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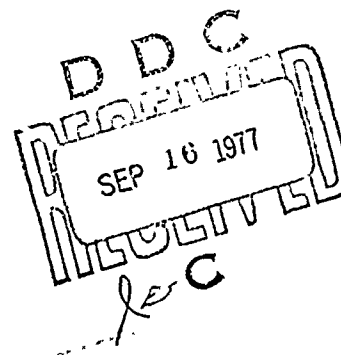
DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER

Bethesda, Md. 20084



HULLBORNE HYDROFOIL SIX-DEGREE OF
FREEDOM MOTION PREDICTION COMPUTER
PROGRAM

by
R. Stahl
and
E.E. Zarnick



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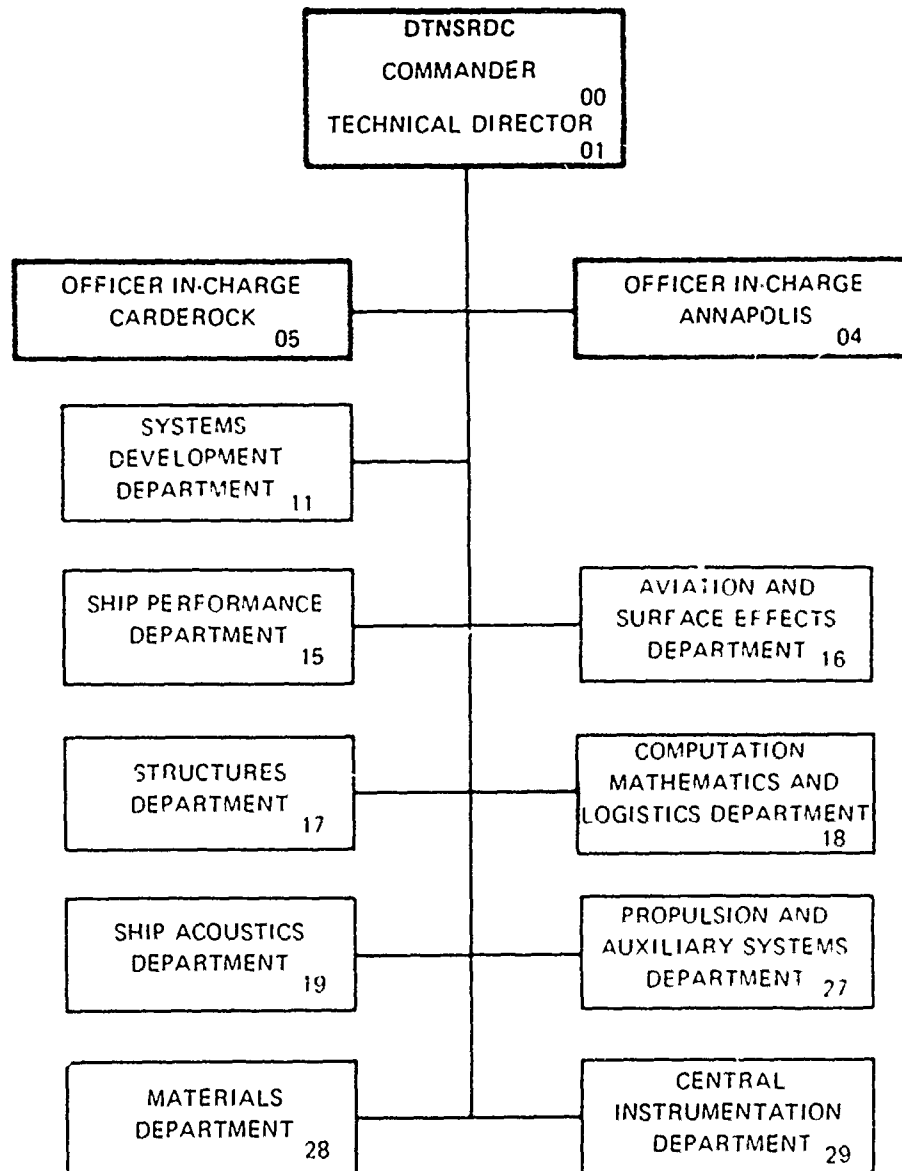
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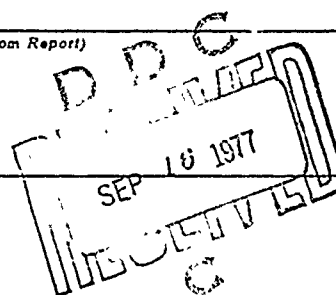
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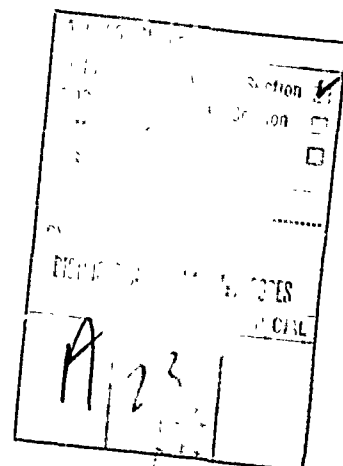
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NOMENCLATURE

A_{jk}	added mass coefficient
B_{jk}	damping coefficient
C_{jk}	restoring coefficient
$C_{L\alpha}$	lift curve slope
$C(k)$	Theodorsin's function
F'_j	excitation force or moment on a single foil element
F_j	exciting force or moment of hydrofoil system
I_j	moment of inertia
I_{jk}	product of inertia
K_2	wave number
L	total lift on foil element
$\bar{M}$	moment on foil element
U	ship speed
V_N	normal velocity on foil element
W_o	orbital wave velocity normal to foil element
Z_G	VCG in body system
X, Y, Z	foil element's midpoint in body frame
a_j	motion amplitude
b	span of foil element
c	chord of foil element
g	gravitational acceleration
h	depth of foil element

NOMENCLATURE (continued)

l	lift on foil of infinitesimal span
k	reduced frequency
m	mass
m_{jk}	generalized mass
$\bar{n}$	unit vector normal to foil element's midpoint
$\bar{r}$	position vector in body fram
t	time variable
v	velocity in body system
v_0	velocity in inertial system
x, y, z	body coordinate system
x_0, y_0, z_0	inertial coordinate system
Γ	dihedral angle of foil element
Ω	angular rotational velocity
ϵ_j	phase lag
	wave amplitude
η_j	motion displacement
λ	wavelength
μ	heading angle
ρ	water density
ω	wave frequency
ω_e	wave encounter frequency

ABSTRACT

A description of a motion prediction computer program for a hullborne hydrofoil is presented. This program computes the six-degree-of-freedom (6DOF) hydrofoil craft motions for a craft advancing at a constant forward speed, less than the critical "lift-off" speed, with arbitrary heading in regular waves. The structure of the program consists essentially of the already existing "DTNSRDC Ship-Motion and Sea-Load Computer Program" modified to incorporate the foil and strut system of a hydrofoil craft. Presented in this report is a brief discussion of the mathematical model, input information pertaining to the hydrofoil and a discussion of the results. The Appendices present a listing of the foil coefficients, data card format description for the original program, and a program listing.

ADMINISTRATIVE INFORMATION

This project was funded by the High Performance Vehicle Hydromechanics Program of the Ship Performance Department, David W. Taylor Naval Ship Research and Development Center, under Work Unit Number 1-1507-200.

INTRODUCTION

A description of the "DTNSRDC Hullborne Hydrofoil Motion Prediction Computer Program" is presented in this report. It predicts the motions for a hullborne hydrofoil craft in six-degrees-of-freedom (6DOF) advancing at a constant forward speed in the displacement mode with foils extended, at an arbitrary heading in unidirectional regular waves. The program is an adaptation of the already existing "DTNSRDC Ship-Motion and Sea-Load Computer Program", based on the theory by Salvesen, Tuck, and Faltinsen^{1*} which was developed for the prediction of the motions and dynamic loads of conventional displacement type hulls and is utilized for planing hulls in the displacement mode as well. The program modifications consist basically of the insertion of the equations of motion for the foil and strut system of a hydrofoil vessel. The linearized hydrofoil terms, derived by the incorporation of Theodorsen's unsteadiness effects into a three dimensional quasi-steady formulation are superimposed on the already computed hull excitation forces, added mass, damping and restoring terms. This technique has been successfully used by R. T. Schmitke who developed two computer programs which determine the motions of a hullborne hydrofoil in single headings; one in head seas² and the second in beam seas.

The hull related input information for the modified program remains identical to the original program, "DTNSRDC Ship-Motion and Sea-Load Computer Program"³. The remaining required input all pertains to the strut-foil system.

*References are listed on page 21.

The modified program output presents, as in the original program for ship-motions, the amplitudes and phases in surge, sway, heave, roll, pitch and yaw for a given set of wave frequencies and a specified set of forward ship speeds and headings. Optionally, one can obtain the two sets of coupled differential equations of motion in matrix form; one for surge, heave, and pitch and the other for sway, roll and yaw. Each set is given for the hull portion, the foil-strut portion, the combination of the two, and the final inverted matrix with the solutions. Both sets are for the minimum specified frequency.

MATHEMATICAL MODEL

BASIC ASSUMPTIONS AND LIMITATIONS

The analytical model for determining the motions of a hullborne hydrofoil craft is derived by adding linearized hydrofoil terms to the strip theory obtained hull terms. The major assumptions and limitations are:

- (1) the craft is traveling in a straight line at a constant forward speed and arbitrary heading in unidirectional regular waves
- (2) the craft responds linearly and harmonically to regular wave excitation
- (3) wave excitation amplitudes are small with correspondingly small craft displacement amplitudes from equilibrium
- (4) all viscous effects are negligible except for the hull portion of the craft in roll

- (5) both the craft's beam and draft are much smaller than its length
- (6) the craft is laterally symmetrical
- (7) dynamic lift attributable to the hull's planing surfaces is insignificant
- (8) interaction between the hull and hydrofoil system is negligible as is the interaction between the foil elements
- (9) the hydrofoil system's contribution to craft surging is negligible
- (10) the foil system is divisible into a set of rectangular foil elements.

EQUATIONS OF MOTION

The conventions used in the hullborne hydrofoil craft motion program are the same as the "DTNSRDC Ship-Motion and Sea-Load Computer Program". The following will briefly restate the definitions used.³ As shown in Figure 1, the vessel oriented, right-handed coordinate system is defined to have its origin in the plane of the undisturbed free water surface. The positive z axis is vertically upward passing through the craft's center of gravity, and the positive x axis passes through the craft's stern. The vessel is considered to be traveling at a constant forward speed (the negative x direction) with arbitrary heading in regular sinusoidal waves. The heading angle μ is defined to be 0 degrees for following waves and 180 degrees for head waves as illustrated in Figure 2. Encounter frequency ω_e to which the vessel will respond is

$$\omega_e = \omega - \frac{\omega^2 U}{g} \cos \mu \quad (1)$$

Where U is the forward speed of the ship, circular wave frequency $\omega = \sqrt{2\pi g/\lambda}$, g is the gravitational acceleration, and λ is the wavelength.

With the assumption that the motions are linear and harmonic, the motion displacements are

$$\eta_j = a_j \cos(\omega_e t - \epsilon_j); j = 1, \dots, 6 \quad (2)$$

where a_j is the amplitude and ϵ_j is the phase lag of the motion with respect to the maximum wave elevation above the origin. The subscripts $j = 1 \dots 6$, refer respectively to the translatory displacements of surge, sway, and heave and the angular displacements of roll, pitch, and yaw. Following from the above assumptions, the six linear coupled differential equations of motion can be written in complex form as:

$$\sum_{k=1}^6 [(m_{jk} + A_{jk}) \ddot{\eta}_k + B_{jk} \dot{\eta}_k + C_{jk} \eta_k] = F_j e^{-i\omega_e t}; j = 1, \dots, 6 \quad (3)$$

where m_{jk} are the components of the craft's generalized mass matrix, A_{jk} are the added-mass coefficients, B_{jk} and C_{jk} are the complex damping and restoring coefficients and F_j are the complex amplitudes of the exciting forces and moments.

For a hullborne hydrofoil craft as well as for a conventional displacement hull the six coupled equations of motion can be separated into two sets of equations. With the exclusion of hydrostatic restoring coefficients that are equal to zero for both the hull and foil system,

the first set of three coupled equations of motion in surge, heave, and pitch are

$$\begin{aligned} \text{Surge} \quad (A_{11} + m) \ddot{\eta}_1 + B_{11} \dot{\eta}_1 + A_{13} \ddot{\eta}_3 + B_{13} \dot{\eta}_3 + A_{15} \ddot{\eta}_5 + B_{15} \dot{\eta}_5 \\ = F_1 \bar{e}^{i\omega t} \end{aligned} \quad (4)$$

$$\begin{aligned} \text{Heave} \quad A_{31} \ddot{\eta}_1 + B_{31} \dot{\eta}_1 + (A_{33} + m) \ddot{\eta}_3 + B_{33} \dot{\eta}_3 + C_{33} \eta_3 + A_{35} \ddot{\eta}_5 \\ + B_{35} \dot{\eta}_5 + C_{35} \eta_5 = F_3 \bar{e}^{i\omega t} \end{aligned} \quad (5)$$

$$\begin{aligned} \text{Pitch} \quad A_{51} \ddot{\eta}_1 + B_{51} \dot{\eta}_1 + A_{53} \ddot{\eta}_3 + B_{53} \dot{\eta}_3 + C_{53} \eta_3 + (A_{55} + I_5) \ddot{\eta}_5 \\ + B_{55} \dot{\eta}_5 + C_{55} \eta_5 = F_5 \bar{e}^{i\omega t} \end{aligned} \quad (6)$$

and the second set of equations are

$$\begin{aligned} \text{Sway} \quad (A_{22} + m) \ddot{\eta}_2 + B_{22} \dot{\eta}_2 + (A_{24} - mZ_G) \ddot{\eta}_4 + B_{24} \dot{\eta}_4 + C_{24} \eta_4 \\ + A_{26} \ddot{\eta}_6 + B_{26} \dot{\eta}_6 + C_{26} \eta_6 = F_2 \bar{e}^{i\omega t} \end{aligned} \quad (7)$$

$$\begin{aligned} \text{Roll} \quad (A_{42} - mZ_G) \ddot{\eta}_2 + B_{42} \dot{\eta}_2 + (A_{44} + I_4) \ddot{\eta}_4 + (B_{44} + B_{44}^*) \dot{\eta}_4 \\ + C_{44} \eta_4 + (A_{46} - I_{46}) \ddot{\eta}_6 + B_{46} \dot{\eta}_6 + C_{46} \eta_6 = F_4 \bar{e}^{i\omega t} \end{aligned} \quad (8)$$

$$\begin{aligned} \text{Yaw} \quad A_{62} \ddot{\eta}_2 + B_{62} \dot{\eta}_2 + (A_{64} - I_{46}) \ddot{\eta}_4 + B_{64} \dot{\eta}_4 + C_{64} \eta_4 \\ + (A_{66} + I_6) \ddot{\eta}_6 + B_{66} \dot{\eta}_6 + C_{66} \eta_6 = F_6 \bar{e}^{i\omega t} \end{aligned} \quad (9)$$

where m is the vessel's mass, Z_G is the location of the vertical center of gravity on the z axis, I_j is the moment of inertia in the j th mode, and I_{jk} is the product of inertia. B_{44}^* in the roll equation is the nonlinear viscous damping attributable to the hull. It is in the form of a quasi-linear function in terms of ω_e , viscosity, hull geometry, and the maximum roll amplitude for a given wave slope, speed V , and heading μ . The second set of equations in sway, roll, and yaw may have to be solved a number of times until the difference between the maximum estimated roll angle and the computed maximum roll angle is within an acceptable tolerance. In the program the allowed tolerance is one degree.

With the assumed insignificance of the hull and foil system interaction, the hull and foil system contribution to the added mass, damping and restoring coefficients and the forcing functions are simply additive. For example the added mass coefficients A_{jk} can be expressed as

$$A_{jk} = A_{jk}^H + A_{jk}^F \quad (10)$$

where A_{jk}^H is the hull added mass and A_{jk}^F is the frequency independent foil system added mass.

The derivation of the hull added mass, damping and hydrostatic restoring coefficients and the exciting forces and moments used in the "DTNSRDC Ship-Motion and Sea-Load Computer Program" are presented as three-dimensional hydrodynamic quantities in Reference 1. Based on strip theory, these quantities are in turn expressed in terms of the solution to the sectional two-dimensional problem of each cylinder oscillating in the free surface. The sectional two-dimensional problem is solved by a close-fit source-distribution method presented in Reference 4.

HYDROFOIL COEFFICIENTS

The foil coefficients for nonzero forward speed are derived from Theodorsen's solution of the two-dimensional thin aerofoil oscillating in an incompressible fluid in pitch and heave with the inclusion of finite span and free-surface correction factors (see Reference 5). This method was used successfully by Schmitke in Reference 2 in predicting both the pitch and heave motions of a hullborne hydrofoil vessel in head seas in one case and the motions of roll, sway, and yaw in beam seas in the second case.

Utilizing Theodorsen's solution, consider first the submerged foil system of a hydrofoil craft as being comprised of individual foil elements. Each element is considered as a plane rectangle with no interaction between the elements. The lift force acting on a single foil element at its midpoint (point of intersection of the mid-chord and mid-span) is

$$\bar{L} = \bar{L}_{NC} + \bar{L}_C \quad (11)$$

$$\bar{L}_{NC} = \pi \cdot (c/2)^2 \cdot b \cdot \bar{\dot{V}}_{N1/2} \quad (12)$$

$$\bar{L}_C = 0.5\rho U b c C_{L\alpha} C(k) \bar{V}_{N3/4} \quad (13)$$

with c as the chord of the foil element

b as the span of the foil element

U as the forward craft speed

$C_{L\alpha}$ as the lift curve slope

$\bar{\dot{V}}_{N1/2}$ is the time derivative of the normal velocity component at the foil element's midpoint

- $\bar{V}_{N3/4}$ is the downwash at the 3/4 chord
 $\bar{L}_{NC}$ is the noncirculatory lift force or added mass term
 $\bar{L}_C$ is the circulatory lift force consisting of dynamic angle-of-attack terms, modified by Theodorsen's function which accounts for circulation delay
 $C(k)$ is Theodorsen's function in terms of the reduced frequency $k = \omega_e c / 2U$ given as

$$C(k) = \frac{J_1(J_1 + Y_0) + Y_1(Y_1 - J_0) - i(Y_1 Y_0 + J_1 J_0)}{(J_1 + Y_0)^2 + (Y_1 - J_0)^2} \quad (14)$$

J_m and Y_m are Bessel functions of the first and second kind and m 'th order. Due to the assumed negligible viscous forces, only the velocity normal to the foil element $\bar{V}_N$ need be considered. With $\bar{n}$ as the unit vector normal to the foil element and $\bar{v}_0$ as the velocity of the element

$$\bar{V}_N = (\bar{v}_0 \cdot \bar{n})\bar{n} \quad (15)$$

In a rotating coordinate system,

$$\bar{v}_0 = \bar{v} + (\bar{\Omega} \times \bar{r}) \quad (16)$$

where $\bar{v}$ is the velocity of the body coordinate's origin

$\bar{\Omega}$ is the angular rotational velocity of the moving system

$\bar{r}$ is the position vector of the foil element's midpoint X, Y, Z .

For small angles in pitch η_5 and yaw η_6

$$\bar{v} = -U\hat{i} + (\dot{\eta}_2 + U\eta_6)\hat{j} + (\dot{\eta}_3 - U\eta_5)\hat{k} \quad (17)$$

Substituting (17) into (16) and evaluating the cross-product term one obtains

$$\begin{aligned} v_0 = & \bar{i} (\dot{Z}_{n_5} - \dot{Y}_{n_6} - U) \\ & + \bar{j} (\dot{n}_2 + \dot{X}_{n_6} - \dot{Z}_{n_4} + U_{n_6}) \\ & + \bar{k} (\dot{n}_3 + \dot{Y}_{n_4} - \dot{X}_{n_5} - U_{n_5}) \end{aligned} \quad (18)$$

Upon substitution into equation (15)

$$\begin{aligned} \bar{V}_N = & \bar{j} [(\dot{n}_2 + \dot{X}_{n_6} - \dot{Z}_{n_4} + U_{n_6}) \sin^2 r \\ & - (\dot{n}_3 + \dot{Y}_{n_4} - \dot{X}_{n_5} - U_{n_5}) \sin r \cos r] \\ & + \bar{k} [-(\dot{n}_2 + \dot{X}_{n_6} - \dot{Z}_{n_4} + U_{n_6}) \sin r \cos r \\ & + (\dot{n}_3 + \dot{Y}_{n_4} - \dot{X}_{n_5} - U_{n_5}) \cos^2 r] \end{aligned} \quad (19)$$

where r is the dihedral angle of the foil element and $\bar{i}$, $\bar{j}$, $\bar{k}$ are unit vectors in the moving system's, x , y , z coordinate axes.

The derivative of $\bar{V}_N$ with respect to time neglecting nonlinear terms and cross terms gives

$$\begin{aligned} \dot{\bar{V}}_N = & \bar{j} [(\ddot{n}_2 + \ddot{X}_{n_6} - \ddot{Z}_{n_4} + \dot{U}_{n_6}) \sin^2 r \\ & - (\ddot{n}_3 + \ddot{Y}_{n_4} - \ddot{X}_{n_5} - \dot{U}_{n_5}) \sin r \cos r] \\ & + \bar{k} [-(\ddot{n}_2 + \ddot{X}_{n_6} - \ddot{Z}_{n_4} + \dot{U}_{n_6}) \sin r \cos r \\ & + (\ddot{n}_3 + \ddot{Y}_{n_4} - \ddot{X}_{n_5} - \dot{U}_{n_5}) \cos^2 r] \end{aligned} \quad (20)$$

Substituting $\bar{V}_N$ and $\ddot{\bar{V}}_N$ into equations (11) thru (13), one obtains the three lift components in the translational displacements of surge, sway, and heave as:

$$\text{Surge} \quad L_x = 0 \quad (21)$$

$$\begin{aligned} \text{Sway} \quad L_y = & A(C_1 \sin^2 \Gamma - C_2 \sin \Gamma \cos \Gamma) \\ & + B(C_3 \sin^2 \Gamma - C_4 \sin \Gamma \cos \Gamma) \\ & - \frac{\partial L}{\partial h} C(k) \sin \Gamma [\eta_3 + Y\eta_4 - (X - \frac{C}{4}) \eta_5] \quad (22) \end{aligned}$$

$$\begin{aligned} \text{Heave} \quad L_z = & A(C_1 \sin \Gamma \cos \Gamma - C_2 \cos^2 \Gamma) \\ & + B(C_3 \sin \Gamma \cos \Gamma + C_4 \cos^2 \Gamma) \\ & + \frac{\partial L}{\partial h} C(k) \cos \Gamma [\eta_3 + Y\eta_4 - (X - \frac{C}{4}) \eta_5] \quad (23) \end{aligned}$$

$$\begin{aligned} \text{where} \quad A = & 0.25 \pi \rho c^2 b \\ B = & 0.50 U b c C_{L\alpha} C(k) \\ C_1 = & \ddot{\eta}_2 + X\ddot{\eta}_6 - Z\ddot{\eta}_4 + U\dot{\eta}_6 \\ C_2 = & \ddot{\eta}_3 + Y\ddot{\eta}_4 - X\ddot{\eta}_5 - U\dot{\eta}_5 \\ C_3 = & \dot{\eta}_2 + (X + \frac{C}{4}) \dot{\eta}_6 - Z\dot{\eta}_4 + U\eta_6 \\ C_4 = & \dot{\eta}_3 + Y\dot{\eta}_4 - (X + \frac{C}{4}) \dot{\eta}_5 - U\eta_5 \end{aligned}$$

The third terms in the sway and heave equations (22 and 23) comprise a correction to the foil element's normal force; a modification due to the finite depth h .

The general moment equation, $\bar{M}$, for the three angular displacements is

$$\bar{M} = (\bar{L} \times \bar{r}) + \bar{M}' \quad (24)$$

where the first term is the moment due to the lift force and the second term is the pure couple about the rotational axis passing through the foil's midpoint. The moments in roll, pitch and yaw can be expressed as follows with reference to equations (22) thru (24):

$$\text{Roll} \quad M_{\phi} = L_y Z - L_z Y + M'_{\phi} \quad (25)$$

$$\text{Pitch} \quad M_{\theta} = L_z X + M'_{\theta} \quad (26)$$

$$\text{Yaw} \quad M_{\psi} = L_y X + M'_{\psi} \quad (27)$$

The terms M'_{ϕ} , M'_{θ} , and M'_{ψ} are comprised of hydrodynamic moments of inertia and damping.

$$M'_{\phi} = \frac{b^2}{12} (A\ddot{\eta}_4 + B\dot{\eta}_4) \quad (28)$$

$$M'_{\theta} = \frac{1}{4} A c \cos^2 \Gamma \left(\frac{c}{8} \ddot{\eta}_5 + U\dot{\eta}_5 \right) \quad (29)$$

$$M'_{\psi} = \frac{1}{4} A c \sin^2 \Gamma \left(\frac{c}{8} \ddot{\eta}_6 + U\dot{\eta}_6 \right) \quad (30)$$

With foil symmetry about the xz-plane as a requirement, one can greatly simplify the foil portion of the coefficients whereby the six coupled equations of motion again are separable into two sets of coupled equations, i.e. (1) surge, heave, and pitch and (2) sway, roll, and yaw. The foil contribution to the coefficients of the two sets of coupled, second order differential equations (4) thru (6) and (7) thru (9) can

now be determined from L_x , L_y , L_z , M_ϕ , M_θ , and M_ψ . In calculating the foil coefficients a summation of all the rectangular foil element contributions on one side of the xz-plane is made and doubled due to symmetry. To this is added the contribution of the foil elements that lie in the xz-plane. Appendix A gives the foil coefficients for the symmetrical foil elements. The foil coefficients for the special case of an element lying in the xz-plane are approximated by taking half the values obtained in Appendix A.

Excitation Forces and Moments on the Hydrofoil

Consider now the wave excitation forces and moments acting on a hydrofoil element. For a foil element with an infinitesimal span, the lift acting through its midpoint located at a distance r from the origin is

$$l = \pi \rho c U W_0 \{ [J_0(K_1) - i J_1(K_1)] C(k) + i \frac{k}{2} [J_0(K_1) + J_2(K_1)] \} \quad (31)$$

where

$$K_1 = \pi c \cos \mu / \lambda ; \mu \text{ is heading angle}$$

$$K_2 = \omega^2 / g \text{ the wave number, and}$$

the term in parenthesis is Sear's function. W_0 is the orbital wave velocity component normal to the foil given by the expression

$$W_0 = i r_a (\cos r + i \sin r \sin \mu) \exp \{ K_2 [Z - i (X \cos \mu + Y \sin \mu)] + i \omega_e t \} \quad (32)$$

with r_a as the wave amplitude.

Integration of l over the span with respect to the distance r gives the total excitation lift force, L , on the foil element at its midpoint

$$L = \pi \rho c U w_1 \{ [J_0(K_1) - iJ_1(K_1)] C(k) + i 0.5k [J_0(K_1) + J_2(K_1)] \} \quad (33)$$

where

$$w_1 = -i \frac{2}{a} \sinh\left(\frac{ab}{2}\right) [\cos r + i \sin r \sin \mu] \exp \{ K_2 [Z - i (X \cos \mu + Y \sin \mu)] + i \omega_e t \}$$

and

$$a = K_2 (\sin^2 - i \sin \mu \cos r)$$

The excitation forces for the three translational displacements can now be determined

$$\text{Surge} \quad F_1' = 0 \quad (34)$$

$$\text{Sway} \quad F_2' = -L \sin r \quad (35)$$

$$\text{Heave} \quad F_3' = L \cos r \quad (36)$$

The moment excitation in roll is expressed by the equation

$$F_4' = \int l r dr + F_3' Y - F_2' Z \quad (37)$$

where the integral is again over the foil element's span. With the appropriate integration

$$\begin{aligned} \text{Roll} \quad F_4' &= \pi \rho c U w_2 \{ [J_0(K_1) - iJ_1(K_1)] C(k) \\ &\quad + i 0.5k [J_0(K_1) + J_2(K_1)] \\ &\quad + F_3' Y - F_2' Z \} \end{aligned} \quad (38)$$

where

$$v_2 = -i\omega \left[\frac{b}{a} \cosh \left(\frac{ab}{2} \right) - \frac{2}{a} \sinh \left(\frac{ab}{2} \right) \right] \\ [\cos \Gamma + i \sin \Gamma \sin \mu] \exp \{ K_2 [Z - i (X \cos \mu + Y \sin \mu)] + i\omega_e t \}$$

The two excitation moments in pitch and yaw are respectively

$$F_5 = (XL + M_{c/2}) \cos \Gamma \quad (39)$$

$$F_6 = (XL + M_{c/2}) \sin \Gamma \quad (40)$$

where $M_{c/2}$, the moment about mid-chord, is given as

$$M_{c/2} = 0.25 \pi c^2 U w_1 \{ J_0(K_1) C(k) \\ + i J_1(K_1) [1 - C(k)] - 0.25 k [J_1(K_1) \\ + J_3(K_1)] + J_2(K_1) \}$$

Since the excitation forces in sway, roll and yaw in head and following waves are negligible F_2^i , F_4^i , and F_6^i are equated to zero in the computer program for headings within 8 degrees of $\mu = 180$ or 0 degrees.

