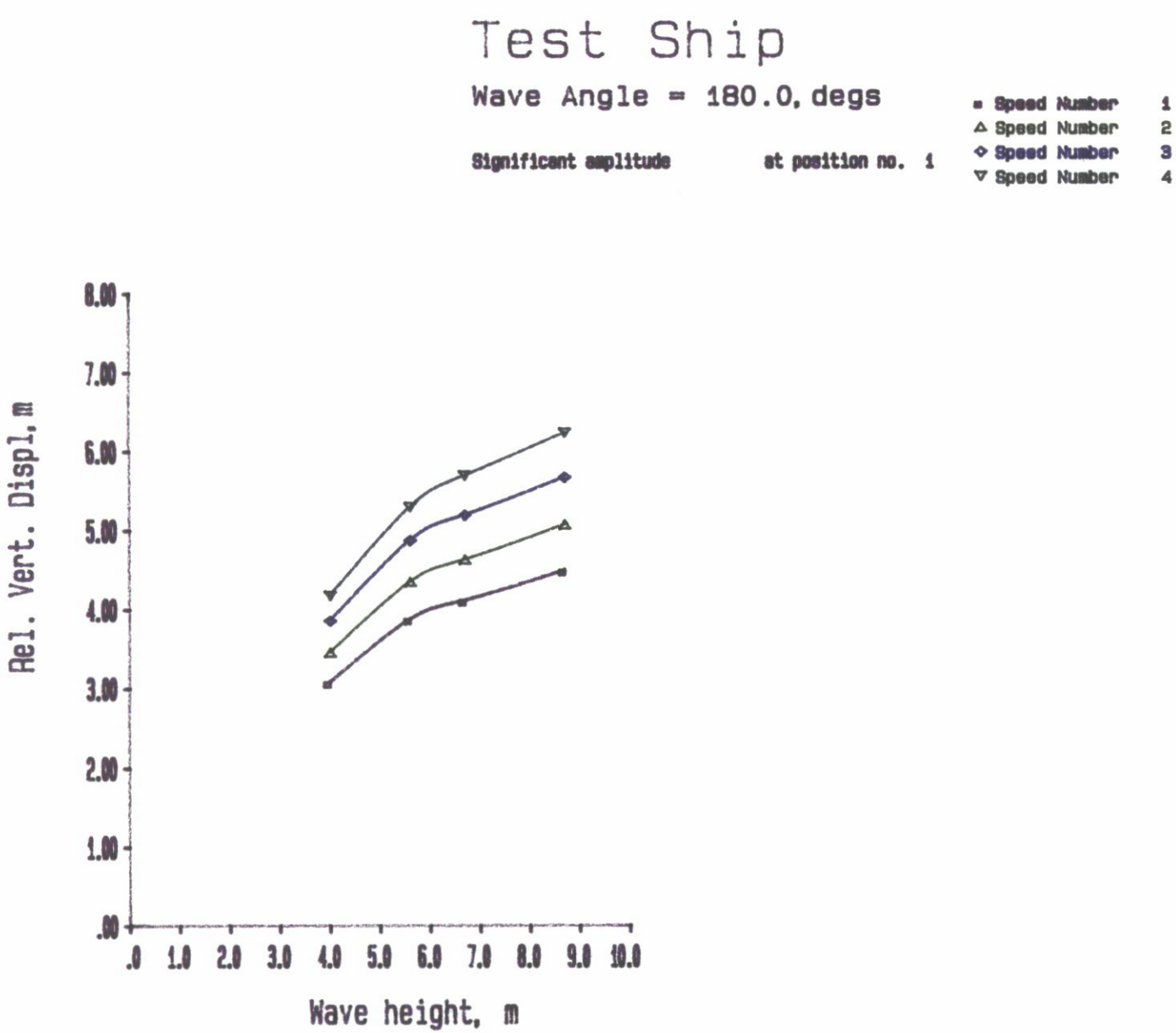

Test Ship
Wave Angle = 180.0, degs
Significant amplitude at position no. 1
Speed Number 1
Speed Number 2
Speed Number 3
Speed Number 4
Rel. Vert. Displ, m
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
.00
.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0
Wave height, m

