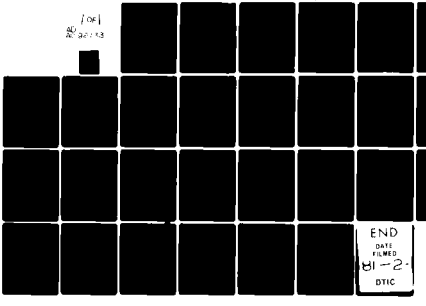
AD-A092 133 DAVID W TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CE--ETC F/G 9/2
DOCUMENTATION FOR AN IMPROVED VERSION OF HULIMP, A SHIP HULL IM--ETC(U)
OCT 80 S C FISHER

UNCLASSIFIED DTNSRDC/SPD-0820-03 NL



DAVID W. TAYLOR NAVAL SHIP
RESEARCH AND DEVELOPMENT CENTER

Bethesda, Maryland 20084

(9) Final rept.,

(6)

DOCUMENTATION FOR AN IMPROVED VERSION OF HULIMP, A SHIP HULL IMPROVEMENT COMPUTER PROGRAM BASED ON THE BABA THEORY

BY

(10)
STEVEN C. FISHER

(16) F43732

(17) SF43421001

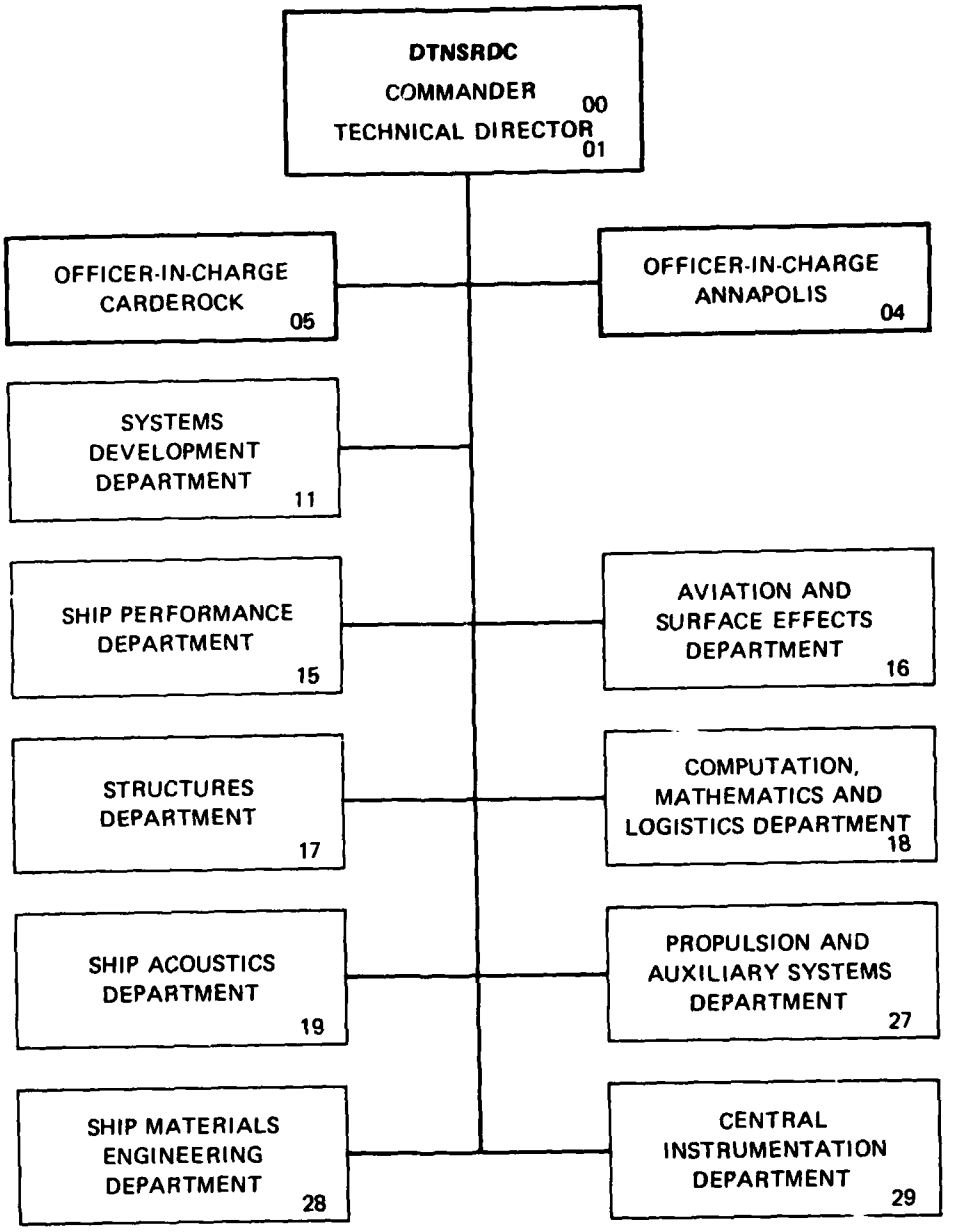
SHIP PERFORMANCE DEPARTMENT REPORT

(12) 44

(11) OCTOBER 1980

(14) DTNSRDC/SPD-0820-03

MAJOR DTNSRDC ORGANIZATIONAL COMPONENTS



UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER DTNSRDC/SPD-0820-03	2. GOVT ACCESSION NO. AD-A092 133	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) DOCUMENTATION FOR AN IMPROVED VERSION OF HULIMP, A SHIP HULL IMPROVEMENT COMPUTER PROGRAM BASED ON THE BABA THEORY		5. TYPE OF REPORT & PERIOD COVERED FINAL 6. PERFORMING ORG. REPORT NUMBER DTNSRDC/SPD-0820-03
7. AUTHOR(s) STEVEN C. FISHER		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS DAVID W TAYLOR NAVAL SHIP R&D CENTER SHIP PERFORMANCE DEPARTMENT BETHESDA, MD. 20084		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS P.E. 62543N SF Subprogram No. 43-421-001 Work Unit 1-1500-104-32
11. CONTROLLING OFFICE NAME AND ADDRESS NAVAL MATERIAL COMMAND (NAVMAT) Code 08D17 Washington, D. C. 20360		12. REPORT DATE OCTOBER 1980 13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

THIN SHIP
LONGITUDINAL WAVECUTS

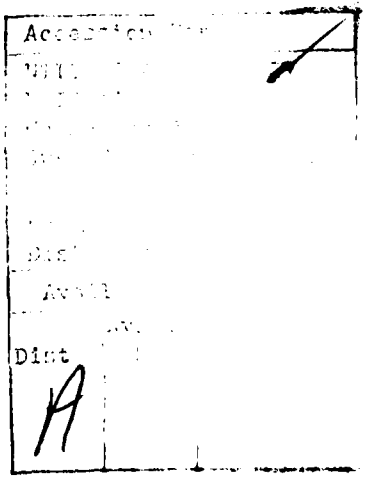
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The revision to an existing computer program which implements wave pattern analysis to improve a ship hull form is described. The revision allows predictions of the change in wave resistance due to adding a given ship to a basic hull form. The instructions on program usage are included.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-LF-014-6601

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

TABLE OF CONTENTS



LIST OF FIGURES

LIST OF TABLES

NOMENCLATURE

SYMBOL	CC SYMBOL	DESCRIPTION
C_n		Sine series coefficients for defining the thin ship
C_W	CW	Wave resistance coefficient of the model without the thin ship Cw = Rw/($\frac{1}{2}\rho L^2V^2$)
C_{WW}	CWW	Wave resistance coefficient of the model with the thin ship Cww = Rww/($\frac{1}{2}\rho L^2V^2$)
f(x)		Spline equations defining the non optimum thin ship
L		Model length, m
R_W		Wave resistance of model without the thin ship
R_{WW}		Wave resistance of model with the thin ship
S		Wetted surface, m^2
V		Model speed, m/s
x		Distance along centerline nondimensionalized by length (positive aft)
X	X	Distance from waveprobe to F.P., in meters
X_e	XE	Endpoint of thin ship (nondimesionalized by L)
X_s	XS	Starting point of thin ship (nondimensionalized by L)
Y	Y	Distance from model centerline to waveprobe along Y axis, in meters.
ρ		Water density
$\eta(x)$		Thin ship beam at x.

ENGLISH/SI EQUIVALENTS

1 degree (angle)	= 0.01745 rad (radians)
1 foot	= 0.3048 m (meters)
1 foot per second	= 0.3048 m/sec (meters per second)
1 inch	= 25.40 mm (millimeters)
1 knot	= 0.5144 m/s (meters per second)
1 lb (force)	= 4.448 N (Newtons)
1 lb (force) - inch	= 0.1130 N·m (Newton-meter)
1 long ton (2240)	= 1.016 metric tons, or 1016 kilograms
1 horsepower	= 0.746 kW (kilowatts)

ABSTRACT

The revision to an existing computer program which implements wave pattern analysis to improve a ship hull form is described. The revision allows predictions of the change in wave resistance due to adding a given thin ship to a basic hull form. The instructions on program usage are included.

ADMINISTRATIVE INFORMATION

This Project was authorized and funded by the Naval Material Command (NAVMAT) Ship Performance and Hydromechanics Program under Program Element 62543N, Subproject Number 43-421-001, Work Unit Number 1500-104-32.

INTRODUCTION

In 1974 Baba[1] proposed a method for applying wave pattern analysis to the improvement of ship hull forms. His procedure determines a thin ship which, when added to a given basic hull form, would reduce the wave making resistance. The wave pattern data would be obtained from longitudinal wavecut experiments.

This method was used in an early version of the HULIMP computer program. However, the cosine series representation of the thin ship used in the original method did not satisfy the prescribed boundary conditions. HULIMP was later modified[2] using a sine series representation of the thin ship to satisfy the boundary conditions.

These early versions of HULIMP would find the optimum thin ship that would reduce the wave resistance of a given ship at a given speed and thin ship volume. These programs could not calculate the effects on wave resistance due to adding an arbitrarily shaped thin ship to an existing ship. This omission seriously limited their usefulness as a design tool.

---

[1]References are listed on page 5 .

Because the shape of the optimum thin ship changes with speed, the optimum thin ship found at one speed would have to be treated as an arbitrary thin ship at another speed. This means that an analysis of the effects upon wave resistance due to a given thin ship could not be made through a range of speeds. Further, the effects due to design compromises to the optimum thin ship cannot be investigated. This new version of HULIMP has the ability to find the optimum thin ship for reducing wave resistance and to determine the effects on wave resistance due to adding an arbitrary (non-optimum) shaped thin ship.

Below are additional program documentation covering only the changes to HULIMP. The unchanged subroutines are documented in Amato et al.[2] Instructions on program usage and a sample output with an arbitrary thin ship are included.

ARBITRARY THIN SHIP

The equation of a given thin ship is represented in the program by

$$\eta(x) = L \sum_{n=1}^{N} C_n \sin n\pi\left(\frac{x-X_s}{X_e-X_s}\right)$$

where $\eta(x)$ is the half beam of the thin ship, N the total number of terms in the series, and X_s and X_e the forward and aft limits of the thin ship. The values of C_n are derived either from the optimization of the thin ship, or from a Fourier sine series analysis of the splines fitted to the half beam offsets of the thin ship.

When the sine series is fit to a specific thin ship, the equation defining the values of C_n is:

$$C_n = \frac{2}{(X_e-X_s)} \sum_{i=1}^{I-1} \int_{x_i}^{x_{i+1}} f_i(x) \sin n\pi\left(\frac{x-X_s}{X_e-X_s}\right) dx \quad ,$$

where I is the number of spline segments, x_i is the longitudinal position of the thin ship offset, and $f_i(x)$ is the cubic spline segment between x_i and x_{i+1}. These values of C_n are directly substituted into the wave resistance equations, replacing the values of C_n that correspond to the optimum thin ship.

OPTIMUM THIN SHIP

The program remains essentially unchanged for the calculation of the optimum thin ship as described by Amato et al.[2]

NUMERICAL CONSIDERATIONS

For the analysis with the optimum thin ship, an appropriate number of terms is equal to $20 * (X_e - X_s)/L$. The exact number will depend upon the relative magnitude of the last few terms in the sine series. Excessively large numbers of terms may not give better results; it may return values of thin ship half-beams in the order of 10000 km.

For the analysis with a given (non-optimum) thin ship, up to 30 terms can be used. The relative fit of the sine series to the input values are printed out. Up to 39 offsets may be input. Even though the cubic splines are used for calculating the sine series coefficients, there should be fewer terms in the sine series than offsets because the accuracy of the coefficients will be affected by the number of offsets used. The end constraints require that the thin ship must have zero beam at each end.

OVERVIEW OF THE DIGITAL PROGRAM

Program HULIMP is a FORTRAN language digital computer program which implements Baba's method of ship hull form improvement. Although intended to be machine independent, HULIMP has been executed only on the Control Data Corporation (CDC) 6000 Series computer installations at DTNSRDC.

A detailed description of the card input data is given in Table 1, and a detailed description of the output is given in Table 2. The input data consists of a three card input to subroutine READ1, a three card input to subroutine SUHULL, and available length wave profile input to subroutine SUHULL from a card input stream or optional magnetic tape or disk binary file. If the non-optimum thin ship analysis is performed, the wave profile data are followed by a variable length thin ship beam offset input from cards. The last thin ship offset card is followed by a card with 99999. starting in column 1. An example input is given in Table 3 and the corresponding output in Table 4.

Run sets can be stacked so that more than one analysis can be performed in one job (see MORE, Table 1, card 1) with the option of reading a new wave profile or retaining the profile from the previous analysis (see REDSUB, Table 1, card 2).