The summation of the excitation forces and moments on each foil element F_j^i results in the total excitation forces and moments on the hydrofoil system $F_j e^{-i\omega_e t}$. For computational purposes, a second set of forcing functions was generated to be used on foil elements that are symmetrical about the xz-plane.

COMPUTER PROGRAM

Based on the foregoing mathematical model, a program was developed to compute the hullborne motions of a hydrofoil craft in regular waves of arbitrary heading. The program is essentially a modification of the already existing DTNSRDC Ship-Motion Computer Program. In itself the existing program can determine the hydrofoil craft's motions in the foil up mode in 6DOF in regular unidirectional waves of any heading. The modification consists of adding the foil system's coefficients of motion and its excitation forces and moments to the corresponding terms for the hull. As a consequence three card sets listed below and pertaining to the foil system of the hullborne hydrofoil craft are added onto the existing 34 data card sets, which are listed in Appendix B.

A. Input Description

Data Card Set 35 - one card with format (2I4)

IFOIL: 2 for hydrofoil craft in the foils down mode. All other integer values are for retracted foil systems where only the hull is subjected to hydrodynamics forces

IPRINT: option of printing the matrix equations of motion. With IPRINT = 0 printing of matrices is suppressed and for IPRINT = 1 printing of matrices takes place

Data Card Set 36 - One card with format (I5,3F12.2)

NF: total number of foil elements on the starboard side of the hydrofoil craft. This total consists of the elements in symmetry about the xz-plane plus the elements lying in the xz-plane

FVOL: is the displaced volume of the entire foil system (including the portion of the struts that are immersed). The units

is WORD**3, (see Data Card Set 4 of Reference 3 or Appendix C)

FXCB: the foil system's longitudinal center of buoyancy, LCB, with respect to the entire craft's LCB, i.e. the x value in the body coordinate system in units of WORD.

FZCB: the foil system's vertical center of buoyancy, VCB, i.e. the z value in the body coordinate system in units of WORD.

Data Card Set 37 - one card per foil element with format
(F3.0, 5F7.2, F5.0, F10.7, F5.1, F8.3)

CPL: If the plane foil element lies in the center plane, i.e. the xz-plane,

CPL = 1.. In all other cases,

CPL = 2. due to the required symmetry of these elements about the center plane.

SPAN: the length of the rectangular foil element taken in a line parallel to the yz-plane in units of WORD.

CHORD: the width of the rectangular foil element taken in a line parallel to the xz-plane in units of WORD.

S: x coordinate of the foil element's midpoint in units of WORD

YF: y coordinate of the foil element's midpoint in units of WORD

ZF: z coordinate of the foil element's midpoint in units of WORD

DGAMMA: is the dihedral angle, i.e. the angle between the starboard plane foil element and the horizontal xy-plane in degrees, see Figure 3

CLZ: is the vertical lift slope of the foil element in dimensionless units

ASP: is a positive number utilized in the aspect ratio correction factor $AR/(AR + ASP)$ for foil elements of finite span. For the example cited $AR = 0$.

Provided that the hydrofoil system can be represented by a set of rectangular foil elements symmetrical about the center plane, each foil element fits into one of three categories as:

1. The most commonly encountered foil element not lying in the center plane counts as one element with $CPL = 2$.

2. The special case of a foil element lying in the center plane counts as one element with $CPL = 1$, and a dihedral angle of 90 degrees.

3. The special case of a foil element with a dihedral angle of 0 degrees intersecting the center plane is considered as just that portion of the foil lying on the starboard side from the center plane. The span is then just the distance from the center plane to the foil tip, and the midpoint $YF = SPAN/2$, and $CPL = 2$.

The listing of the Hullborne Hydrofoil Six-Degree of Freedom Motion Computer Program is given in Appendix C. The original program's organization consisted of a main program and a series of thirty subprograms. These routines are divided into four overlays and all are written in FORTRAN IV. Currently, the program is used on DTNSRDC's CDC 6700 computer system. Updated is the main program HANSEL in the main overlay, and the subroutines PRGM1 in the first overlay, and SPRG5 in the third overlay, see Reference 3. To this is added the subroutine FOIL which computes the foil coefficients of motion and the excitation forces and moments and three

additional subroutines THEO, EXCIT, and IBESJ which are required for calculations in FOIL. The final organization of the Hullborne Hydrofoil Six-Degree of Freedom Computer Program is presented in Figure 4.

COMPARISON OF PREDICTED AND EXPERIMENTAL RESULTS

The experimental results chosen for comparison with predicted results were the hullborne motion measurements of a model of the 313-ton Plainview AC(EH)-1 hydrofoil craft as presented in Reference 6. The experiments were conducted on a 1:12 scale model in DTNSRDC's Harold E. Saunders Seakeeping and Maneuvering Facility. The model was run in both the foils up and foils down modes in unidirectional regular waves. The full scale velocities were 6 and 12 knots at the three headings of head (180^0), bow (150^0), and beam waves (90^0). The regular waves were of a constant wave steepness $1/60$ and wave lengths ranged from $\lambda/L = 0.25$ to $\lambda/L = 3.0$, corresponding to wave frequencies of $\omega = 0.57$ to 1.98 rad/sec.

The Hullborne Hydrofoil Six-Degree of Freedom Motion Program was likewise run in both the foils up and foils down modes at the three headings of 180^0 , 150^0 , and 90^0 . The predicted motions generally agreed well with the experimental results as shown in Figures 5 through 11, which show the craft's transfer function versus wave encounter frequency together with the phase lag with respect to the maximum height of the wave at the CG. At the headings of 90 and 150 degrees, both the theoretical and experimental results show that the immersion of the foils significantly reduces the craft's motion in roll. The foil system's effects in reducing pitch and heave are much less pronounced.

Some of the minor discrepancies, especially in roll, between the predicted and experimental results are likely attributable to differences in the roll cyradii of the physical and simulation models since they were not given for the model for either the foil up or the foil down mode. A less significant source

for error may also be inaccuracies in the estimation of the foil system's displacement and center of buoyancy.

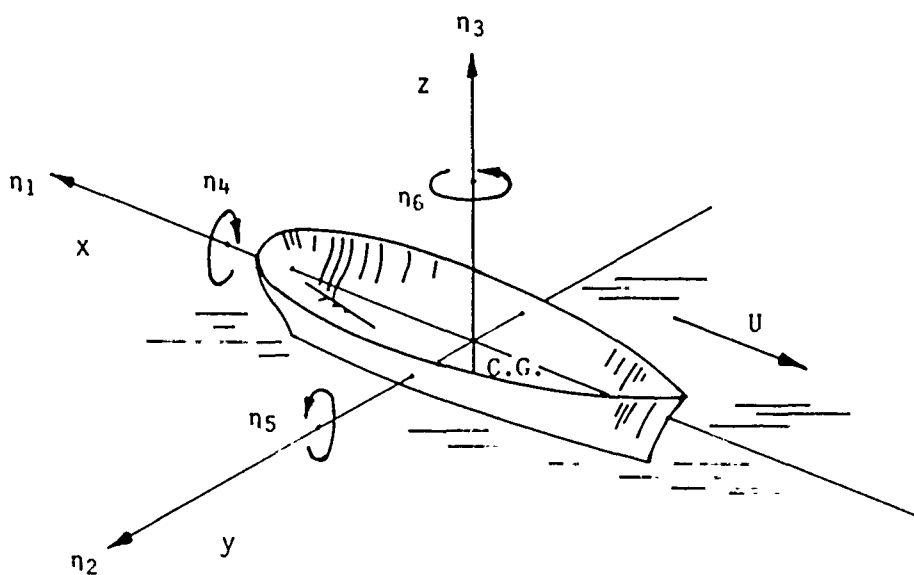
CONCLUDING REMARKS

The motions predicted for the AG(EH)-1 hydrofoil craft in the hullborne condition using the DTNSRDC Hullborne Hydrofoil 6DOF Computer Program agree satisfactorily with the available experimental data, namely for the heading angles of 90, 150, and 180 degrees.

Additional comparisons directed toward verification of the DTNSRDC Hullborne Hydrofoil 6-D Motion Computer Program should be made as more experimental results are made available. The program in its present state cannot be used to predict motions at zero craft speed and in conditions of negative encounter frequencies.

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3. Meyers, W.G., D.J. Sheridan; and N. Salvesen, "Manual - NSRDC Ship-Motion and Sea-Load Program", Naval Ship R&D Center, Report No. 3376, Feb 1975
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TRANSLATORY DISPLACEMENTS

η_1 = SURGE

η_2 = SWAY

η_3 = HEAVE

ANGULAR DISPLACEMENTS

η_4 = ROLL

η_5 = PITCH

η_6 = YAW

Figure 1 - Sign Convention of Coordinate System with Origin at the C.G.

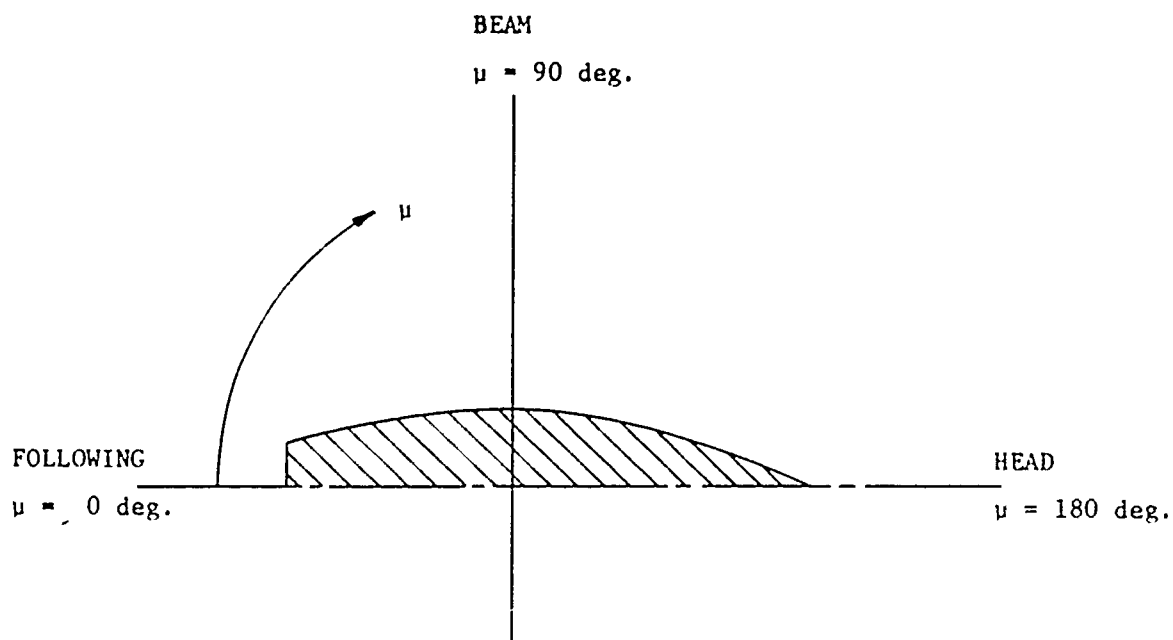


Figure 2 - Definition of Heading Angle, μ

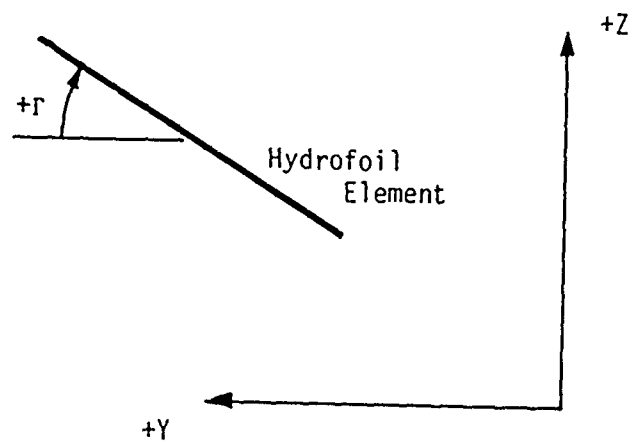
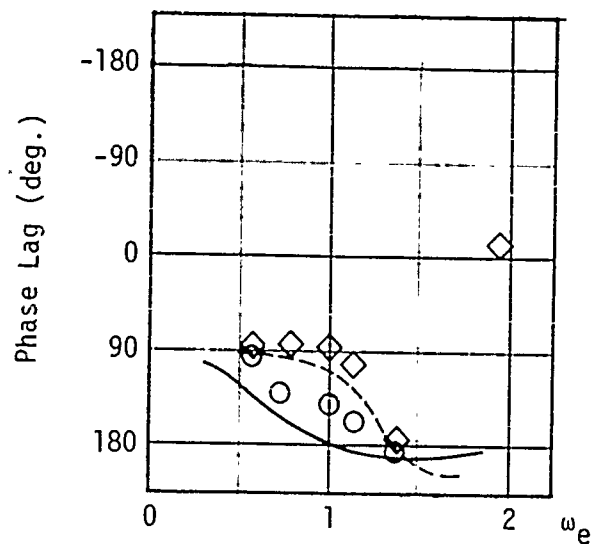
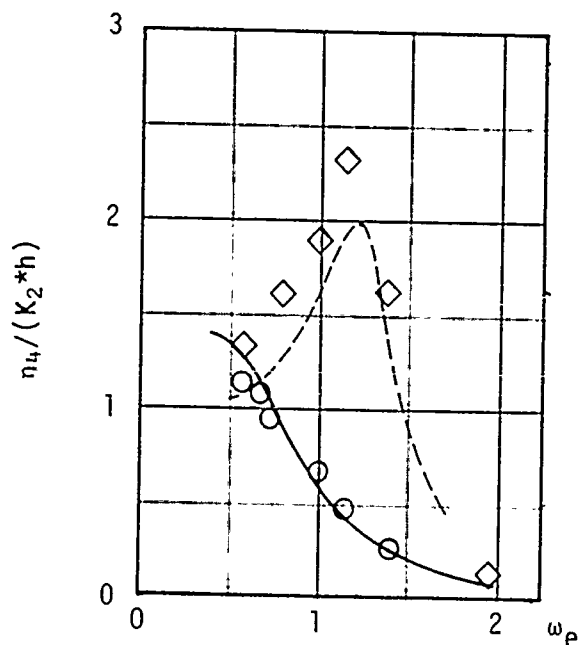
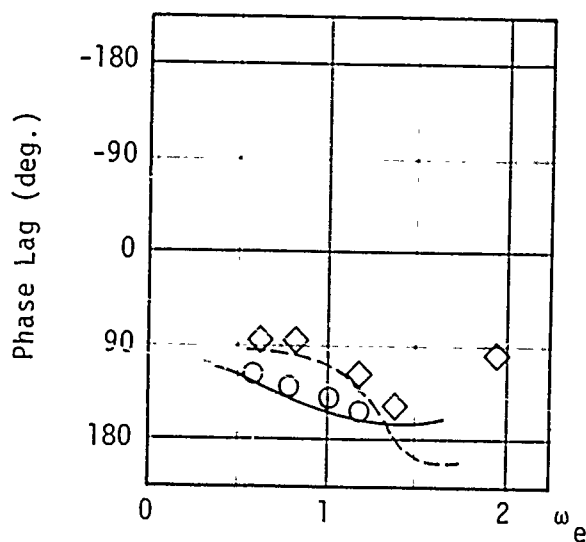
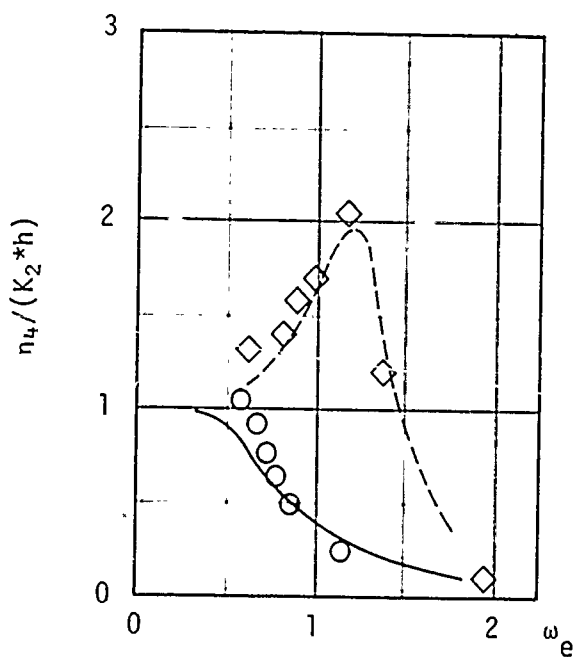


Figure 3 - Definition of Hydrofoil Element Angle, Γ



VELOCITY = 6 knots

	Theory	Exper.
FOILS UP	-----	◇
FOILS DOWN	————	○



VELOCITY = 12 knots

Figure 5 - Non-Dimensional Transfer Function and Phase Versus Wave Frequency of Encounter for Beam Sea Roll

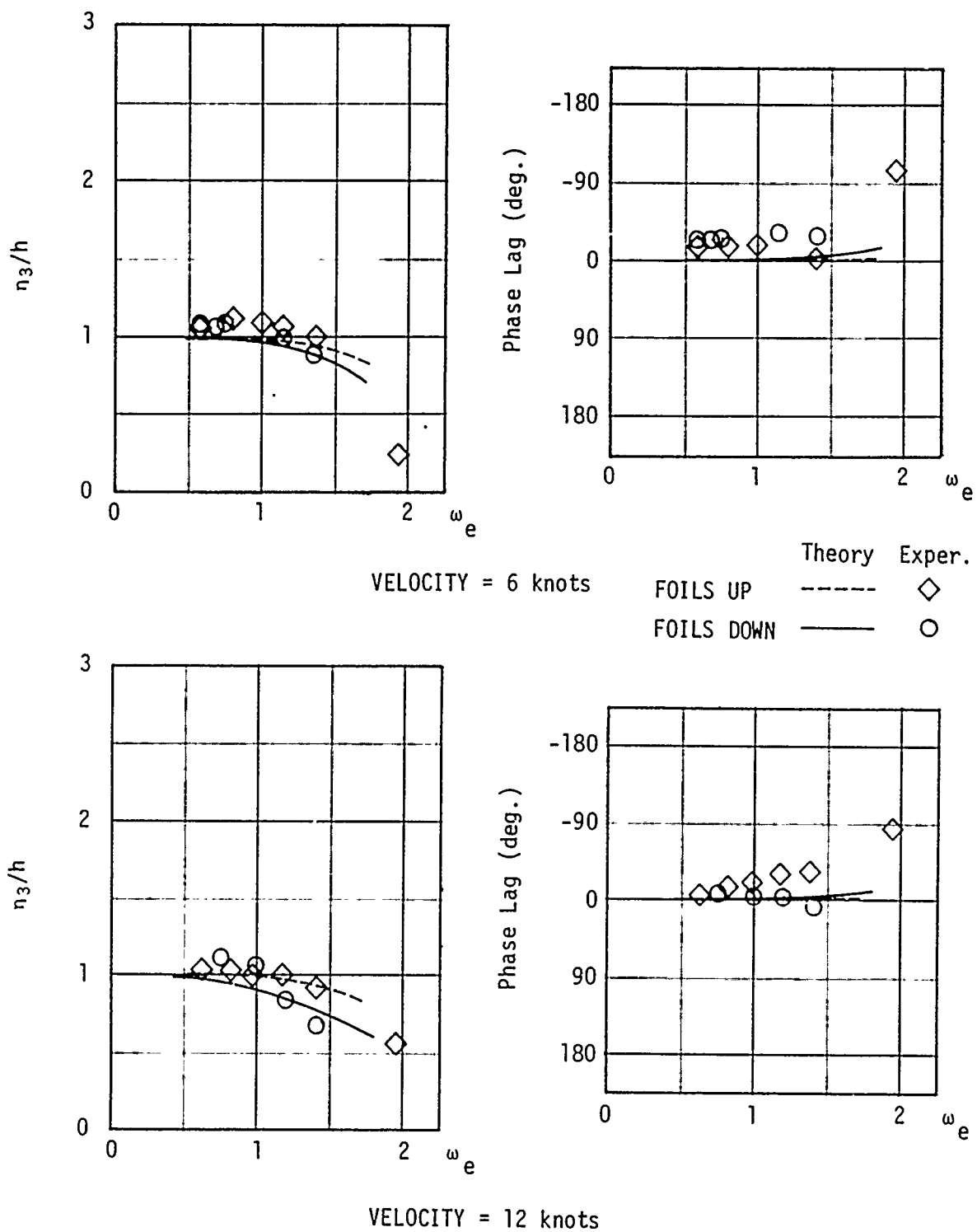


Figure 6 - Non-Dimensional Transfer Function and Phase Versus Wave Frequency of Encounter for Beam Sea Heave

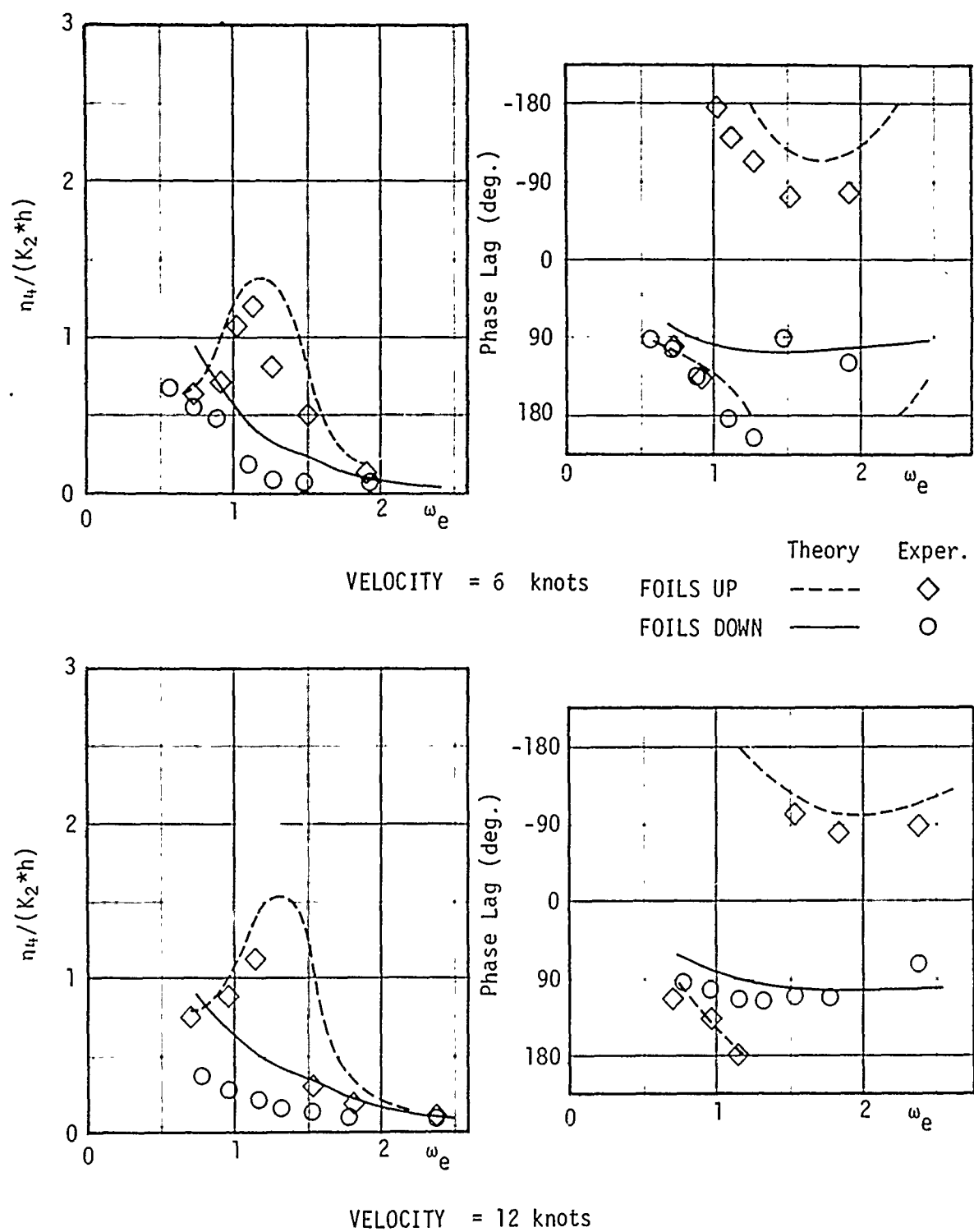


Figure 7 - Non-Dimensional Transfer Function and Phase Versus Wave Frequency of Encounter for Bow Sea Roll

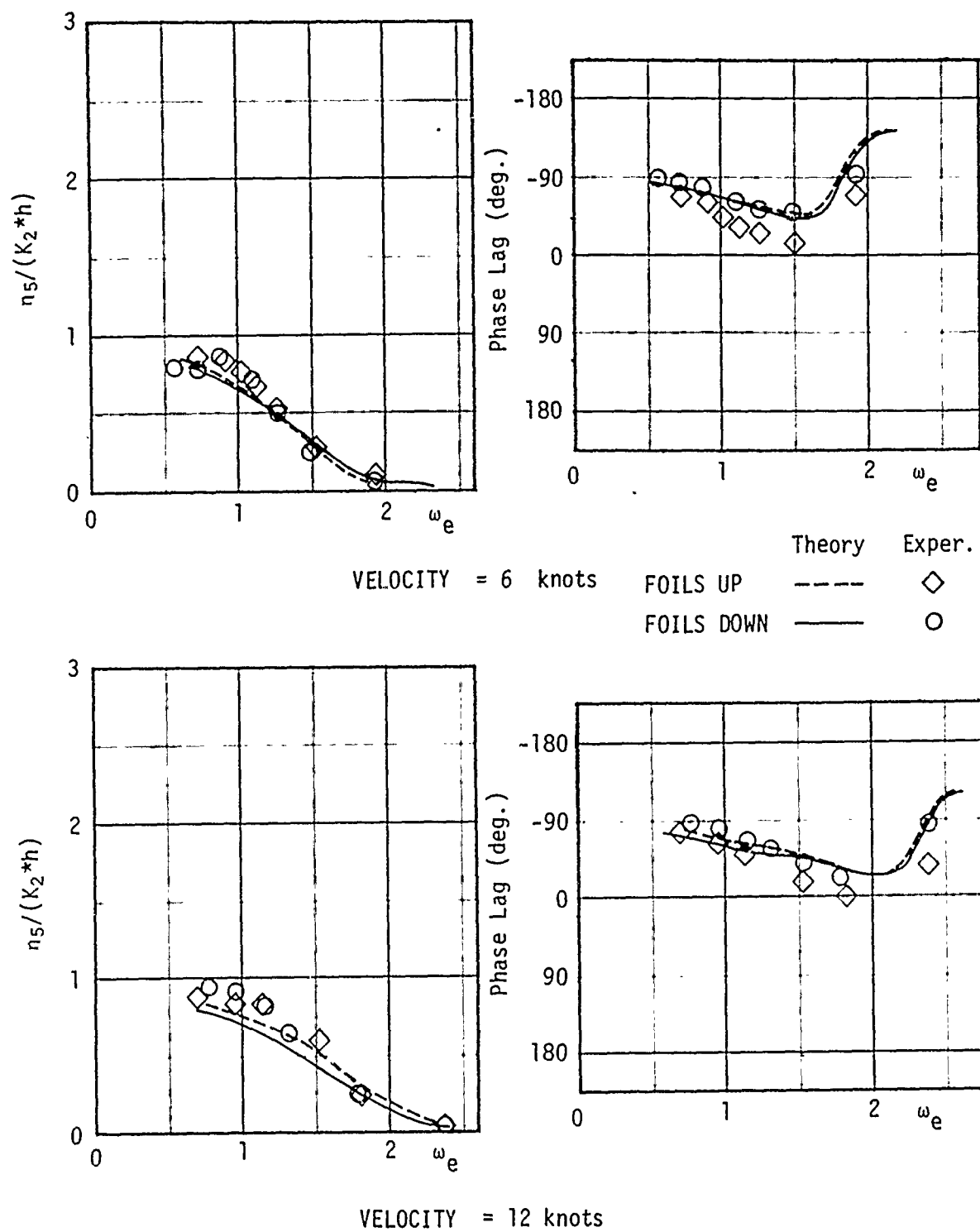


Figure 8 - Non-Dimensional Transfer Function and Phase Versus Wave Frequency of Encounter for Bow Sea Pitch