Fig 10

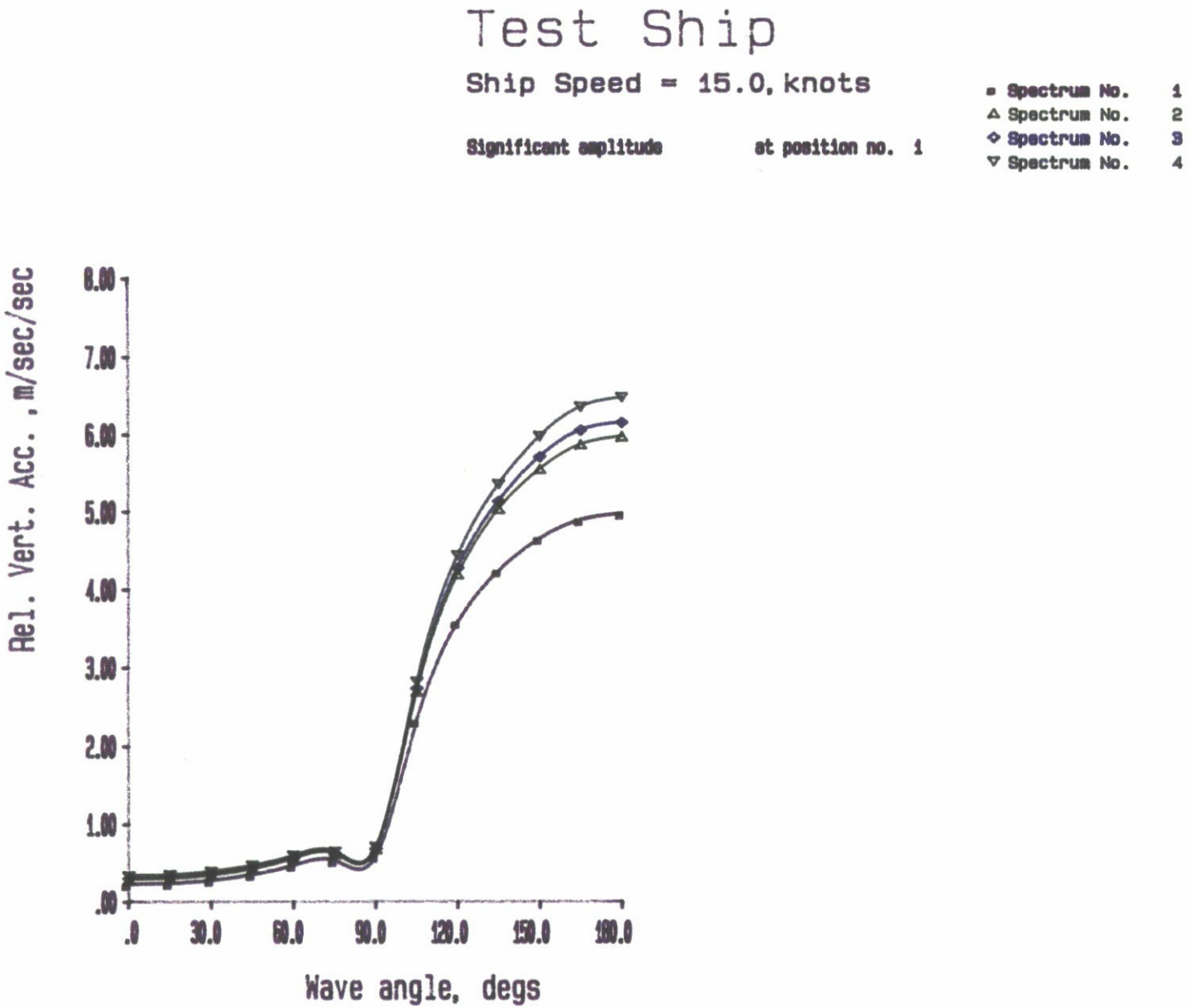

Test Ship
Ship Speed = 15.0, knots
Significant amplitude at position no. 1
Spectrum No. 1
Spectrum No. 2
Spectrum No. 3
Spectrum No. 4
Rel. Vert. Acc. , m/sec/sec
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
.00
.0
30.0
60.0
90.0
120.0
150.0
180.0
Wave angle, degs