The wavemaking resistance coefficients presented in the output, Cw and Cww, are nondimensionalized using L^2 instead of using the wetted surface, S. These values must be multiplied by L^2/S to convert them to the standard wavemaking resistance coefficient form. The beam and draft constraints have been nondimensionalized by L and L^2 * draft, respectively.

The job cards required to run the program on the CDC 6000 series computer are shown in Table 5. The core requirement for loading and running the program is 120,000 octal words. The core requirement can be reduced to 57,700 octal words by using segmentation. The reduction in the required core size by segmentation significantly increases the execution priority of the job. Execution times normally do not exceed 30 seconds.

Included in the 19 subprograms are 18 operational subroutines and one BLOCK DATA subprogram which initializes certain data in particular common blocks. The initialization takes place before program execution.

A block diagram for the digital program is illustrated in Figure 1. As indicated, the main program, HULIMP, serves as a driver for the entire system. In addition to the brief functional description of each subroutine given in Table 6, a more detailed description of the new subroutines and common blocks is provided in Appendix A.

Standardized communication is used among various subroutines wherever possible. FORTRAN symbols used in communicating between routines are defined in a global sense, i.e., the FORTRAN symbol, DRAFT, is the nondimensional draft of the thin ship in all subroutines.

CDC job control statements, segmentation information, sample input data, and corresponding printer output complete the program description.

REFERENCES

1. Baba, E., "Ship Form Improvement by Use of Wave Pattern Analysis," Japan Shipbuilding and Marine Engineering, Vol. 8, No. 1, pp 35-43 (1974).

2. Reed, A.M., and Amato, A.J., "A Ship Hull Form Improvement Technique Based on the Baba Theory", DTNSRDC/SPD-0820-02, June 1980.

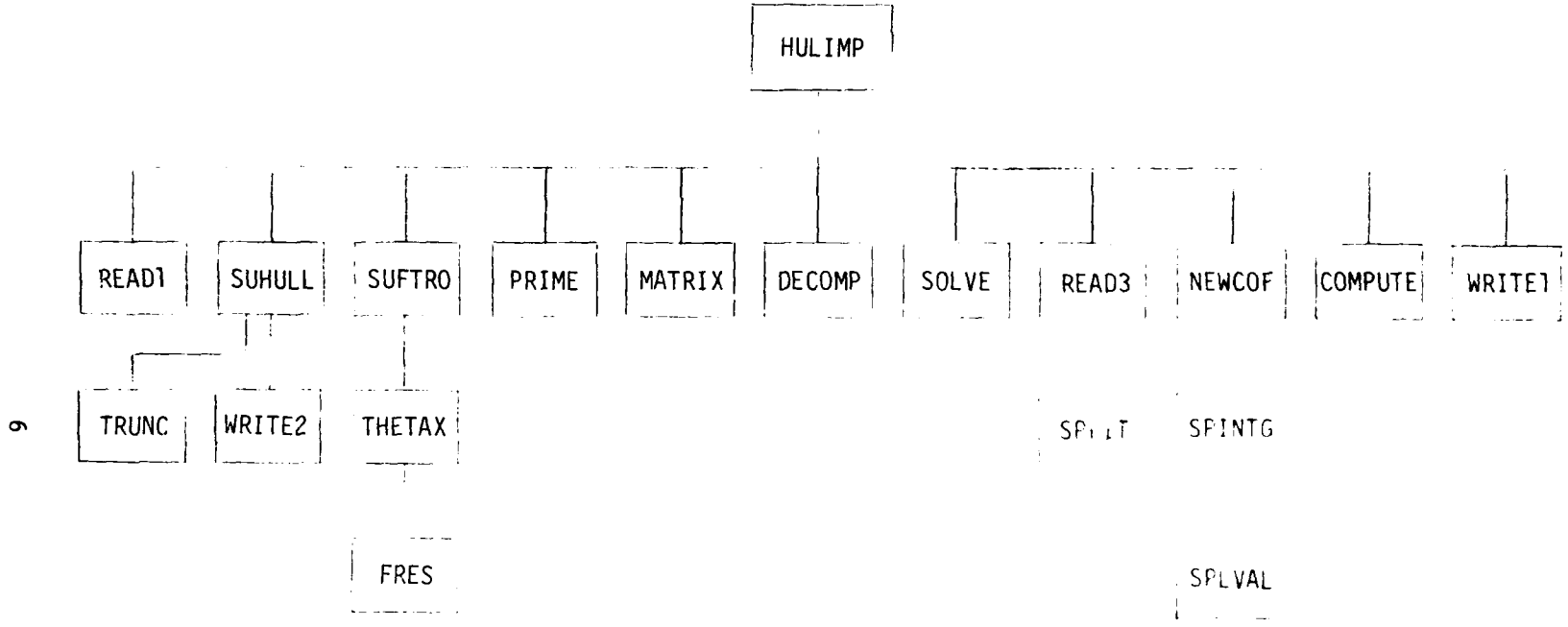


FIGURE 1

BLOCK DIAGRAM OF HULIMP

TABLE 1

CARD INPUT DATA DESCRIPTION

Rec.	Format	Col.	Name	Description
1	I4	1-4	NG	Number of longitudinal intervals along hull of existing ship
	I4	5-8	NK	Number of coefficients in truncated sine series
	I4	9-12	MORE	Control variable for processing more data: 0 = No more data to be read 1 = New set of data to be read
	I4	13-16	NP1	Control variable for printing (if NP1=1) free-wave spectra
	I4	17-20	NP2	Control variable for printing (if NP2=1) free-wave amplitude
2	F8.5	1-8	XS	Nondimensional x-coordinate of thin ship F.P.
	F8.5	9-16	XE	Nondimensional x-coordinate of thin ship A.P.
	F8.5	17-24	DRAFT	Draft of thin ship, nondimensionalized by model length
	F8.5	25-32	REDSUB	Control variable to read (if REDSUB=0.0) new wave cut
	F8.5	33-40	CS1	$(2/L)\eta(L/2)$, nondimensional beam constraint amidships of the thin ship
	F8.5	41-48	CS2	$(2/L^2)\int_{x_s}^{x_e}\eta(x)dx$, nondimensional volume constraint for thin ship
3	I4	1-4	NSC	Number of constraints on thin ship If NSC=3, then the non-optimum thin ship case will be analyzed, and CS1,CS2, NS1, and NS2 are ignored.

Table 1 - Card Input Data Description (Cont)

	I4	5-8	NS1	Priority of beam constraint
	I4	9-12	NS2	Priority of volume constraint
4	12A6	1-72	TIT	Alphanumeric title card variable
5	F8.4	1-8	FN	Froude number
	F8.4	9-16	SLWL	Length of model, in meters
	F8.4	17-24	Y	Transverse location of wave cut, in meters
	F8.4	25-32	X	Location of first point in wave cut relative to origin, in meters
	F8.4	33-40	SAMPT	Time interval between data points, in seconds
	F8.4	41-48	SCL	Factor to convert wave input to meters
6	I5	1-5	NDATA	Number of data points in wave profile
	I5	6-10	MTR	Final truncation point for the longitudinal wave cut data
	I5	11-15	IOUT	Control variable for input of wave profile as follows: 0 = Read from magnetic tape binary file 1 = Read formatted data from card stream
	I5	16-20	MEAN	Number of points used to compute mean wave height
	I5	21-25	MTRUNC	First truncation point for the longitudinal wave cut data

Table 1 - Card Input Data Description (Cont)

7*	8F10.0	1-80	WAVE(N) N=1,.. NDATA	Wave height at corresponding x-y coordinates of longitudinal wave cut - (NDATA/8) of these records are read (a maximum of 250 records)
8**	F10.5	1-10	XVAL	Nondimensional (x/L) distance of offset value from the bow.
	F10.5	11-20	YVAL	Half beam of the thin ship (in meters). The thin ship is assumed to be wall sided. A maximum of 39 offsets (using 39 cards) is allowed.
9**	F10.5	1-10		99999. In columns 1-10 will indicate the end of beam offset information.

* Note: An option exists (see IOUT, record 6) to read wave profile data via magnetic tape binary file (tape unit 1).

** Omitted if the optimized thin ship is desired.

TABLE 2

OUTPUT INFORMATION

The line printer output includes:

- o Echo of the first six input records
- o Processed wave cut data (translated vertically to zero mean and converted to meters)
- o Necessary information associated with Newman-Sharma method, including truncation correction parameters
- o Free-wave spectra and wave-making resistance of the existing ship with and without truncation correction, and the influence function of the existing ship
- * o Thin ship half beam offsets echo
- * o Coefficients of the sine series representation of the input beam values.
- * o Comparison of input half beam values to values calculated from the sine series
- o Coefficients of the sine series (solution vector for the linear system)
- o Non-dimensional beam and volume constraints (Nondimensionalized by L and L^2 * draft, respectively)
- ** o Determinant of the matrix and residuals for the approximate solution vector, along with relative and absolute error
- o Wave resistance of the existing ship and modified ship (Nondimensionalized using L^2, not wetted surface)
- o Influence function for the thin ship and modified ship
- o Thin ship element station areas and offsets
- o Free wave amplitude before and after modification

An example of the line printer output is provided in Table 4.

* Printed only for the non-optimum thin ship case (NSC = 3)
** Printed only for the optimum thin ship case (NSC = 3)

TABLE 3

EXAMPLE CASE INPUT

CARD No.	VARIABLE	VALUE
1	NG	40
	NK	10
	MORE	0
	NP1	1
	NP2	1
2	XS	-.025
	XE	0.5
	DRAFT	0.0474
	REDSUB	0
	CS1	0
	CS2	0
3	NSC	3
	NS1	2
	NS2	1
4	TIT	Model 5079 FN=0.28 = 6.521 FPS RUN 15
5	FN	0.2793
	SLWL	5.158
	Y	1.364
	X	1.075
	SAMPT	0.01
	SCL	-.07282
6	NDATA	1700
	MTR	1679
	IOUT	0
	MEAN	25
	MTRUNC	1552
8	Thin ship offsets	
9		99999.

NOTE: Card 7 has been omitted since the wavecut data is stored on the disk (IOUT=0).

```
  40  10   0   1   1
-.025   .5       .0474
   3   2   1
MODEL 5079 FN = 0.28  C VM = 6.521 FPS  RUN 15
.2793   5.158   1.364   1.075   .01      -.07282
 1700 1679    0   25 1552
-.025      0.0
0.0        0.0117
.025       .0124
.050       0.0124
.075       0.0109
.100       .0077
.125       .0040
.150       -.0018
.175       -.0077
.200       -.0131
.225       -.0157
.250       -.0161
.275       -.0106
.300       -.0051
.325       -.0004
.350       .0011
.375       .0018
.400       .0015
.425       .0007
.450       .0007
.475       .0
.500       .0
99999.
```

Table 3 - Example Case Input (Cont)

```
   ECHO INPUT TO SUBROUTINE READ1

 NG   NK MORE NP1 NP2
 40   10    0   1   1

 X-FWD    X-AFT    DRAFT    REDSUB      CS1       CS2
-.02500   .50000   .04740 0.00000 0.00000 0.00000

 NSC NS1 NS2
  3   2   1
```