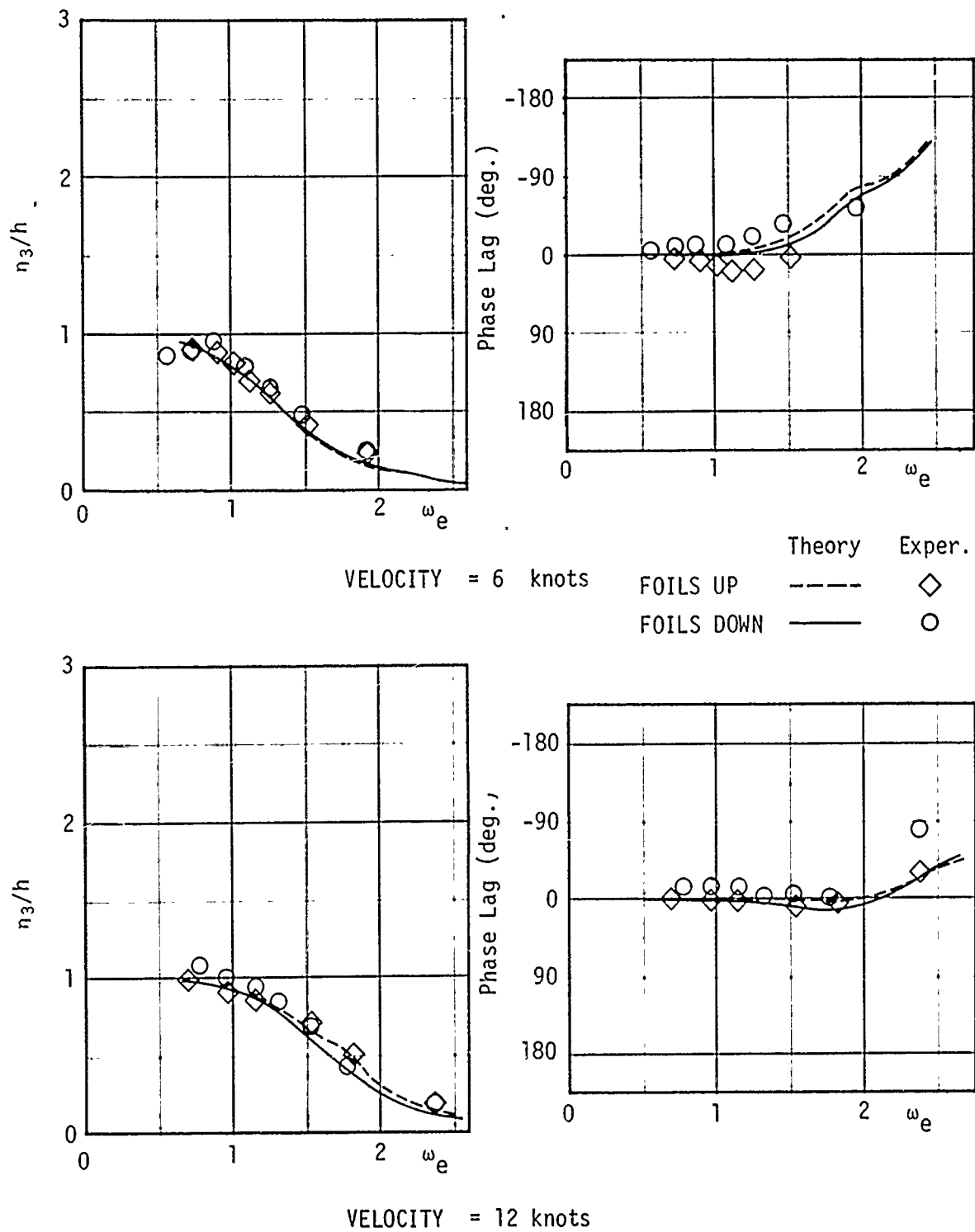


Figure 9 - Non-Dimensional Transfer Function and Phase Versus Wave Frequency of Encounter for Bow Sea Heave

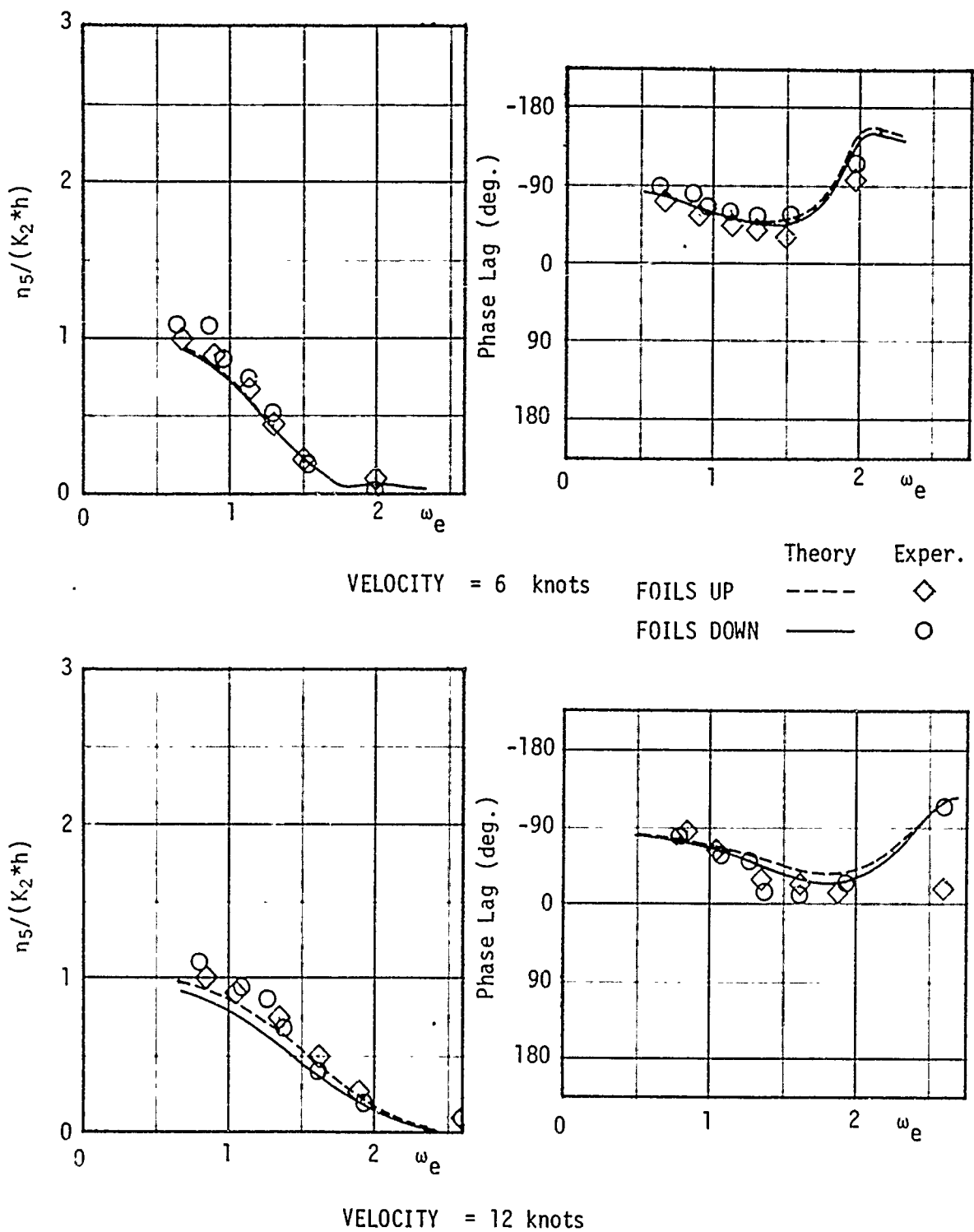


Figure 10 - Non-Dimensional Transfer Function and Phase Versus Wave Frequency of Encounter for Head Sea Pitch

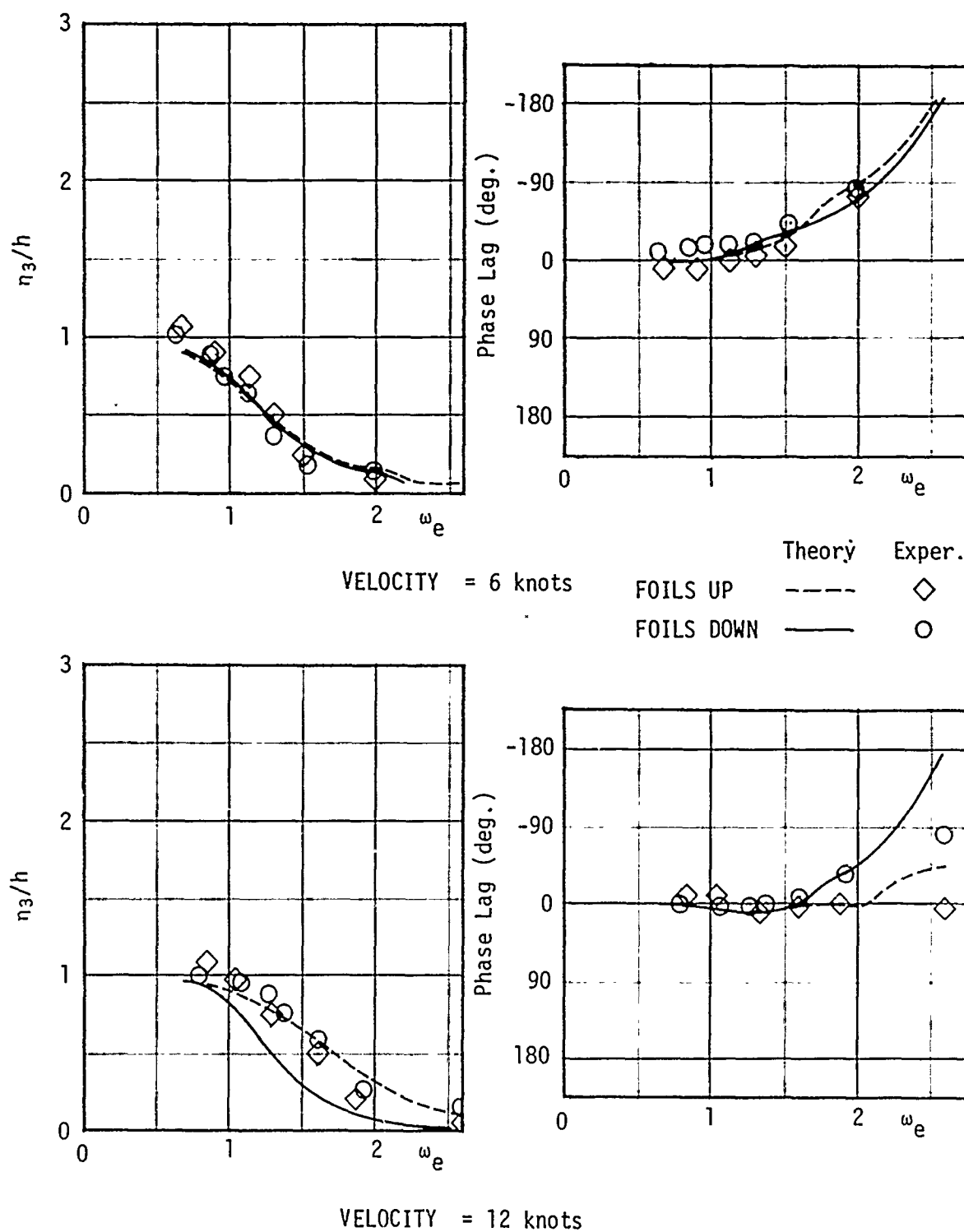


Figure 11 - Non-Dimensional Transfer Function and Phase Versus Wave Frequency of Encounter for Head Sea Heave

APPENDIX A

LISTING OF HYDROFOIL COEFFICIENTS

The hydrofoil portion of the added mass, damping, and restoring coefficients of the two sets of three simultaneous differential equations of motions in (1) surge, heave, and pitch and in (2) sway, roll, and yaw are listed below for rectangular foil elements in symmetry about the xz-plane. For the special case of a foil element lying in the xz-plane, half of the magnitudes given below give a good approximation. The coefficients are in:

$$\text{Surge: } A_{1j}^F = B_{1j}^F = C_{1j}^F = 0 ; j = 1, 3, 5$$

$$\text{Heave: } A_{31}^F = B_{31}^F = C_{31}^F = 0$$

$$A_{33}^F = \frac{1}{2} \pi \rho \Sigma bc^2 \cos^2 \Gamma$$

$$B_{33}^F = \rho U \Sigma bc C_{L\alpha} C(k) \cos^2 \Gamma$$

$$C_{33}^F = 2 \Sigma \frac{\partial LC(k)}{\partial h} \cos \Gamma$$

$$A_{35}^F = -\frac{1}{2} \pi \rho \Sigma bc^2 \chi \cos^2 \Gamma$$

$$B_{35}^F = -\frac{1}{2} \pi \rho U \Sigma bc^2 \chi \cos^2 \Gamma \\ - \rho U \Sigma bc C_{L\alpha} C(k) \left(\chi + \frac{c}{4} \right) \cos^2 \Gamma$$

$$C_{35}^F = -\rho U^2 \Sigma bc C_{L\alpha} C(k) \cos^2 \Gamma \\ + 2 \Sigma \frac{\partial LC(k)}{\partial h} \left(\chi - \frac{c}{4} \right) \cos \Gamma$$

Sway:

$$A_{22}^F = \frac{1}{2} \pi \rho \Sigma b c^2 \sin^2 \Gamma$$

$$B_{22}^F = \rho U \Sigma b c C_{L\alpha} C(k) \sin^2 \Gamma$$

$$A_{24}^F = -\frac{1}{2} \pi \rho \Sigma b c^2 \sin \Gamma (Z \sin \Gamma + Y \cos \Gamma)$$

$$B_{24}^F = -\rho U \Sigma b c C_{L\alpha} C(k) \sin \Gamma (Z \sin \Gamma + Y \cos \Gamma)$$

$$C_{24}^F = -2 \Sigma \frac{\partial L}{\partial h} C(k) Y \sin \Gamma$$

$$A_{26}^F = \frac{1}{2} \pi \rho \Sigma b c^2 \chi \sin^2 \Gamma$$

$$B_{26}^F = \frac{1}{2} \pi \rho U \Sigma b c^2 \sin^2 \Gamma$$

$$+ \rho U \Sigma b c C_{L\alpha} C(k) \left(\chi + \frac{c}{4} \right) \sin^2 \Gamma$$

$$C_{26}^F = \rho U^2 \Sigma b c C_{L\alpha} C(k) \sin^2 \Gamma$$

Roll:

$$A_{42}^F = -\frac{1}{2} \pi \rho \Sigma b c^2 \sin \Gamma (Z \sin \Gamma + Y \cos \Gamma)$$

$$B_{42}^F = -\rho U \Sigma b c C_{L\alpha} C(k) \sin \Gamma (Z \sin \Gamma + Y \cos \Gamma)$$

$$A_{44}^F = \frac{1}{24} \pi \rho \Sigma b^3 c^2 + \frac{1}{2} \pi \rho \Sigma b c^2 (Z \sin \Gamma + Y \cos \Gamma)^2$$

$$B_{44}^F = \frac{1}{12} \rho U \Sigma C_{L\alpha} C(k) b^3 c + \rho U \Sigma b c C_{L\alpha} C(k) (Z \sin \Gamma + Y \cos \Gamma)^2$$

$$C_{44}^F = 2 \Sigma \frac{\partial L}{\partial h} C(k) Y (Y \cos \Gamma + Z \sin \Gamma)$$

$$A_{46}^F = -\frac{1}{2} \pi \rho \Sigma b c^2 \chi \sin \Gamma (Z \sin \Gamma + Y \cos \Gamma)$$

$$B_{46}^F = -\frac{1}{2} \pi \rho U \Sigma b c^2 \sin \Gamma (Z \sin \Gamma + Y \cos \Gamma)$$

$$- \rho U \Sigma b c C_{L\alpha} C(k) \left(\chi + \frac{c}{4} \right) \sin \Gamma (X \sin \Gamma + Y \cos \Gamma)$$

$$C_{46}^F = -\rho U^2 \Sigma b c C_{L\alpha} C(k) \sin \Gamma (Z \sin \Gamma + Y \cos \Gamma)$$

Pitch: $A_{51}^F = B_{51}^F = 0$

$$A_{53}^F = -\frac{1}{2} \pi \rho \Sigma b c^2 \chi \cos^2 \Gamma$$

$$B_{53}^F = -\rho U \Sigma b c C_{L\alpha} C(k) \left(\chi - \frac{c}{4}\right) \cos^2 \Gamma$$

$$C_{53}^F = -2 \Sigma \frac{\partial L}{\partial h} C(k) \left(\chi - \frac{c}{4}\right) \cos \Gamma$$

$$A_{55} = \frac{1}{64} \pi \rho \Sigma b c^4 \cos^2 \Gamma + \frac{1}{2} \pi \rho \Sigma b c^2 \chi^2 \cos^2 \Gamma$$

$$B_{55} = \frac{1}{2} \pi \rho U \Sigma b c^2 \chi \cos^2 \Gamma + \frac{1}{8} \pi \rho U \Sigma b c^3 \cos^2 \Gamma + \rho U \Sigma b c C_{L\alpha} C(k) \left(\chi + \frac{c}{4}\right) \left(\chi - \frac{c}{4}\right) \cos^2 \Gamma$$

$$C_{55} = \rho U^2 \Sigma b c C_{L\alpha} C(k) \left(\chi - \frac{c}{4}\right) \cos^2 \Gamma + 2 \Sigma \frac{\partial L}{\partial h} C(k) \left(\chi + \frac{c}{4}\right) \left(\chi - \frac{c}{4}\right) \cos \Gamma$$

Yaw: $A_{62} = \frac{1}{2} \pi \rho \Sigma b c^2 \chi \sin^2 \Gamma$

$$B_{62} = \rho U \Sigma b c C_{L\alpha} C(k) \left(\chi - \frac{c}{4}\right) \sin^2 \Gamma$$

$$A_{64} = -\frac{1}{2} \pi \rho \Sigma b c^2 \chi \sin \Gamma (Z \sin \Gamma + Y \cos \Gamma)$$

$$B_{64} = -\rho U \Sigma b c C_{L\alpha} C(k) \left(\chi - \frac{c}{4}\right) \sin \Gamma (Z \sin \Gamma + Y \cos \Gamma)$$

$$C_{64} = -2 \Sigma \frac{\partial L}{\partial h} C(k) \left(\chi - \frac{c}{4}\right) Y \sin \Gamma$$

$$A_{66} = \frac{1}{64} \pi \rho \Sigma b c^4 \sin^2 \Gamma + \frac{1}{2} \pi \rho \Sigma b c^2 \chi^2 \sin^2 \Gamma$$

$$B_{66} = \frac{1}{2} \pi \rho U \Sigma b c^2 \chi \sin^2 \Gamma + \rho U \Sigma b c C_{L\alpha} C(k) \left(s + \frac{c}{4}\right) \left(s - \frac{c}{4}\right) \sin^2 \Gamma + \frac{1}{8} \pi \rho U \Sigma b c^3 \sin^2 \Gamma$$

$$C_{66} = \rho U^2 \Sigma b c C_{L\alpha} C(k) \left(\chi - \frac{c}{4}\right) \sin^2 \Gamma$$

The lift slope curve, $C_{L\alpha}$, is taken in the program as equal to 2π

APPENDIX B

DATA CARD FORMAT DESCRIPTION OF NSRDC SHIP-MOTION COMPUTER PROGRAM AS PERTAINING TO THE HULLBORNE HYDROFOIL CRAFT MOTION COMPUTER PROGRAM (Data Card Sets 1 - 34)

For a particular hullborne hydrofoil craft the input on punched cards consists of 37 Data Card Sets. A description of the initial 34 non-hydrofoil related Data Card Sets (see Reference 2) is given below. Deleted are those sets that deal with the Sea-Load portion of the original Computer Program. The exact number of Data Card Sets as well as the number of cards in each set will vary according to the requirements of a particular problem. The final Data Card Sets 35, 36, and 37 which relate to the hydrofoil system are described in the text.

Data Card Set 1, one card, FORMAT (3A10).

This card contains three alphanumeric variables used to identify the output.

- (1) NAME1, columns 1 - 10, identifies the user's name.
- (2) NAME2, columns 11 - 20, identifies the user's code,
- (3) NAME3, columns 21 - 30, identifies the user's telephone extension.

Data Card Set 2, one card, FORMAT (5X, A4, 7X, A3, 8X, A3).

This card contains three alphanumeric variables used as controls for a number of options. The spelling of the values of the variables is tested in the program against defined names. Hence care should be exercised in using the correct spelling.

- (1) IPASS, columns 6 - 9, is a control for reading in Data Card Sets 3 - 34. The options are,
 - IPASS = GOGO, read-in sets 3 - 34.
 - IPASS = STOP, program stops.
 - IPASS undefined, GOGO assumed (default).

(2) OTAPE, columns 17 - 19, is a control for positioning the output tape. Results are stored on an output tape as well as printed out. The options are:

OTAPE = NEW, no tape positioning, new tape.

OTAPE = OLD, output tape automatically positioned past previous results.

OTAPE undefined, NEW assumed (default).

(3) PRNTOP, columns 28 - 30, is a printout option.

PRNTOP = MAX, maximum printing.

PRNTOP = MIN, printing of results suppressed, only data cards listed.

PRNTOP undefined, MAX assumed (default!).

NOTE - Data Card Set 2 provides a method for including data for more than one ship at a time. This set should be placed before and after the cards for each ship (Data Card Sets 3 - 34). After the data for the last ship use IPASS = STOP.

Data Card Set 3, one card, FORMAT (12A6).

This card contains alphanumeric information identifying the project, ship, calculations, etc.

TITO (array), columns 1 - 72.

Data Card Set 4, one card, FORMAT (2A6, A8)

This card contains three alphanumeric variables.

(1) WORD, columns 1 - 6, identifies the input length unit used. A unit commonly used is FEET. All dimensional variables input to the program must be in units consistent with this length unit.

(2) WORD2, columns 7 - 12, identifies the force unit, if WORD = FEET then WORD2 = TONS.

(3) WORD3, columns 13 - 20, identifies the moment unit. If WORD = FEET then WORD3 = FT-TONS.

WORD, WORD2, and WORD3 are printed out with the dimensional part of the output to identify the dimensional units.

Data Card Set 5, one card, FORMAT (4I6)

This card contains four integer variables.

(1) NUT $\leq$ 8, column 6, is the number of offset points used to describe each station. All stations must have the same number of offsets. It is recommended that 8 offset points be used.

(2) NST $\leq$ 27, columns 11 - 12, is the number of stations used to longitudinally subdivide the ship.

(3) NMAS = NST, columns 17 - 18, is the number of mass points. If IT $\neq$ 0 (see the next integer description) then punch a one in column 18.

(4) IT, column 24, is a control for reading in Data Card Set 9 or Data Card Sets 10 - 14.

IT = 0, read in the mass and mass-distribution data for each station, contained in Data Card Sets 10 - 14. This option must be used when load calculations are desired.

IT $\neq$ 0, read in the mass and mass-distribution data for the ship as a whole, contained on Data Card Set 9. This option is used when only motion calculations are desired.

Data Card Set 6, from one to four cards, FORMAT (8F10.4)

This card set contains the NST station numbers, ST1(I), used to longitudinally subdivide the ship. The stations are input in the order they occur along the ship starting with the first station at the extreme forward point of the ship. For example, 0.0, 0.25, 1.0, . . . , 19.75, 20.0. See Appendix B.1 for recommended station numbering.

ST1 (array), columns 1 - 10, 11 - 20, . . . , 71 - 80/repeat for up to four cards, eight numbers per card.

Data Card Set 7, one card, FORMAT (2F10.4)

This card contains the following two floating point numbers:

- (1) ELL, columns 1 - 10, is the length between perpendiculars, L_{pp} , in WORD units.
- (2) BEAM, columns 11 - 20, is the beam at midships in WORD units.

Data Card Set 8, two cards for each of NST-2 stations, a total of 2 * (NST-2) cards, FORMAT (8F10.4)

This card set contains the y and z coordinates of the offset points for each of NST-2 stations (see Figures 4 and 5). The foremost and aftermost stations have no offsets and are not specified in this data card set. Appendix B.2 provides information on allowable section shapes and contour specifications.

(1) Y (array), first card, columns 1 - 10, 11 - 20, . . . , 71 - 80, contains the NUT y coordinates of the offset points for Section I^{*} in WORD units. The y coordinates (positive) are given proceeding clockwise around the station contour, with the first y value at the intersection of the waterline and the station contour, and the last y value at the intersection of the centerline and the station contour. For fully submerged sections the first y value is zero.

(2) Z (array), second card, columns 1 - 10, 11 - 20, . . . , 71 - 80, contains the NUT z coordinates (negative) of the offset points for Section I in WORD units. The z coordinates are given in the same manner as the y coordinates. For fully submerged sections the first z value is at the intersection of the station contour nearest the free surface and the centerline.

Data Card Set 9, one card, FORMAT (F10.4, 4F10.6, F10.4)

This card set is included when motions only are desired. In this case, IT $\neq$ 0 (see Data Card Set 5). This card set contains six floating point numbers.

(1) TMASS, columns 1 - 10, is the total mass of the ship in units consistent with the WORD length unit. For example, if FEET is the length unit, the mass unit would be TONS * SECONDS²/FEET.

* Note that station number ST1(I+1) is associated with Section I.

(2) EI44, columns 11 - 20, is the square of the roll radius of gyration divided by the length between perpendiculars, $(K_{\phi}/L_{pp})^2$.

(3) EI55, columns 21 - 30, is the square of the pitch radius of gyration divided by the length between perpendiculars, $(K_{\theta}/L_{pp})^2$.

(4) EI66, columns 31 - 40, is the square of the yaw radius of gyration divided by the length between perpendiculars, $(K_{\psi}/L_{pp})^2$. Usually EI66 is set equal to EI55.

(5) EI46, columns 41 - 50, is the mass product of inertia about the x and z axes divided by TMASS $\cdot$ ELL.² EI46 is very close to zero for most ships and in fact equal to zero for ship with fore and aft symmetry.

(6) ZG, columns 51 - 60, is the z coordinate of the center of gravity, CG, of the ship referenced to the waterline in WORD units (positive for CG above the waterline).

The next five Data Card Sets, 10 through 14, are included when load calculations are desired. In this case, IT = 0 (Data Card Set 5) and Data Card Set 9 is not required.

Data Card Sets 10-14 Delete

Data Card Set 15, one card, FORMAT(I6)

This card contains one integer variable.

IXAST, columns 5 - 6, is only used when end-effect corrections are made to the added-mass and damping coefficients for ships with transom type sterns (Data Card Set 23, IEND = 1). In this case, IXAST = NST - 2, which is the sequence number of the last section along the hull near the stern. Note that this card set must be included irrespective of the value of IEND.

Data Card Set 16, one card, FORMAT (4I6)

This card contains four integer variables.

(1) NOK $\leq$ 30, columns 5 - 6, is the number of wavelengths for which motion and load calculations are performed.

(2) NOB $\leq$ 5, column 12, is the number of Froude numbers for which motion and load calculations are performed.

(3) NOH $\leq$ 10, columns 17 - 18, is the number of headings for which motion and load calculations are performed.

(4) NWSTP $\leq$ 12, columns 23 - 24, is the number of waveslopes for which motion and load calculations are performed.

Data Card Set 17, one card, FOPMAT (1216)

This card contains the NWSTP reciprocals of wave steepness, INWSTP(1), defined as the ratio of wavelength to wave height, λ/ζ_w , i.e., 50, 80, 110. Wave slope in degrees is determined in the program as $180/\text{INWSTP}(1)$. The program also computes a wave amplitude for each wavelength as $\zeta_A = \lambda/2 \cdot \text{INWSTP}(1)$ where the wave slope is kept constant for each heading and Froude number. See Section IIA for a discussion of the use of wave amplitude in the nonlinear viscous roll-damping calculations and Section IV for a general discussion about the use of wave amplitude for scaling the output.

Data Card Set 18, from one to two cards, FORMAT (8F10.4)

This card set contains the NOH heading angles, HDG1(1), in degrees. The convention used in the program is head waves = 180 degrees.

Data Card Set 19, one card, FORMAT (5F10.4)

This card contains the NOB Froude numbers, FN(1). The Froude number is defined as,

$$F_n = \frac{V}{\sqrt{g \cdot L_{pp}}}$$

where V is the ship speed in feet/second, g is the acceleration due to gravity, and L_{pp} is the length between perpendiculars.

Data Card Set 20, from one to four cards, FORMAT (8F10.4)

This card set contains the NOK numbers of nondimensional wavelengths, BAM(1), for which calculations are to be performed. The wavelength is nondimensionalized by the length between perpendiculars, λ/L_{pp} .

Data Card Set 21, one card, FORMAT (15, 2F10.4)

This card contains one integer variable and two floating point variables:

(1) NFR ≤ 40 , columns 4-5, is the number of nondimensional frequencies of encounter, ω_{EN} , for which added-mass and damping values are calculated. The nondimensional frequency is defined by,

$$\omega_{EN} = \omega_E \cdot \sqrt{L_{pp}/g}$$

where ω_E is the dimensional frequency of encounter, L_{pp} is the length between perpendiculars, and g is the acceleration due to gravity. Note that NFR is in an 15 field instead of the usual 16. If NFR is undefined, the program will compute a value for it.

(2) OMIN, columns 6-15, defines the lower end of the range of ω_{EN} values. If OMIN is undefined, the program will compute a value.