Fig 11

Test Ship

Sea State Number = 4 = Speed Number 1

Significant amplitude at position no. 3

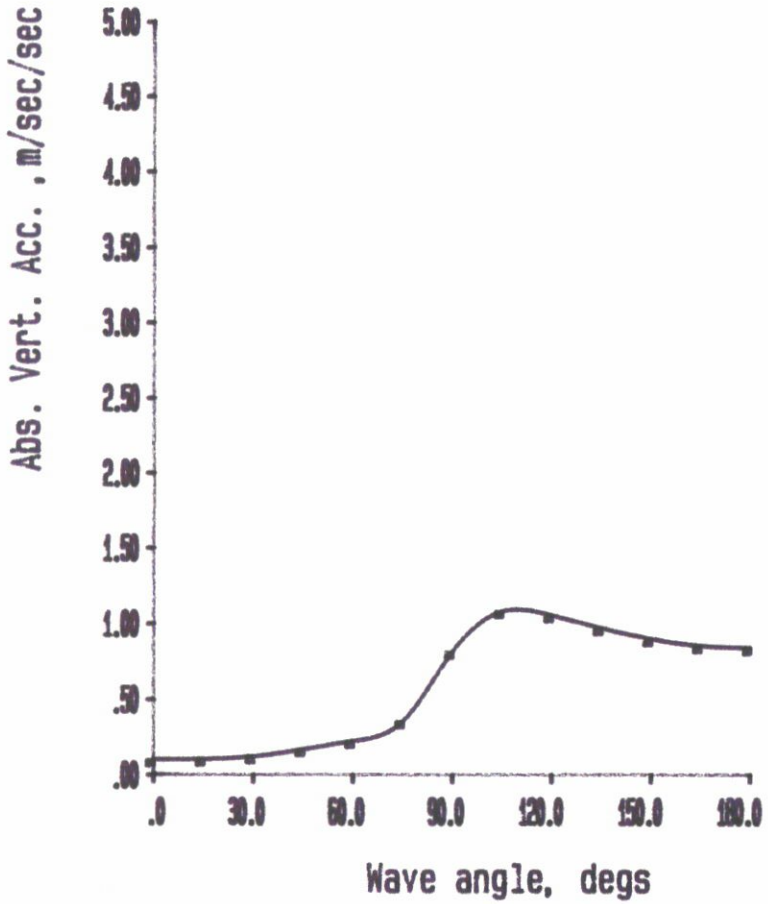


Fig 12

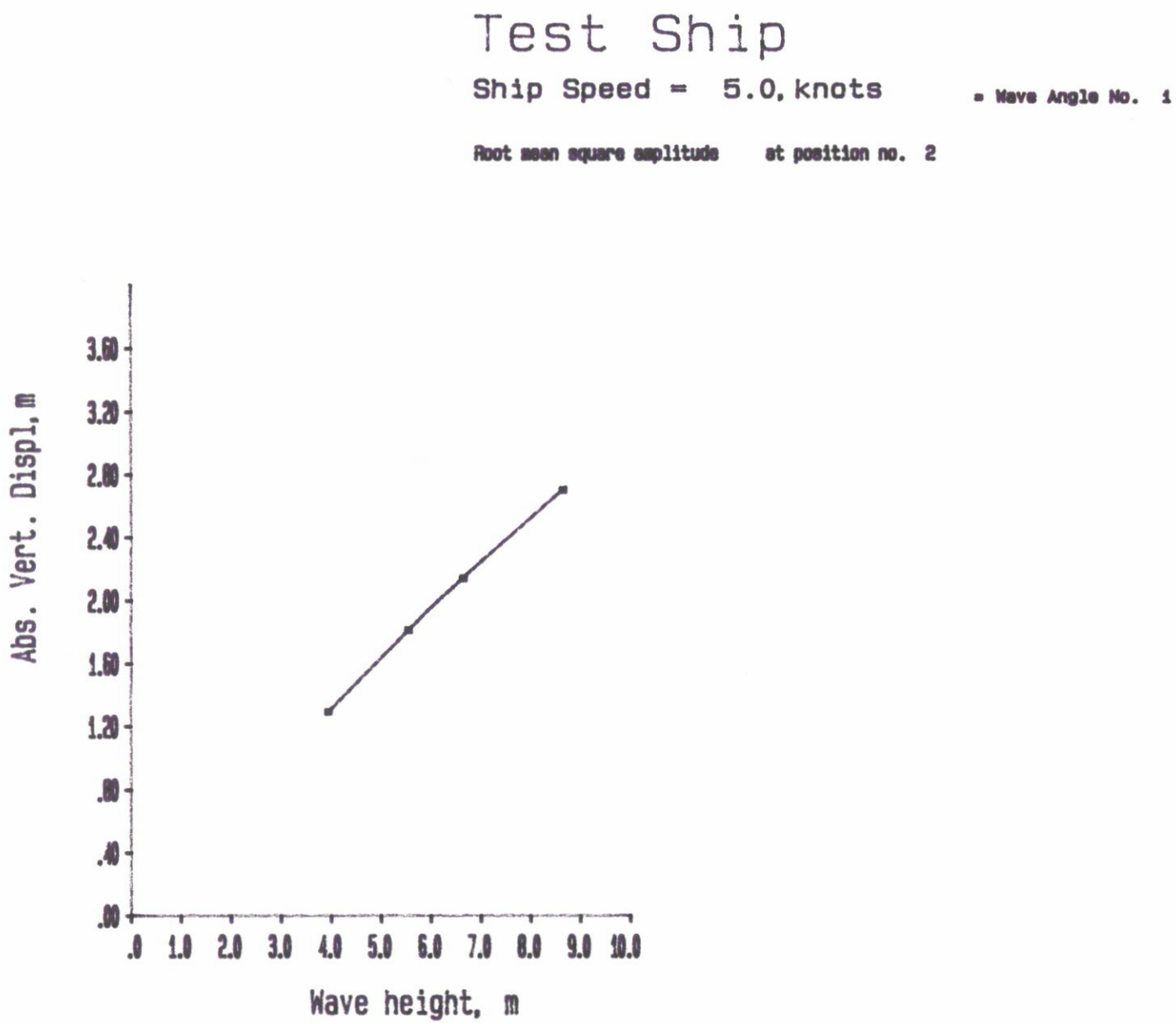

Test Ship
Ship Speed = 5.0, knots
Wave Angle No. 1
Root mean square amplitude at position no. 2
Abs. Vert. Displ, m
3.60
3.20
2.80
2.40
2.00
1.60
1.20
.80
.40
.00
.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0
Wave height, m