TABLE 4

EXAMPLE CASE OUTPUT

ECHO INPUT TO SUBROUTINE WRITE2
MODEL 5079 FN = 0.28 C VM = 6.521 FPS RUN 15

FN	LMODEL-M	Y-DIST	X-DIST	DELTA-T	SCALE
.2793	5.1580	1.3640	1.0750	.0100	-.0728

NDATA	MTR	IOUT	MEAN	MTRUNC
1700	1679	0	25	1552

WAVE HEIGHT MEASUREMENTS CONVERTED INTO METERS

-.87825E-03	.94403E-03	-.47824E-03	.41068E-03	.27734E-03	-.74491E-03	.98847E-03	-.56713E-03	.41068E-03	.23290E-03
-.65602E-03	.94403E-03	-.56713E-03	.36623E-03	.14400E-03	-.74491E-03	.81069E-03	-.56713E-03	.27734E-03	.99559E-04
-.87825E-03	.72180E-03	-.65602E-03	.23290E-03	-.12267E-03	-.92269E-03	.58846E-03	-.83380E-03	.55113E-04	-.34490E-03
-.11449E-02	.45513E-03	-.11449E-02	-.12267E-03	-.43379E-03	-.12783E-02	.18845E-03	-.13227E-02	-.34490E-03	-.61157E-03
-.15894E-02	.10667E-04	-.15005E-02	-.56713E-03	-.92269E-03	-.17672E-02	-.21156E-03	-.17672E-02	-.74491E-03	-.12338E-02
-.19449E-02	-.43379E-03	-.19894E-02	-.96714E-03	-.14560E-02	-.21672E-02	-.61157E-03	-.23005E-02	-.12338E-02	-.16338E-02
-.24339E-02	-.92269E-03	-.25672E-02	-.14116E-02	-.19449E-02	-.27005E-02	-.12338E-02	-.27005E-02	-.16338E-02	-.23005E-02
-.29672E-02	-.14116E-02	-.30561E-02	-.18561E-02	-.25227E-02	-.31005E-02	-.15894E-02	-.33226E-02	-.21672E-02	-.27894E-02
-.33228E-02	-.18116E-02	-.35450E-02	-.23894E-02	-.30561E-02	-.34561E-02	-.20338E-02	-.38117E-02	-.25672E-02	-.31894E-02
-.36783E-02	-.23005E-02	-.39450E-02	-.26561E-02	-.32339E-02	-.37228E-02	-.23450E-02	-.40339E-02	-.26561E-02	-.33672E-02
-.37672E-02	-.23450E-02	-.39006E-02	-.25227E-02	-.32339E-02	-.35450E-02	-.21227E-02	-.37228E-02	-.22561E-02	-.30116E-02
-.33228E-02	-.17227E-02	-.33672E-02	-.18561E-02	-.25672E-02	-.27005E-02	-.11005E-02	-.27005E-02	-.11449E-02	-.18561E-02
-.18561E-02	-.38935E-03	-.19005E-02	-.21156E-03	-.78936E-03	-.74491E-03	.63291E-03	-.74491E-03	.10329E-02	.41068E-03
.45513E-03	.20107E-02	.63291E-03	.24996E-02	.18329E-02	.20552E-02	.36108E-02	.22330E-02	.40552E-02	.36552E-02
.39219E-02	.54775E-02	.41441E-02	.60997E-02	.55864E-02	.59220E-02	.75665E-02	.63220E-02	.80998E-02	.76998E-02
.81442E-02	.96554E-02	.84109E-02	.10367E-01	.98332E-02	.10278E-01	.11878E-01	.10544E-01	.12455E-01	.11967E-01
.12411E-01	.13878E-01	.12633E-01	.14411E-01	.13967E-01	.14411E-01	.15744E-01	.14367E-01	.16144E-01	.15433E-01
.15878E-01	.17167E-01	.15611E-01	.17300E-01	.16500E-01	.16811E-01	.17922E-01	.16233E-01	.17878E-01	.16900E-01
.16089E-01	.17922E-01	.16189E-01	.17522E-01	.16456E-01	.16367E-01	.17078E-01	.15167E-01	.16322E-01	.14944E-01
.14856E-01	.15300E-01	.13211E-01	.14189E-01	.12589E-01	.12278E-01	.12589E-01	.10144E-01	.11033E-01	.93443E-02
.88109E-02	.87665E-02	.64553E-02	.70775E-02	.51664E-02	.45886E-02	.45441E-02	.20107E-02	.24996E-02	.54402E-03
-.78225E-04	-.25601E-03	-.28339E-02	-.23005E-02	-.43006E-02	-.48784E-02	-.51006E-02	-.76340E-02	-.69673E-02	-.90563E-02
-.92341E-02	-.92785E-02	-.11590E-01	-.10790E-01	-.12567E-01	-.12656E-01	-.12345E-01	-.14345E-01	-.13190E-01	-.14701E-01
-.14301E-01	-.13723E-01	-.15101E-01	-.13368E-01	-.14345E-01	-.13364E-01	-.12434E-01	-.13323E-01	-.11012E-01	-.11323E-01
-.98119E-02	-.83007E-02	-.86119E-02	-.57673E-02	-.56339E-02	-.37225E-02	-.17672E-02	-.18116E-02	.12996E-02	.15663E-02
.36108E-02	.56997E-02	.56997E-02	.87220E-02	.89443E-02	.11078E-01	.12767E-01	.12633E-01	.15522E-01	.15344E-01
.17122E-01	.18500E-01	.17967E-01	.20456E-01	.19745E-01	.21167E-01	.22056E-01	.21034E-01	.23122E-01	.21789E-01
.22722E-01	.23034E-01	.21656E-01	.22000E-01	.21122E-01	.21384E-01	.21122E-01	.19167E-01	.19967E-01	.17522E-01
.17389E-01	.16456E-01	.13833E-01	.14278E-01	.11255E-01	.10544E-01	.92554E-02	.61442E-02	.60109E-02	.28108E-02
.20107E-02	.45513E-03	-.26561E-02	-.26561E-02	-.58117E-02	-.64340E-02	-.76785E-02	-.10123E-01	-.94118E-02	-.11679E-01
-.11190E-01	-.11056E-01	-.11945E-01	-.97230E-02	-.10390E-01	-.84785E-02	-.69673E-02	-.68784E-02	-.37228E-02	-.41228E-02
-.21227E-02	-.87825E-03	-.12338E-02	-.11663E-02	.27734E-03	.17885E-02	.22330E-02	.12551E-02	.30330E-02	.16990E-02
.24107E-02	.20990E-02	.58840E-03	.17885E-02	-.38935E-03	-.34490E-03	-.12339E-02	-.34117E-02	-.29228E-02	-.57673E-02
-.63006E-02	-.78562E-02	-.10523E-01	-.10567E-01	-.13901E-01	-.14612E-01	-.16212E-01	-.19012E-01	-.18657E-01	-.21723E-01
-.22257E-01	-.23768E-01	-.25990E-01	-.25412E-01	-.27768E-01	-.27368E-01	-.27857E-01	-.28924E-01	-.27057E-01	-.27990E-01
-.26301E-01	-.25590E-01	-.25323E-01	-.22301E-01	-.22346E-01	-.19768E-01	-.18345E-01	-.17634E-01	-.14168E-01	-.14079E-01
-.11501E-01	-.10212E-01	-.96341E-02	-.65673E-02	-.67451E-02	-.45229E-02	-.36783E-02	-.34117E-02	-.70047E-03	-.12784E-02
.72180E-03	.12551E-02	.13440E-02	.37441E-02	.29885E-02	.47664E-02	.50775E-02	.48997E-02	.72553E-02	.63664E-02
.80999E-02	.84998E-02	.84998E-02	.10944E-01	.10322E-01	.12411E-01	.13122E-01	.13433E-01	.16144E-01	.15789E-01
.18189E-01	.18945E-01	.19433E-01	.22189E-01	.21789E-01	.24100E-01	.24678E-01	.24989E-01	.27300E-01	.26534E-01
.28456E-01	.28500E-01	.28278E-01	.30189E-01	.28900E-01	.30145E-01	.29567E-01	.28678E-01	.29957E-01	.27834E-01
.28545E-01	.27167E-01	.25745E-01	.26234E-01	.23434E-01	.23345E-01	.21345E-01	.19300E-01	.19033E-01	.15433E-01
.14811E-01	.12189E-01	.92998E-02	.84998E-02	.45441E-02	.34774E-02	.32179E-03	-.24339E-02	-.32783E-02	-.71451E-02
-.80340E-02	-.10879E-01	-.13523E-01	-.13812E-01	-.17190E-01	-.17412E-01	-.19590E-01	-.21234E-01	-.21012E-01	-.23857E-01
-.23590E-01	-.25190E-01	-.26340E-01	-.25812E-01	-.28035E-01	-.27190E-01	-.28435E-01	-.29101E-01	-.28079E-01	-.30124E-01
-.29012E-01	-.30079E-01	-.30435E-01	-.29235E-01	-.31013E-01	-.29412E-01	-.30168E-01	-.30124E-01	-.28346E-01	-.29457E-01
-.27146E-01	-.26968E-01	-.25990E-01	-.23323E-01	-.23546E-01	-.20301E-01	-.19412E-01	-.17679E-01	-.14390E-01	-.14079E-01
-.10434E-01	-.94563E-02	-.75890E-02	-.42561E-02	-.41228E-02	-.74491E-03	.14400E-03	.19218E-02	.48553E-02	.48108E-02
.79220E-02	.84554E-02	.97443E-02	.12189E-01	.11700E-01	.14144E-01	.14500E-01	.15033E-01	.16945E-01	.16011E-01
.17967E-01	.17522E-01	.17878E-01	.19300E-01	.17833E-01	.19300E-01	.18411E-01	.18411E-01	.19300E-01	.17389E-01

Table 4 - Example Case Output (Cont)

.18589E-01	.17433E-01	.16989E-01	.17789E-01	.15656E-01	.16674E-01	.15211E-01	.14944E-01	.15389E-01	.13256E-01
.14322E-01	.12900E-01	.12589E-01	.13256E-01	.11167E-01	.12367E-01	.11211E-01	.11122E-01	.11033E-01	.10011E-01
.11389E-01	.10189E-01	.10367E-01	.11255E-01	.94776E-02	.10900E-01	.98332E-02	.10011E-01	.10811E-01	.90776E-02
.10455E-01	.92554E-02	.94332E-02	.10011E-01	.80554E-02	.93443E-02	.79220E-02	.77442E-02	.81442E-02	.60109E-02
.68553E-02	.51219E-02	.48997E-02	.49442E-02	.24552E-02	.31219E-02	.11663E-02	.54402E-03	.14400E-03	-.23450E-02
-.19449E-02	-.41228E-02	-.49673E-02	-.55451E-02	-.85229E-02	-.83007E-02	-.10656E-01	-.11767E-01	-.12331E-01	-.15323E-01
-.15101E-01	-.17545E-01	-.18301E-01	-.18701E-01	-.21279E-01	-.20657E-01	-.22568E-01	-.22746E-01	-.22568E-01	-.24346E-01
-.22790E-01	-.23901E-01	-.22968E-01	-.21768E-01	-.22568E-01	-.20168E-01	-.20479E-01	-.19012E-01	-.17412E-01	-.17723E-01
-.14968E-01	-.15101E-01	-.13412E-01	-.11901E-01	-.12345E-01	-.96785E-02	-.99452E-02	-.83896E-02	-.70118E-02	-.77673E-02
-.52784E-02	-.57228E-02	-.42561E-02	-.32339E-02	-.39895E-02	-.16783E-02	-.23450E-02	-.11449E-02	-.78225E-04	-.78936E-03
.13885E-02	.63291E-03	.19663E-02	.30330E-02	.22330E-02	.44552E-02	.38330E-02	.52108E-02	.61886E-02	.54331E-02
.76998E-02	.67664E-02	.81442E-02	.90332E-02	.80998E-02	.10322E-01	.93443E-02	.10589E-01	.11300E-01	.10367E-01
.12367E-01	.11344E-01	.12544E-01	.13167E-01	.12144E-01	.14233E-01	.12944E-01	.14144E-01	.14722E-01	.13611E-01
.15567E-01	.14233E-01	.15211E-01	.15522E-01	.14367E-01	.15967E-01	.14367E-01	.15167E-01	.15167E-01	.13700E-01
.15033E-01	.13211E-01	.13833E-01	.13478E-01	.11744E-01	.12900E-01	.10855E-01	.11211E-01	.10767E-01	.89443E-02
.99221E-02	.79220E-02	.81887E-02	.75220E-02	.55219E-02	.65442E-02	.43664E-02	.44552E-02	.37441E-02	.19218E-02
.27663E-02	.45513E-03	.63291E-03	-.21156E-03	-.19894E-02	-.12338E-02	-.34561E-02	-.33228E-02	-.40339E-02	-.58117E-02
-.47895E-02	-.68340E-02	-.63006E-02	-.68340E-02	-.83007E-02	-.68784E-02	-.86563E-02	-.79007E-02	-.82118E-02	-.94118E-02
-.79007E-02	-.95452E-02	-.87452E-02	-.90118E-02	-.10345E-01	-.87007E-02	-.10345E-01	-.96341E-02	-.99007E-02	-.11145E-01
-.96341E-02	-.11456E-01	-.10745E-01	-.11234E-01	-.12345E-01	-.10967E-01	-.12656E-01	-.11945E-01	-.12390E-01	-.13323E-01
-.11723E-01	-.13145E-01	-.12079E-01	-.12212E-01	-.12834E-01	-.10790E-01	-.11812E-01	-.10301E-01	-.10034E-01	-.10345E-01
-.79896E-02	-.87896E-02	-.69673E-02	-.67451E-02	-.68340E-02	-.43895E-02	-.51895E-02	-.34117E-02	-.31894E-02	-.33228E-02
-.10116E-02	-.19449E-02	-.43379E-03	-.30045E-03	-.38935E-03	.16552E-02	.49357E-03	.20552E-02	.21441E-02	.17885E-02
.36552E-02	.26774E-02	.42330E-02	.40552E-02	.38330E-02	.58775E-02	.48108E-02	.64109E-02	.64553E-02	.63664E-02
.83665E-02	.73887E-02	.91221E-02	.90776E-02	.88998E-02	.11033E-01	.98775E-02	.11389E-01	.11389E-01	.11033E-01
.12856E-01	.11567E-01	.13033E-01	.12544E-01	.12055E-01	.13611E-01	.11922E-01	.13033E-01	.12278E-01	.11655E-01
.12900E-01	.10999E-01	.12055E-01	.11122E-01	.10233E-01	.11389E-01	.94776E-02	.10411E-01	.95665E-02	.85887E-02
.96999E-02	.76998E-02	.87220E-02	.77442E-02	.68553E-02	.79220E-02	.60109E-02	.68998E-02	.57886E-02	.50775E-02
.60109E-02	.38330E-02	.47219E-02	.34330E-02	.25885E-02	.32997E-02	.10774E-02	.18774E-02	.54402E-03	-.43379E-03
.32179E-03	-.18116E-02	-.96714E-03	-.23894E-02	-.33228E-02	-.23894E-02	-.46117E-02	-.35894E-02	-.50562E-02	-.57228E-02
-.47895E-02	-.68340E-02	-.57228E-02	-.70118E-02	-.75896E-02	-.66118E-02	-.85229E-02	-.71896E-02	-.85229E-02	-.89229E-02
-.78118E-02	-.97230E-02	-.83896E-02	-.95896E-02	-.98563E-02	-.88340E-02	-.10612E-01	-.91896E-02	-.10167E-01	-.10390E-01
-.93230E-02	-.10923E-01	-.93674E-02	-.10167E-01	-.10167E-01	-.88785E-02	-.10345E-01	-.86118E-02	-.91896E-02	-.91007E-02
-.76785E-02	-.90118E-02	-.71007E-02	-.77673E-02	-.73673E-02	-.58562E-02	-.71896E-02	-.52339E-02	-.57228E-02	-.53228E-02
-.38117E-02	-.50117E-02	-.31450E-02	-.36783E-02	-.31450E-02	-.16334E-02	-.28783E-02	-.92269E-03	-.14560E-02	-.92269E-03
.54402E-03	-.70047E-03	.11218E-02	.72180E-03	.12551E-02	.26330E-02	.13885E-02	.34330E-02	.29441E-02	.33441E-02
.48997E-02	.37441E-02	.56553E-02	.50775E-02	.57442E-02	.71220E-02	.57886E-02	.76998E-02	.71220E-02	.76553E-02
.88554E-02	.75665E-02	.92109E-02	.84554E-02	.89887E-02	.10011E-01	.84554E-02	.10055E-01	.92109E-02	.94332E-02
.10411E-01	.88109E-02	.10233E-01	.92554E-02	.96110E-02	.10367E-01	.86332E-02	.10189E-01	.90332E-02	.93443E-02
.93221E-02	.81442E-02	.95665E-02	.82331E-02	.84554E-02	.89443E-02	.70775E-02	.83220E-02	.68553E-02	.68998E-02
.72553E-02	.52997E-02	.63220E-02	.48997E-02	.49442E-02	.49442E-02	.32552E-02	.44108E-02	.28552E-02	.28552E-02
.30774E-02	.11218E-02	.22773E-02	.63291E-03	.72180E-03	.10329E-02	-.87825E-03	.14400E-03	-.14560E-02	-.12338E-02
-.11005E-02	-.31005E-02	-.19449E-02	-.36339E-02	-.34117E-02	-.33228E-02	-.53673E-02	-.42117E-02	-.57673E-02	-.55895E-02
-.54117E-02	-.73229E-02	-.60784E-02	-.75007E-02	-.70562E-02	-.67006E-02	-.83896E-02	-.67895E-02	-.81674E-02	-.75451E-02
-.72340E-02	-.86563E-02	-.71007E-02	-.83896E-02	-.77673E-02	-.73229E-02	-.88785E-02	-.72784E-02	-.86118E-02	-.79451E-02
-.75896E-02	-.90563E-02	-.74118E-02	-.87452E-02	-.78562E-02	-.74118E-02	-.87452E-02	-.68340E-02	-.79451E-02	-.69229E-02
-.62562E-02	-.74118E-02	-.53673E-02	-.63006E-02	-.51450E-02	-.43895E-02	-.53229E-02	-.32339E-02	-.41229E-02	-.28783E-02
-.21672E-02	-.31894E-02	-.96714E-03	-.20338E-02	-.78936E-03	-.21156E-03	-.10560E-02	.10774E-02	-.16712E-03	.11218E-02
.17441E-02	.94403E-03	.28995E-02	.18329E-02	.31219E-02	.36552E-02	.28552E-02	.49886E-02	.37886E-02	.50775E-02
.55664E-02	.47664E-02	.67664E-02	.56108E-02	.68553E-02	.71661E-02	.62331E-02	.82776E-02	.69887E-02	.80109E-02
.82776E-02	.73887E-02	.91221E-02	.79220E-02	.88554E-02	.89887E-02	.79220E-02	.96999E-02	.82331E-02	.90332E-02
.90332E-02	.79220E-02	.95221E-02	.79220E-02	.88109E-02	.85887E-02	.73442E-02	.88554E-02	.72109E-02	.78776E-02
.76998E-02	.63220E-02	.76998E-02	.59220E-02	.66331E-02	.62775E-02	.48553E-02	.63220E-02	.45441E-02	.50775E-02
.47219E-02	.33441E-02	.47219E-02	.28108E-02	.35219E-02	.30330E-02	.16107E-02	.28996E-02	.11663E-02	.17441E-02
-.10329E-02	-.38935E-03	.94403E-03	-.92269E-03	-.43379E-03	-.11449E-02	-.25227E-02	-.11894E-02	-.31005E-02	-.25227E-02
-.31894E-02	-.43450E-02	-.30561E-02	-.48339E-02	-.41228E-02	-.47006E-02	-.57228E-02	-.43895E-02	-.61229E-02	-.51895E-02
-.57673E-02	-.67895E-02	-.52784E-02	-.71007E-02	-.62117E-02	-.67006E-02	-.76340E-02	-.60784E-02	-.78118E-02	-.69229E-02
-.73673E-02	-.82118E-02	-.66118E-02	-.83007E-02	-.71896E-02	-.75451E-02	-.82563E-02	-.65673E-02	-.80340E-02	-.68784E-02
-.71451E-02	-.76785E-02	-.58562E-02	-.72784E-02	-.59451E-02	-.60784E-02	-.65673E-02	-.47006E-02	-.60340E-02	-.46117E-02
-.47006E-02	-.50562E-02	-.32783E-02	-.45228E-02	-.30561E-02	-.31894E-02	-.34561E-02	-.16783E-02	-.29228E-02	-.12783E-02
-.14116E-02	-.18116E-02	.55113E-04	-.11449E-02	.41068E-03	.14400E-03	-.12267E-03	.18774E-02	.58846E-03	.21885E-02
.20107E-02	.18774E-02	.36552E-02	.23218E-02	.40108E-02	.37441E-02	.35219E-02	.53442E-02	.40552E-02	.56108E-02
.53886E-02	.51664E-02	.68998E-02	.54331E-02	.68998E-02	.65442E-02	.61442E-02	.77442E-02	.63220E-02	.77442E-02