(3) OMAX, columns 16-25, defines the higher end of the range of ω_{EN} . If OMAX is undefined, the program will compute a value.

Data Card Set 22, one card, FORMAT (16)

This card contains one integer variable.

IRR, column 6, is a control for interpolating the added-mass and damping values if irregular frequencies exist.

IRR = 1, no irregular frequencies.

IRR = 2, irregular frequencies exist.

IRR undefined, program will supply the proper value.

See Appendix C for a discussion of the effect of irregular frequencies on the calculation of the range of nondimensional frequencies and on the interpolation of the added-mass and damping coefficients.

Data Card Set 23, one card, FORMAT (616)

This card contains the following six integer variables:

(1) ML, column 6, is a control for the motion and load calculations.

ML = 1, only motions are calculated.

ML = 2, both motions and loads are calculated.

ML must be defined.

(2) IEND, column 12, is a control for including endterms in the equations of motion.

IEND = 1, end terms will be included. Set IXAST = NST-2 (Data Card Set 15).

IEND = 2, no end terms.

IEND must be defined.

(3) IBILGE, column 18, controls reading in Data Card Sets 27-28 which contain bilge keel information required by the program for computing the viscous roll-damping coefficient when Option 1 or Method 2 of Option 2 is used. (For definitions of the options see Section IIIA.3.)

IBILGE = 1, the ship has bilge keels. Read in Data Card Sets 27-28. See IDAMP and IPRCNT (integers 5 and 6 of this Data Card Set) for choice of option and method.

IBILGE = 2, no bilge keels. Skip Data Card Sets 27-28.

IBILGE must be defined.

(4) IPRES, column 24, is a control for the pressure calculations. It also controls reading in Data Card Set 29.

IPRES = 1, calculate pressures for the stations specified by Data Card Set 29.

IPRES = 2, no pressure calculations. Skip Data Card Set 29.

IPRES must be defined.

(5) IDAMP, column 30, is a control integer used to specify the option used to compute the viscous roll-damping coefficients. It also controls reading in Data Card Sets 32-34.

IDAMP = 1, Option 1 will be used and the total and sectional viscous roll-damping coefficients will be computed by the program using information supplied in Data Card Sets 25-28.

IDAMP = 2 (Future option), Option 2 will be used and the total viscous roll-damping coefficients will be read in from Data Card Set 32. See IPRCNT (next integer description) for the choice of method for determining the sectional coefficients.

IDAMP = 3 (Future option), Option 3 will be used and the program will determine the total and sectional viscous roll-damping coefficients from defined classes of ships. The class of ship is specified in Data Card Set 34.

IDAMP undefined, program will assume IDAMP = 1. If IDAMP = 1, Data Card Sets 32-34 will not be read in.

(6) IPRCNT, column 36, is a control integer used to specify the method used in Option 2 to determine the sectional viscous roll-damping coefficients.

IPRCNT = 1, Method 1 is used and the percentage of the sectional roll-damping is supplied in Data Card Set 33.

IPRCNT = 2, Method 2 is used. The program computes the percentages. Skip Data Card Set 33.

See Section III.A.3 - Viscous Roll-Damping Input and Table 3 for a discussion of the various Options and Methods.

Data Card Set 24, one card, FORMAT (F10.8, 2F10.4, I6)

This card contains three floating point numbers and one integer.

(1) VNY, columns 1 - 10, is the kinematic viscosity of water, ν , in units consistent with the WORD length unit. For fresh water at 70°F, $\nu = 1.059 \times 10^{-5} \text{ FT}^2 \cdot \text{SEC}$.

(2) GRAV, columns 11 - 20, is the acceleration due to gravity in units consistent with the WORD length unit. For instance, if WORD = FEET, $\text{GRAV} = 32.2 \text{ feet} \cdot \text{seconds}^{-2}$

(3) AMODL, columns 21 - 30, is the total length of the submerged portion of the hull. It is used by the program for the calculation of the Reynolds number.

(4) MOD, column 36, is a control integer for the type of flow around the hull.

MOD = 1, laminar flow around the hull is assumed.

MOD = 2, turbulent flow around the hull is assumed.

MOD must be defined.

Most cases require specification of turbulent flow. For small ships at slow speeds the flow may be laminar. Note—VNY, MODL, and MOD are required only when the program computes the roll damping (Option 1 or Method 2 of Option 2).

The next four Data Card Sets, 25 through 28, are not included when IDAMP = 2. They contain information the program uses to calculate roll damping.

Data Card Set 25, from one to two cards, FORMAT (16I5)

This card set contains the NST-2 control integers, ITS(I), one for each station except the extreme forward and extreme aft stations. The values of ITS(I) are used in the calculation of roll induced eddymaking. They specify the local hull shapes at Section I and are determined according to the following procedure:

(1) ITS(I) = 1, Section I has a V or U shape with a small radius at the keel (bow sections).

(2) ITS(I) = 2, Section I has a sectional area coefficient greater than 0.95 (parallel midbody with rectangular shapes).

(3) ITS(I) = 3, Section I has a shallow V or U shape with a local beam/draft ratio greater than 1.0 (aft sections of destroyers or cruisers).

(4) ITS(I) = 4, Section I has an extremely rounded shape (a destroyer hull section with extremely rounded bilges and no skeg).

Note that ITS is punched in 15 fields.

Data Card Set 26, from one to four cards, FORMAT (8F10.4)

This card set contains the NST-2 bilge radii, RD(I), in WORD units, one for each station except the extreme forward and extreme aft stations. RD(I) is defined as follows:

RD(I) = radius of bilge circle at Section I for,

(1) sections that have bilge keels,

and

(2) sections with ITS(I) = 2.

RD(I) = 1.0 otherwise.

The next two Data Card Sets, 27 and 28, are included only if the ship has bilge keels (IBILGE = 1).

Data Card Set 27, one card, FORMAT (2F10.4)

This card contains the following two bilge keel parameters:

(1) AKEELL, columns 1 - 10, is the total length of the bilge keel in WORD units.

(2) BEANKL, columns 11 - 20, is the maximum width of the bilge keel in WORD units.

Data Card Set 28, NST-2 number of cards, FORMAT (6F10.4)

This data card set provides a description of the bilge keel at each of the NST-2 stations. The extreme fore and aft stations are not considered. Each card contains the following six numbers (see Figure 8):

(1) RFD(I), columns 1 - 10, is the deadrise of Section I in WORD units. Set equal to 0.0 for stations with no bilge keels.

(2) DELTAD(I), columns 11 - 20, is the length of the bilge keel along Section I in WORD units. Set equal to 0.0 for stations with no bilge keel. The program tests for 0.0 in this case in order to by-pass a number of calculations.

(3) RKD(I), columns 21 - 30, is the distance from the middle of the bilge keel at Section I to an axis through the center of gravity of the ship and parallel to the x-axis. It is in WORD units. Set equal to 1.0 for sections with no bilge keels.

(4) SD(I), columns 31 - 40, is the distance from the root of the bilge keel to the waterline as measured along the countour of the hull at Section I. It is in WORD units. Set equal to 1.0 for stations with no bilge keels.

(5) COSPHD(I), columns 41 - 50, is the cosine of the angle, α , between RKD(I) and the bilge keel at Section I. Set equal to 1.0 for sections with no bilge keels.

(6) PHID(I), columns 51 - 60, is the angle, Φ , in radians, formed by RKD(I) and a line connecting the center of gravity with the waterline at Section I. Set equal to 1.0 for sections with no bilge keels.

The next Data Card Set, 29, is included only if pressure calculations are desired (IPRES = 1).

Data Card Set 29, from one to four cards, FORMAT (8F10.4)

This card set contains the NST-2 control numbers, STPR(I), which determine at which sections the pressure distribution will be calculated. The program can compute the pressures for up to *eight* sections. There are two options:

STPR(I) = 0.0, the pressure on Section I will not be calculated; and

STPR(I) = 1.0, the pressure distribution will be calculated on Section I.

STPR(I) must be defined.

Data Card Set 30 Delete

The next Data Card Set, 31, is not included if roll damping coefficients are read in (IDAMP = 2).

Data Card Set 31, from one to seven cards, FORMAT (8F10.4)

This card set contains the $NHF = NOH \cdot NOB \cdot NWSTP$ estimates of maximum roll angle (single amplitude), THMD(I), in radians. (See Data Card Set 16 for the definitions of NOH, NOB, and NWSTP.) The THMD(I) values are the initial values in the "trial and error" procedure used in solving the quasi-linear equations for roll. (See Equation 11 in Section IIA.) These estimates are functions of wave slope, Froude number and heading angle. Eight THMD(I) values are given per card in a sequential order given by varying the wave slope first, then the Froude number and finally the heading angle. If THMD(I) is undefined the program will supply initial estimates. If accurate estimates can be provided by the user, the run time will be reduced substantially. Note that due to storage restrictions $NHF \leq 50$.

The next Data Card Set, 32, is included when roll damping coefficients are to be read in (IDAMP = 2).

Data Card Set 32, from one to two cards, FORMAT (8F10.4)

This card set contains the following two roll-damping coefficients as a function of Froude number:

(1) B2(I), columns 1 - 10, is the linear viscous roll damping coefficient for the first Froude number.

(2) B3(I), columns 11 - 20, is the nonlinear viscous-roll damping coefficient for the first Froude number. If more than one Froude number is given, the remainder of the card should be filled with pairs of numbers, B2(I) and B3(I).

The next Data Card Set, 33, is included only when the roll-damping coefficients are to be determined for each station by the user (load calculations are desired and IDAMP = 2). In this case, IPRCNT = 1.

Data Card Set 33, from one to fifty cards, FORMAT (8F10.4)

This card set contains the percentages of B2(I) and B3(I) to be used for each of NST-2 stations. There are up to two cards for each station (excluding the extreme fore and extreme aft stations). The order of input per card is the same as in Data Card Set 32.

(1) PB2(I,J), columns 1 - 10, is the percentage of the B2 coefficient as a function of Station I and Froude number J.

(2) PB3(I,J), columns 11 - 20, is the percentage of the B3 coefficient. Note that, if IPRCNT = 2, the program will determine these percentages and Data Card Set 33 will not be required.

The next Data Card Set, 34, is included only if IDAMP = 3.

Data Card Set 34, one card, FORMAT (I6)

This card contains one control integer, ICLASS.

ICLASS, column 6, specifies the class of ship for which roll damping will be computed. The program will use stored values for the roll-damping coefficients as a function of ship class. The options are:

ICLASS = 1, small boats.

ICLASS = 2, high-speed transom-stern hulls.

ICLASS = 3, moderate-speed cruiser-stern hulls.

If data cards for another ship are to be included, first repeat Data Card Set 2 using IPASS = GOGO, followed by Data Card Sets 3 - 34 for the next ship. When no more ships are to be run, repeat Data Card Set 2 with IPASS = STOP. This completes the data card input for the program.

Commonly Used Equations	
Encounter frequency	$\omega_E = \omega - \frac{\omega^2 V}{g} \cos \mu$
Nondimensional ω_E	$\omega_{EN} = \omega_E \cdot \sqrt{L_{pp}/g}$
Wave frequency	$\omega = \sqrt{\frac{2\pi g}{\lambda}}$
Froude number	$F_n = \frac{V}{\sqrt{g L_{pp}}}$
Wave slope	$WS = \frac{360 \cdot \zeta_A}{\lambda}$
V is the ship speed in feet/second g is the acceleration due to gravity μ is the heading angle λ is the wavelength ζ_A is the wave amplitude L_{pp} is the length between perpendiculars	

APPENDIX C

Listing of the DTNSRDC Hullborne Hydrofoil Six-Degree of Freedom Motion Prediction Computer Program (see Ref. 3)