Fig 13

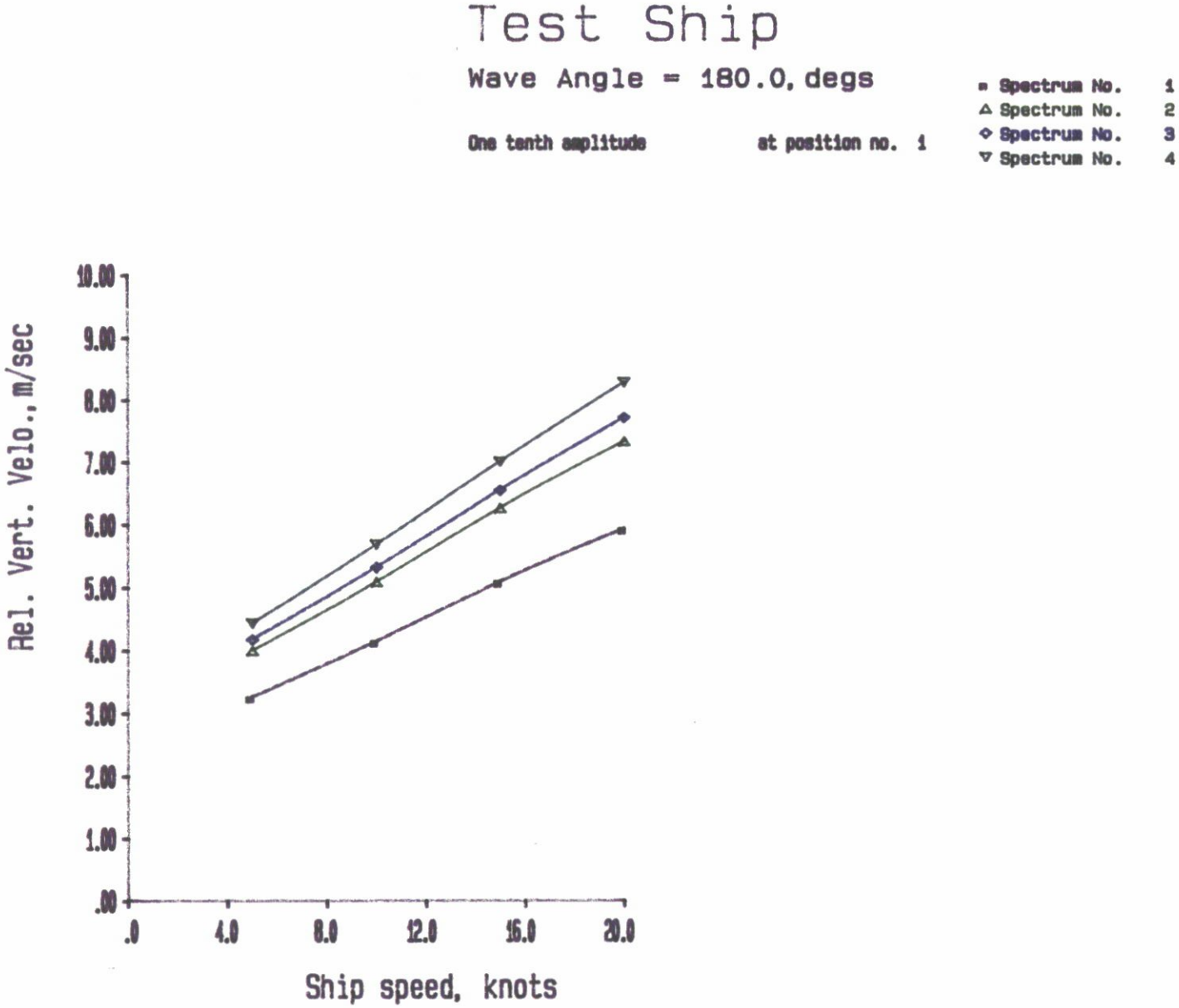