Table 4 - Example Case Output (Cont)

.70775E-02	.67664E-02	.82776E-02	.66331E-02	.80109E-02	.74776E-02	.68998E-02	.84109E-02	.67220E-02	.80998E-02
.72553E-02	.69887E-02	.83220E-02	.65442E-02	.79220E-02	.71220E-02	.65442E-02	.77887E-02	.60553E-02	.73442E-02
.62331E-02	.57886E-02	.68998E-02	.48997E-02	.60109E-02	.49442E-02	.43664E-02	.52108E-02	.32108E-02	.43664E-02
.30330E-02	.24107E-02	.33885E-02	.13440E-02	.23218E-02	.10329E-02	.49957E-03	.13885E-02	-.61157E-03	.49957E-03
-.65602E-03	-.12338E-02	-.34490E-03	-.23450E-02	-.11005E-02	-.23005E-02	-.27005E-02	-.18561E-02	-.38117E-02	-.26116E-02
-.36783E-02	-.41228E-02	-.33229E-02	-.52784E-02	-.39895E-02	-.51895E-02	-.55451E-02	-.46117E-02	-.65673E-02	-.52784E-02
-.63895E-02	-.66562E-02	-.56784E-02	-.75007E-02	-.61229E-02	-.70562E-02	-.71896E-02	-.61229E-02	-.78118E-02	-.63006E-02
-.72784E-02	-.71896E-02	-.60784E-02	-.76785E-02	-.61229E-02	-.67895E-02	-.67451E-02	-.55451E-02	-.70118E-02	-.53673E-02
-.59895E-02	-.58117E-02	-.45228E-02	-.59895E-02	-.41672E-02	-.48784E-02	-.44784E-02	-.31005E-02	-.45228E-02	-.27005E-02
-.34117E-02	-.29228E-02	-.15894E-02	-.30116E-02	-.12338E-02	-.19449E-02	-.13227E-02	-.21156E-03	-.15449E-02	.14400E-03
-.47824E-03	.55113E-04	.12107E-02	-.16712E-03	.16107E-02	.98847E-03	.15218E-02	.26774E-02	.14329E-02	.31219E-02
.24552E-02	.31663E-02	.43219E-02	.29441E-02	.47219E-02	.40109E-02	.45886E-02	.56553E-02	.43219E-02	.60553E-02
.51664E-02	.56997E-02	.66775E-02	.52553E-02	.68998E-02	.60109E-02	.64109E-02	.72109E-02	.56553E-02	.72998E-02
.63220E-02	.65886E-02	.73887E-02	.57886E-02	.72553E-02	.62331E-02	.65442E-02	.71220E-02	.54775E-02	.70331E-02
.57442E-02	.60553E-02	.67220E-02	.50775E-02	.63220E-02	.50775E-02	.54331E-02	.58331E-02	.40552E-02	.54331E-02
.40552E-02	.42775E-02	.45886E-02	.28552E-02	.40997E-02	.25441E-02	.28108E-02	.30774E-02	.12107E-02	.24552E-02
.94403E-03	.11663E-02	.13885E-02	-.47824E-03	.76625E-03	-.65602E-03	-.43379E-03	-.25601E-03	-.20338E-02	-.65602E-03
-.22116E-02	-.19449E-02	-.17672E-02	-.34117E-02	-.21227E-02	-.37672E-02	-.34117E-02	-.31894E-02	-.48339E-02	-.35450E-02
-.51450E-02	-.47006E-02	-.43895E-02	-.60784E-02	-.46561E-02	-.62562E-02	-.57228E-02	-.54562E-02	-.70118E-02	-.55451E-02
-.70562E-02	-.63895E-02	-.60784E-02	-.75007E-02	-.59451E-02	-.73229E-02	-.65673E-02	-.62117E-02	-.75896E-02	-.59006E-02
-.71896E-02	-.63006E-02	-.58562E-02	-.71007E-02	-.53673E-02	-.66118E-02	-.56339E-02	-.51450E-02	-.62117E-02	-.44784E-02
-.57228E-02	-.46561E-02	-.41228E-02	-.52339E-02	-.33672E-02	-.45673E-02	-.33672E-02	-.28783E-02	-.39450E-02	-.19894E-02
-.31894E-02	-.21227E-02	-.15005E-02	-.24783E-02	-.47824E-03	-.15893E-02	-.43379E-03	.55113E-04	-.78936E-03	.12107E-02
-.33779E-04	.11663E-02	.16996E-02	.81069E-03	.27663E-02	.16107E-02	.28552E-02	.31663E-02	.23218E-02	.42775E-02
.30330E-02	.41441E-02	.43664E-02	.34774E-02	.54331E-02	.40997E-02	.53442E-02	.53886E-02	.43064E-02	.62331E-02
.49886E-02	.60109E-02	.60109E-02	.51219E-02	.68998E-02	.54331E-02	.64553E-02	.64553E-02	.53886E-02	.70775E-02
.56553E-02	.65886E-02	.64109E-02	.53442E-02	.70331E-02	.53442E-02	.61442E-02	.60553E-02	.48997E-02	.64109E-02
.47219E-02	.53442E-02	.52553E-02	.39219E-02	.55664E-02	.38330E-02	.44997E-02	.40997E-02	.29441E-02	.44552E-02
.26330E-02	.34774E-02	.29885E-02	.18329E-02	.32108E-02	.15219E-02	.22774E-02	.17441E-02	.58846E-03	.19663E-02
.23290E-03	.85514E-03	.41068E-03	-.61157E-03	.63291E-03	-.11449E-02	-.47824E-03	-.87825E-03	-.20338E-02	-.61157E-03
-.24339E-02	-.16338E-02	-.22116E-02	-.32783E-02	-.19449E-02	-.35894E-02	-.27450E-02	-.33672E-02	-.44784E-02	-.30116E-02
-.47006E-02	-.37228E-02	-.43450E-02	-.53673E-02	-.39006E-02	-.55006E-02	-.46117E-02	-.50117E-02	-.59895E-02	-.44784E-02
-.60340E-02	-.49673E-02	-.55006E-02	-.62562E-02	-.47006E-02	-.62117E-02	-.51450E-02	-.55451E-02	-.62562E-02	-.46561E-02
-.61229E-02	-.48784E-02	-.53673E-02	-.59451E-02	-.41672E-02	-.56339E-02	-.43006E-02	-.47006E-02	-.51450E-02	-.33672E-02
-.47006E-02	-.33228E-02	-.35894E-02	-.39450E-02	-.21227E-02	-.34117E-02	-.19894E-02	-.21227E-02	-.24783E-02	-.70047E-03
-.20338E-02	-.52268E-03	-.78936E-03	-.10116E-02	.67735E-03	-.56713E-03	.89958E-03	.58846E-03	.27734E-03	.20996E-02
.72180E-03	.21441E-02	.18329E-02	.16552E-02	.33441E-02	.18329E-02	.33441E-02	.29441E-02	.27663E-02	.43219E-02
.28996E-02	.43664E-02	.38775E-02	.36552E-02	.53442E-02	.37886E-02	.52108E-02	.46330E-02	.44552E-02	.58331E-02
.43219E-02	.58331E-02	.51664E-02	.48553E-02	.62331E-02	.46775E-02	.60109E-02	.52553E-02	.49886E-02	.63220E-02
.45441E-02	.59664E-02	.51219E-02	.47219E-02	.60109E-02	.42775E-02	.56553E-02	.45886E-02	.42330E-02	.54775E-02
.35219E-02	.48997E-02	.38330E-02	.34330E-02	.44552E-02	.25441E-02	.39219E-02	.27219E-02	.22330E-02	.32552E-02
.13440E-02	.26330E-02	.12996E-02	.80958E-03	.19218E-02	-.78225E-04	.11663E-02	-.33779E-04	-.38935E-03	.63291E-03
-.14116E-02	-.16712E-03	-.12338E-02	-.15894E-02	-.61157E-03	-.26116E-02	-.12783E-02	-.23894E-02	-.27005E-02	-.18561E-02
-.35450E-02	-.23450E-02	-.34561E-02	-.37228E-02	-.26116E-02	-.45673E-02	-.32783E-02	-.43895E-02	-.45228E-02	-.35450E-02
-.53673E-02	-.39450E-02	-.50562E-02	-.51006E-02	-.40339E-02	-.57673E-02	-.44339E-02	-.55451E-02	-.53673E-02	-.43006E-02
-.59895E-02	-.45673E-02	-.54117E-02	-.53228E-02	-.44339E-02	-.59006E-02	-.43006E-02	-.51895E-02	-.49228E-02	-.38117E-02
-.55006E-02	-.39006E-02	-.46117E-02	-.42561E-02	-.31005E-02	-.46561E-02	-.29672E-02	-.36783E-02	-.32783E-02	-.22116E-02
-.36339E-02	-.18561E-02	-.26116E-02	-.21672E-02	-.10116E-02	-.23450E-02	-.56713E-03	-.14116E-02	-.83380E-03	.27734E-03
-.10560E-02	.58846E-03	-.12267E-03	.49957E-03	.16107E-02	.14400E-03	.19218E-02	.12107E-02	.17885E-02	.27663E-02
.14329E-02	.32108E-02	.24107E-02	.29441E-02	.39663E-02	.25885E-02	.42775E-02	.34330E-02	.40108E-02	.49886E-02
.34774E-02	.52108E-02	.43219E-02	.48108E-02	.57886E-02	.42330E-02	.58775E-02	.48553E-02	.53442E-02	.61886E-02
.45886E-02	.61442E-02	.51219E-02	.56108E-02	.62331E-02	.46330E-02	.61886E-02	.48997E-02	.53442E-02	.59664E-02
.42775E-02	.57442E-02	.44108E-02	.48553E-02	.52997E-02	.35663E-02	.50775E-02	.36997E-02	.40108E-02	.44108E-02
.27663E-02	.41886E-02	.26774E-02	.31219E-02	.35663E-02	.17885E-02	.31663E-02	.17885E-02	.21885E-02	.24107E-02
.67735E-03	.21441E-02	.63291E-03	.10329E-02	.12996E-02	-.38935E-03	.10774E-02	-.56713E-03	-.78225E-04	.55113E-04
-.15005E-02	-.21156E-03	-.16783E-02	-.12783E-02	-.10560E-02	-.27005E-02	-.13227E-02	-.28783E-02	-.23894E-02	-.21227E-02
-.38117E-02	-.24339E-02	-.39006E-02	-.33672E-02	-.31894E-02	-.47450E-02	-.32783E-02	-.47450E-02	-.40783E-02	-.39450E-02