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C-----VERSION 4 - CDC 6700 - H A N S E L - JUNE, 1972
C-----NAVSHIP AND CEN SHIP-MOTION AND SEA-LOAD COMPUTER PROGRAM-----
C-----VERSION 0 - N.SALVESEN, NSRDC M.FRANK, NSRDC O.FALTINSEN, DNV
C-----VERSION 1 - UPDATED AND CONVERTED TO RUN ON THE UNIVAC 1108-----
C-----VERSION 2 - UPDATED ON UNIVAC 1108 AT NBS BY BILL MEYERS-----
C-----VERSION 3 - UPDATED AND CONVERTED TO RUN ON CDC 6700-----
C-----VERSION 4 - LOAD OUTPUT MODIFIED, SEQUENTIAL STORAGE OF-----
C-----FAA AND PAV - BILL MEYERS, JUNE, 1972-----
C
OVERLAY (LINK0,0,0)
PROGRAM HANSEL (INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,
2 TAP_1,TAP_10,TAPE20)
COMMON DUM1(2720),PRNTUP,LL42(356)
COMMON /TEMP/ DUM3(5000)
COMMON /LOADPRN/ STLC(24),NLOJ2,NLOJ3,LDAMP,IPPCNT,B2(5),B3(5),
2 P2(25,5),P3(25,5),ILASS
COMMON /PFOIL/ DUM5(93),IPRINT
COMMON /FOIL/ DUM6(36)
DATA ISTOP /4HSTOP/
1000 FORMAT (1H1,27(/),55X,19H* H A N S E L *)
1004 FORMAT ( 3A10)
1006 FORMAT (/50X,3A10)
1008 FORMAT (12X,3A10)
1010 FORMAT (1H1,40X,21H1LISTING OF ALL INPUT DATA CAPCS/)
1020 FORMAT (21X,1H1,3X,1H2,4X,1H3,9X,1H4,9X,1H5,9X,1H6,9X,1H7,9X,1H8/
24X,CAPCS)MNS ,8(10H1234567000)/)
1030 FORMAT (5X,A4,7X,A3,8X,A3)
1040 FORMAT (12X,*FASS=*,A4,* TAPE=*,A3,* PRINT=*,A3)
1050 FORMAT (11X,*VERSION 3 - CDC 6700 - H A N S E L - JUNE, 19*
2 *71*/11X,*NSRDC SHIP-MOTION AND SEA-LOAD COMPUTER PROGRAM*
2 /20X,3A10,
2 //10X,*FILE*,13,* JCU OUTPUT TAPE HI=HIGH DENSITY (556)*/)
1060 FORMAT (1H1,27(/),50X,13H* C E N D *)
CALL FTNIN (1,1,10)
CALL FTJIN (1,1,20)
REKIND 1
NPA55 = 0
WRITE (6,1000)
C-----
C DATA CARD SET 1
C-----
READ (5,1004) NAME1,NAME2,NAME3
WRITE (6,1006) NAME1,NAME2,NAME3
10 NPA55 = NPA55 + 1
WRITE (6,1010)
WRITE (6,1020)
IF (NPA55 .EQ. 1) WRITE (6,1008) NAME1,NAME2,NAME3
C-----
C DATA CARD SET 2

```

C-----	READ (5,1030) IPASS,OTAPE,PRNTOP	LK0	57
	WRITE (6,1040) IPASS,OTAPE,FRNTOP	LK0	58
	IF (IPASS.EQ. ISTOP) GO TO 20	LK0	59
	IF (NPASS.EQ. 1) CALL SKIP (CTAPE,NSKIP)	LK0	60
	IF (NPASS.GT. 1) CALL SKPFIL (1,-1)	LK0	61
	NFILE = NSKIP + NPASS	LK0	62
	WRITE (1,1050) NAME1,NAME2,NAME3,NFILE	LK0	63
	CALL SEPART (2)	LK0	64
	CALL OVERLAY (5HLINK1,1,0)	LK0	65
	CALL OVERLAY (5HLINK2,2,0)	LK0	66
	CALL OVERLAY (5HLINK3,3,0)	LK0	67
	ENDFILE 1	LK0	68
	K = NFILE + 1	LK0	69
	WRITE (1,1050) NAME1,NAME2,NAME3,K	LK0	70
	CALL SEPART (2)	LK0	71
	GO TO 10	LK0	72
20	ENDFILE 1	LK0	73
	REWIND 1	LK0	74
	WRITE (6,1060)	LK0	75
	STOP	LK0	76
	END	LK0	77
		LK0	78
C-----	VERSION 4 - CDC 6700 - S K I P - JUNE, 1972-----	SKP	2
C		SKP	3
	SUBROUTINE SKIP (OTAPE,L)	SKP	4
	INTEGER OTAPE,OLD,TITLE,ENDTAP,ENDGRO	SKP	5
	DATA OLD /3HOLD/, ENDTAP /10HEND OF TAP/, ENDGRO /10HEND OF GRO/	SKP	6
1000	FORMAT (A10)	SKP	7
2000	FORMAT (*1 *.13.* FILES SKIPPED ON OUTPUT TAPE*)	SKP	8
	L = 0	SKP	9
	IF (OTAPE.NE. OLD) GO TO 30	SKP	10
10	READ (1,1000) TITLE	SKP	11
	IF (TITLE.EQ. ENDGRO) GO TO 20	SKP	12
	IF (TITLE.NE. ENDTAP) GO TO 10	SKP	13
	CALL SKPFIL (1,-1)	SKP	14
	GO TO 30	SKP	15
20	L = L + 1	SKP	16
	CALL SKPFIL (1,1)	SKP	17
	GO TO 10	SKP	18
30	WRITE (6,2000) L	SKP	19
	RETURN	SKP	20
	END	SKP	21
C		SKP	22
C-----	VERSION 4 - CDC 6700 - S E P A R T - JUNE, 1972-----	SEP	2
C		SEP	3
	SUBROUTINE SEPART (N)	SEP	4
1000	FORMAT (/END OF GROUP*,2(4X,A10),2X,F10.3/)	SEP	5
1010	FORMAT (/END OF TAPE *,2(4X,A10),2X,F10.3)	SEP	6
	CDATE = DATE (D)	SEP	7
	CTIME = TIME (E)	SEP	8
	ATIME = SECOND (A)	SEP	9
	IF (N.EQ. 1) WRITE (1,1000) CDATE,CTIME,ATIME	SEP	10
	IF (N.EQ. 1) GO TO 10	SEP	11
	WRITE (1,1010) CDATE,CTIME,ATIME	SEP	12
	WRITE (1,1010) CDATE,CTIME,ATIME	SEP	13
	BACKSPACE 1	SEP	14
10	RETURN	SEP	15
	END	SEP	16
C		SEP	17
C-----	VERSION 4 - CDC 6700 - S I M P U N - JUNE, 1972-----	SIM	2
C		SIM	3
	FUNCTION SIMPUN(X,Y,N)	SIM	4
C		SIM	5
	FORTAN IV FUNCTION FOR SIMPSONS RULE INTEGRATION	SIM	6
C		SIM	7
	EQUAL OR UNEQUAL INTERVALS.W.FRANK	SIM	8
C		SIM	9
	DIMENSION X(50),Y(50)	SIM	10
2	FORMAT(23HCNON MONOTONE X SIMPUN I4,1PE12.4)	SIM	11
	IF(N-2) 7,5,4	SIM	12
5	S=(Y(1)+Y(2))*(X(2)-X(1))/2.	SIM	13
	GO TO 6	SIM	14
7	S=0.	SIM	15
	GO TO 6	SIM	16

4	M=N-1	SIM	17
	S=(X(2)-X(1))/6.*(Y(1)*((X(2)-X(3))/(X(1)-X(3))+2.))+Y(2)*((X(1)-X(3))	SIM	18
	13)/(X(2)-X(3))+2.))-Y(3)*(X(2)-X(1))*2/((X(1)-X(3))*(X(2)-X(3)))	SIM	19
	LB=2	SIM	20
	IF(N-3) 8,8,9	SIM	21
9	S=(X(3)-X(2))/6.*(Y(2)*((X(3)-X(4))/(X(2)-X(4))+2.))+Y(3)*((X(2)-X(4))	SIM	22
	1X(4))/(X(3)-X(4))+2.))-Y(4)*(X(3)-X(2))*2/((X(2)-X(4))*(X(3)-X(4)))	SIM	23
	2))	SIM	24
	LB=3	SIM	25
8	DO 1 K=LB,M	SIM	26
	XDIFF=ABS(X(K+1)-X(1))	SIM	27
	XDIFF1=ABS(X(K)-X(1))	SIM	28
	IF(XDIFF-XDIFF1) 3,11,11	SIM	29
3	WRITE(6,2) K,X(K)	SIM	30
	GO TO 7	SIM	31
11	CONTINUE	SIM	32
	AB=(X(K+1)-X(K))/6.	SIM	33
	AC=Y(K)*((X(K+1)-X(K-1))/(X(K)-X(K-1))+2.)	SIM	34
	AD=Y(K+1)*((X(K)-X(K-1))/(X(K+1)-X(K-1))+2.)	SIM	35
	AE=Y(K-1)*(X(K+1)-X(K))*2/((X(K)-X(K-1))*(X(K+1)-X(K-1)))	SIM	36
1	S=S+AB*(AC+AD-AE)	SIM	37
6	SIMPUN=S	SIM	38
	RETURN	SIM	39
	END	SIM	40
C		MIV	2
C	-----VERSION 4 - CDC 6700 - M A T I N S - JUNE, 1972-----	MIV	3
C		MIV	4
	SUBROUTINE MATINS(A,NR,N1,B,NC,M1,DETERM,ID,INDEX)	MIV	5
C		MIV	6
C	PROGRAMMER- S. GOOD,NSRDC	MIV	7
C		MIV	8
	EQUIVALENCE (IROW,JROW),(ICOLUM,JCOLUM),(AMAX,T,SWAP)	MIV	9
	DIMENSION A(NR,NR),B(NR,NC),INDEX(NR,3)	MIV	10
C		MIV	11
C	INITIALIZATION	MIV	12
C		MIV	13
	N=N1	MIV	14
	M=M1	MIV	15
	DETERM=0.0	MIV	16
	DO 20 J=1,N	MIV	17
20	INDEX(J,3)=0	MIV	18
	DO 550 I=1,N	MIV	19
C		MIV	20
C	SEARCH FOR PIVOT ELEMENT	MIV	21
C		MIV	22
	AMAX=0.0	MIV	23
	DO 105 J=1,N	MIV	24
	IF(INDEX(J,3)-1) 60,105,60	MIV	25
60	DO 100 K=1,N	MIV	26
	IF(INDEX(K,3)-1) 80,100,715	MIV	27
80	IF(AMAX-ABS(A(J,K))) 85,100,100	MIV	28
85	IROW=J	MIV	29
	ICOLUM=K	MIV	30
	AMAX=ABS(A(J,K))	MIV	31
100	CONTINUE	MIV	32
105	CONTINUE	MIV	33
	INDEX(ICOLUM,3)=INDEX(ICOLUM,3)+1	MIV	34
	INDEX(I,1)=IROW	MIV	35
	INDEX(I,2)=ICOLUM	MIV	36
C		MIV	37
C	INTERCHANGE ROWS TO PUT PIVOT ELEMENT ON DIAGONAL	MIV	38
C		MIV	39
	IF(IROW-ICOLUM) 140,310,140	MIV	40
140	DETERM=-DETERM	MIV	41
	DO 200 L=1,N	MIV	42
	SWAP=A(IROW,L)	MIV	43

A(IROW,L)=A(ICOLUM,L)	MIV	44
200 A(ICOLUM,L)=SWAP	MIV	45
IF(M) 310,310,210	MIV	46
210 DO 250 L=1,M	MIV	47
SWAP=B(IROW,L)	MIV	48
B(IROW,L)=B(ICOLUM,L)	MIV	49
250 B(ICOLUM,L)=SWAP	MIV	50
C	MIV	51
C DIVIDE PIVOT ROW BY PIVOT ELEMENT	MIV	52
C	MIV	53
310 PIVOT=A(ICOLUM,ICOLUM)	MIV	54
DETERM=DETERM*PIVOT	MIV	55
330 A(ICOLUM,ICOLUM)=1.0	MIV	56
DO 350 L=1,N	MIV	57
350 A(ICOLUM,L)=A(ICOLUM,L)/PIVOT	MIV	58
IF(M) 380,380,360	MIV	59
360 DO 370 L=1,M	MIV	60
370 B(ICOLUM,L)=B(ICOLUM,L)/PIVOT	MIV	61
C	MIV	62
C REDUCE NON-PIVOT ROWS	MIV	63
C	MIV	64
380 DO 550 L1=1,N	MIV	65
IF(L1-ICOLUM) 400,550,400	MIV	66
400 T=A(L1,ICOLUM)	MIV	67
A(L1,ICOLUM)=0.0	MIV	68
DO 450 L=1,N	MIV	69
450 A(L1,L)=A(L1,L)-A(ICOLUM,L)*T	MIV	70
C	MIV	71
C	MIV	72
IF(M) 550,550,460	MIV	73
460 DO 500 L=1,M	MIV	74
500 B(L1,L)=B(L1,L)-B(ICOLUM,L)*T	MIV	75
550 CONTINUE	MIV	76
C	MIV	77
C INTERCHANGE COLUMNS	MIV	78
C	MIV	79
DO 710 I=1,N	MIV	80
L=N+1-I	MIV	81
IF(INDEX(L,1)-INDEX(L,2)) 630,710,630	MIV	82
630 JROW=INDEX(L,1)	MIV	83
JCOLUM=INDEX(L,2)	MIV	84
DO 705 K=1,N	MIV	85
SWAP=A(K,JROW)	MIV	86
A(K,JROW)=A(K,JCOLUM)	MIV	87
A(K,JCOLUM)=SWAP	MIV	88
705 CONTINUE	MIV	89
710 CONTINUE	MIV	90
DO 730 K=1,N	MIV	91
IF(INDEX(K,3)-1) 715,720,715	MIV	92
720 CONTINUE	MIV	93
730 CONTINUE	MIV	94
ID=1	MIV	95
810 RETURN	MIV	96
715 ID=2	MIV	97
GO TO 810	MIV	98
END	MIV	99
C	LK1	2
C-----VERSION 4 - CDC 6700 - P R O I - JUNE, 1972-----	LK1	3
C	LK1	4
OVERLAY (LINK1,1,0)	LK1	5
PROGRAM PRO1	LK1	6
CALL PRGM1	LK1	7
END	LK1	8

C		PR1	2
C	-----VERSION 4 - CDC 6700 - P R C M 1 - JUNE, 1972-----	PR1	3
C		PR1	4
	SUBROUTINE PRGM1	PR1	5
C		PR1	6
C	PROGRAMMER- O. FALTINSEN, ONV	PR1	7
C		PR1	8
	COMMON AY(27), NUT, NMAS, NUS, ST(25), OS(25), EL, ELL, X(25, 8), Y(25, 8), PH	PR1	9
	1AS(27), XMAS(27), ZMAS(27), KKG(27), XG, ZG, TMAS, L144, L155, L156, L146, TP	PR1	10
	2ST, RF33, RH35, RM55, CGH, JIP, K, N, TVOL, ALFA(40, 11), BETA(40, 11), HCG(10)	PR1	11
	3, FN(5), BAH(30), CUG(10), SDG(10), OMAX, OMN, NFR, NOK, NOB, NOH, ONEA(40),	PR1	12
	4FK(7, 6), XX(25, 7), YY(25, 7), GEL(25, 7), SHE(25, 7), CSE(25, 7), EN1(25, 7),	PR1	13
	SUN, ONEA, IJ, TITO(12), MORU, NUN, IXAST, HOG1(10), AT, LSV, CFC, PRNTOP	PR1	14
	COMMON SI1(27), YMAS(27), DEAM, CRAFT, UMAY, IRR, PL, ILAC, IBILGE, IPRES,	PR1	15
	2VNY, GRAV, AMOUL, MOD, AKELL, BEAMKL, ITS(25), RJ(25), FFL(25), DELTAD(25)	PR1	16
	2, RKD(25), SU(25), CUSPHD(25), PHIC(25), STPK(25), THMD(50)	PR1	17
	COMMON NMSTP, INMSIP(12)	PR1	18
	COMMON /TEMP/ ST2(29), OS1(27), XMAS1(27), SQAR(27), SAS(27), HBA(27),	PR1	19
	2 HB3(27), SS(27), X1(8), Y1(5), XY(6), SHB(27), HSB(27), DUM3(4704)	PR1	20
	COMMON /LODPRN/ STLD(24), MORO2, MORO3, IDAMP, IPACNT, B2(5), B3(5),	PR1	21
	2 PB2(25, 5), PB3(25, 5), ICLEAS	PR1	22
	COMMON /PFUIL/ FFOIL, RHO, NF, CPL(10), SPAN(10), CHORD(10), S(10), YF(10	FM00	3
	2), ZF(10), OGAPHA(10), CLZ(10), ASP(10), IPRINT	FM00	4
C		PR1	23
C	READ AND PRINT ALL DATA CARD INPUT	PR1	24
C	WRITE ALL DATA CARD INPUT ON SCO OUTPUT TAPE	PR1	25
C		PR1	26
	299 FORMAT (1H1, 12A6)	PR1	27
	1000 FORMAT (10X, *SHIP DATA CARD INPUT TO HANSEL*)	PR1	28
	8005 FORMAT (1H1, 40X, 31HLISTING OF ALL INPUT DATA CARDS/)	PR1	29
	8007 FORMAT (21X, 1H1, 9X, 1H2, 9X, 1H3, 9X, 1H4, 9X, 1H5, 9X, 1H6, 9X, 1H7, 9X, 1H8/	PR1	30
	24X, 8HCOLUMNS, 8(10H1234567890)/)	PR1	31
	8008 FORMAT (/24H END OF DATA CARD INPUT)	PR1	32
	8009 FORMAT (/27H ...CONTINUED ON NEXT PAGE.)	PR1	33
	8002 FORMAT (5X, A3, 8X, A3)	PR1	34
	8004 FORMAT (2H6, A8)	PR1	35
	8006 FORMAT (12X, 2H6, A8)	PR1	36
	8008 FORMAT (12A6)	PR1	37
	8010 FORMAT (12X, 12A6)	PR1	38
	8020 FORMAT (12I6)	PR1	39
	8030 FORMAT (12X, 12I6)	PR1	40
	8032 FORMAT (F10.4, 4F10.6, F10.4)	PR1	41
	8034 FORMAT (12X, F10.4, 4F10.6, F10.4)	PR1	42
	8040 FORMAT (6F10.4)	PR1	43
	8050 FORMAT (12X, 8F10.4)	PR1	44
	8060 FORMAT (15, 2F10.4)	PR1	45
	8070 FORMAT (12X, 15, 2F10.4)	PR1	46
	8080 FORMAT (F10.4, 2F10.4, I6)	PR1	47
	8090 FORMAT (12X, F10.4, 2F10.4, I6)	PR1	48
	8100 FORMAT (16I5)	PR1	49
	8110 FORMAT (12X, 16I5)	PR1	50
	WRITE (6, 8005)	PR1	51
	WRITE (6, 8007)	PR1	52
	BACKSPACE 1	PR1	53
	CALL SEPART (1)	PR1	54
	WRITE (1, 1000)	PR1	55
C	-----	PR1	56

C	DATA CARD SET 3	PR1	57
C	-----	PR1	58
	READ (5,8000) TITO	PR1	59
	WRITE (6,8010) TITC	PR1	60
	WRITE (1,8000) TITO	PR1	61
C	-----	PR1	62
C	DATA CARD SET 4	PR1	63
C	-----	PR1	64
	READ (5,8004) WORD,WORD2,WORD3	PR1	65
	WRITE (6,8006) WORD,WORD2,WORD3	PR1	66
	WRITE (1,8004) WORD,WORD2,WORD3	PR1	67
C	-----	PR1	68
C	DATA CARD SET 5	PR1	69
C	-----	PR1	70
	READ (5,8020) NUT,NST,NMAS,IT	PR1	71
	WRITE (6,8030) NUT,NST,NMAS,IT	PR1	72
	WRITE (1,8020) NUT,NST,NMAS,IT	PR1	73
	NUS = NST - 2	PR1	74
	M2 = NST	PR1	75
C	-----	PR1	76
C	DATA CARD SET 6	PR1	77
C	-----	PR1	78
	READ (5,8040) (ST1(I),I=1,M2)	PR1	79
	WRITE (6,8050) (ST1(I),I=1,M2)	PR1	80
	WRITE (1,8040) (ST1(I),I=1,M2)	PR1	81
C	-----	PR1	82
C	DATA CARD SET 7	PR1	83
C	-----	PR1	84
	READ (5,8040) ELL,SEAM	PR1	85
	WRITE (6,8050) ELL,SEAM	PR1	86
	WRITE (1,8040) ELL,SEAM	PR1	87
	DO 9010 I=1,NUS	PR1	88
C	-----	PR1	89
C	DATA CARD SET 8	PR1	90
C	-----	PR1	91
	READ (5,8040) (X(I,J),J=1,NUT)	PR1	92
	WRITE (6,8050) (X(I,J),J=1,NUT)	PR1	93
	WRITE (1,8040) (X(I,J),J=1,NUT)	PR1	94
	READ (5,8040) (Y(I,J),J=1,NUT)	PR1	95
	WRITE (6,8050) (Y(I,J),J=1,NUT)	PR1	96
	WRITE (1,8040) (Y(I,J),J=1,NUT)	PR1	97
	9010 CONTINUE	PR1	98
	IF (IT.EQ. 0) GO TO 9020	PR1	99
C	-----	PR1	100
C	DATA CARD SET 9	PR1	101
C	-----	PR1	102
	READ (5,8032) THAS,EI44,EI55,EI66,EI46,ZG	PR1	103
	WRITE (6,8034) THAS,EI44,EI55,EI66,EI46,ZG	PR1	104
	WRITE (1,8032) THAS,EI44,EI55,EI66,EI46,ZG	PR1	105
	WRITE (6,8009)	PR1	106
	WRITE (6,299)	PR1	107
	WRITE (6,8007)	PR1	108
	GO TO 9030	PR1	109
C	-----	PR1	110
C	DATA CARD SET 10	PR1	111
C	-----	PR1	112
	9020 READ (5,8040) (PMAS(I),I=1,NMAS)	PR1	113

WRITE (6,8050) (PMAS(I),I=1,NMAS)	PR1	114
WRITE (1,8040) (PMAS(I),I=1,NMAS)	PR1	115
C-----	PR1	116
C DATA CARD SET 11	PR1	117
C-----	PR1	118
READ (5,8040) (XMAS(I),I=1,NMAS)	PR1	119
WRITE (6,8050) (XMAS(I),I=1,NMAS)	PR1	120
WRITE (1,8040) (XMAS(I),I=1,NMAS)	PR1	121
C-----	PR1	122
C DATA CARD SET 12	PR1	123
C-----	PR1	124
READ (5,8040) (YMAS(I),I=1,NMAS)	PR1	125
WRITE (6,8050) (YMAS(I),I=1,NMAS)	PR1	126
WRITE (1,8040) (YMAS(I),I=1,NMAS)	PR1	127
C-----	PR1	128
C DATA CARD SET 13	PR1	129
C-----	PR1	130
WRITE (6,8009)	PR1	131
WRITE (6,299)	PR1	132
WRITE (6,8007)	PR1	133
READ (5,8040) (ZMAS(I),I=1,NMAS)	PR1	134
WRITE (6,8050) (ZMAS(I),I=1,NMAS)	PR1	135
WRITE (1,8040) (ZMAS(I),I=1,NMAS)	PR1	136
C-----	PR1	137
C DATA CARD SET 14	PR1	138
C-----	PR1	139
READ (5,8040) (RRG(I),I=1,NMAS)	PR1	140
WRITE (6,8050) (RRG(I),I=1,NMAS)	PR1	141
WRITE (1,8040) (RRG(I),I=1,NMAS)	PR1	142
C-----	PR1	143
C DATA CARD SET 15	PR1	144
C-----	PR1	145
9030 READ (5,8020) IXAST	PR1	146
WRITE (6,8030) IXAST	PR1	147
WRITE (1,8020) IXAST	PR1	148
C-----	PR1	149
C DATA CARD SET 16	PR1	150
C-----	PR1	151
READ (5,8020) NOK,N08,NOH,NWSTP	PR1	152
WRITE (6,8030) NOK,N08,NOH,NWSTP	PR1	153
WRITE (1,8020) NOK,N08,NOH,NWSTP	PR1	154
C-----	PR1	155
C DATA CARD SET 17	PR1	156
C-----	PR1	157
READ (5,8020) (INWSTP(I),I=1,NWSTP)	PR1	158
WRITE (6,8030) (INWSTP(I),I=1,NWSTP)	PR1	159
WRITE (1,8020) (INWSTP(I),I=1,NWSTP)	PR1	160
C-----	PR1	161
C DATA CARD SET 18	PR1	162
C-----	PR1	163
READ (5,8040) (HOG1(I),I=1,NOH)	PR1	164
WRITE (6,8050) (HOG1(I),I=1,NOH)	PR1	165
WRITE (1,8040) (HOG1(I),I=1,NOH)	PR1	166
C-----	PR1	167
C DATA CARD SET 19	PR1	168
C-----	PR1	169
READ (5,8040) (FN(I),I=1,N08)	PR1	170

WRITE (6,8050) (FN(I),I=1,NUS)	PR1	171
WRITE (1,8040) (FN(I),I=1,NUS)	PR1	172
C-----	PR1	173
C DATA CARD SET 20	PR1	174
C-----	PR1	175
READ (5,8040) (3AN(I),I=1,NCK)	PR1	176
WRITE (6,8050) (3AN(I),I=1,NCK)	PR1	177
WRITE (1,8040) (3AN(I),I=1,NCK)	PR1	178
C-----	PR1	179
C DATA CARD SET 21	PR1	180
C-----	PR1	181
READ (5,8060) NFR,OMIN,OMAX	PR1	182
WRITE (6,8070) NFR,OMIN,OMAX	PR1	183
WRITE (1,8060) NFR,OMIN,OMAX	PR1	184
C-----	PR1	185
C DATA CARD SET 22	PR1	186
C-----	PR1	187
READ (5,8020) IRR	PR1	188
WRITE (6,8030) IRR	PR1	189
WRITE (1,8020) IRR	PR1	190
C-----	PR1	191
C DATA CARD SET 23	PR1	192
C-----	PR1	193
READ (5,8020) HL,IENU,I3ILGE,IPRES,ICAMP,IPRCNT	PR1	194
WRITE (6,8030) HL,IENU,I3ILGE,IPRES,ICAMP,IPRCNT	PR1	195
WRITE (1,8020) HL,IENU,I3ILGE,IPRES,ICAMP,IPRCNT	PR1	196
C-----	PR1	197
C DATA CARD SET 24	PR1	198
C-----	PR1	199
READ (5,8060) VNY,GRAV,AMODL,MOD	PR1	200
WRITE (6,8090) VNY,GRAV,AMODL,MOD	PR1	201
WRITE (1,8080) VNY,GRAV,AMODL,MOD	PR1	202
IF (1CA1P.EQ. 2) GO TO 9045	PR1	203
C-----	PR1	204
C DATA CARD SET 25	PR1	205
C-----	PR1	206
READ (5,8100) (ITS(I),I=1,NUS)	PR1	207
WRITE (6,8110) (ITS(I),I=1,NUS)	PR1	208
WRITE (1,8100) (ITS(I),I=1,NUS)	PR1	209
C-----	PR1	210
C DATA CARD SET 26	PR1	211
C-----	PR1	212
READ (5,8040) (RO(I),I=1,NUS)	PR1	213
WRITE (6,8050) (RO(I),I=1,NUS)	PR1	214
WRITE (1,8040) (RO(I),I=1,NUS)	PR1	215
IF (13ALGE.EQ. 2) GO TO 9050	PR1	216
C-----	PR1	217
C DATA CARD SET 27	PR1	218
C-----	PR1	219
READ (5,8040) AKEELL,BEAKKL	PR1	220
WRITE (6,8050) AKEELL,DEAKKL	PR1	221
WRITE (1,8040) AKEELL,DEAKKL	PR1	222
DO 9040 I=1,NUS	PR1	223
C-----	PR1	224
C DATA CARD SET 28	PR1	225
C-----	PR1	226
READ (5,8040) RFD(I),DELTAD(I),RKU(I),SD(I),CCSFHU(I),PHIC(I)	PR1	227

WRITE (6,8050) RFO(I),CELTAD(I),RKO(I),SD(I),COSPHO(I),PHIC(I)	PR1	228
WRITE (1,8040) RFO(I),DELTAU(I),RKE(I),SJ(I),COSPHU(I),PHIC(I)	PR1	229
9040 CONTINUE	PR1	230
9045 CONTINUE	PR1	231
C-----	PR1	232
C DATA CARD SET 29	PR1	233
C-----	PR1	234
9050 IF (IPRES.EQ. 1) READ (5,8040) (STPR(I),I=1,NOS)	PR1	235
IF (IPRES.EQ. 1) WRITE (6,8050) (STPR(I),I=1,NOS)	PR1	236
IF (IPRES.EQ. 1) WRITE (1,8040) (STPR(I),I=1,NOS)	PR1	237
NOSM1 = NOS - 1	PR1	238
C-----	PR1	239
C DATA CARD SET 30	PR1	240
C-----	PR1	241
IF (IT.EQ. 0) READ (5,8040) (STLD(I),I=1,NOSM1)	PR1	242
IF (IT.EQ. 0) WRITE (6,8050) (STLD(I),I=1,NOSM1)	PR1	243
IF (IT.EQ. 0) WRITE (1,8040) (STLD(I),I=1,NOSM1)	PR1	244
NHF = NOH*NOB*NWSTP	PR1	245
IF (IDAMP.EQ. 2) GO TO 9052	PR1	246
C-----	PR1	247
C DATA CARD SET 31	PR1	248
C-----	PR1	249
READ (5,8040) (THMO(I),I=1,NHF)	PR1	250
WRITE (6,8050) (THMO(I),I=1,NHF)	PR1	251
WRITE (1,8040) (THMO(I),I=1,NHF)	PR1	252
9052 CONTINUE	PR1	253
IF (IDAMP.LE. 0) IDAMP = 1	PR1	254
IF (IDAMP=2) 9090,9055,9080	FMOD	5
9055 CONTINUE	PR1	256
C-----	PR1	257
C DATA CARD SET 32	PR1	258
C-----	PR1	259
READ (5,8040) (B2(I),B3(I),I=1,NOB)	PR1	260
WRITE (6,8050) (B2(I),B3(I),I=1,NOB)	PR1	261
WRITE (1,8040) (B2(I),B3(I),I=1,NOB)	PR1	262
IF (IFRCNT.NE. 1) GO TO 9090	PR1	263
DO 9070 I=1,NOS	PR1	264
C-----	PR1	265
C DATA CARD SET 33	PR1	266
C-----	PR1	267
READ (5,8040) (PB2(I,J),PB3(I,J),J=1,NOB)	PR1	268
WRITE (6,8050) (PB2(I,J),PB3(I,J),J=1,NOB)	PR1	269
WRITE (1,8040) (PB2(I,J),PB3(I,J),J=1,NOB)	PR1	270
9070 CONTINUE	PR1	271
GO TO 9090	PR1	272
9080 CONTINUE	PR1	273
C-----	PR1	274
C DATA CARD SET 34	PR1	275
C-----	PR1	276
READ (5,8020) ICLASS	PR1	277
WRITE (6,8030) ICLASS	PR1	278
WRITE (1,8020) ICLASS	PR1	279
9090 CONTINUE	PR1	280
905 FORMAT(15,3F12.2)	FMOD	6
906 FORMAT(12X,15,3F12.2)	FMOD	7
907 FORMAT(15,3F12.2)	FMOD	8
970 FORMAT(F3.0,5F7.2,F5.0,F10.7,F5.1)	FMOD	9

971	FORMAT (12X,F3.0,5F7.2,F5.0,F10.7,F5.1)	FMOD	10
980	FORMAT (//13H CARD SET 36)	FMOD	11
990	FORMAT (//13H CARD SET 37)	FMOD	12
7001	FORMAT (2I4)	FMOD	13