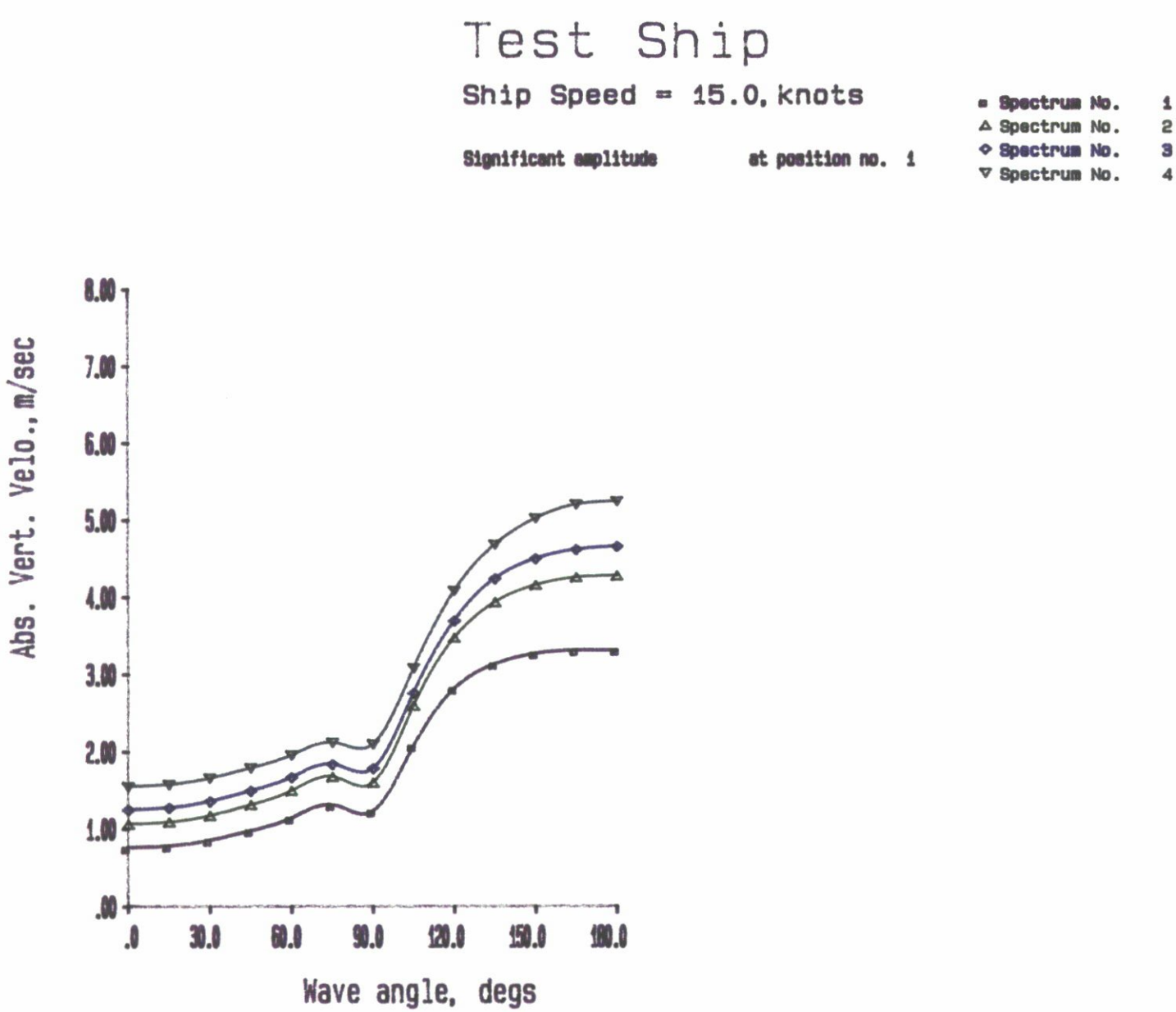