Table 4 - Example Case Output (Cont)

*** ANALYSIS OF WAVE PATTERN RESISTANCE BY NEWMAN-SHARMA METHOD ***

(1) CONDITION

MODEL LENGTH 5.1580 M
FROUDE NUMBER .2793
MODEL VELOCITY 1.9864 M/S

(2) DATA

PROBE POSITION Y= 1.364M FROM MODEL CL (2Y/L = .529)
MEASURED RANGE X= -1.C75 TO 32.257 M
NO. OF DATA POINTS 1700
TRUNCATION POINT 1 1552
TRUNCATION POINT 2 1679
NO.POINTS FOR MEAN 25
SAMPLING INTERVAL .0100 SEC

(3) TRUNCATION CORRECTION

TRUNCATION POINT X= 32.257 M
APPROXIMATED WAVE PROFILE IS EXPRESSED AS FOLLOWS ZETA6ZETA0*COS(KX)/(KX)**1/2
ZETA0 .046606
EPSILON -3.0676

(4) ANALYZED ENERGY SPECTRUM

ELEMENTARY WAVE ANGLE	FREE WAVE SPECTRUM: SINE COMPONENT	SINE COMPONENT (CORRECTED)	COSINE COMPONENT	COSINE COMPONENT (CORRECTED)	TOTAL FREE WAVE SPECTRUM	TOTAL FREE WAVE SPECTRUM (CORRECTED)
0.0	0.0	[illegible]	0.0	[illegible]	0.0	[illegible]
.50	.9127E-04	[illegible]	[illegible]	[illegible]	.3041E-07	.13111E-04
1.00	.1752E-03	[illegible]	-.3022E-03	[illegible]	[illegible]	[illegible]
1.50	[illegible]	[illegible]	[illegible]	[illegible]	.2761E-06	[illegible]
2.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3.00	[illegible]	[illegible]	[illegible]	[illegible]	.1137E-05	[illegible]
3.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5.00	[illegible]	[illegible]	[illegible]	[illegible]	.3372E-05	[illegible]
5.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6.50	.1017E-02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7.00	.1124E-02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11.00	.2532E-02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12.00	.3071E-02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
12.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
13.00	[illegible]	[illegible]	-.4334E-02	[illegible]	[illegible]	[illegible]
13.50	[illegible]	[illegible]	-.4381E-02	[illegible]	[illegible]	[illegible]
14.00	.4354E-02	[illegible]	-.4395E-02	[illegible]	[illegible]	[illegible]
14.50	.4703E-02	.47911E-02	-.4374E-02	[illegible]	.4125E-04	[illegible]
15.00	.5054E-02	.49471E-02	-.4316E-02	[illegible]	.4417E-04	[illegible]
15.50	.5402E-02	.51067E-02	-.4219E-02	-.31060E-02	.4698E-04	.35725E-04
16.00	.5742E-02	.52691E-02	-.4081E-02	-.30651E-02	.4962E-04	.37156E-04
16.50	.6066E-02	.54335E-02	-.3904E-02	-.30144E-02	.5204E-04	.36609E-04

Table 4 - Example Case Output (Cont)

17.00	.E367E-02	.55090E-02	-.3690E-02	-.29535E-02	.5416E-04	.40072E-04
17.50	.6640E-02	.57488E-02	-.3440E-02	-.28870E-02	.5592E-04	.41534E-04
18.00	.6876E-02	.5924+E-02	-.3162E-02	-.28198E-02	.5727E-04	.43059E-04
18.50	.7098E-02	.60927E-02	-.2860E-02	-.27215E-02	.5816E-04	.44521E-04
19.00	.7217E-02	.62549E-02	-.2543E-02	-.26131E-02	.5955E-04	.45902E-04
19.50	.7315E-02	.64123E-02	-.2222E-02	-.24918E-02	.5945E-04	.47342E-04
20.00	.7363E-02	.65639E-02	-.1906E-02	-.23667E-02	.5785E-04	.48686E-04
20.50	.7363E-02	.67090E-02	-.1608E-02	-.22292E-02	.5640E-04	.49980E-04
21.00	.7321E-02	.68469E-02	-.1337E-02	-.20828E-02	.5538E-04	.51218E-04
21.50	.7244E-02	.69771E-02	-.1105E-02	-.19280E-02	.5370E-04	.52397E-04
22.00	.7143E-02	.70990E-02	-.9193E-03	-.17635E-02	.5188E-04	.53512E-04
22.50	.7034E-02	.72122E-02	-.7847E-03	-.15949E-02	.5010E-04	.54562E-04
23.00	.6931E-02	.73164E-02	-.7025E-03	-.14199E-02	.4954E-04	.55546E-04
23.50	.6851E-02	.74116E-02	-.6690E-03	-.12321E-02	.4739E-04	.56464E-04
24.00	.6810E-02	.74975E-02	-.6754E-03	-.10510E-02	.4683E-04	.57317E-04
24.50	.6820E-02	.75742E-02	-.7077E-03	-.85841E-03	.4701E-04	.58106E-04
25.00	.6891E-02	.76417E-02	-.7470E-03	-.66216E-03	.4804E-04	.58834E-04
25.50	.7026E-02	.76999E-02	-.7714E-03	-.46040E-03	.4996E-04	.59501E-04
26.00	.7220E-02	.77488E-02	-.7572E-03	-.25475E-03	.5270E-04	.60109E-04
26.50	.7461E-02	.77879E-02	-.6819E-03	-.43840E-04	.5613E-04	.60653E-04
27.00	.7727E-02	.78168E-02	-.5274E-03	.17213E-03	.5998E-04	.61132E-04
27.50	.7991E-02	.78348E-02	-.2824E-03	.39335E-03	.6394E-04	.61539E-04
28.00	.8222E-02	.78407E-02	.5405E-04	.62027E-03	.6761E-04	.61862E-04
28.50	.8387E-02	.78335E-02	.4713E-03	.85260E-03	.7056E-04	.62090E-04
29.00	.8457E-02	.78115E-02	.9467E-03	.10902E-02	.7242E-04	.62208E-04
29.50	.8415E-02	.77731E-02	.1447E-02	.13325E-02	.7290E-04	.62197E-04
30.00	.8253E-02	.77167E-02	.1931E-02	.15787E-02	.7185E-04	.62040E-04
30.50	.7983E-02	.76405E-02	.2359E-02	.18274E-02	.6931E-04	.61716E-04
31.00	.7635E-02	.75428E-02	.2694E-02	.20770E-02	.6555E-04	.61207E-04
31.50	.7247E-02	.74221E-02	.2915E-02	.23265E-02	.6102E-04	.60495E-04
32.00	.6870E-02	.72772E-02	.3020E-02	.25703E-02	.5631E-04	.59564E-04
32.50	.6550E-02	.71072E-02	.3028E-02	.28046E-02	.5207E-04	.58400E-04
33.00	.6373E-02	.69115E-02	.2981E-02	.30374E-02	.4887E-04	.56994E-04
33.50	.6202E-02	.66901E-02	.2934E-02	.32533E-02	.4707E-04	.55341E-04
34.00	.6169E-02	.64436E-02	.2946E-02	.34526E-02	.4674E-04	.53441E-04
34.50	.6180E-02	.61735E-02	.3013E-02	.36319E-02	.4757E-04	.51302E-04
35.00	.6166E-02	.58819E-02	.3303E-02	.37877E-02	.4844E-04	.48944E-04
35.50	.6057E-02	.55720E-02	.3644E-02	.39173E-02	.5000E-04	.46392E-04
36.00	.5798E-02	.52475E-02	.4040E-02	.40166E-02	.4941E-04	.43665E-04
36.50	.5350E-02	.49124E-02	.4397E-02	.40911E-02	.4806E-04	.40803E-04
37.00	.4778E-02	.45706E-02	.4630E-02	.41365E-02	.4424E-04	.37843E-04
37.50	.4125E-02	.42251E-02	.4674E-02	.41537E-02	.3846E-04	.35109E-04
38.00	.3504E-02	.38774E-02	.4517E-02	.41447E-02	.3204E-04	.32219E-04
38.50	.3015E-02	.35267E-02	.4206E-02	.41233E-02	.2678E-04	.29439E-04
39.00	.2714E-02	.31707E-02	.3846E-02	.40763E-02	.2218E-04	.26694E-04
39.50	.2584E-02	.28059E-02	.3559E-02	.40163E-02	.1935E-04	.24001E-04
40.00	.2533E-02	.24273E-02	.3440E-02	.39310E-02	.1825E-04	.21344E-04
40.50	.2473E-02	.20345E-02	.3526E-02	.38173E-02	.1816E-04	.18711E-04
41.00	.2121E-02	.16283E-02	.3679E-02	.36677E-02	.1803E-04	.16104E-04
41.50	.1575E-02	.12143E-02	.3803E-02	.34752E-02	.1695E-04	.13552E-04
42.00	.8495E-03	.80146E-03	.3717E-02	.32319E-02	.1454E-04	.11114E-04
42.50	.1093E-03	.39426E-03	.3331E-02	.29505E-02	.1111E-04	.88952E-05
43.00	-.4507E-03	.14617E-04	.2694E-02	.26245E-02	.7467E-05	.68868E-05
43.50	-.7147E-03	-.33815E-03	.1986E-02	.22674E-02	.4454E-05	.52554E-05
44.00	-.7268E-03	-.67173E-03	.1426E-02	.18887E-02	.2561E-05	.40188E-05
44.50	-.6866E-03	-.98864E-03	.1145E-02	.14953E-02	.1784E-05	.32132E-05
45.00	-.8397E-03	-.12980E-02	.1085E-02	.10841E-02	.1883E-05	.24687E-05
45.50	-.1314E-02	-.16077E-02	.1009E-02	.66218E-03	.2743E-05	.30233E-05
46.00	-.2008E-02	-.19215E-02	.6504E-03	.20759E-03	.4454E-05	.37354E-05
46.50	-.2637E-02	-.22364E-02	-.8754E-04	-.28551E-03	.6963E-05	.50829E-05
47.00	-.2936E-02	-.25430E-02	-.1034E-02	-.82707E-03	.9686E-05	.71508E-05
47.50	-.2879E-02	-.28271E-02	-.1857E-02	-.14196E-02	.1174E-04	.10008E-04
48.00	-.2736E-02	-.30740E-02	-.2338E-02	-.20576E-02	.1296E-04	.13683E-04

Table 4 - Example Case Output (Cont)