7002	FORMAT (//22H FOIL DATA CARD INPUT)	FMOD	14
7003	FORMAT (//32H1 HYDROFOIL VESSEL WITH FOILS UP/)	FMOD	15
7004	FORMAT (//34H1 HYDROFOIL VESSEL WITH FOILS DOWN/)	FMOD	16
2212	FORMAT (/21X,1M1,9X,1H2,9X,1H3,9X,1H4,9X,1H5,9X,1H6,9X,1H7,9X,1H8/ 24X,0H0LUMNS ,0(10H1234567890))	FMOD	17
2213	FORMAT (/14X,2HNF,9X,4HFVOL,8X,4HFXCB,3X,4HFZCB/)	FMOD	18
2214	FORMAT (/12X,3HCPL,3X,4HSPAN,2X,5HCHORD,3X,4HX(S),4X,1HY,6X,1H2,2X 2,6HOGAMMA,3X,3HCLZ,5X,3HASP/)	FMOD	19
C	-----	FMOD	20
C	DATA CARD SET 35	FMOD	21
C	-----	FMOD	22
C	HYDROFOIL VESSEL WITH FOILS UP - IFOIL=1	FMOD	23
C	HYDROFOIL VESSEL WITH FOILS DOWN - IFOIL=2	FMOD	24
C	PRINTOUT OF MATRIX EQUATIONS (NU = 0 , YES = 1)	FMOD	25
C	-----	FMOD	26
	READ(5,7001) IFOIL,IFRINT	FMOD	27
	IF(IFOIL.NE. 2) IFOIL=1	FMOD	28
	WRITE(1,7001) IFOIL	FMOD	29
	IF(IFOIL-1) 9091,9092,9092	FMOD	30
9091	WRITE(6,7003)	FMOD	31
	GO TO 9515	FMOD	32
9092	WRITE(6,7004)	FMOD	33
	WRITE(6,7002)	FMOD	34
	WRITE(6,2212)	FMOD	35
C	-----	FMOD	36
C	DATA CARD SET 36	FMOD	37
C	-----	FMOD	38
C	NUMBER OF INPUT FOIL ELEMENTS, DISPLACED VOLUME (HORO**3),	FMOD	39
C	LONGITUDINAL CENTER OF BOYANCY FROM F.P. AND VERTICAL CENTER OF	FMOD	40
C	BOYANCY FROM WATERLINE (HORO) OF THE ENTIRE HYDROFOIL SYSTEM	FMOD	41
C	-----	FMOD	42
	READ(5,905) NF,FVOL,FXCB,FZCB	FMOD	43
	WRITE(6,906)	FMOD	44
	WRITE(6,2213)	FMOD	45
	WRITE(6,906) NF,FVOL,FXCB,FZCB	FMOD	46
	WRITE(1,907) NF,FVOL,FXCB,FZCB	FMOD	47
	WRITE(6,907)	FMOD	48
	WRITE(6,2214)	FMOD	49
	DO 100 I=1,NF	FMOD	50
C	-----	FMOD	51
C	DATA CARD SET 37	FMOD	52
C	-----	FMOD	53
C	FOIL ELEMENT IN VERTICAL CENTER PLANE (CPL=1. FOR YES, CPL=2. FOR	FMOD	54
C	NO) , HYDROFOIL ELEMENT SPAN (FT), CHORD (FT), COORDINATES X,Y,Z	FMOD	55
C	OF MIDPOINT (FT), DIRECTIONAL ANGLE OF V-FOIL (DEG), VERTICAL LIFT	FMOD	56
C	SLOPE (HORO2/HORO), ASP IN THE FACTOR AR/(AR+ASP) FOR FINITE	FMOD	57
C	SPAN	FMOD	58
C	-----	FMOD	59
	READ(5,970) CPL(I),SPAN(I),CHORD(I),S(I),YF(I),ZF(I),OGAMMA(I),CL	FMOD	60
	ZZ(I),ASP(I)	FMOD	61
	WRITE(6,971) CPL(I),SPAN(I),CHORD(I),S(I),YF(I),ZF(I),OGAMMA(I),CL	FMOD	62
	ZZ(I),ASP(I)	FMOD	63
	WRITE(1,970) CPL(I),SPAN(I),CHORD(I),S(I),YF(I),ZF(I),OGAMMA(I),CL	FMOD	64
		FMOD	65
		FMOD	66

2Z(I),ASP(I)	FMOD	67
100 CONTINUE	FMOD	68
WRITE(6,2212)	FMOD	69
9515 CONTINUE	FMOD	70
WRITE(6,8008)	PR1	281
XG = 0.	PR1	282
FACT=0.017453293	PR1	283
C-----ALGORITHM TO COMPUTE SECTION WIDTHS-----	PR1	284
EPS = 0.001	PR1	285
K = 2	PR1	286
SECTB = ST1(1)	PR1	287
DIFF = ST1(2) - SECTB	PR1	288
SECTE = ST1(2) + DIFF	PR1	289
IF (SECTE.GT. (ST1(3)+EPS)) GO TO 956	PR1	290
IF (ABS(SECTE-ST1(3)).LE. EPS) SECTB = ST1(2) - 0.5*DIFF	PR1	291
NOS = NST - 2	PR1	292
DO 955 N=1,NOS	PR1	293
K = N + 1	PR1	294
ST(N) = ST1(K)	PR1	295
DIFF = ST1(K) - SECTB	PR1	296
SECTE = ST1(K) + DIFF	PR1	297
IF ((K+1).EQ.NST .AND. SECTE.GT. (ST1(NST)+EPS)) GO TO 956	PR1	298
IF ((K+1).LT.NST .AND. SECTE.GE. (ST1(K+1)-EPS)) GO TO 956	PR1	299
DS(N) = SECTE - SECTB	PR1	300
SECTB = SECTE	PR1	301
955 CONTINUE	PR1	302
GO TO 957	PR1	303
956 WRITE(6,2000) ST1(K),ST1(K+1),SECTE	PR1	304
2000 FORMAT (*1 STATION NUMBER ERROR -*/13X,*SECTION ASSOCIATED *	PR1	305
2 *WITH STATION*,F8.3,* INCLUDES STATION*,F8.3,*,*/13X,	PR1	306
2 *END OF SECTION =*,F8.3,*. CORRECT STATION NUMBERS AND RERUN.*/	PR1	307
2 26X,*- PROGRAM STOP -*)	PR1	308
STOP	PR1	309
957 CONTINUE	PR1	310
C	PR1	311
C NUT=NUMBER OF OFFSETPOINTS FOR EACH SECTION	PR1	312
C NMAS=NUMBER OF MASSPOINTS	PR1	313
C NOS=NUMBER OF STATIONS	PR1	314
C IT=0 MASS INERTIA MOMENTS, MASS AND CENTER OF GRAVITY FOR EACH SECTION	PR1	315
C IS INPUT	PR1	316
C ST=THE DISTANCE FROM FORWARD PERPENDICULAR TO THE STATIONS	PR1	317
C DS=THE LENGTH OF THE STATIONS	PR1	318
C BEAM=THE BEAM OF THE SHIP	PR1	319
C	PR1	320
EL=ELL/2.0	PR1	321
EL2=EL*EL	PR1	322
EL3=EL2*EL	PR1	323
DRAFT = ABS(Y(10,NUT))	PR1	324
DO 9060 I=1,N2	PR1	325
J = ST1(I) + .0001	PR1	326
9060 IF (J.EQ. 10) DRAFT = ABS(Y(I-1,NUT))	PR1	327
OMAX = DRAFT	PR1	328
DO 5 K=1,NOS	PR1	329
DO 5 J=1,NUT	PR1	330
TERM = ABS(Y(K,J))	PR1	331
5 IF (OMAX.LT. TERM) OMAX = TERM	PR1	332
DO 260 K=1,NOS	PR1	333

DS(K)=DS(K)*ELL/20.	PR1	334
ST(K)=ST(K)*ELL/20.	PR1	335
200 CONTINUE	PR1	336
IF(IT) 70,71,70	PR1	337
70 CONTINUE	PR1	338
C	PR1	339
C ZG=Z-COORDINATE OF CENTER OF GRAVITY WITH RESPECT TO THE CHOSEN	PR1	340
C COORDINATE-SYSTEM IN WATERPLANE	PR1	341
GO TO 72	PR1	342
71 CONTINUE	PR1	343
C	PR1	344
C CALCULATE TOTAL MASS=TMAS	PR1	345
C CALCULATE CENTER OF GRAVITY	PR1	346
C CALCULATE MOMENTS OF INERTIA AND CENTRIFUGAL MOMENTS	PR1	347
C	PR1	348
TMAS=0.0	PR1	349
XG=0.0	PR1	350
ZG=0.0	PR1	351
DO 9 I=1,NMAS	PR1	352
TMAS=TMAS+PMAS(I)	PR1	353
XG=XG+PMAS(I)*XMAS(I)	PR1	354
ZG=ZG+PMAS(I)*ZMAS(I)	PR1	355
9 CONTINUE	PR1	356
XG=XG/TMAS	PR1	357
ZG=ZG/TMAS	PR1	358
EI44=0.0	PR1	359
EI55=0.0	PR1	360
EI66=0.0	PR1	361
EI46=0.0	PR1	362
DO 10 I=1,NMAS	PR1	363
XMAS(I)=XMAS(I)-XG	PR1	364
10 CONTINUE	PR1	365
DO 11 I=1,NMAS	PR1	366
ZD2=ZMAS(I)**2	PR1	367
EI44=EI44+PMAS(I)*(ZD2+XMAS(I)**2)	PR1	368
EI55=EI55+PMAS(I)*(ZD2+XMAS(I)**2)	PR1	369
EI66=EI66+PMAS(I)*(XMAS(I)**2+YMAS(I)**2)	PR1	370
EI46=EI46+PMAS(I)*XMAS(I)*ZMAS(I)	PR1	371
11 CONTINUE	PR1	372
EI44=EI44/TMAS/ELL/ELL	PR1	373
EI55=EI55/TMAS/ELL/ELL	PR1	374
EI66=EI66/TMAS/ELL/ELL	PR1	375
EI46=EI46/TMAS/ELL/ELL*(-1.)	PR1	376
72 CONTINUE	PR1	377
C	PR1	378
C EI44=(ROLL-RADIUS OF GYRATION/L)**2	PR1	379
C EI55=(PITCH-RADIUS OF GYRATION/L)**2	PR1	380
C EI66=(YAW-RADIUS OF GYRATION/L)**2	PR1	381
C EI46=CENTRIFUGAL-MOMENT-X-Z/MASS/L/L	PR1	382
C	PR1	383
C	PR1	384
C CALCULATION OF HYDROSTATIC QUANTITIES	PR1	385
C	PR1	386
SOAK(1)=0.0	PR1	387
AM(1)=0.0	PR1	388
SAS(1)=0.0	PR1	389
HBM(1)=0.0	PR1	390

HB3(1)=0.0	PR1	391
MOM=NCS	PR1	392
MAG=NUS+1	PR1	393
MUD=MAG+1	PR1	394
SQAK(MUD)=0.0	PR1	395
AM(MUD)=0.0	PR1	396
SAS(MUD)=0.0	PR1	397
HOM(MUD)=0.0	PR1	398
HB3(MUD)=0.0	PR1	399
SS(1)=ST1(1)/10.	PR1	400
SS(MUL)=ST1(NST)/10.	PR1	401
DO 13 K=2,MAD	PR1	402
IP1=K-1	PR1	403
SS(K)=ST(IP1)/EL	PR1	404
DO 17 J=1,NUT	PR1	405
XI(J)=X(IP1,J)/EL	PR1	406
YI(J)=Y(IP1,J)/EL	PR1	407
XY(J)=XI(J)*YI(J)	PR1	408
17 CONTINUE	PR1	409
SQAK(K)=2.0*ABS(SIMPUN(YI,XI,NUT))	PR1	410
AM(K)=-2.0*SIMPUN(YI,XY,NUT)	PR1	411
SAS(K)=SS(K)*SQAK(K)	PR1	412
HB3(K)=2.*X(IP1,1)**3/EL3	PR1	413
13 CONTINUE	PR1	414
TVOL=SIMPUN(SS,SQAK,MUD)	PR1	415
TPST=SIMPUN(SS,SAS,MUD)/TVOL	PR1	416
TPCH=SIMPUN(SS,HB3,MUD)	PR1	417
CBV=0.5*SIMPUN(SS,AM,MUD)/TVOL	PR1	418
IF(IFOIL-1) 51,51,52	FMCD	71
52 FXCB=FXC3/EL	FMCD	72
FZCB=FZC3/EL	FMCD	73
FVCL=FVOL/EL3	FMCD	74
HVCL=TVOL	FMCD	75
TVOL=HVCL+FVCL	FMCD	76
TPST=(TPST*HVCL+FXCB*FVCL)/TVOL	FMCD	77
CBV=(CBV*HVCL+FZCB*FVCL)/TVOL	FMCD	78
51 CONTINUE	FMCD	79
RHO=7MAS/(TVOL*EL3)	FMCD	80
CMC=CBV+TPCH/3.0/TVOL*0.5	FR1	419
C TVOL=VOLUME OF THE HULL/(L/2)**3	PR1	420
C TPST=LONGITUDINAL CENTER OF BOYANCY/(L/2)	PR1	421
C CBV=VERTICAL CENTER OF BOYANCY/L	PR1	422
C CMC=METACENTER HEIGHT OVER WATERPLANE/L	PR1	423
C	PR1	424
C	PR1	425
C	PR1	426
C CALCULATION OF HEAVE-HEAVE,PITCH-PITCH,HEAVE-PITCH RESTORING COEFFICI	FR1	427
C	PR1	428
DO 22 K=2,MAD	PR1	429
IP1=K-1	PR1	430
SS(K)=ST(IP1)/EL	PR1	431
HBM(K)=X(IP1,1)/EL	PR1	432
22 CONTINUE	PR1	433
DO 26 K=1,MUD	PR1	434
SPD=SS(K)-TPST	PR1	435
SPD=-SPD	PR1	436
SHB(K)=SPD*HBM(K)*(-1.)	FR1	437

	HSB(K)=SPD*SHB(K)*(-1.)	PR1	438
26	CONTINUE	PR1	439
	RF33=4.J*SIMPON(SS,HBM,MUD)/TVOL	PR1	440
	RM35=-2.J*SIMPON(SS,SH,MUD)/TVOL	PR1	441
	RM55=SIMPON(SS,HBE,UCD)/TVOL	PR1	442
	OGM=HJS(ZG/ELL-CAO)	PR1	443
	NON=NUT-1	PR1	444
C		PR1	445
C	IXAST=NUMBER OF THE STATION WHERE SEPARATION IN WATERPLANE BEGIN	PR1	446
C		PR1	447
	CALL PRINT1	PR1	448
	KCTUKK	PR1	449
	END	PR1	450
C		PN1	2
C	-----VERSION 4 - CDC 6700 - P R I N T 1 - JUNE, 1972-----	PN1	3
C		PN1	4
	SUBROUTINE PRINT1	PN1	5
	COMMON AM(27),NUT,NMAS,NOS,ST(25),OS(25),EL,ELL,X(25,8),Y(25,8),PMPN1		6
	IAS(27),XMAS(27),ZMAS(27),RRG(27),XG,ZG,THAS,EI44,EI55,EI66,FI46,TPPN1		7
	2ST,RF33,RM35,RM55,OGM,DIP,K,N,TVOL,ALFA(40,11),BETA(40,11),HDG(10)PN1		8
	3,FN(5),BAM(10),CDG(10),SDG(10),OMAX,OMIN,NFR,NOK,NOR,NOH,OMEN(40),PN1		9
	4FR(7,6),XX(25,7),YY(25,7),DEL(25,7),SNE(25,7),CSE(25,7),EN1(25,7),PN1		10
	5UN,OMEGA,IO,TITO(12),WORD,NON,IXAST,HOG1(10),IT,CRV,CMC,PRNTOP PN1		11
	COMMON ST1(27),YMAS(27),BEAM,DRAFT,OMAX,IRR,ML,IEND,IBILGE,IPRES, PN1		12
	2VNY,GRAV,AMODL,MOD,AKEELL,BEAMKL,ITS(25),RD(25),RFD(25),DELTAD(25)PN1		13
	2,RKD(25),SD(25),COSPHD(25),PHID(25),STPR(25),THMD(50)	PN1	14
	COMMON NWSTP,INWSTP(12)	PN1	15
	COMMON /TEMP/ ST2(29),OS1(27),XMAS1(27),SOAR(27),SAS(27),HAM(27),PN1		16
	2 HB3(27),SS(27),XI(8),YI(8),XY(8),SHB(27),HSB(27),DUM3(4704)	PN1	17

COMMON /LOOPRN/ STLD(24),WORD2,WORD3, IDAMP, IPRCNT, R2(5), R3(5),	PN1	18
2 PR2(25,5), PB3(25,5), ICLASS	PN1	19
INTEGER PRNTP	PN1	20
DATA MIN /3HMIN/	PN1	21
10 FORMAT(20HNUMBER OF HEADINGS=16)	PN1	22
11 FORMAT(10H HEADIN' -8F10.4)	PN1	23
12 FORMAT(26HNUMBER OF FROUDE NUMBERS=16)	PN1	24
13 FORMAT(16H FROUDE NUMBERS-8F10.4)	PN1	25
14 FORMAT(*0NUMBER OF WAVE STEEPNESSES=*16)	PN1	26
15 FORMAT(* WAVE STEEPNESSES=*1216)	PN1	27
16 FORMAT(23HNUMBER OF WAVELENGTHS=16)	PN1	28
17 FORMAT(14H WAVELENGTH/L-8F10.4)	PN1	29
299 FORMAT (1H1.1246)	PN1	30
300 FORMAT(///)	PN1	31
301 FORMAT(103H DEFINITIONS, OUTPUT SCALING INFORMATION, DIMENSIONALIZ	PN1	32
ATION FACTORS, AND COORDINATE SYSTEM DESCRIPTION)	PN1	33
302 FORMAT (* M=DISPLACED MASS V=DISPLACED VOLUME *	PN1	34
2 *RQ=DENSITY OF FLUID (M/V) G=ACCELERATION OF GRAVITY*)	PN1	35
303 FORMAT (* FN=FROUDE NUMBER B=REAR L=LENGTH BETWEEN PERPE	PN1	36
2 *NDICULARS*/ * AMPL.=AMPLITUDE R=WAVE AMPLITUDE LAM=WAVE	PN1	37
2 *ENGTH K=WAVE NUMBER (360 DEG/LAM) K*, 1H*, *R=WAVE SLOPE*/	PN1	38
2 *PHASE=PHASE LAG (DEGREES) WITH RESPECT TO THE MAXIMUM WAVE *	PN1	39
2 *ELEVATION AT THE ORIGIN OF THE X,Y,Z COORDINATE SYSTEM,*)	PN1	40
304 FORMAT (* WE=WAVE FREQUENCY OF ENCOUNTER (RAD/SEC) *	PN1	41
2 *WE(ND)= WE *, 1H*, * SORT(L/G) (NONDIMENSIONAL)*)	PN1	42
305 FORMAT(27H A(1,1)=ADDED MASS IN SURGE, 4X, 26H A(2,2)=ADDED MASS IN	PN1	43
1SWAY, 4X, 27H A(3,3)=ADDED MASS IN HEAVE, 4X, 28H A(4,4)=ADDED MOMENT	PN1	44
2IN ROLL)	PN1	45
306 FORMAT(29H A(5,5)=ADDED MOMENT IN PITCH, 4X, 27H A(6,6)=ADDED MOMENT	PN1	46
1 IN YAW, 4X, 47H A(3,5)=COUPLED ADDED MASS FOR PITCH INTO HEAVE)	PN1	47
307 FORMAT(45H A(2,4)=COUPLED ADDED MASS FOR ROLL INTO SWAY, 4X, 44H A(2	PN1	48
1,6)=COUPLED ADDED MASS FOR YAW INTO SWAY)	PN1	49
308 FORMAT(46H A(4,6)=COUPLED ADDED MOMENT FOR YAW INTO ROLL)	PN1	50
309 FORMAT(21H B(1,1)=SURGE DAMPING, 4X, 20H B(2,2)=SWAY DAMPING, 4X, 21H	PN1	51
1B(3,3)=HEAVE DAMPING, 4X, 20H B(4,4)=ROLL DAMPING)	PN1	52
310 FORMAT(21H B(5,5)=PITCH DAMPING, 4X, 19H B(6,6)=YAW DAMPING, 4X, 40H	PN1	53
1(3,5)=COUPLED PITCH INTO HEAVE DAMPING)	PN1	54
311 FORMAT(38H B(2,4)=COUPLED ROLL INTO SWAY DAMPING, 4X, 37H B(2,6)=COU	PN1	55
1PLED YAW INTO SWAY DAMPING, 4X, 37H B(4,6)=COUPLED YAW INTO ROLL DAM	PN1	56
2PING)	PN1	57
312 FORMAT(63H A(1,1), A(2,2) AND A(3,3) ARE DIMENSIONED WITH RESPECT	PN1	58
10 MASS, 2X, 48H A(4,4), A(5,5), A(6,6) AND A(4,6) ARE DIMENSIONED)	PN1	59
313 FORMAT(26H WITH RESPECT TO MASS*L, 2X, 65H A(3,5), A(2,6) AND A(2,	PN1	60
14) ARE DIMENSIONED WITH RESPECT TO MASS*L.)	PN1	61
314 FORMAT(100H THE DAMPING COEFFICIENTS ARE DIMENSIONED WITH RESPECT	PN1	62
1TO THE CORRESPONDING FACTORS * SORT(G/L).)	PN1	63
315 FORMAT (*0EXCITING FORCES ARE SCALED BY *.7HM*G*R/L,*. *	PN1	64
2 *EXCITING MOMENTS ARE SCALED BY *.5HM*G*R, 1H,.)	PN1	65
316 FORMAT (* SURGE, SWAY AND HEAVE MOTIONS ARE SCALED BY R. *	PN1	66
2 *ROLL, PITCH AND YAW MOTIONS ARE SCALED BY K*, 3H*, /	PN1	67
2 * SHEAR FORCES ARE SCALED BY *.10HRO*G*B*L*R,*. MOMENTS ARE *	PN1	68
2 *SCALED BY *.13HRO*G*R*L*L*R.)	PN1	69
317 FORMAT(63H THE REFERENCE COORDINATE SYSTEM FOR THE MOTIONS IS AS	PN1	70
1OLLOWS-)	PN1	71
318 FORMAT(114H0THE ORIGIN IS ON THE CENTERLINE AND LIES IN THE LOAD	PN1	72
1ATER PLANE WITH A LONGITUDINAL LOCATION THE SAME AS THE CG.)	PN1	73
319 FORMAT(76H THE X-AXIS IS ALONG THE CENTERLINE AND POSITIVE IN THE	PN1	74
1DIRECTION OF THE AP, 2X, 37H THE Y-AXIS IS POSITIVE TO STARBOARD.)	PN1	75
320 FORMAT(32H THE Z-AXIS IS POSITIVE UPWARDS.)	PN1	76
321 FORMAT(88H0THE POSITIVE DIRECTIONS OF THE MOTIONS ARE THE SAME AS	PN1	77
1THE POSITIVE DIRECTIONS OF AXES.)	PN1	78
322 FORMAT(120H THE REFERENCE COORDINATE SYSTEM FOR SEA-LOADS HAS ITS	PN1	79
1ORIGIN ON THE CENTERLINE OF THE STATION AND AXES PARALLEL TO THE)	PN1	80
323 FORMAT(31H MOTION COORDINATE SYSTEM AXES.)	PN1	81
431 FORMAT (* THE LENGTH DIMENSION USED=*.A6,*. THE FORCE DIMENS	PN1	82
1TICS OF THE SHIP)	PN1	85

2	FORMAT(8F10.4)	PN1	86
33	FORMAT(20H0NUMBER OF STATIONS=16)	PN1	87
36	FORMAT(133H0DISTANCE FROM THE F.P. TO THE STATIONS USING A SCALE OPNI	PN1	88
	IF L.B.P.=20.0 (A MINUS SIGN INDICATES THAT THE STATION IS FORWARD	PN1	89
	20F THE F.P.))	PN1	90
37	FORMAT(17H STATION SPACING-)	PN1	91
39	FORMAT(37H0NUMBER OF OFFSET POINTS PER STATION=12)	PN1	92
40	FORMAT(60H OFFSET POINTS(EXCLUDING THE EXTREME FORE AND AFT STATIO	PN1	93
	INS)-)	PN1	94
42	FORMAT(10H STATION FR.3)	PN1	95
43	FORMAT(4H Y- 8F10.4)	PN1	96
44	FORMAT(4H Z- 8F10.4)	PN1	97
45	FORMAT(23H0NUMBER OF MASS POINTS=16)	PN1	98
46	FORMAT(25H MASS FOR EACH MASSPOINT-)	PN1	99
47	FORMAT(69H MASS POINT COORDINATES IN THE MOTION REFERENCE SYSTEM(OPNI	PN1	100
	IRIGIN AT CG).)	PN1	101
48	FORMAT(4H Z- 8F10.4)	PN1	102
31	FORMAT(31H0LENGTH BETWEEN PERPENDICULARS=F10.4)	PN1	103
325	FORMAT(17H BEAM AT MIDSHIP=F10.4)	PN1	104
50	FORMAT(12H TOTAL MASS=F10.4)	PN1	105
51	FORMAT(12H (ROLL-RADIUS OF GYRATION/L)**2=E14.6)	PN1	106
52	FORMAT(13H (PITCH-RADIUS OF GYRATION/L)**2=E14.6)	PN1	107
53	FORMAT(13H (YAW-RADIUS OF GYRATION/L)**2=E14.6)	PN1	108
54	FORMAT(139H CENTRIFUGAL MOMENT YAW-ROLL/MASS/L**2=E14.6)	PN1	109
55	FORMAT(127H DISPLACED VOLUME/(L/2)**3=E14.6)	PN1	110
56	FORMAT(138H LONGITUDINAL CENTER OF BOYANCY/(L/2)=E14.6)	PN1	111
57	FORMAT(130H VERTICAL CENTER OF BOYANCY/L=E14.6)	PN1	112
58	FORMAT(137H METACENTER HEIGHT OVER WATE-PLANE/L=E14.6)	PN1	113
59	FORMAT(135H HEAVE-HEAVE RESTORING COEFFICIENT=E14.6)	PN1	114
60	FORMAT(135H HEAVE-PITCH RESTORING COEFFICIENT=E14.6)	PN1	115
61	FORMAT(135H PITCH-PITCH RESTORING COEFFICIENT=E14.6)	PN1	116
62	FORMAT(161H DISTANCE OF CENTER OF GRAVITY FROM THE FORWARD MOST STAPNI	PN1	117
	ITION=E14.6)	PN1	118
63	FORMAT(26H Z-COORDINATE OF THE C.G.=E14.6)	PN1	119
900	FORMAT (51H0 ADDITIONAL INPUT DATA)	PN1	120
910	FORMAT(4H0IT=16.8X.7H IXAST=16)	PN1	121
930	FORMAT(48H0SECTIONAL MASS AND MASS DISTRIBUTION INPUT DATA)	PN1	122
940	FORMAT(26H XMAS FOR EACH MASS POINT-)	PN1	123
950	FORMAT(26H YMAS FOR EACH MASS POINT-)	PN1	124
960	FORMAT(26H ZMAS FOR EACH MASS POINT-)	PN1	125
970	FORMAT(25H RRG FOR EACH MASS POINT-)	PN1	126
8000	FORMAT (* STATION SPACING=*)	PN1	127
8010	FORMAT (9F14.6)	PN1	128
C		PN1	129
C	OUTPUT	PN1	130
C		PN1	131
	IF (PRNTOP .EQ. MIN) GO TO 2000	PN1	132
	WRITE (6,299) TITO	PN1	133
	WRITE(6,300)	PN1	134
	WRITE(6,301)	PN1	135
	WRITE(6,300)	PN1	136
	WRITE(6,302)	PN1	137
	WRITE(6,303)	PN1	138
	WRITE(6,304)	PN1	139
	WRITE(6,300)	PN1	140
	WRITE(6,305)	PN1	141
	WRITE(6,306)	PN1	142
	WRITE(6,307)	PN1	143
	WRITE(6,308)	PN1	144
	WRITE(6,309)	PN1	145
	WRITE(6,310)	PN1	146
	WRITE(6,311)	PN1	147
	WRITE(6,300)	PN1	148
	WRITE(6,312)	PN1	149
	WRITE(6,313)	PN1	150
	WRITE(6,314)	PN1	151

WRITE(6,315)	PN1 152
WRITE(6,316)	PN1 153
WRITE(6,300)	PN1 154
WRITE(6,317)	PN1 155
WRITE(6,318)	PN1 156
WRITE(6,319)	PN1 157
WRITE(6,320)	PN1 158
WRITE(6,321)	PN1 159
WRITE(6,300)	PN1 160
WRITE(6,322)	PN1 161
WRITE(6,323)	PN1 162
WRITE(6,300)	PN1 163
WRITE(6,431) WORD,WORD2,WORD3	PN1 164
WRITE(6,324)	PN1 165
WRITE(6,300)	PN1 166
NOS2 = NOS + 2	PN1 167
WRITE(6,33) NOS2	PN1 168
WRITE(6,36)	PN1 169
NOSHAL=NOS	PN1 170
NOSHIL=NOSHAL+2	PN1 171
WRITE(6,2) (ST1(K),K=1,NOSHIL)	PN1 172
WRITE(6,37)	PN1 173
WRITE(6,2) (DS(K),K=1,NOSHAL)	PN1 174
WRITE(6,39) NUT	PN1 175
WRITE(6,40)	PN1 176
DO 41 K=1,NOSHAL	PN1 177
IK=K+1	PN1 178
WRITE(6,42) (ST1(IK))	PN1 179
WRITE(6,43) (X(K,J),J=1,NUT)	PN1 180
WRITE(6,44) (Y(K,J),J=1,NUT)	PN1 181
41 CONTINUE	PN1 182
IF(IT) 73,74,73	PN1 183
74 CONTINUE	PN1 184
WRITE(6,45) NMAS	PN1 185
WRITE(6,46)	PN1 186
WRITE(6,2) (PMAS(I),I=1,NMAS)	PN1 187
WRITE(6,47)	PN1 188
WRITE(6,43) (XMAS(I),I=1,NMAS)	PN1 189
WRITE(6,48) (ZMAS(I),I=1,NMAS)	PN1 190
73 CONTINUE	PN1 191
WRITE(6,31) ELL	PN1 192
WRITE(6,325) BEAM	PN1 193
WRITE(6,55) TVOL	PN1 194
WRITE(6,56) TPST	PN1 195
WRITE(6,57) CBV	PN1 196
WRITE(6,58) CMC	PN1 197
WRITE(6,59) RF33	PN1 198
WRITE(6,60) RM35	PN1 199
WRITE(6,61) RM55	PN1 200
WRITE(6,62) XG	PN1 201
WRITE(6,63) ZG	PN1 202
WRITE(6,50) TMAS	PN1 203
WRITE(6,51) EI44	PN1 204
WRITE(6,52) EI55	PN1 205
WRITE(6,53) EI66	PN1 206
WRITE(6,54) EI46	PN1 207
WRITE(6,900)	PN1 208
WRITE(6,910) IT,IXAST	PN1 209
IF(IT) 1000,920,1000	PN1 210
920 WRITE(6,930)	PN1 211
WRITE(6,940)	PN1 212
DO 20 I=1,NMAS	PN1 213
XMAS1(I)=XMAS(I)+XG	PN1 214
20 CONTINUE	PN1 215
WRITE(6,2) (XMAS1(I),I=1,NMAS)	PN1 216
WRITE(6,950)	PN1 217

WRITE(6,2) (YMAS(I),I=1,NMAS)	PN1	218
WRITE(6,960)	PN1	219
WRITE(6,2) (ZMAS(I),I=1,NMAS)	PN1	220
WRITE(6,970)	PN1	221
WRITE(6,2) (RRG(I),I=1,NMAS)	PN1	222
1000 CONTINUE	PN1	223
WRITE(6,10) NOH	PN1	224
WRITE(6,11) (MDG1(JJ),JJ=1,NOH)	PN1	225
WRITE(6,12) NOB	PN1	226
WRITE(6,13) (FN(JJ),JJ=1,NOB)	PN1	227
WRITE(6,14) NWSTP	PN1	228
WRITE(6,15) (INWSTP(JJ),JJ=1,NWSTP)	PN1	229
WRITE(6,16) NOK	PN1	230