Test Ship
Wave Angle = 180.0, degs
One tenth amplitude
at position no. 1
Spectrum No. 1
Spectrum No. 2
Spectrum No. 3
Spectrum No. 4
Rel. Vert. Velo., m/sec
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
.00
.0
4.0
8.0
12.0
16.0
20.0
Ship speed, knots

Fig 14


Test Ship
Ship Speed = 15.0, knots
Significant amplitude at position no. 1
Spectrum No. 1
Spectrum No. 2
Spectrum No. 3
Spectrum No. 4
Abs. Vert. Velo., m/sec
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
.00
.0
30.0
60.0
90.0
120.0
150.0
180.0
Wave angle, degs

APPENDIX B

Codes that are used in the figues are:

Angles in degrees

.0 15.0 30.0 45.0 60.0 75.0 90.0 105.0 120.0 135.0 150.0 165.0 180.0

Number of angles in graphs

1 2 3 4 5 6 7 8 9 10 11 12 13

Ship speeds in knots

2.5 5.0 7.5 10.0 12.5 15.0 20.0

Number of speeds in graphs

1 2 3 4 5 6 7

Significant wave height of spectra

1.0 2.5 3.0 4.0 5.0 10.0 11.0 11.5 12.0 13.0

Number of sea spectra in graphs

1 2 3 4 5 6 7 8 9 10

Data has been generated for 1 total motions points

x	y	z	no.
1.0	.0	3.0	1

Ship name is

Significant wave height is 1.0, metres

Type of response is Significant amplitude for total motions point number 1

X-axis is Wave angle, degs

Y-axis is Rel. Vert. Velo.

Total motions at point number 1

Graph number 1

x	y
.000	.27
15.000	.28
30.000	.30
45.000	.30
60.000	.42
75.000	.26
90.000	.18

105.000	.53
120.000	.66
135.000	.50
150.000	.49
165.000	.45
180.000	.43

Graph number 2

x	y
.000	.22
15.000	.23
30.000	.25
45.000	.27
60.000	.39
75.000	.25
90.000	.18
105.000	.59
120.000	.72
135.000	.54
150.000	.51
165.000	.47
180.000	.46

Graph number 3

x	y
.000	.18
15.000	.19
30.000	.21
45.000	.24
60.000	.36
75.000	.25
90.000	.17
105.000	.65
120.000	.76
135.000	.57
150.000	.51
165.000	.47
180.000	.47

X-axis is Wave angle, degs
Y-axis is Rel. Vert. Velo.
Total motions at point number 1
Graph number 4

x	y
.000	.13
15.000	.14
30.000	.17
45.000	.20
60.000	.33
75.000	.24
90.000	.17
105.000	.69
120.000	.78
135.000	.58
150.000	.51
165.000	.48
180.000	.48

Graph number 5

x	y
.000	.09
15.000	.10
30.000	.12
45.000	.17
60.000	.29
75.000	.23
90.000	.16
105.000	.73
120.000	.78
135.000	.59
150.000	.52
165.000	.50
180.000	.50

Graph number 6

x	y