48.50	-.2862E-02	-.32735E-02	-.2590E-02	-.27278E-02	.1490E-04	.18156E-04
49.00	-.3340E-02	-.34258E-02	-.2992E-02	-.34136E-02	.2011E-04	.23389E-04
49.50	-.3869E-02	-.35412E-02	-.3831E-02	-.41049E-02	.2965E-04	.29390E-04
50.00	-.4021E-02	-.36310E-02	-.4973E-02	-.48045E-02	.4090E-04	.36267E-04
50.50	-.3706E-02	-.36942E-02	-.5946E-02	-.55247E-02	.4910E-04	.44170E-04
51.00	-.3333E-02	-.37130E-02	-.6446E-02	-.62697E-02	.5266E-04	.53095E-04
51.50	-.3369E-02	-.36698E-02	-.6732E-02	-.70196E-02	.5667E-04	.62742E-04
52.00	-.3747E-02	-.35775E-02	-.7366E-02	-.77431E-02	.6829E-04	.72754E-04
52.50	-.3890E-02	-.34814E-02	-.8489E-02	-.84424E-02	.8720E-04	.83394E-04
53.00	-.3467E-02	-.34039E-02	-.9589E-02	-.91853E-02	.1040E-03	.95956E-04
53.50	-.2891E-02	-.32664E-02	-.1021E-01	-.10058E-01	.1126E-03	.11183E-03
54.00	-.2672E-02	-.28959E-02	-.1070E-01	-.11038E-01	.1217E-03	.13022E-03
54.50	-.2471E-02	-.21751E-02	-.1165E-01	-.11922E-01	.1419E-03	.14687E-03
55.00	-.1517E-02	-.12160E-02	-.1271E-01	-.12452E-01	.1639E-03	.15653E-03
55.50	-.7772E-04	-.31596E-03	-.1289E-01	-.12574E-01	.1662E-03	.15821E-03
56.00	.6701E-03	.34788E-03	-.1230E-01	-.12524E-01	.1516E-03	.15697E-03
56.50	.7144E-03	.94785E-03	-.1221E-01	-.12529E-01	.1497E-03	.15788E-03
57.00	.1482E-02	.17802E-02	-.1270E-01	-.12442E-01	.1634E-03	.15798E-03
57.50	.3061E-02	.27762E-02	-.1211E-01	-.11841E-01	.1559E-03	.14792E-03
58.00	.3658E-02	.34460E-02	-.1028E-01	-.10601E-01	.1190E-03	.12426E-03
58.50	.3116E-02	.34775E-02	-.8997E-02	-.91304E-02	.9065E-04	.95458E-04
59.00	.3121E-02	.31486E-02	-.8168E-02	-.77851E-02	.7645E-04	.70521E-04
59.50	.3140E-02	.27716E-02	-.6212E-02	-.63131E-02	.4845E-04	.47537E-04
60.00	.1786E-02	.20232E-02	-.4105E-02	-.44030E-02	.2004E-04	.23479E-04
60.50	.3710E-03	.52948E-03	-.2784E-02	-.24397E-02	.7889E-05	.62324E-05
61.00	-.9657E-03	-.13413E-02	-.7927E-03	-.83209E-03	.1561E-05	.24916E-05
61.50	-.3549E-02	-.33030E-02	.1006E-02	.72094E-03	.1360E-04	.11429E-04
62.00	-.5749E-02	-.56823E-02	.1839E-02	.22047E-02	.3643E-04	.37159E-04
62.50	-.7908E-02	-.82210E-02	.3364E-02	.31590E-02	.7385E-04	.77564E-04
63.00	-.1088E-01	-.10511E-01	.3922E-02	.38655E-02	.1337E-03	.12542E-03
63.50	-.1261E-01	-.12870E-01	.4012E-02	.42778E-02	.1751E-03	.18393E-03
64.00	-.1481E-01	-.14730E-01	.4210E-02	.38484E-02	.2371E-03	.23180E-03
64.50	-.1542E-01	-.15336E-01	.2905E-02	.32645E-02	.2464E-03	.24584E-03
65.00	-.1498E-01	-.15185E-01	.3442E-02	.31387E-02	.2361E-03	.24045E-03
65.50	-.1478E-01	-.14498E-01	.2585E-02	.28245E-02	.2251E-03	.21818E-03
66.00	-.1175E-01	-.12062E-01	.2620E-02	.24291E-02	.1450E-03	.15137E-03
66.50	-.8868E-02	-.85518E-02	.3054E-02	.32313E-02	.8797E-04	.83627E-04
67.00	-.3976E-02	-.42735E-02	.4363E-02	.41505E-02	.3485E-04	.35489E-04
67.50	.2894E-03	.53278E-03	.6222E-02	.64936E-02	.3879E-04	.42451E-04
68.00	.4603E-02	.44696E-02	.8586E-02	.82405E-02	.9490E-04	.87982E-04
68.50	.8159E-02	.81125E-02	.1000E-01	.10361E-01	.1666E-03	.17316E-03
69.00	.1015E-01	.10407E-01	.1071E-01	.10452E-01	.2178E-03	.21756E-03
69.50	.1237E-01	.12005E-01	.1006E-01	.10019E-01	.2542E-03	.24511E-03
70.00	.1191E-01	.12103E-01	.6421E-02	.67298E-02	.1831E-03	.19178E-03
70.50	.1048E-01	.10687E-01	.2965E-02	.26679E-02	.1185E-03	.12133E-03
71.00	.8305E-02	.79713E-02	-.3713E-02	-.38598E-02	.8276E-04	.78432E-04
71.50	.4383E-02	.42164E-02	-.8628E-02	-.82918E-02	.9348E-04	.86581E-04
72.00	-.1114E-02	-.82028E-03	-.1017E-01	-.99559E-02	.1047E-03	.99742E-04
72.50	-.4852E-02	-.45278E-02	-.6377E-02	-.65458E-02	.6421E-04	.63347E-04
73.00	-.6977E-02	-.68342E-02	.6214E-04	-.29431E-03	.4868E-04	.47617E-04
73.50	-.4573E-02	-.47112E-02	.4335E-02	.39935E-02	.3976E-04	.38143E-04
74.00	-.2120E-02	-.23513E-02	.4510E-03	.16594E-03	.4698E-05	.55559E-05
74.50	-.3958E-02	-.41115E-02	-.3541E-02	-.38273E-02	.2821E-04	.32216E-04
75.00	-.7013E-02	-.71445E-02	-.2552E-02	-.28982E-02	.5569E-04	.59444E-04
75.50	-.1272E-02	-.11590E-02	-.4272E-03	-.78188E-03	.1802E-05	.19545E-05
76.00	.2500E-02	.28658E-02	-.1754E-02	-.18345E-02	.9327E-05	.11575E-04
76.50	.9957E-03	.11192E-02	.2946E-03	.65059E-03	.1078E-05	.16759E-05
77.00	.2731E-03	-.10637E-03	-.1051E-02	-.10420E-02	.1180E-05	.10971E-05
77.50	-.2632E-02	-.23728E-02	.8941E-02	.86601E-02	.8688E-04	.80626E-04
78.00	.4357E-02	.41937E-02	-.5470E-02	-.51194E-02	.4890E-04	.43796E-04
78.50	.3061E-02	.32973E-02	.1193E-02	.88220E-03	.1080E-04	.11651E-04
79.00	-.1236E-02	-.16261E-02	.2760E-02	.28209E-02	.9145E-05	.10602E-04
79.50	-.2368E-02	-.22215E-02	.2320E-02	.26927E-02	.1099E-04	.12185E-04

Table 4 - Example Case Output (Cont)

80.00	-.2180E-02	-.17727E-02	.3802E-02	.38[illegible]1E-02	.19[illegible]E-04	.18[illegible]E-04
80.50	.174[illegible]E-02	.21009E-02	-.3277E-03	-.54[illegible]0E-03	.3159E-05	.47[illegible]E-05
81.00	-.15[illegible]E-02	-.12132E-02	.6472E-03	.455[illegible]2E-03	.2947E-05	.167[illegible]E-05
81.50	-.982[illegible]E-04	.32587E-03	.3064E-03	.39215E-03	.1035E-06	.259[illegible]E-06
82.00	.2599E-02	.26723E-02	.3448E-03	.7824[illegible]5E-03	.6873E-05	.77541E-05
82.50	.9165E-03	.46257E-03	.2274E-02	.2334[illegible]8E-02	.6012E-05	.56652E-05
83.00	-.5061E-03	-.48150E-03	-.1583E-02	-.2054[illegible]8E-02	.2763E-05	.44623E-05
83.50	.1483E-02	.19765E-02	.2674E-03	.24390E-03	.2272E-05	.39661E-05
84.00	-.5146E-03	-.36154E-04	.2865E-03	.48299E-03	.3469E-06	.23459E-06

(5) WAVE PATTERN RESISTANCE

CW = .163889E-03
CW = .157724E-03 (WITHOUT TRUNCATION CORRECTION)

Table 4 - Example Case Output (Cont)

MODEL 5079 FN = 0.28 C VM = 6 521 FPS RUN 15

X VALUES

0.	.25000E-01	.50000E-01	.75000E-01	.10000E+00	.12500E+00	.15000E+00	.17500E+00	.20000E+00	.22500E+00
.25000E+00	.27500E+00	.30000E+00	.32500E+00	.35000E+00	.37500E+00	.40000E+00	.42500E+00	.45000E+00	.47500E+00
.50000E+00	.52500E+00	.55000E+00	.57500E+00	.60000E+00	.62500E+00	.65000E+00	.67500E+00	.70000E+00	.72500E+00
.75000E+00	.77500E+00	.80000E+00	.82500E+00	.85000E+00	.87500E+00	.90000E+00	.92500E+00	.95000E+00	.97500E+00
.10000E+01									

INFLUENCE FUNCTION OF SHIP BEFORE MODIFICATION

-.12678E-02	-.15301E-02	-.17453E-02	-.17084E-02	-.13335E-02	-.66540E-03	.24565E-03	.12953E-02	.22569E-02	.27399E-02
.24547E-02	.14367E-02	.11604E-03	-.89589E-03	-.12198E-02	-.99400E-03	-.57210E-03	-.31525E-03	-.41398E-03	-.77724E-03
-.10136E-02	-.81242E-03	-.37261E-03	.83004E-04	.37751E-03	.49616E-03	.51784E-03	.52847E-03	.61715E-03	.70483E-03
.67853E-03	.46712E-03	.15055E-03	-.71149E-04	-.13843E-03	-.23274E-03	-.40283E-03	-.58285E-03	-.66522E-03	-.58404E-03
-.45606E-03									

NUMBER OF OFFSETS FOR THIN SHIP = 22

X	HALF BEAM
-.0250	0.0000
0.0000	.0117
.0250	.0124
.0500	.0124
.0750	.0109
.1000	.0077
.1250	.0040
.1500	-.0018
.1750	-.0077
.2000	-.0131
.2250	-.0157
.2500	-.0161
.2750	-.0106
.3000	-.0051
.3250	-.0004
.3500	.0011
.3750	.0018
.4000	.0015
.4250	.0007
.4500	.0007
.4750	0.0000
.5000	0.0000

SINE TERM COEFFICIENTS FOR THE THIN SHIP

N	COEF
1	-.374957E-02
2	.311308E-02
3	.990553E-02
4	.366977E-02
5	-.107801E-02
6	.892957E-03
7	.163471E-02
8	.619524E-03
9	.410998E-03
10	.685205E-03

Table 4 - Example Case Output (Cont)

COMPARISON OF ORIGINAL OFFSETS TO THE SINE SERIES

X	HALF BEAMS	SINE SERIES	DIFFERENCE	RATIO
-.02500	0.00000	0.00000	0.00000	I
0.00000	.01170	.00991	.00179	.84696
.02500	.01240	.01396	-.00155	1.12612
.05000	.01240	.01259	-.00019	1.01528
.07500	.01090	.01003	.00087	.92015
.10000	.00770	.00787	-.00017	1.02157
.12500	.00400	.00426	-.00026	1.06435
.15000	-.00180	-.00165	-.00015	.91860
.17500	-.00770	-.00806	.00036	1.04712
.20000	-.01310	-.01304	-.00006	.99525
.22500	-.01570	-.01580	.00010	1.00662
.25000	-.01610	-.01546	-.00064	.96023
.27500	-.01060	-.01129	.00069	1.06506
.30000	-.00510	-.00502	-.00008	.98422
.32500	-.00040	-.00023	-.00017	.57291
.35000	.00110	.00138	-.00028	1.25305
.37500	.00180	.00133	.00047	.74138
.40000	.00150	.00138	.00012	.92266
.42500	.00070	.00127	-.00057	1.82127
.45000	.00070	.00046	.00024	.66269
.47500	0.00000	-.00020	.00020	-R
.50000	0.00000	-.00000	.00000	-R

THIN SHIP ELEMENT SINE SERIES COEFFICIENTS

-.147331097E-02 .120708780E-02 .387573741E-02 .150049403E-02 -.417995663E-03 .346241627E-03
.633854954E-03 .240218807E-03 .159363260E-03 .205686152E-03

LAGRANGIAN MULTIPLIERS
0.

THIN SHIP ELEMENT BEAM FACTOR= -.52372E-17
THIN SHIP ELEMENT VOLUME FACTOR= -.52386E-04

Table 4 - Example Case Output (Cont)

```
MODEL 5079 FN = 0.28   C VM = 6 521 FPS   RUN 15

  (10) WAVE PATTERN RESISTANCE
                    C# =    .163888821E-03
                   CWW =    .104636998E-03          ( WITH THIN SHIP ADDED )

     THIN SHIP INFLUENCE FUNCTION

 .10007E-02  .18535E-02  .20135E-02  .18143E-02  .14299E-02  .77838E-03 -.18350E-03 -.12075E-02 -.20050E-02 -.23487E-02
-.21126E-02 -.12803E-02 -.18280E-03  .71569E-03  .11252E-02  .11770E-02  .10683E-02  .85423E-03  .58572E-03  .30366E-03
 .14470E-03 -.66797E-05 -.14069E-03 -.24325E-03 -.33443E-03 -.40799E-03 -.41619E-03 -.41567E-03 -.38799E-03 -.27883E-03
-.20659E-03 -.80831E-04  .26552E-04  .16572E-03  .22662E-03  .29755E-03  .37271E-03  .32746E-03  .31175E-03  .25874E-03
 .17565E-03

     MODIFIED HULL FORM INFLUENCE FUNCTION

-.26706E-03 -.18050E-03 -.34922E-03 -.46926E-03 -.38528E-03 -.29013E-03 -.31320E-03 -.34711E-03 -.24520E-03  .29014E-04
 .42203E-03  .85163E-03  .12032E-02  .13335E-02  .12116E-02  .93263E-03  .50773E-03 -.12103E-03 -.97882E-03 -.17800E-02
-.20708E-02 -.18143E-02 -.11551E-02 -.32216E-03  .46343E-03  .97913E-03  .11649E-02  .10377E-02  .82893E-03  .62055E-03
 .40300E-03  .20689E-03  .77743E-05 -.94992E-04 -.21794E-03 -.32454E-03 -.42478E-03 -.51168E-03 -.49824E-03 -.40203E-03
-.22076E-03


 NSC NS1 NS2
   3   1   2

     LIST OF THIN SHIP ELEMENT STATION AREA IN SQUARE METERS

 .48455E-02  .68280E-02  .61560E-02  .49043E-02  .38463E-02  .20818E-02 -.60854E-03 -.39426E-02 -.63752E-02 -.77278E-02
-.75594E-02 -.55219E-02 -.24544E-02 -.11204E-03  .67399E-03  .65253E-03  .67674E-03  .62339E-03  .22682E-03 -.98725E-04
-.66045E-17  0.          0.          0.          0.          0.          0.          0.          0.          0.
 0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
 0.

   (11)  THIN SHIP OFFSET TABLE IN METERS

    X VALUE       OFFSET
      0.000        .0099
       .050        .0126
       .100        .0079
       .150       -.0017
       .200       -.0130
       .250       -.0155
       .300       -.0050
       .350        .0014
       .400        .0014
       .450        .0005
       .500       -.0100
       .550        0.0000
       .600        0.0000
       .650        0.0000
       .700        0.0000
       .750        0.0000
       .800        0.0000
       .850        0.0000
       .900        0.0000
       .950        0.0000
      1.000        0.0000
```