WRITE(6,17) (RAM(LL),LL=1,NOK)	PN1	231
WRITE(6,9003)	PN1	232
9003 FORMAT(29H1ADDITIONAL INPUT INFORMATION)	PN1	233
WRITE(6,591) IEND	PN1	234
591 FORMAT(6H0IEND=16)	PN1	235
WRITE(6,592) IBILGE	PN1	236
592 FORMAT(8H IBILGE=16)	PN1	237
WRITE(6,594) VNY,GRAV,AMODL,MOD	PN1	238
594 FORMAT(5H VNY=F10.8,2X,6H GRAV=F10.4,2X,7H AMODL=F10.4,5H MOD=16)	PN1	239
WRITE(6,595)	PN1	240
595 FORMAT(8H0ITS(K)=)	PN1	241
WRITE(6,6) (ITS(K),K=1,NOS)	PN1	242
6 FORMAT(16I5)	PN1	243
WRITE(6,596)	PN1	244
596 FORMAT(7H0RD(K)=)	PN1	245
WRITE(6,8001) (RD(K),K=1,NOS)	PN1	246
8001 FORMAT(8F10.4)	PN1	247
GO TO (651,650),IBILGE	PN1	248
651 WRITE(6,597) AKEELL,BEAMKL	PN1	249
597 FORMAT(8H0AKEELL=F10.4,2X,8H BEAMKL=F10.4)	PN1	250
WRITE(6,598)	PN1	251
598 FORMAT(8H0RFD(K)=)	PN1	252
WRITE(6,410) (RFD(K),K=1,NOS)	PN1	253
WRITE(6,599)	PN1	254
599 FORMAT(11H0DELTA(D(K)=)	PN1	255
WRITE(6,410) (DELTA(D(K),K=1,NOS)	PN1	256
WRITE(6,9001)	PN1	257
9001 FORMAT(8H0RKD(K)=)	PN1	258
WRITE(6,410) (RKD(K),K=1,NOS)	PN1	259
410 FORMAT(12F10.4)	PN1	260
WRITE(6,601)	PN1	261
601 FORMAT(7H0SD(K)=)	PN1	262
WRITE(6,410) (SD(K),K=1,NOS)	PN1	263
WRITE(6,602)	PN1	264
602 FORMAT(11H0COSPHD(K)=)	PN1	265
WRITE(6,410) (COSPHD(K),K=1,NOS)	PN1	266
WRITE(6,603)	PN1	267
603 FORMAT(9H0PHID(K)=)	PN1	268
WRITE(6,410) (PHID(K),K=1,NOS)	PN1	269
650 CONTINUE	PN1	270
GO TO (653,652),IPRES	PN1	271
653 WRITE(6,604)	PN1	272
604 FORMAT(9H0STPR(K)=)	PN1	273
WRITE(6,8001) (STPR(K),K=1,NOS)	PN1	274
652 CONTINUE	PN1	275
WRITE(6,655)	PN1	276
655 FORMAT(9H0THMD(K)=)	PN1	277
WRITE(6,5060) (THMD(K),K=1,NHF)	PN1	278
5060 FORMAT(12F10.4)	PN1	279
2000 CONTINUE	PN1	280
CALL SEPART (1)	PN1	281
WRITE (1,8000)	PN1	282
WRITE (1,8010) (DS(K),K=1,NOS)	PN1	283

WRITE(1,55) TVOL	PN1	284
WRITE(1,56) TPST	PN1	285
WRITE(1,57) CRV	PN1	286
WRITE(1,58) CMC	PN1	287
WRITE(1,59) RF33	PN1	288
WRITE(1,60) RM35	PN1	289
WRITE(1,61) RM55	PN1	290
WRITE(1,62) XG	PN1	291
WRITE(1,63) ZG	PN1	292
WRITE(1,50) TMAS	PN1	293
WRITE(1,51) EI44	PN1	294
WRITE(1,52) EI55	PN1	295
WRITE(1,53) EI66	PN1	296
WRITE(1,54) FI46	PN1	297
RETURN	PN1	298
END	PN1	299
C	LK2	2
C-----VERSION 4 - CDC 6700 - P R O 2 - JUNE, 1972-----	LK2	3
C	LK2	4
OVERLAY (LINK2,2,0)	LK2	5
PROGRAM PRO2	LK2	6
CALL SPRG1	LK2	7
CALL SPRG2	LK2	8
END	LK2	9
C	SP1	2
C-----VERSION 4 - CDC 6700 - S P R G 1 - JUNE, 1972-----	SP1	3
C	SP1	4
SUBROUTINE SPRG1	SP1	5
C	SP1	6
C PROGRAMMER- W. FRANK,NSRDC	SP1	7
C	SP1	8
COMMON AM(27),NUT,NMAS,NOS,ST(25),DS(25),EL,ELL,X(25,8),Y(25,8),PMSP1	SP1	9
IAS(27),XMAS(27),ZMAS(27),RRG(27),XG,ZG,TMAS,EI44,EI55,EI66,EI46,TPSP1	SP1	10
2ST,RF33,RM35,RM55,DGM,DIP,K,N,TVOL,ALFA(40,11),BETA(40,11),HDG(10)SP1	SP1	11
3,FN(5),BAM(30),CDG(10),SDG(10),OMAX,OMIN,NFR,NOK,NOR,NOH,OMEN(40),SP1	SP1	12
4FR(7,6),XX(25,7),YY(25,7),DEL(25,7),SNE(25,7),CSE(25,7),EN1(25,7),SP1	SP1	13
5UN,OMEGA,IO,TITO(12),WORD,NON,IXAST,HDG1(10),IT,CRV,CMC,PRNTOP	SP1	14
COMMON ST1(27),YMAS(27),BEAM,DRAFT,OMAX,IRR,ML,IEND,IBILGE,IPRES,	SP1	15
2VNY,GRAV,AMODL,MOD,AKEELL,BEAMKL,ITS(25),RD(25),RFD(25),DELTAD(25)SP1	SP1	16
2,RKD(25),SD(25),COSPHD(25),PHID(25),STPR(25),THMD(50)	SP1	17
COMMON NWSTP,1NWSTP(12)	SP1	18
COMMON /TEMP/ HD2(10),IK(27),DUM3(4963)	SP1	19
MOM=NOS-1	SP1	20
NIX=NOS-2	SP1	21
TOP=6.283185	SP1	22
NOSHAL=NOS	SP1	23
DO 22 K=1,NOSHAL	SP1	24
ST(K)=ST(K)/EL	SP1	25
DO 20 J=1,NUT	SP1	26
X(K,J)=X(K,J)/EL	SP1	27
Y(K,J)=Y(K,J)/EL	SP1	28
20 CONTINUE	SP1	29
DS(K)=DS(K)/EL	SP1	30
22 CONTINUE	SP1	31
DO 110 JJ=1,NOH	SP1	32
HDG(JJ)=180.0-HDG1(JJ)	SP1	33
110 CONTINUE	SP1	34
DO 168 JJ=1,NOH	SP1	35
HDR(JJ)=0.017453293*HDG(JJ)	SP1	36
SDG(JJ)=SIN(HDR(JJ))	SP1	37
168 CDG(JJ)=COS(HDR(JJ))	SP1	38
C	SP1	39
C CALCULATION OF NON-DIMENSIONAL FREQUENCY RANGES	SP1	40
C	SP1	41
OTMIN = 99999.	SP1	42
OTMAX = 0.	SP1	43

DO 6000 N=1,NOM	SP1	44
DO 6000 M=1,NOM	SP1	45
TERM = FN(M)*CDG(N)	SP1	46
DO 6000 K=1,NOK	SP1	47
FACT = 6.283185/BAM(K)	SP1	48
OTEMP = ABS(SQRT(FACT) + FACT*TERM)	SP1	49
IF (OTEMP .LT. OTHIN) OTHIN = OTEMP	SP1	50
6000 IF (OTEMP .GT. OTHAX) OTHAX = OTEMP	SP1	51
EPS = .0001	SP1	52
SRLG = SQRT(ELL/GRAV)	SP1	53
SRDG = SQRT(DMAX/GRAV)	SP1	54
SRLO = SQRT(ELL/DMAX)	SP1	55
WEMAX = OTHAX/SRLG	SP1	56
FACT = WEMAX*SRDG	SP1	57
IF (FACT .GE. 1.) GO TO 6010	SP1	58
C IRREGULAR FREQUENCIES DO NOT EXIST	SP1	59
IRR = 1	SP1	60
OMAX = OTHAX + EPS	SP1	61
KFR = 10	SP1	62
GO TO 6020	SP1	63
C IRREGULAR FREQUENCIES EXIST	SP1	64
6010 IRR = 2	SP1	65
BT = BEAM/DRAFT	SP1	66
IF (BT .LE. 4.) CON = .35	SP1	67
IF (BT .GT. 4.) CON = .60	SP1	68
OMAX = (WEMAX*SRDG + CON)*SRLO	SP1	69
6020 OMIN = OTHIN - EPS	SP1	70
CRIT = .7*SRLO	SP1	71
IF (OMIN .GE. CRIT) OMIN = CRIT - EPS	SP1	72
IF (IRR .EQ. 2) KFR = (OMAX - OMIN)/(.05*SRLO) + .9999999	SP1	73
KFR = MIN0(KFR,40)	SP1	74
IF (NFR .LE. 0) NFR = KFR	SP1	75
IF (OMIN .LE. 0. .OR. OMIN .GT. OMIN) OMIN = OMIN	SP1	76
IF (OMAX .LE. 0. .OR. OMAX .LT. OMAX) OMAX = OMAX	SP1	77
OMAX=OMAX*SQRT(0.5)	SP1	78
OMIN=OMIN*SQRT(0.5)	SP1	79
DO 18 N=1,NFR	SP1	80
DO 18 L=1,11	SP1	81
ALFA(N,L)=0.0	SP1	82
BETA(N,L)=0.0	SP1	83
18 CONTINUE	SP1	84
DO 19 K=1,NOSHAL	SP1	85
DO 21 J=1,NON	SP1	86
XX(K,J)=.5*(X(K,J)+X(K,J+1))	SP1	87
YY(K,J)=.5*(Y(K,J)+Y(K,J+1))	SP1	88
XINT=X(K,J)-X(K,J+1)	SP1	89
YINT=Y(K,J)-Y(K,J+1)	SP1	90
DEL(K,J)=SQRT(XINT**2+YINT**2)	SP1	91
SNE(K,J)=YINT/DEL(K,J)	SP1	92
21 CSE(K,J)=XINT/DEL(K,J)	SP1	93
19 CONTINUE	SP1	94
IK(1)=1	SP1	95
DO 15 K=2,MOM	SP1	96
15 IK(K)=2	SP1	97
IK(NOS)=3	SP1	98
DO 35 K=1,NOS	SP1	99
LIK=IK(K)	SP1	100
GO TO(36,27,28),LIK	SP1	101
36 CALL PQRT(ST(3),ST(1),ST(2),P,Q,R,T)	SP1	102
DO 29 J=1,NON	SP1	103
29 EN1(K,J)=(SNE(1,J)*(0*XX(3,J)-P*XX(2,J)+R*XX(1,J))-CSE(1,J)*(0*YY(13,J)-P*YY(2,J)+R*YY(1,J)))/T	SP1	104
GO TO 35	SP1	105
27 CALL PQRT(ST(K+1),ST(K),ST(K-1),P,Q,R,T)	SP1	106
DO 30 J=1,NON	SP1	107
30 EN1(K,J)=(SNE(K,J)*(0*XX(K+1,J)-P*XX(K-1,J)+R*XX(K,J))-CSE(K,J)*(0*YY(13,J)-P*YY(2,J)+R*YY(1,J)))/T	SP1	108
	SP1	109

1*YY(K+1,J)-P*YY(K-1,J)+R*YY(K,J))/T	SP1	110
GO TO 35	SP1	111
28 CALL PORT(ST(NIX),ST(NOS),ST(MOM),P,Q,R,T)	SP1	112
DO 31 J=1,NON	SP1	113
31 EN1(K,J)=(SNE(NOS,J)*(Q*XX(NIX,J)-P*XX(MOM,J)+R*XX(NOS,J))-CSE(NOS	SP1	114
1,J)*(Q*YY(NIX,J)-P*YY(MOM,J)+R*YY(NOS,J)))/T	SP1	115
35 CONTINUE	SP1	116
DO 101 K=1,NOS	SP1	117
DO 102 J=1,NON	SP1	118
EN1(K,J)=EN1(K,J)/SQRT(1.+EN1(K,J)**2)	SP1	119
102 CONTINUE	SP1	120
101 CONTINUE	SP1	121
77 RETURN	SP1	122
END	SP1	123
C	SP2	2
C-----VERSION 4 - CDC 6700 - S P R G 2 - JUNE, 1972-----	SP2	3
C	SP2	4
SUBROUTINE SPRG2	SP2	5
C	SP2	6
C PROGRAMMER- O. FALTINSEN,DNV	SP2	7
C	SP2	8
INTEGER H	SP2	9
COMMON AM(27),NUT,NMAS,NOS,ST(25),DS(25),EL,ELL,X(25,8),Y(25,8),PMSP2	10	
1AS(27),XMAS(27),ZMAS(27),RRG(27),XG,ZG,TMAS,EI44,EI55,EI66,EI46,TPSP2	11	
2ST,RF33,RM35,RM55,DGM,DIP,K,N,TVOL,ALFA(40,11),9ETA(40,11),HDG(10)SP2	12	
3,FN(5),8AM(30),CDG(10),SDG(10),OMAX,UMIN,NFR,NOK,NOR,NOH,OMEN(40),SP2	13	
4FR(7,6),XX(25,7),YY(25,7),DEL(25,7),SNE(25,7),CSE(25,7),EN1(25,7),SP2	14	
SUN,OMEGA,ID,TITO(12),WORD,NON,IXAST,HDG1(10),IT,CBV,CMC,PMNTOP	SP2	15
COMMON ST1(27),YMAS(27),BEAM,DRAFT,OMAX,IRR,ML,IEND,I8ILGE,IPRES,	SP2	16
2VNY,GRAV,AMODL,MOD,AKEELL,BEAMKL,ITS(25),RO(25),RFD(25),DELTAD(25)SP2	17	
2,RKD(25),SD(25),COSPHD(25),PHID(25),STPR(25),THMD(50)	SP2	18
COMMON NWSTP,INWSTP(12)	SP2	19
COMMON /TEMP/ BLOG(2,7,7),YLOG(2,7,7),PRA(7,6),PRV(7,6),	SP2	20
2 DUM3(1116),AR1(42),AR2(42),AI2(40),AI3(40),C(40),WD(40),A(3360)	SP2	21
DATA MIN /3HMIN/	SP2	22
FM=1.	SP2	23
VOL=TVOL	SP2	24
NFM=NFR-1	SP2	25
DOME=(OMAX-OMIN)/(NFR-1)	SP2	26
OMEN(1)=OMIN	SP2	27
DO 27 N=2,NFR	SP2	28
27 OMEN(N)=OMEN(N-1)+DOME	SP2	29
L1=1	SP2	30
L2=1	SP2	31
NUMB = (NUT-1)*6	SP2	32
NELEM = NFR*NUMB*2	SP2	33
REWIND 20	SP2	34
DO 37 K=1,NOS	SP2	35
CALL FINV	SP2	36
DIP=ST(K)-TPST	SP2	37
KI=0	SP2	38
KM = - NUMB	SP2	39
DO 53 N=1,NFR	SP2	40
OMEGA=OMEN(N)	SP2	41
UN=OMEGA**2	SP2	42
CALL KERN	SP2	43
GO TO(34,35),ID	SP2	44
35 WRITE(6,14) K,N	SP2	45
14 FORMAT(29H0 MATRIX IS SINGULAR. K= I2,6H, N = I2)	SP2	46
GO TO 777	SP2	47
34 CONTINUE	SP2	48
IF(IRR-1) 311,54,311	SP2	49
311 CONTINUE	SP2	50
C	SP2	51
C IRR=1 MEANS NO INTERPOLATION BECAUSE OF IRREGULAR FREQUENCIES	SP2	52
C	SP2	53

YK=Y(K,1)+0.0001	SP2	54
IF(YK) 54,2222,2222	SP2	55
2222 CONTINUE	SP2	56
YKN=Y(K,NUT)	SP2	57
DAFT=ABS(YKN)	SP2	58
WDR=OMEGA*SQRT(DAFT)	SP2	59
IF(WDR=0.7) 54,55,55	SP2	60
54 CONTINUE	SP2	61
DO 41 LK=1,10	SP2	62
GO TO(70,70,70,70,70,70,71,72,73,74),LK	SP2	63
70 CONTINUE	SP2	64
L=LK	SP2	65
M=LK	SP2	66
GO TO 75	SP2	67
71 CONTINUE	SP2	68
L=5	SP2	69
M=3	SP2	70
GO TO 75	SP2	71
72 CONTINUE	SP2	72
L=2	SP2	73
M=6	SP2	74
GO TO 75	SP2	75
73 CONTINUE	SP2	76
L=2	SP2	77
M=4	SP2	78
GO TO 75	SP2	79
74 CONTINUE	SP2	80
L=6	SP2	81
M=4	SP2	82
75 CONTINUE	SP2	83
42 DADS =0.0	SP2	84
DDDS =0.0	SP2	85
DO 43 J=1,NON	SP2	86
DADS =DADS +DEL(K,J)*FR(J,L)*PRA(J,M)	SP2	87
43 DDDS =DDDS +DEL(K,J)*FR(J,L)*PRV(J,M)	SP2	88
DADS =2.0*DADS	SP2	89
DDDS =2.0*DDDS	SP2	90
ALFA(N,LK)=ALFA(N,LK)+DS(K)*DADS*FM	SP2	91
BETA(N,LK)=BETA(N,LK)+DS(K)*DDDS*FM	SP2	92
41 CONTINUE	SP2	93
GO TO 76	SP2	94
55 CONTINUE	SP2	95
KI=KI+1	SP2	96
WD(KI)=WDR	SP2	97
AI2(KI)=0.0	SP2	98
AI3(KI)=0.0	SP2	99
DO 52 J=1,NON	SP2	100
AI2(KI)=AI2(KI)+DEL(K,J)*FR(J,2)*PRA(J,2)	SP2	101
AI3(KI)=AI3(KI)+DEL(K,J)*FR(J,3)*PRA(J,3)	SP2	102
52 CONTINUE	SP2	103
FC1=2./DAFT/DAFT/UN/1.57	SP2	104
AI2(KI)=AI2(KI)*FC1	SP2	105
AI3(KI)=AI3(KI)*FC1	SP2	106
76 CONTINUE	SP2	107
KM = KM + NUMB	SP2	108
DO 220 J=1,NON	SP2	109
DO 220 M=1,6	SP2	110
KM = KM + 1	SP2	111
A(KM) = PRA(J,M)	SP2	112
A(KM+NUMB) = PRV(J,M)	SP2	113
220 CONTINUE	SP2	114
NON=NUT-1	SP2	115
NUMB=6*NON	SP2	116
53 CONTINUE	SP2	117
C	SP2	118
C INTERPOLATION BECAUSE OF IRREGULAR FREQUENCIES	SP2	119

C		SP2	120
C	FIRST WE WRITE OUT FROM THE DRUM ALL PRESSURES FROM OMEGA*SQRT(DAFT/	SP2	121
C	GRAV)=0.7	SP2	122
	IF(KI-2) 32,32,77	SP2	123
77	CONTINUE	SP2	124
	KID=NFR-KI	SP2	125
	DO 78 N12=1,NFR	SP2	126
	ITEMP = N12	SP2	127
	FAC=OMEN(N12)*SQRT(DAFT)	SP2	128
	IF(FAC-0.7) 78,79,79	SP2	129
78	CONTINUE	SP2	130
79	CONTINUE	SP2	131
	N12 = ITEMP	SP2	132
	NUMR=6*NON	SP2	133
	NSKIP = 2*(N12-1)*NUMR	SP2	134
	NDO = 2*(NFR-N12+1)	SP2	135
	C(NFR)=-1.	SP2	136
	C(KID+1)=-1.	SP2	137
	KIM=KI-1	SP2	138
	DO 21 N=2,KIM	SP2	139
	NN=KID+N	SP2	140
	AL1=A12(N+1)-A12(N)	SP2	141
	AL2=A12(N+1)-A12(N-1)	SP2	142
	AL3=A12(N)-A12(N-1)	SP2	143
	CL1=WD(N+1)-WD(N)	SP2	144
	CL2=WD(N+1)-WD(N-1)	SP2	145
	CL3=WD(N)-WD(N-1)	SP2	146
	C(NN)=(AL1**2+CL1**2+AL3**2+CL3**2-AL2**2-CL2**2)/2./SQRT(AL1**2+CSP2	SP2	147
	1L1**2)/SQRT(AL3**2+CL3**2)	SP2	148
21	CONTINUE	SP2	149
	DO 320 N13=1,NFR	SP2	150
	ITEMP = N13	SP2	151
	FAC=OMEN(N13)*SQRT(DAFT)	SP2	152
	IF(FAC-0.95) 320,321,321	SP2	153
320	CONTINUE	SP2	154
321	CONTINUE	SP2	155
	N13 = ITEMP	SP2	156
	DO 322 N=1,N13	SP2	157
	C(N)=-1.0	SP2	158
322	CONTINUE	SP2	159
	DO 811 N=2,NFM	SP2	160
	IF(C(N)-(-0.5)) 811,811,24	SP2	161
24	NV=IFIX(0.3/DOME/SQRT(DAFT))	SP2	162
	IF(NV) 9998,9998,9999	SP2	163
9998	NV=1	SP2	164
9999	CONTINUE	SP2	165
	KN=N-NV	SP2	166
	IF(KN-1) 531,532,532	SP2	167
531	KN=1	SP2	168
532	CONTINUE	SP2	169
	KS=N+NV	SP2	170
	ISUM=0	SP2	171
4301	CONTINUE	SP2	172
	KS=KS+ISUM	SP2	173
	IF(KS-NFR) 431,431,432	SP2	174
432	KS=NFR	SP2	175
431	CONTINUE	SP2	176
	JR=KS+IFIX(0.1/DOME/SQRT(DAFT))	SP2	177
	IF(JR-NFR) 4303,4303,4302	SP2	178
4302	JR=NFR	SP2	179
4303	CONTINUE	SP2	180
	DO 4305 JM=KS,JR	SP2	181
	IF(C(JM)-(-0.5)) 4305,4306,4306	SP2	182
4305	CONTINUE	SP2	183
	GO TO 4307	SP2	184
4306	ISUM=NV	SP2	185

IF(JR-NFR) 4308,4307,4307	SP2 186
4308 GO TO 4301	SP2 187
4307 CONTINUE	SP2 188
DNO=FLOAT(KS-KN)	SP2 189
DO 350 IR=1,2	SP2 190
DO 350 J=1,NON	SP2 191
DO 350 M=2,6,2	SP2 192
NU1=(KN-N12)*NUMB*2*(IR-1)*NON*6*(J-1)*6+M	SP2 193
NU2=(KS-N12)*NUMB*2*(IR-1)*NON*6*(J-1)*6+M	SP2 194
NU1 = NU1 + NSKIP	SP2 195
NU2 = NU2 + NSKIP	SP2 196
DELT1=A(NU2)-A(NU1)	SP2 197
DO 350 JK=KN,KS	SP2 198
NU=(JK-N12)*NUMB*2*(IR-1)*NON*6*(J-1)*6+M	SP2 199
NU = NU + NSKIP	SP2 200
A(NU)=A(NU1)+DELT1*(JK-KN)/DNO	SP2 201
C(JK)=-1.	SP2 202
350 CONTINUE	SP2 203
811 CONTINUE	SP2 204
DO 121 N=2,KIM	SP2 205
NN=KID+N	SP2 206
AL1=A13(N+1)-A13(N)	SP2 207
AL2=A13(N+1)-A13(N-1)	SP2 208
AL3=A13(N)-A13(N-1)	SP2 209
CL1=WD(N+1)-WD(N)	SP2 210
CL2=WD(N+1)-WD(N-1)	SP2 211
CL3=WD(N)-WD(N-1)	SP2 212
C(NN)=(AL1**2+CL1**2+AL3**2+CL3**2-AL2**2-CL2**2)/2./SQRT(AL1**2+CSP2 213	
1L1**2)/SQRT(AL3**2+CL3**2)	SP2 214
121 CONTINUE	SP2 215
DO 323 N=1,N13	SP2 216
C(N)=-1.0	SP2 217
323 CONTINUE	SP2 218
DO 821 N=2,NFM	SP2 219
IF(C(N)-(-0.5)) 821,821,124	SP2 220
124 NV=FIX(0.3/DOME/SQRT(DAFT))	SP2 221
IF(NV) 9996,9996,9997	SP2 222
9996 NV=1	SP2 223
9997 CONTINUE	SP2 224
KN=N-NV	SP2 225
IF(KN-1) 511,512,512	SP2 226
511 KN=1	SP2 227
512 CONTINUE	SP2 228
KS=N+NV	SP2 229
ISUM=0	SP2 230
4311 CONTINUE	SP2 231
KS=KS+ISUM	SP2 232
IF(KS-NFR) 411,411,412	SP2 233
412 KS=NFR	SP2 234
411 CONTINUE	SP2 235
JR=KS+FIX(0.1/DOME/SQRT(DAFT))	SP2 236
IF(JR-NFR) 4313,4313,4312	SP2 237
4312 JR=NFR	SP2 238
4313 CONTINUE	SP2 239
DO 4315 JM=KS,JR	SP2 240
IF(C(JM)-(-0.5)) 4315,4316,4316	SP2 241
4315 CONTINUE	SP2 242
GO TO 4317	SP2 243
4316 ISUM=NV	SP2 244
IF(JR-NFR) 4318,4317,4317	SP2 245
4318 GO TO 4311	SP2 246
4317 CONTINUE	SP2 247
DNO=FLOAT(KS-KN)	SP2 248
DO 351 IR=1,2	SP2 249
DO 351 J=1,NON	SP2 250
DO 351 M=1,5,2	SP2 251

NU1=(KN-N12)*NUMB*2*(IR-1)*NON*6*(J-1)*6*M	SP2 252
NU2=(KS-N12)*NUMB*2*(IR-1)*NON*6*(J-1)*6*M	SP2 253
NU1 = NU1 + NSKIP	SP2 254
NU2 = NU2 + NSKIP	SP2 255
DELT1=A(NU2)-A(NU1)	SP2 256
DO 351 JK=KN,KS	SP2 257
NU=(JK-N12)*NUMB*2*(IR-1)*NON*6*(J-1)*6*M	SP2 258
NU = NU + NSKIP	SP2 259
A(NU)=A(NU1)+DELT1*(JK-KN)/DNO	SP2 260
C(JK)=-1.	SP2 261
351 CONTINUE	SP2 262
821 CONTINUE	SP2 263
C	SP2 264
C WE HAVE NOW ADJUSTED IF NECESSARY THE PRESSURES FROM OMEGA*SQRT(DAFT	SP2 265
C /GRAV)=0.7,AND ARE NOW GOING TO CALCULATE THE CORRESPONDING ADDED	SP2 266
C MASS AND DAMPING	SP2 267
C	SP2 268
DO 58 N=N12,NFR	SP2 269
DO 58 LK=1,10	SP2 270
GO TO(80,80,80,80,80,80,81,82,83,84),LK	SP2 271
80 CONTINUE	SP2 272
L=LK	SP2 273
M=LK	SP2 274
GO TO 85	SP2 275
81 CONTINUE	SP2 276
L=5	SP2 277
M=3	SP2 278
GO TO 85	SP2 279
82 CONTINUE	SP2 280
L=2	SP2 281
M=6	SP2 282
GO TO 85	SP2 283
83 CONTINUE	SP2 284
L=2	SP2 285
M=4	SP2 286
GO TO 85	SP2 287
84 CONTINUE	SP2 288
L=6	SP2 289
M=4	SP2 290
85 CONTINUE	SP2 291
DADS=0.0	SP2 292
DDDS=0.0	SP2 293
DO 60 J=1,NON	SP2 294
NU1=(N-N12)*NUMB*2*((J-1)*6*M)	SP2 295
NU2=(N-N12)*NUMB*2*NON*6*(J-1)*6*M	SP2 296
NU1 = NU1 + NSKIP	SP2 297
NU2 = NU2 + NSKIP	SP2 298
DADS=DADS+DEL(K,J)*FR(J,L)*A(NU1)	SP2 299
60 DDDS=DDDS+DEL(K,J)*FR(J,L)*A(NU2)	SP2 300
DADS=2.0*DADS	SP2 301
DDDS=2.0*DDDS	SP2 302
ALFA(N,LK)=ALFA(N,LK)+DS(K)*DADS*FM	SP2 303
BETA(N,LK)=BETA(N,LK)+DS(K)*DDDS*FM	SP2 304
58 CONTINUE	SP2 305
32 CONTINUE	SP2 306
WRITE (20) (A(I),I=1,NELEM)	SP2 307
37 CONTINUE	SP2 308
ENDFILE 20	SP2 309
REWIND 20	SP2 310
DO 33 N=1,NFR	SP2 311
OMEGA=OMEN(N)	SP2 312
UN=OMEGA**2	SP2 313
DO 44 L=1,10	SP2 314
ALFA(N,L)=ALFA(N,L)/VOL/UN	SP2 315
BETA(N,L)=BETA(N,L)/VOL/OMEGA*1.4142136	SP2 316
44 CONTINUE	SP2 317

DO 45 L=4,6	SP2	318
ALFA(N,L)=ALFA(N,L)*0.5*0.5	SP2	319
BETA(N,L)=BETA(N,L)*0.5*0.5	SP2	320
45 CONTINUE	SP2	321
DO 46 L=7,10	SP2	322
ALFA(N,L)=ALFA(N,L)*0.5	SP2	323
BETA(N,L)=BETA(N,L)*0.5	SP2	324
46 CONTINUE	SP2	325
ALFA(N,10)=0.5*ALFA(N,10)	SP2	326
BETA(N,10)=0.5*BETA(N,10)	SP2	327
33 CONTINUE	SP2	328
C PRINT ZERO SPEED NON-DIMENSIONAL ADDED MASS AND DAMPING COEFFICIENTS	SP2	329
CALL SEPART (1)	SP2	330
DO 2300 JH=1,2	SP2	331
IF (JH.EQ. 1) H = 1	SP2	332
IF (JH.EQ. 2) H = 6	SP2	333
IF (H.EQ. 6 .AND. PRNTP .EQ. MIN) GO TO 2300	SP2	334
WRITE (H,300) NFR	SP2	335
WRITE (H,400) IRR	SP2	336
WRITE (H,2235)	SP2	337
WRITE (H,2224)	SP2	338
DO 2225 N=1,NFR	SP2	339
GXI=OMEN(N)*SQRT(2.)	SP2	340
WRITE (H,2226) GXI,ALFA(N,1),ALFA(N,2),ALFA(N,3),ALFA(N,4),ALFA(N,5),	SP2	341
ALFA(N,6),ALFA(N,7),ALFA(N,8),ALFA(N,9),ALFA(N,10)	SP2	342
2225 CONTINUE	SP2	343
WRITE (H,2227)	SP2	344
WRITE (H,2228)	SP2	345
DO 2229 N=1,NFR	SP2	346
GXI=OMEN(N)*SQRT(2.)	SP2	347
WRITE (H,2226) GXI,BETA(N,1),BETA(N,2),BETA(N,3),BETA(N,4),BETA(N,5),	SP2	348
BETA(N,6),BETA(N,7),BETA(N,8),BETA(N,9),BETA(N,10)	SP2	349
2229 CONTINUE	SP2	350
300 FORMAT(107H1NON-DIMENSIONAL, SPEED INDEPENDENT ADDED MASS AND DAMPING	SP2	351
COEFFICIENTS FOR THE SPECIFIED FREQUENCIES (NFR=,13,2H).)	SP2	352
400 FORMAT(5H0IRR=12,2H .,4X,104H IF IRR=2 INTERPOLATION OF IRRREGULAR	SP2	353
FREQUENCIES IS PERFORMED. IF IRR=1 INTERPOLATION IS NOT PERFORMED	SP2	354
2.)	SP2	355
2235 FORMAT(/45H NON-DIMENSIONALIZED ADDED MASS COEFFICIENTS-)	SP2	356
2224 FORMAT(3X,6HWE(ND),5X,6HA(1,1),6X,6HA(2,2),6X,6HA(3,3),6X,6HA(4,4),	SP2	357
2,6X,6HA(5,5),6X,6HA(6,6),6X,6HA(3,5),6X,6HA(2,6),6X,6HA(2,4),6X,	SP2	358
26HA(4,6))	SP2	359
2226 FORMAT(3X,F6.3,1P10E12.4)	SP2	360
2227 FORMAT(/42H NON-DIMENSIONALIZED DAMPING COEFFICIENTS-)	SP2	361
2228 FORMAT(3X,6HWE(ND),5X,6HB(1,1),6X,6HB(2,2),6X,6HB(3,3),6X,6HB(4,4),	SP2	362
2,6X,6HB(5,5),6X,6HB(6,6),6X,6HB(3,5),6X,6HB(2,6),6X,6HB(2,4),6X,	SP2	363
26HB(4,6))	SP2	364
2300 CONTINUE	SP2	365
CALL SEPART (2)	SP2	366
777 RETURN	SP2	367
END	SP2	368
C	PQR	2
C-----VERSION 4 - CDC 6700 - P O R T - JUNE, 1972-----	PQR	3
C	PQR	4
SUBROUTINE PORT(A,B,C,P,Q,R,T)	PQR	5
P=(A-B)/(B-C)	PQR	6
Q=1.0/P	PQR	7
R=P-Q	PQR	8
T=A-C	PQR	9
RETURN	PQR	10
END	PQR	11
C	FIV	2
C-----VERSION 4 - CDC 6700 - F I N V - JUNE, 1972-----	FIV	3
C	FIV	4
SUBROUTINE FINV	FIV	5
C	FIV	6

C PROGRAMMER- W. FRANK, NSRDC

C		FIV	7