Table 4 - Example Case Output (Cont)

MODEL 5079 FN = 0.28 C VM = 6.521 FPS RUN 15

NSC	NS1	NS2
3	1	2

FREE WAVE AMPLITUDE

BEFORE MODIFICATION		THIN SHIP OR BULB		AFTER MODIFICATION	
SINE	COSINE	SINE	COSINE	SINE	COSINE
.23536E-02	-.27303E-02	-.18920E-02	.29210E-03	.46159E-03	-.24382E-02
.23855E-02	-.27240E-02	-.18922E-02	.2922HE-03	.4932JE-03	-.24317E-02
.24201E-02	-.27219E-02	-.18930E-02	.29282E-03	.52708E-03	-.24290E-02
.24574E-02	-.27236E-02	-.18943E-02	.29375E-03	.56310E-03	-.24299E-02
.24974E-02	-.27290E-02	-.18961E-02	.29505E-03	.60133E-03	-.24339E-02
.25401E-02	-.27377E-02	-.18984E-02	.29671E-03	.64173E-03	-.24410E-02
.25857E-02	-.27496E-02	-.19012E-02	.29875E-03	.6844HE-03	-.2450?E-02
.26342E-02	-.27644E-02	-.19045E-02	.3011HE-03	.72960E-03	-.24632E-02
.26857E-02	-.27817E-02	-.19084E-02	.3039HE-03	.7772?E-03	-.24777E-02
.27404E-02	-.28015E-02	-.19128E-02	.3071HE-03	.82769E-03	-.24943E-02
.27985E-02	-.28234E-02	-.19177E-02	.31077E-03	.88067E-03	-.2512HE-02
.28602E-02	-.28471E-02	-.19231E-02	.31477E-03	.93715E-03	-.25324E-02
.29257E-02	-.28725E-02	-.19290E-02	.31917E-03	.9966?E-03	-.25533E-02
.29952E-02	-.28991E-02	-.19355E-02	.3239HE-03	.1059?E-02	-.25751E-02
.30688E-02	-.29264E-02	-.19425E-02	.32924E-03	.11263E-02	-.25975E-02
.31469E-02	-.29551E-02	-.19501E-02	.33492E-03	.1196HE-02	-.26202E-02
.32296E-02	-.29837E-02	-.19582E-02	.3410?E-03	.12711E-02	-.26427E-02
.33172E-02	-.30123E-02	-.19668E-02	.34764E-03	.1352?E-02	-.26646E-02
.34099E-02	-.30403E-02	-.19760E-02	.35470E-03	.1437HE-02	-.26856E-02
.35078E-02	-.30667E-02	-.19857E-02	.3622HE-03	.1522?E-02	-.27052E-02
.36111E-02	-.30931E-02	-.19960E-02	.37029E-03	.16151E-02	-.2722HE-02
.37200E-02	-.31164HE-02	-.20069E-02	.37869E-03	.17132E-02	.2737HE-02
.38346E-02	-.31379HE-02	-.20183E-02	.38790E-03	.1816HE-02	-.27500E-02
.39553E-02	-.31559HE-02	-.20303E-02	.3975HE-03	.1924HE-02	-.27594E-02
.40824E-02	-.31701E-02	-.20428E-02	.40772E-03	.2037HE-02	-.27623E-02
.42158E-02	-.31794E-02	-.20560E-02	.41849E-03	.2156?E-02	-.27588E-02
.43544E-02	-.31844E-02	-.20697E-02	.42996E-03	.2279?E-02	-.27507E-02
.44971E-02	-.31853E-02	-.20840E-02	.44189E-03	.2407?E-02	-.27415E-02
.46432E-02	-.31756HE-02	-.20990E-02	.45451E-03	.25402E-02	-.27211E-02
.47911E-02	-.31606E-02	-.21135E-02	.46785E-03	.2676HE-02	-.26927E-02
.49381E-02	-.31367E-02	-.21286E-02	.48185E-03	.2816HE-02	-.26557E-02
.50847E-02	-.31067E-02	-.21443E-02	.49650E-03	.29593E-02	-.26104E-02
.52291E-02	-.30691E-02	-.21607E-02	.51210E-03	.3104HE-02	-.25563E-02
.53735E-02	-.30244E-02	-.21776E-02	.52839E-03	.3255?E-02	-.24948E-02
.55140E-02	-.29739E-02	-.21952E-02	.5454HE-03	.3414?E-02	-.24251E-02
.57044E-02	-.29178E-02	-.22135E-02	.56344E-03	.3584?E-02	-.23479E-02
.59244E-02	-.28560E-02	-.22323E-02	.5822?E-03	.37634E-02	-.22635E-02
.60442E-02	-.27915E-02	-.22518E-02	.60208E-03	.3948HE-02	-.21735E-02
.62539E-02	-.27131E-02	-.22719E-02	.62276E-03	.41398E-02	-.20823E-02
.64123E-02	-.26944E-02	-.23037E-02	.64447E-03	.4310?E-02	-.18853E-02
.65939E-02	-.23667E-02	-.23201E-02	.66724E-03	.4487?E-02	-.17944E-02
.67910E-02	-.22292E-02	-.23431E-02	.69110E-03	.4639?E-02	-.15341E-02
.69869E-02	-.20828E-02	-.23728E-02	.71610E-03	.4474?E-02	-.13[illegible]7E-02
.69771E-02	-.19240E-02	-.23971E-02	.74224E-03	.4640?E-02	-.11857E-02
.70990E-02	-.17655E-02	-.24220E-02	.76972E-03	.4676HE-02	-.99577E-03
.72122E-02	-.15959E-02	-.24476E-02	.79845E-03	.47646E-02	-.79746E-03
.73164E-02	-.14199E-02	-.24738E-02	.82853E-03	.4842GE-02	-.59139E-03
.74116E-02	-.12381E-02	-.25007E-02	.86003E-03	.49109E-02	-.37807E-03
.74975E-02	-.10510E-02	-.25281E-02	.89301E-03	.49694E-02	-.15797E-03
.75742E-02	-.85891E-03	-.25561E-02	.92753E-03	.50181E-02	.68615E-04

Table 4 - Example Case Output (Cont)

.76417E-02	-.66216E-03	-.25817E-02	.96367E-03	.50570E-02	.30151E-03
[illegible]	-.46080E-03	-.23139E-02	[illegible]	[illegible]	[illegible]
.77488E-02	-.25475E-03	-.26436E-02	.10411E-02	[illegible]	[illegible]
.77879E-02	-.43660E-04	-.26739E-02	[illegible]	.51140E-02	[illegible]
.78108E-02	.17213E-03	-.27047E-02	[illegible]	.51122E-02	[illegible]
.78348E-02	.39345E-03	-.27359E-02	.11712E-02	[illegible]	.15647E-02
.78407E-02	.62027E-03	-.27675E-02	.12187E-02	.50732E-02	[illegible]
.78335E-02	.85260E-03	-.27996E-02	.12634E-02	[illegible]	.21210E-02
.78115E-02	.10902E-02	-.28321E-02	.13204E-02	[illegible]	[illegible]
.77731E-02	.13325E-02	-.28648E-02	.13747E-02	.49083E-02	.27072E-02
.77167E-02	.15787E-02	-.28978E-02	.14316E-02	[illegible]	.30103E-02
.76405E-02	.18274E-02	-.29310E-02	.14910E-02	[illegible]	.33184E-02
.75428E-02	.20770E-02	-.29643E-02	.15532E-02	[illegible]	[illegible]
.74221E-02	.23255E-02	-.29977E-02	.16183E-02	[illegible]	.39437E-02
.72772E-02	.25703E-02	-.30311E-02	.16862E-02	.42461E-02	[illegible]
.71072E-02	.28086E-02	-.30643E-02	.17573E-02	[illegible]	[illegible]
.69115E-02	.30374E-02	-.30973E-02	.18316E-02	.38142E-02	.48690E-02
.66901E-02	.32533E-02	-.31299E-02	.19092E-02	[illegible]	[illegible]
.64136E-02	.34526E-02	-.31621E-02	.19903E-02	.32815E-02	[illegible]
.61735E-02	.36319E-02	-.31937E-02	.20750E-02	[illegible]	[illegible]
.58619E-02	.37877E-02	[illegible]	.21634E-02	[illegible]	.59511E-02
.55720E-02	.39173E-02	-.32544E-02	.22557E-02	[illegible]	[illegible]
.52475E-02	.40186E-02	-.32832E-02	.23521E-02	.19643E-02	.63707E-02
.49124E-02	.40911E-02	-.33107E-02	.24525E-02	.16017E-02	.65437E-02
.45706E-02	.41255E-02	-.33366E-02	.25573E-02	[illegible]	[illegible]
.42251E-02	.41537E-02	-.33608E-02	.26665E-02	[illegible]	[illegible]
.38774E-02	.41487E-02	-.33829E-02	.27803E-02	[illegible]	[illegible]
.35267E-02	.41233E-02	-.34027E-02	[illegible]	[illegible]	.70220E-02
.31707E-02	.40793E-02	-.34199E-02	.30220E-02	[illegible]	.71013E-02
.28055E-02	.40163E-02	-.34342E-02	.31522E-02	[illegible]	[illegible]
.24273E-02	.39310E-02	[illegible]	[illegible]	[illegible]	[illegible]
.20345E-02	.38173E-02	-.34523E-02	[illegible]	[illegible]	[illegible]
.16283E-02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
.12143E-02	.34752E-02	[illegible]	[illegible]	[illegible]	[illegible]
.80146E-03	.32339E-02	-.34473E-02	[illegible]	[illegible]	[illegible]
[illegible]	.29505E-02	[illegible]	.40271E-02	[illegible]	[illegible]
.18617E-04	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
-.33815E-03	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
-.67173E-03	[illegible]	[illegible]	[illegible]	[illegible]	.64245E-02
-.98864E-03	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
-.16077E-02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
-.19215E-02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.43154E-03
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	-.84424E-02	[illegible]	[illegible]	-.44105E-02	[illegible]
[illegible]	-.91653E-02	[illegible]	[illegible]	-.40359E-02	[illegible]
-.32064E-02	-.10059E-01	-.31444E-03	[illegible]	-.35814E-02	-.20146E-02
[illegible]	[illegible]	.21486E-04	.81454E-02	-.28744E-02	-.28919E-02
-.21751E-02	-.11922E-01	.37651E-03	.82241E-02	-.17988E-02	-.36980E-02
-.12160E-02	-.12452E-01	.74885E-03	.82743E-02	-.46710E-03	-.41776E-02
-.31596E-03	-.12574E-01	.11368E-02	.82929E-02	.82060E-03	-.42813E-02
.34788E-03	-.12524E-01	.15379E-02	.82761E-02	.18858E-02	-.42477E-02

Table 4 - Example Case Output (Cont)

.94785E-03	-.12529E-01	.19493E-02	.82202E-02	.28971E-02	-.43091E-02
.17802E-02	-.12442E-01	.23672E-02	.81213E-02	.41474E-02	-.43209E-02
.27762E-02	-.11841E-01	.27872E-02	.79759E-02	.55631E-02	-.38654E-02
.34460E-02	-.10601E-01	.32038E-02	.77805E-02	.66499E-02	-.28208E-02
.34775E-02	-.91304E-02	.36109E-02	.75322E-02	.70884E-02	-.15933E-02
.31496E-02	-.77851E-02	.40012E-02	.7228?E-02	.71499E-02	-.55652E-03
.27716E-02	-.63131E-02	.43665E-02	.68681E-02	.713?1E-02	.55506E-03
.20?32E-02	-.44030E-02	.46?77E-02	.64604E-02	.6720 E-02	.20474E-02
.52?14E-03	-.24497E-02	.49848E-02	.59762E-02	.5514?E-02	.35365E-02
-.13113E-02	-.83209E-03	.52?72E-02	.54480E-02	.?875?E-02	.46159E-02
-.33030E-02	.72094E-03	.53937E-02	.48?70E-02	.?08?7E-02	.55911E-02
-.56423E-02	.22067E-02	.54?28E-02	.42491E-02	-.2?45 E-03	.64557E-02
-.82?12E-02	.31590E-02	.54?33E-02	.35?4CE-02	-.?747?E-02	.67530E-02
-.10511E-01	.3?655E-02	.53715E-02	.29?6EE-02	-.5136?E-02	.67824E-02
-.12870E-01	.4277?E-02	.51674E-02	.22321E-02	-.??0?3E-02	.650 E-02
-.14730E-01	.38484E-02	.48445E-02	.15973E-02	-.9?56?E-02	.54?5?E-02
-.15336E-01	.32647E-02	.44015E-02	.91301E-03	-.10993E-01	.41775E-02
-.15185E-01	.3134?E-02	.38376E-02	.3?17?E-03	-.1134?E-01	.34?5?E-02
-.14498E-01	.2?245E-02	.31574E-02	-.191?4E-03	-.1134?E-01	.263 E-02
-.12092E-01	.2?25?E-02	.23?4?E-02	-.60251E-03	-.9?31?E-02	.142? E-02
-.85518E-02	.32?13E-02	.14910E-02	-.895?1E-03	-.70?0?E-02	.2?1 E-02
-.42?35E-02	.4150 E-02	.5?32?E-03	-.10175E-02	-.3?3?1E-02	.31?32E-02
.5327?E-03	.6?1?0E-02	-.44?69E-03	-.98?14E-03	.8?90?E-04	.551? E-02
.44?9?E-02	.82465E-02	-.14379E-02	-.76022E-03	.3?31?E-02	.?4?? E-02
.81125E-02	.10?61E-01	-.23951E-02	-.35273E-03	.5?1?1E-02	.10?0?E-01
.10407E-01	.10452E-01	-.32?69E-02	.2375EE-03	.713?1E-02	.10?3?E-01
.12605E-01	.10049E-01	-.40373E-02	.99504E-03	.?96?0E-02	.11043E-01
.12103E-01	.8729?E-02	-.46370E-02	.1?92?E-02	.?46?2E-02	.8522?E-02
.10?87E-01	.26?7 E-02	-.50413E-02	.28?30E-02	.5?457E-02	.55?0?E-02
.79713E-02	-.38588E-02	-.52?40E-02	.39?6?E-02	.27473E-02	.?9?5?E-04
.42?64E-02	-.?2?4?E-02	-.51?5?E-02	.50?4?E-02	-.95211E-03	-.32?0?E-02
-.82?2?E-03	-.?????E-02	-.48?20E-02	.59?4?E-02	-.5?30?E-02	-.395?5E-02
-.45?7?E-02	-.65459E-02	-.43?5?E-02	.68?2?E-02	-.85?43E-02	.31647E-03
-.68?2?E-02	-.29?31E-03	-.35?9?E-02	.?517?E-02	-.1048?E-01	.722?1E-02
-.47?12E-02	.3??0?E-02	-.2?951E-02	.?87?1E-02	-.?4??1E-02	.11?7?E-01
-.23513E-02	.1?50?E-03	-.173?? E-02	.?857?E-02	-.40?9?E-02	.80221E-02
-.41?15E-02	-.38273E-02	-.?8?,?8E-03	.7388?E-02	-.50513E-02	.35614E-02
-.71435E-02	-.2?9??E-02	-.38?2?E-03	.64853E-02	-.753??E-02	.354??E-02
-.11590E-02	-.7?16 E-03	-.51?1?E-03	.5319?E-02	-.16?51E-02	.45?7?E-02
-.28?54E-02	-.1531?E-02	-.14?76E-02	.42922E-02	.13?3?E-02	.24?7?E-02
.11?92E-02	.6?5?1E-03	-.31401E-02	.3?987E-02	-.2?2?1E-02	.46?1?E-02
-.10637E-03	-.10?2?E-02	-.49?62E-02	.49?6?E-02	-.5?2?1E-02	.3?2?1E-02
-.23?2?E-02	.?5?31E-02	-.57175E-02	.7143?E-02	-.?0?01E-02	.15?2?E-01
.41?37E-02	-.51?3?E-02	-.?637?E-02	.94?6?E-02	-.44?01E-03	.43?7?E-02
.32?73E-02	.?2?23E-03	-.?0?35E-02	.10114E-01	.12535E-02	.10?4?E-01
-.16?61E-02	.2?20?E-02	.24?31E-05	.83401E-02	-.1623?E-02	.11?6?E-01
-.22?15E-02	.2?427E-02	-.42?6?E-03	.5?65?E-02	-.2?49?E-02	.?5?7?E-02
-.17?27E-02	.3?49?E-02	-.21?37E-02	.5331?E-02	-.3?46?E-02	.92?2?E-02
.21???E-02	-.5?0?0?E-03	-.23?7?E-02	.5?073E-02	-.237?3E-03	.53?5?E-02
-.12132E-02	.45547E-03	-.?0?7?E-02	.4?243E-02	-.32511E-02	.527?7E-02
.32?47E-03	.3?215E-03	-.33341E-02	.41?9?E-02	-.3?083E-02	.45?1?E-02
.25723E-02	.?829?E-03	-.3?56?E-02	.41?56E-02	-.5?44?E-03	.49?4?E-02
.46257E-03	.23?4?E-02	-.40?71E-02	.?8657E-02	-.35?45E-02	.52?05E-02
-.48150E-03	-.?056?E-02	-.40?64E-02	.?6161E-02	-.45?7?E-02	.55?26E-03
.19765E-02	.24?9?E-03	-.48?97E-02	.14846E-02	-.?8?32E-02	.17?85E-02
-.36154E-04	.48?3?E-03	-.47?35E-02	.10057E-03	-.47456E-02	.58356E-03

Table 4 - Example Case Output (Cont)

TABLE 5

Job Control Statements for HULIMP

The following describes the deck arrangement and job control statements required to run the program using segmentation.

```
JOB CARD
CHARGE CARD
ATTACH,HULIMP,ID=XXXX.
ATTACH,TAPE1,WAVECUT,ID=CHXX.
    (if the wavecut data are restored in a file)
SEGLOAD.
LOAD(HULIMP)
EXECUTE.
7/8/9           END OF RECORD
HULIMP          INCLUDE HULIMP,BLKDAT
SUHULL          INCLUDE SUHULL,TRUNC,WRITE2,SUFTRO,THETAX,FRES
MATRIX          INCLUDE MATRIX,PRIME,COMPUTE
READ3           INCLUDE READ3,NEWCOF,SPLVAL,SPINTG,SPFIT
READ1           INCLUDE READ1,DECOMP,SOLVE,WRITE1
HULIM           TREE    HULIMP-(READ1,READ3,MATRIX,SUHULL)
                GLOBAL  CONST,TRNCWR,COMP,GLOBL,COMWRZ,HULWR2,COMWR1
READ3           GLOBAL  RE3COF
MATRIX          GLOBAL  MATCOM-SAVE
SUHULL          GLOBAL  WAVES
END
7/8/9           END OF RECORD
     USER DATA
7/8/9
6/7/8/9         END OF FILE
```

The core requirement for loading and running the program is 57,700 octal words, using segmentation. If segmentation is not used, the core requirement increases to approximately 120,000 octal words which significantly lowers the execution priority of the job. Below are the job control statements used to run the program without using segmentation.

```
JOB CARD
CHARGE CARD
ATTACH,HULIMP,ID=XXXX.
ATTACH,TAPE1,WAVECUT,ID=CHXX.
HULIMP.
7/8/9               END OF RECORD
      USER DATA
7/8/9               END OF RECORD
6/7/8/9             END OF FILE
```

TABLE 6

FUNCTIONAL DESCRIPTION OF SUBROUTINES

HULIMP	Drives the entire system (calls subroutines), stores free wave spectra and computes residuals for solution of linear system of equations.
BLOCK DATA	Initializes certain program variables which are in common block storage before execution.
COMPUTE	Computes the thin ship offsets and wave-making resistance of existing ship and modified ship.
DECOMP	Performs matrix triangularization by Gaussian elimination.
FRES	Calculates the value of Fresnel integrals.
MATRIX	Calculates matrix and vector elements for the linear system.
NEWCOF	Calls subroutines to calculate the non-optimum thin ship sine series.
PRIME	Determines the free wave spectra components due to thin ship.
READ1	Reads and echoes control variables, ship parameters and constraint parameters.
READ3	Reads and echoes the offsets of the thin ship.
SOLVE	Solves a linear system of equations whose coefficient matrix has been triangularized.
SPFIT	Fits cubic splines to non-optimum thin ship offsets.
SPINTG	Calculates the integral of f(x)* sin(nx) for the non-optimum thin ship.
SPLVAL	Evaluates the splines from SPFIT at a given x.
SUFTRO	Analyses a longitudinal wave cut using the Newman-Sharma method.
SUHULL	Reads and checks experimental wave cut data.
THETAX	Computes free wave spectra for the Newman-Sharma method.

TABLE 6 (continued)

FUNCTIONAL DESCRIPTION OF SUBROUTINES

TRUNC	Calculates truncation correction parameters by least squares.
WRITE1	Prints the results of optimization.
WRITE2	Prints the results of wave pattern analysis.

APPENDIX A

DOCUMENTATION OF ADDITIONAL SUBROUTINES

PROGRAM HULIMP

PURPOSE

To serve as a driver for the entire program which determines the optimum hull form modification to reduce wave-making resistance.

CALLING SEQUENCE

None - main routine.

COMMON BLOCKS

COMP,COMWR2,CONST,GLOBL,HULWR1,TRNCWR

SUBPROGRAMS CALLED

READ1, SUHULL, SUFTRO, PRIME, MATRIX, DECOMP, SOLVE, READ3, NEWCOF, COMPUTE, WRITE1

DETAILED DESCRIPTION

This routine calls subroutines, stores free wave spectra and computes residuals for the solution of a linear system of equations.

SUBROUTINE NEWCOF

PURPOSE

To call subroutines that fit a cubic spline to the half beam offsets of the non-optimum thin ship and to calculate the respective fourier sine series representation.

CALLING SEQUENCE

NEWCOF (NTERMS, SLWL,COEFS,XS,XE)

Variable	Type	Dimension	Use	Description
COEFS	Real	(40)	output	Sine series coefficients for the non-optimum thin ship.
NTERMS	Integer	-	input	Number of terms in the series
SLWL	Real	-	input	Model length
XS	Real	-	input	Nondimensional location of the thin ship bow
XE	Real	-	input	Nondimensional location of the thin ship stern

COMMON BLOCKS

RD3COF

SUBPROGRAMS CALLED

SPFIT, SPINTG, SPLVAL

DETAILED DESCRIPTION

This subroutine calls subroutines to fit the non-optimum thin ship offsets with a cubic spline, and then to find the sine series representation. It also prints a comparison of the original thin ship offsets to the values calculated using the sine series.

SUBROUTINE READ3

PURPOSE

To read the half beam offsets of the non-optimum thin ship.

CALLING SEQUENCE

READ3

COMMON BLOCKS

RD3COF

SUBPROGRAMS CALLED

NONE

DETAILED DESCRIPTION

This subroutine reads and echos the half beam offsets of the non-optimum thin ship.

SUBROUTINE SPFIT

PURPOSE

To fit non-parametric spline segments to the non-optimum thin ship offsets.

CALLING SEQUENCE

SPFIT(X,Y,ELEMS,NPTS)

Variable	Type	Dimension	Use	Description
ELEMS	Real	(4,NPTS-1)	output	Array containing the spline information
NPTS	Integer	-	input	Number of points
X	Real	(NPTS)	input	X values
Y	Real	(NPTS)	input	Y values (half beams)

COMMON BLOCKS

None

SUBPROGRAMS CALLED

None

SUBROUTINE SPINTG

PURPOSE

To evaluate the integrals f(x)* sin(AX) and f(x)* cos(AX) where f(x) is a cubic spline.

CALLING SEQUENCE

SPINTG(XA,XB,X,NPTS,ELEMS,A,CINTG,SINTG)

Variable	Type	Dimension	Use	Description
A	Real	-	Input	Constant for specific integral to be evaluated
ELEMS	Real	(4,NPTS-1)	Input	Spline segments generated by SPFIT
NPTS	Integer	-	Input	Number of values in X-array
X	Real	(NPTS)	Input	X values
XA	Real	-	Input	Lower limit of integration
XB	Real	-	Input	Upper limit of integration
CINTG	Real	-	Output	Integral of f(x)* cos (AX)
SINTG	Real	-	Output	Integral of f(x)* sin (AX)

COMMON BLOCKS

None

SUBPROGRAMS CALLED

SPLVAL

SUBROUTINE SPLVAL

PURPOSE

To evaluate a spline at some x value.

CALLING SEQUENCE

SPLVAL(X,NPTS,ELEMS,XO,YO,SO,I ELEM)

Variable	Type	Dimension	Use	Description
ELEMS	Real	(4,NPTS-1)	Input	Spline segments from SPFIT
NPTS	Integer	-	Input	Number of values in x array
X	Real	(NPTS)	Input	X array
XO	Real	-	Input	X value to evaluate spline at
YO	Real	-	Output	f(XO)
SO	Real	-	Output	Second derivative at XO
IELM	Integer	-	Output	Index of spline segment containing XO

COMMON BLOCKS

None

SUBPROGRAMS CALLED

None

COMMON BLOCK RD3COF

FORTRAN Symbol	Math Symbol	Type	Description
XVAL		Real	Nondimensional distance to bow, X/L
YVAL	$\eta(x)/2$	Real	Half breadth of thin ship corresponding to XVAL
NVAL		Integer	Number of elements in XVAL and YVAL

DTNSRDC ISSUES THREE TYPES OF REPORTS

1. DTNSRDC REPORTS, A FORMAL SERIES, CONTAIN INFORMATION OF PERMANENT TECHNICAL VALUE. THEY CARRY A CONSECUTIVE NUMERICAL IDENTIFICATION REGARDLESS OF THEIR CLASSIFICATION OR THE ORIGINATING DEPARTMENT.

2. DEPARTMENTAL REPORTS, A SEMIFORMAL SERIES, CONTAIN INFORMATION OF A PRELIMINARY, TEMPORARY, OR PROPRIETARY NATURE OR OF LIMITED INTEREST OR SIGNIFICANCE. THEY CARRY A DEPARTMENTAL ALPHANUMERICAL IDENTIFICATION.

3. TECHNICAL MEMORANDA, AN INFORMAL SERIES, CONTAIN TECHNICAL DOCUMENTATION OF LIMITED USE AND INTEREST. THEY ARE PRIMARILY WORKING PAPERS INTENDED FOR INTERNAL USE. THEY CARRY AN IDENTIFYING NUMBER WHICH INDICATES THEIR TYPE AND THE NUMERICAL CODE OF THE ORIGINATING DEPARTMENT. ANY DISTRIBUTION OUTSIDE DTNSRDC MUST BE APPROVED BY THE HEAD OF THE ORIGINATING DEPARTMENT ON A CASE-BY-CASE BASIS.