	COMMON AM(27),NUT,NMAS,NOS,ST(25),DS(25),EL,ELL,X(25,8),Y(25,8),PMFIV	FIV	8
	1AS(27),XMAS(27),ZMAS(27),RRG(27),XG,ZG,TMAS,EI44,EI55,EI66,F146,TPFIV	FIV	9
	2ST,RF33,RM35,RM55,DGM,DIP,K,N,TVOL,ALFA(40,11),BETA(40,11),HDG(10)FIV	FIV	10
	3,FN(5),BAM(30),COG(10),SDG(10),OMAX,OMIN,NFR,NOK,NOR,NOH,OMEN(40),FIV	FIV	11
	4FR(7,6),XX(25,7),YY(25,7),DEL(25,7),SNE(25,7),CSE(25,7),EN1(25,7),FIV	FIV	12
	SUN,OMEGA,ID,TITO(12),WORD,NON,IXAST,HDG1(10),IT,CBV,CMC,PRNTOP FIV	FIV	13
	COMMON ST1(27),YMAS(27),BEAM,DRAFT,UMAX,IRR,ML,IEND,IBILCE,IPRES, FIV	FIV	14
	2VNY,GRAY,AMODL,MOD,AKEELL,BEAMKL,ITS(25),RD(25),RFD(25),DELTAD(25)FIV	FIV	15
	2,RKD(25),SD(25),COSPHD(25),PHID(25),STPR(25),THMD(50) FIV	FIV	16
	COMMON NWSTP,INWSTP(12) FIV	FIV	17
	COMMON /TEMP/ BLOG(2,7,7),YLOG(2,7,7),DUM3(4R04) FIV	FIV	18
	DO 10 I=1,NON FIV	FIV	19
	XM2=XX(K,I)-X(K,1) FIV	FIV	20
	YM2=YY(K,I)-Y(K,1) FIV	FIV	21
	XP2=XX(K,I)+X(K,1) FIV	FIV	22
	YP2=YY(K,I)+Y(K,1) FIV	FIV	23
	FPR2=.5*ALOG(XM2**2+YM2**2) FIV	FIV	24
	FPL2=.5*ALOG(XP2**2+YM2**2) FIV	FIV	25
	FCR2=.5*ALOG(XM2**2+YP2**2) FIV	FIV	26
	FCL2=.5*ALOG(XP2**2+YP2**2) FIV	FIV	27
	APR2=ATAN2(YM2,XM2) FIV	FIV	28
	APL2=ATAN2(YM2,XP2) FIV	FIV	29
	ACR2=ATAN2(YP2,XM2) FIV	FIV	30
	ACL2=ATAN2(YP2,XP2) FIV	FIV	31
	DO 10 J=1,NON FIV	FIV	32
	XM1=XX(K,I)-X(K,J+1) FIV	FIV	33
	YM1=YY(K,I)-Y(K,J+1) FIV	FIV	34
	XP1=XX(K,I)+X(K,J+1) FIV	FIV	35
	YP1=YY(K,I)+Y(K,J+1) FIV	FIV	36
	FPR1=.5*ALOG(XM1**2+YM1**2) FIV	FIV	37
	FPL1=.5*ALOG(XP1**2+YM1**2) FIV	FIV	38
	FCR1=.5*ALOG(XM1**2+YP1**2) FIV	FIV	39
	FCL1=.5*ALOG(XP1**2+YP1**2) FIV	FIV	40
	APR1=ATAN2(YM1,XM1) FIV	FIV	41
	APL1=ATAN2(YM1,XP1) FIV	FIV	42
	ACR1=ATAN2(YP1,XM1) FIV	FIV	43
	ACL1=ATAN2(YP1,XP1) FIV	FIV	44
	SIMJ=SNE(K,I)*CSE(K,J)-SNE(K,J)*CSE(K,I) FIV	FIV	45
	CIMJ=CSE(K,I)*CSE(K,J)+SNE(K,I)*SNE(K,J) FIV	FIV	46
	SIPJ=SNE(K,I)*CSE(K,J)+SNE(K,J)*CSE(K,I) FIV	FIV	47
	CIPJ=CSE(K,I)*CSE(K,J)-SNE(K,I)*SNE(K,J) FIV	FIV	48
	DPNR=SIMJ*(FPR1-FPR2)+CIMJ*(APR1-APR2) FIV	FIV	49
	PPR=CSE(K,J)*(XM1*FPR1-YM1*APR1-XM1-XM2*FPR2+YM2*APR2+XM2)+SNE(K,J)FIV	FIV	50
	1)*(YM1*FPR1+XM1*APR1-YM1-YM2*FPR2-XM2*APR2+YM2) FIV	FIV	51
	DPNL=SIPJ*(FPL2-FPL1)+CIPJ*(APL2-APL1) FIV	FIV	52
	PPL=CSE(K,J)*(XP2*FPL2-YM2*APL2-XP2-XP1*FPL1+YM1*APL1+XP1)+SNE(K,J)FIV	FIV	53
	1)*(YM1*FPL1+XP1*APL1+YM2*FPL2-XP2*APL2-YM1) FIV	FIV	54
	DCNR=SIPJ*(FCR1-FCR2)+CIPJ*(ACR1-ACR2) FIV	FIV	55
	PCR=CSE(K,J)*(XM1*FCR1-YP1*ACR1-XM1-XM2*FCR2+YP2*ACR2+XM2)+SNE(K,J)FIV	FIV	56
	1)*(YP2*FCR2+XM2*ACR2+YP1-YP1*FCR1-XM1*ACR1-YP2) FIV	FIV	57
	DCNL=SIMJ*(FCL2-FCL1)+CIMJ*(ACL2-ACL1) FIV	FIV	58
	PCL=CSE(K,J)*(XP2*FCL2-YP2*ACL2-XP2-XP1*FCL1+YP1*ACL1+XP1)+SNE(K,J)FIV	FIV	59
	1)*(YP2*FCL2+XP2*ACL2-YP2-YP1*FCL1-XP1*ACL1+YP1) FIV	FIV	60
	BLOG(1,I,J)=DPNR+DPNL-DCNR-DCNL FIV	FIV	61
	YLOG(1,I,J)=PPR+PPL-PCR-PCL FIV	FIV	62
	BLOG(2,I,J)=DPNR-DCNR-DCNL FIV	FIV	63
	YLOG(2,I,J)=PPR-PPL-PCR-PCL FIV	FIV	64
	IF(J-NON) 475,10,10 FIV	FIV	65
475	XM2=XM1 FIV	FIV	66
	YM2=YM1 FIV	FIV	67
	XP2=XP1 FIV	FIV	68
	YP2=YP1 FIV	FIV	69
	FPR2=FPR1 FIV	FIV	70
	FPL2=FPL1 FIV	FIV	71
		FIV	72

FCR2=FCR1	FIV	73
FCL2=FCL1	FIV	74
APR2=APR1	FIV	75
APL2=APL1	FIV	76
ACR2=ACR1	FIV	77
ACL2=ACL1	FIV	78
10 CONTINUE	FIV	79
RETURN	FIV	80
END	FIV	81
C	KRN	2
C-----VERSION 4 - CDC 6700 - KERN - JUNE, 1972-----	KRN	3
C	KRN	4
SUBROUTINE KERN	KRN	5
C	KRN	6
C PROGRAMMER- W. FRANK, NSRDC	KRN	7
C	KRN	8
COMMON AM(27),NUT,NMAS,NOS,ST(25),DS(25),EL,ELL,X(25,4),Y(25,8),PMKRN	KRN	9
1AS(27),XMAS(27),ZMAS(27),PRG(27),XG,ZG,TMAS,EI44,EI55,EI66,EI66,TPKRN	KRN	10
2ST,RF33,RM35,RM55,DGM,DIP,K,N,TVOL,ALFA(40,11),HETA(40,11),HDG(10)KRN	KRN	11
3,FN(5),RAM(30),CDG(10),SUG(10),OMAX,OMIN,NFR,NOK,NOR,NOH,OMEN(40),KRN	KRN	12
4FR(7,6),XX(25,7),YY(25,7),DEL(25,7),SNE(25,7),CSE(25,7),EN1(25,7),KRN	KRN	13
5UN,OMEGA,ID,TITU(12),WORD,NON,IXAST,HDG1(10),IT,CHV,CMC,PRNTOP	KRN	14
COMMON ST1(27),YMAS(27),BEAM,DRAFT,DMAX,IRR,ML,IEND,IRILGE,IPRES,	KRN	15
2VNY,GRAY,AMODL,MUD,AKEELL,BEAMKL,ITS(25),RD(25),RFD(25),DELTA(25)KRN	KRN	16
2,RKD(25),SD(25),COSPHD(25),PHID(25),STPP(25),THMD(50)	KRN	17
COMMON NWSTP,INWSTP(12)	KRN	18
COMMON /TEMP/ BLOG(2,7,7),YLOG(2,7,7),PRA(7,6),PRV(7,6),	KRN	19
2 CON1(14,2),CON2(14,2),CT1(14,14),CT2(14,14),SOUR1(7,7),	KRN	20
2 SOUR2(7,7),WAVE1(7,7),WAVE2(7,7),INDEX(14,3),DUM3(4034)	KRN	21
NOE=2*NO:	KRN	22
DO 1 I=1,NON	KRN	23
NI=NON+1	KRN	24
FR(I,1)=EN1(K,I)	KRN	25
FR(I,2)=-SNE(K,I)	KRN	26
FR(I,3)=CSE(K,I)	KRN	27
FR(I,4)=XX(K,I)*CSE(K,I)-YY(K,I)*FP(I,2)	KRN	28
FR(I,5)=-DIP*FR(I,3)	KRN	29
FR(I,6)=DIP*FR(I,2)	KRN	30
CON1(I,1)=0.0	KRN	31
CON1(I,2)=0.0	KRN	32
CON2(I,1)=0.0	KRN	33
CON2(I,2)=0.0	KRN	34
CON1(NI,1)=OMEGA*FR(I,1)	KRN	35
CON1(NI,2)=OMEGA*FR(I,3)	KRN	36
CON2(NI,1)=OMEGA*FR(I,2)	KRN	37
CON2(NI,2)=OMEGA*FR(I,4)	KRN	38
XR2=UN*(XX(K,I)-X(K,I))	KRN	39
YR2=-UN*(YY(K,I)+Y(K,I))	KRN	40
XL2=UN*(XX(K,I)+X(K,I))	KRN	41
YL2=YR2	KRN	42
CALL DAVID(XR2,YR2,EJ2,CXR2,SXR2,RAH2,RBR2,CR2,SR2)	KRN	43
CALL DAVID(XL2,YL2,EJ2,CXL2,SXL2,RAL2,RBL2,CL2,SL2)	KRN	44
DO 1 J=1,NON	KRN	45
NJ=NON+J	KRN	46
SIPJ=SNE(K,I)*CSE(K,J)+SNE(K,J)*CSE(K,I)	KRN	47
CIPJ=CSE(K,I)*CSE(K,J)-SNE(K,I)*SNE(K,J)	KRN	48
SIMJ=SNE(K,I)*CSE(K,J)-SNE(K,J)*CSE(K,I)	KRN	49
CIMJ=CSE(K,I)*CSE(K,J)+SNE(K,I)*SNE(K,J)	KRN	50
XR1=UN*(XX(K,I)-X(K,J+1))	KRN	51
YR1=-UN*(YY(K,I)+Y(K,J+1))	KRN	52
XL1=UN*(XX(K,I)+X(K,J+1))	KRN	53
YL1=YR1	KRN	54
CALL DAVID(XR1,YR1,EJ1,CXR1,SXR1,RAH1,RBR1,CR1,SR1)	KRN	55
CALL DAVID(XL1,YL1,EJ1,CXL1,SXL1,RAL1,RBL1,CL1,SL1)	KRN	56
DPR=2.*(SIPJ*(CR1-CR2)-CIPJ*(SR1-SR2))	KRN	57
DPL=2.*(CIMJ*(SL1-SL2)-SIMJ*(CL1-CL2))	KRN	58

PPR=2./UN*(SNE(K,J)*(RAR1-RAR2)+CSE(K,J)*(RBR1-RBR2))	KRN	59
PPL=2./UN*(SNE(K,J)*(RAL1-RAL2)+CSE(K,J)*(RBL2-RBL1))	KRN	60
DWR=6.2831853*(EJ2*(SXR2*CIPJ-CXR2*SIPJ)-EJ1*(SXR1*CIPJ-CXR1*SIPJ))	KRN	61
1) DWL=6.2831853*(EJ1*(SXL1*CIMJ-CXL1*SIMJ)-EJ2*(SXL2*CIMJ-CXL2*SIMJ))	KRN	62
1) PWR=6.2831853/UN*(EJ1*(SXR1*CSE(K,J)-CXR1*SNE(K,J))-EJ2*(SXR2*CSE(K,J)-CXR2*SNE(K,J)))	KRN	65
1) K,J)-CXR2*SNE(K,J)))	KRN	66
PWL=6.2831853/UN*(EJ2*(SXL2*CSE(K,J)+CXL2*SNE(K,J))-EJ1*(SXL1*CSE(K,J)+CXL1*SNE(K,J)))	KRN	67
1) K,J)+CXL1*SNE(K,J)))	KRN	68
CT1(I,J)=ALOG(1,I,J)+DPR+DPL	KRN	69
CT2(I,J)=ALOG(2,I,J)+DPR-DPL	KRN	70
CT1(NI,NJ)=CT1(I,J)	KRN	71
CT2(NI,NJ)=CT2(I,J)	KRN	72
CT1(I,NJ)=DWR+DWL	KRN	73
CT2(I,NJ)=DWR-DWL	KRN	74
CT1(NI,J)=-CT1(I,NJ)	KRN	75
CT2(NI,J)=-CT2(I,NJ)	KRN	76
SOUR1(I,J)=YLOG(1,I,J)+PPR+PPL	KRN	77
SOUR2(I,J)=YLOG(2,I,J)+PPR-PPL	KRN	78
WAVE1(I,J)=PWR+PWL	KRN	79
WAVE2(I,J)=PWR-PWL	KRN	80
IF(J-NON) 2,1,1	KRN	81
2) XR2=XR1	KRN	82
YR2=YR1	KRN	83
CXR2=CXR1	KRN	84
SXR2=SXR1	KRN	85
RAR2=RAR1	KRN	86
RBR2=RBR1	KRN	87
CR2=CR1	KRN	88
SR2=SR1	KRN	89
XL2=XL1	KRN	90
YL2=YL1	KRN	91
EJ2=EJ1	KRN	92
CXL2=CXL1	KRN	93
SXL2=SXL1	KRN	94
RAL2=RAL1	KRN	95
RBL2=RBL1	KRN	96
CL2=CL1	KRN	97
SL2=SL1	KRN	98
1) CONTINUE	KRN	99
CALL MATINS(CT1,14,NOE,CON1,2,2,DTE,ID,INDEX)	KRN	100
GO TO(3,9),ID	KRN	101
3) CALL MATINS(CT2,14,NOE,CON2,2,2,DTE,ID,INDEX)	KRN	102
GO TO(4,9),ID	KRN	103
4) DO 5 I=1,NON	KRN	104
DO 6 L=1,4	KRN	105
PRA(I,L)=0.0	KRN	106
6) PRV(I,L)=0.0	KRN	107
DO 7 J=1,NON	KRN	108
NJ=NON+J	KRN	109
PRA(I,1)=PRA(I,1)+CON1(J,1)*WAVE1(I,J)-CON1(NJ,1)*SOUR1(I,J)	KRN	110
PRA(I,2)=PRA(I,2)+CON2(J,1)*WAVE2(I,J)-CON2(NJ,1)*SOUR2(I,J)	KRN	111
PRA(I,3)=PRA(I,3)+CON1(J,2)*WAVE1(I,J)-CON1(NJ,2)*SOUR1(I,J)	KRN	112
PRA(I,4)=PRA(I,4)+CON2(J,2)*WAVE2(I,J)-CON2(NJ,2)*SOUR2(I,J)	KRN	113
PRV(I,1)=PRV(I,1)+CON1(J,1)*SOUR1(I,J)+CON1(NJ,1)*WAVE1(I,J)	KRN	114
PRV(I,2)=PRV(I,2)+CON2(J,1)*SOUR2(I,J)+CON2(NJ,1)*WAVE2(I,J)	KRN	115
PRV(I,3)=PRV(I,3)+CON1(J,2)*SOUR1(I,J)+CON1(NJ,2)*WAVE1(I,J)	KRN	116
7) PRV(I,4)=PRV(I,4)+CON2(J,2)*SOUR2(I,J)+CON2(NJ,2)*WAVE2(I,J)	KRN	117
DO 8 L=1,4	KRN	118
PRA(I,L)=OMEGA*PRA(I,L)	KRN	119
8) PRV(I,L)=OMEGA*PRV(I,L)	KRN	120
PRA(I,5)=-DIP*PRA(I,3)	KRN	121
PRA(I,6)=DIP*PRA(I,2)	KRN	122
PRV(I,5)=-DIP*PRV(I,3)	KRN	123
5) PRV(I,6)=DIP*PRV(I,2)	KRN	124

9 RETURN	KRN	125
END	KRN	126
C	DAV	2
C-----VERSION 4 - COC 6700 - D A V I D - JUNE, 1972-----	DAV	3
C	DAV	4
SUBROUTINE DAVID(X,Y,E,C,S,RA,RR,CIN,SON)	DAV	5
C	DAV	6
C PROGRAMMER- W. FRANK,NSRDC, AND O. FALTINSEN,DNV	DAV	7
C	DAV	8
AT=ATAN2(X,Y)	DAV	9
ARG=AT-1.5707963	DAV	10
E=EXP(-Y)	DAV	11
C=COS(X)	DAV	12
S=SIN(X)	DAV	13
R=X**2+Y**2	DAV	14
TEST=0.00001	DAV	15
IF(R-1.0) 5,10,10	DAV	16
10 TEST=0.1*TEST	DAV	17
IF(R-2.0) 5,20,20	DAV	18
20 TEST=0.1*TEST	DAV	19
IF(R-4.0) 5,30,30	DAV	20
30 TEST=0.1*TEST	DAV	21
IF(R-200.0) 5,31,31	DAV	22
31 TEST=0.0001	DAV	23
AL=0.5*ALOG(R)	DAV	24
Y=-Y	DAV	25
SUMC=Y/SQRT(R)	DAV	26
SUMS=X/SQRT(R)	DAV	27
TC=SUMC	DAV	28
TS=SUMS	DAV	29
DO 33 K=1,15	DAV	30
TO=TC	DAV	31
TC=-(TC*Y-X*TS)*K/R	DAV	32
TS=-(TS*Y+X*TO)*K/R	DAV	33
SUMC=SUMC+TC	DAV	34
SUMS=SUMS+TS	DAV	35
IF(K-15) 34,35,35	DAV	36
34 IF((ABS(TC)+ABS(TS))-TEST) 35,35,33	DAV	37
35 SUMC=SUMC/SQRT(R)*(-1.)	DAV	38
SUMS=SUMS/SQRT(R)*(-1.)	DAV	39
SON=SUMS+3.141593*E*C	DAV	40
SON=-SON	DAV	41
CIN=SUMC+3.141593*E*S	DAV	42
RA=AL-CIN	DAV	43
RB=ARG+SON	DAV	44
GO TO 4	DAV	45
33 CONTINUE	DAV	46
5 AL=0.5*ALOG(R)	DAV	47
SUMC=0.57721566+AL*Y	DAV	48
SUMS=AT*X	DAV	49
TC=Y	DAV	50
TS=X	DAV	51
DO 1 K=1,500	DAV	52
TO=TC	DAV	53
COX=K	DAV	54
CAY=K+1	DAV	55
FACT=COX/CAY**2	DAV	56
TC=FACT*(Y*TC-X*TS)	DAV	57
TS=FACT*(Y*TS+X*TO)	DAV	58
25 SUMC=SUMC+TC	DAV	59
SUMS=SUMS+TS	DAV	60
IF(K-500) 40,3,3	DAV	61
40 IF((ABS(TC)+ABS(TS))-TEST) 3,3,1	DAV	62
3 CIN=E*(C*SUMC+S*SUMS)	DAV	63
SON=E*(S*SUMC-C*SUMS)	DAV	64
RA=AL-CIN	DAV	65

RR=ARG+SUN	DAV	66
GO TO 4	DAV	67
1 CONTINUE	DAV	68
4 RETURN	DAV	69
END	DAV	70
C	LK3	2
C-----VERSION 4 - CDC 6700 - P R O 3 - JUNE, 1972-----	LK3	3
C	LK3	4
OVERLAY (LINK3,3,0)	LK3	5
PROGRAM PR03	LK3	6
DIMENSION GMU(6,6)	LK3	7
CALL SPRG4 (GMU)	LK3	8
CALL SPRG5 (GMU)	LK3	9
END	LK3	10
C	SP4	2
C-----VERSION 4 - CDC 6700 - S P R G 4 - JUNE, 1972-----	SP4	3
C	SP4	4
SUBROUTINE SPRG4 (GMU)	SP4	5
C	SP4	6
C PROGRAMMER- O. FALTINSEN,DNV	SP4	7
C	SP4	8
COMMON AM(27),NUT,NMAS,NOS,ST(25),DS(25),EL,ELL,X(25,8),Y(25,8),PMSP4		9
1AS(27),XMAS(27),ZMAS(27),RRG(27),XG,ZG,TMAS,EI44,EI55,EI66,EI46,TPSP4		10
2ST,RF33,RM35,RM55,DGM,DIP,K,N,TVOL,ALFA(40,11),BETA(40,11),HOG(10)SP4		11
3,FN(5),BAM(30),COG(10),SDG(10),OMAX,OMIN,NFR,NOK,NOR,NOH,OMEN(40),SP4		12
4FR(7,6),XX(25,7),YY(25,7),DEL(25,7),SNE(25,7),CSE(25,7),ENI(25,7),SP4		13
SUN,OMEGA,IO,TITO(12),WORD,NON,IXAST,HOG1(10),IT,CBV,CMC,PRNTOP	SP4	14
COMMON ST1(27),YMAS(27),BEAM,DRAFT,OMAX,IRR,ML,IEND,IBILGE,IPRES,	SP4	15
ZVNY,GRAY,AMODL,MOD,AKEELL,BEAMKL,ITS(25),PD(25),RFD(25),DELTAD(25)SP4		16
2,RKD(25),SD(25),COSPHO(25),PHIO(25),STPR(25),THMD(50)	SP4	17
COMMON NWSTP,INWSTP(12)	SP4	18
DIMENSION GMU(6,6)	SP4	19
DO 111 I=1,6	SP4	20
DO 111 J=1,6	SP4	21
111 GMU(I,J)=0.0	SP4	22
GMU(1,1)=1.	SP4	23
GMU(2,2)=1.	SP4	24
GMU(3,3)=1.	SP4	25
GMU(4,4)=EI44	SP4	26
GMU(4,6)=EI46	SP4	27
GMU(5,5)=EI55	SP4	28
GMU(6,6)=EI66	SP4	29
GMU(4,2)=-ZG/ELL	SP4	30
GMU(2,4)=-ZG/ELL	SP4	31
GMU(1,5)=ZG/ELL	SP4	32
GMU(5,1)=ZG/ELL	SP4	33
RETURN	SP4	34
END	SP4	35

U		SP5	2
C	-----VERSION 4 - CDC 6700 - S P R G S - JUNE, 1972-----	SP5	3
C		SP5	4
	SUBROUTINE SPRG5(GMU)	SP5	5
C		SP5	6
C	PROGRAMMER- W. FRANK, NSRCC, AND O. FALTINSEN, DNV	SP5	7
C		SP5	8
	DIMENSION THCAL(30)	SP5	9
	COMMON AM(27), NUT, NMAS, NOS, ST(25), OS(25), EL, ELL, X(25,8), Y(25,8), PH	SP5	10
	1AS(27), XMAS(27), ZMAS(27), KRG(27), XU, ZG, THAS, EI44, EI55, EI66, EI46, TP	SP5	11
	2ST, RF33, RM35, RM55, CGM, DIP, K, N, TVUL, ALFA(40,11), BETA(40,11), HOG(10)	SP5	12
	3, FN(5), BAM(30), COG(10), SDG(10), OMAX, OHIN, NFR, NOK, NOD, NUH, OME(40),	SP5	13
	4FR(7,6), XX(25,7), YY(25,7), DEL(25,7), SNE(25,7), CSE(25,7), ENI(25,7),	SP5	14
	SUN, OMEGA, IO, TITO(12), WORU, NON, IXAST, HOG1(10), IT, LEV, CMC, FRNTOP	SP5	15
	COMMON ST1(27), YMAS(27), BEAM, DRAFT, OMAX, IAR, HL, IEND, IBILGE, IPRES,	SP5	16
	2VNY, GRAV, AMODL, MOD, AKEELL, BEAKL, ITS(25), RD(25), RFL(25), DELTAC(25)	SP5	17
	2, RKD(25), SJ(25), CUSP(25), PHID(25), STPK(25), THMD(50)	SP5	18
	COMMON NWSTP, INWSTP(12)	SP5	19
	COMMON /LOADPRN/ STLD(24), WORD2, WORD3, IDAMP, IPRCNT, B2(5), B3(5),	SP5	20
	2 PB2(25,5), PB3(25,5), ICLASS	SP5	21
	COMMON /FOIL/ FOIL, RHO, NF, CPL(10), SPAN(10), CHORD(10), S(10), YF(10	FMOD	81
	2), ZF(10), DUAHMA(10), CLZ(10), ASP(10), IPRINT	FMOD	82
	COMMON /FOIL/ GA(6,6)	FMOD	83
	DIMENSION A(3360)	SP5	22
	INTEGER PRNTOP, H	SP5	23
	COMPLEX CFAC(6), CSUM(6), DOUC, DEVEN, DUM3, DUM2, CPET, PP, QQ, II	SP5	24
	COMPLEX CFX(6)	SP5	25
	COMPLEX DEF(6)	SP5	26
	COMMON /TEMP/ POFI(6,25), POFI(6,25), RMO(6,30), AIMO(6,30),	SP5	27
	2 DA1(11), DB1(11), PEXR(6,25), PEXI(6,25), UADS(10,26), DCOS(10,26),	SP5	28
	2 TOA(6,6), TOI(6,6), SKF33(27), SPH35(27), SKM55(27), SL44(27),	SP5	29
	2 PAV(25,7,6), FAA(25,7,6), DA(6,6), DJ(6,6), TEV(6,6), DEV(6,1),	SP5	30
	2 TUD(6,6), JOU(6,1), INDEX(6,3), AR1(42), AR2(42), AT1(42), AT2(42),	SP5	31
	2 VC(25), SOKU(27), EDOY(27), AG8(27), PRER(8,14), PKEIP(8,14),	SP5	32
	2 FZRS(25), BVRS(25), BVIS(25), FZIS(25), FYRS(25), FYIS(25),	SP5	33
	2 THRS(25), THIS(25), ELKS(25), JLIS(25), RHMD(50), WE(30), ZN(30),	SP5	34
	2 XLILMD(30), IHMD(50), MAVAIF(30), OUY4(76)	SP5	35
	COMMON /IMP1/ FACT, JJ, HUIG1, VKNOTS, WLOPE, WSTP, IWSTP, LL, GXI	SP5	36
	COMMON /IMP2/ SHH(30,6,2)	SP5	37
	COMMON /IMP3/ RLO(5,30,25), AILO(5,30,25), STATN(24)	SP5	38
	COMMON /IMP4/ HMD(5,50,2), NHF, EPS	SP5	39
	COMMON /IMP5/ BOV(30,6,2)	SP5	40
	DIMENSION GHU(6,6), TUCF(6,6), TEVF(6,6), BOOF(6), BEVF(6), T(32,62)	FMOD	84
	DIMENSION TODA(6,6), TEVA(6,6), BODA(6), BEVA(6), TOLD(6,6), TEVD(6,6),	FMOD	85
	230UE(6), BEVD(6), TUUC(6,6), TEVC(6,6), BOUC(6), BEVC(6)	FMOD	86
	DATA MIN /3HMIN/	SP5	42
	BACKSPACE 1	FMOD	87
	2198 FORMAT(118H1NON-DIMENSIONAL ADDED MASS, DAMPING, AND RESTORING COEFF	FMOD	88
	2ICIENTS AND EXCITING FORCES AND MOMENTS OF THE STRUTS AND FOILS)	FMOD	89
	2199 FORMAT(41X, 12A6, 15X, 3H***//17X, 9HHEADLINE =, F5.0, 4H DEG, 7X, 12HSHIP	FMOD	90
	2 SPEED =, F6.2, 6H KNOTS/18X, 16H HEAD SEAS =180), 9X, 15H FROUDE NUMBER	FMOD	91
	3 =, F7.4, ///)	FMOD	92
	2200 FORMAT(156H NON-DIMENSIONALIZED ADDED MASS COEFFICIENTS OF THE FOI	FMOD	93
	1LS-)	FMOD	94
	2201 FORMAT(3X, 6HWE(NO), 5X, 6HA(1,1), 6X, 6HA(2,2), 6X, 6HA(3,3), 6X, 6HA(4,4)	FMOD	95
	1, 6X, 6HA(5,5), 6X, 6HA(6,6), 6X, 6HA(3,5), 6X, 6HA(2,6), 6X, 6HA(2,4), 6X, 6H	FMOD	96
	2A(4,6))	FMOD	97

2202	FORMAT(3X,F6.3,1P10E12.4)	FM00	98
2203	FORMAT(9X,1P10E12.4)	FM00	99
2204	FORMAT(/55H NON-DIMENSIONALIZED DAMPING COEFFICIENTS OF THE FOILS-	FM00	100
	1)	FM00	101
2205	FORMAT(3X,6HWE(ND),5X,6H3(1,1),6X,6H3(2,2),6X,6H3(3,3),6X,6H3(4,4)	FM00	102
	1,6X,6H3(5,5),6X,6H3(6,6),6X,6H3(3,5),6X,6H3(2,6),6X,6H3(2,4),6X,6H	FM00	103
	23(4,6))	FM00	104
2206	FORMAT(/57H NON-DIMENSIONALIZED RESTORING COEFFICIENTS OF THE FOIL	FM00	105
	1S-)	FM00	106
2207	FORMAT(3X,6HWE(ND),5X,6HC(1,1),6X,6HC(2,2),6X,6HC(3,3),6X,6HC(4,4)	FM00	107
	1,6X,6HC(5,5),6X,6HC(6,6),6X,6HC(3,5),6X,6HC(2,6),6X,6HC(2,4),6X,6H	FM00	108
	2C(4,6))	FM00	109
2208	FORMAT(/,* NON-DIMENSIONALIZED FORCE AND MOMENT FUNCTIONS OF THE F	FM00	110
	10ILS-*)	FM00	111
2209	FORMAT(3X,6HWE(ND),4X,5HSURGE,0X,4HSHAY,7X,5HHEAVE,0X,4HROLL,7X,5H	FM00	112
	2PITCH,9X,3HYAW)	FM00	113
2210	FORMAT(3X,F6.3,1P6E12.4)	FM00	114
2211	FORMAT(9X,1P6E12.4)	FM00	115
8001	FORMAT(/51H T00*X=800 BEFORE INSERTION OF HYDROFOIL ELEMENTS/)	FM00	116
8011	FORMAT(/51H T0V*X=80V BEFORE INSERTION OF HYDROFOIL ELEMENTS/)	FM00	117
8003	FORMAT(/50H T00*X=800 AFTER INSERTION OF HYDROFOIL ELEMENTS/)	FM00	118
8013	FORMAT(/50H T0V*X=80V AFTER INSERTION OF HYDROFOIL ELEMENTS/)	FM00	119
8002	FORMAT(/51H T00F AND B00F*)	FM00	120
8012	FORMAT(/51H T0VF AND B0VF*)	FM00	121
8021	FORMAT(3X,1P6E12.3,7X,1HX,12,7H REAL,0X,1P1E12.3)	FM00	122
8022	FORMAT(3X,1P6E12.3,7X,1HX,12,7H IMAG,0X,1P1E12.3)	FM00	123
8004	FORMAT(/51H X=INVT00*800/)	FM00	124
8014	FORMAT(/51H X=INVT0V*80V/)	FM00	125
8023	FORMAT(9X,1P1E12.3,12X,1P6E12.3,12X,1P1E12.3)	FM00	126
C		SP5	43
C	BY CALLING PREST THE RESTORING FORCES AND MOMENTS FOR THE VARIOUS SECT	SP5	44
C	OF THE SP5 ARE CALCULATED.	SP5	45
C	SKF33(K)=RESTORING COEFFICIENT(HEAVL-HEAVE) UP TO STATION K	SP5	46
C	SKF35(K)=RESTORING COEFFICIENT(HEAVL-PITCH) UP TO STATION K	SP5	47
C	SKF55(K)=RESTORING COEFFICIENT(PITCH-PITCH) UP TO STATION K	SP5	48
C	SL44(K)=MULTIPLICATIVE HEIGHT OVER THE WATERPLANE FOR THE PART OF THE	SP5	49
C	UP TO STATION K	SP5	50
C	THESE VARIABLES ARE USED FOR THE CALCULATION OF LOADS.	SP5	51
C		SP5	52
	DO 667 K=1,NOS	SP5	53
	CALL PREST(PKF33,PRM35,PRM55,PC44)	SP5	54
	SKF33(K)=PKF33	SP5	55
	SKM35(K)=PRM35	SP5	56
	SKM55(K)=PRM55	SP5	57
	SL44(K)=PC44	SP5	58
667	CONTINUE	SP5	59
	II=(0.,1.)	SP5	60
	FACT=57.255779	SP5	61
	PI=3.141593	SP5	62
	C33=KF33	SP5	63
	C35=KM35	SP5	64
	C55=KM55	SP5	65
	C44=DGM	SP5	66
C		SP5	67
C	IPRES=1 WE WANT TO CALCULATE PRESSURE	SP5	68
C	IPRES=2 WE DO NOT WANT TO CALCULATE PRESSURE	SP5	69
C		SP5	70

C		SP5	71
C	IEND=1 ENDTERMS IN THE EQUATIONS OF MOTION	SP5	72
C	IEND=2 NO ENDTERMS IN THE EQUATIONS OF MOTION	SP5	73
C	IBILGE=1 MEANS THAT THE SHIP HAS BILGEKEEL	SP5	74
C	IBILGE=2 MEANS THAT THE SHIP HAS NOT BILGEKEEL	SP5	75
C		SP5	76
C		SP5	77
C	MOD=1 MEANS MODEL WITHOUT BILGEKEEL	SP5	78
C	MOD=2 THE OTHER CASES	SP5	79
C	THM IS A FIRST APPROXIMATION TO MEAN MAXIMUM ROLL-AMPLITUDE (RADIANS)	SP5	80
C	VNY=KINEMATIC VISCOSITY	SP5	81
C	GRAV=ACCELERATION OF GRAVITY	SP5	82
C		SP5	83
C	AMODL= THE LENGTH OF THE MODEL FOR REYNOLDS NUMBER	SP5	84
C		SP5	85
C		SP5	86
C	KD(K)='GILGERADIUS' FOR STATION K	SP5	87
C		SP5	88
C		SP5	89
C	ITS(K)=1 FORESECTION WHERE KG/3#1.2	SP5	90
C	ITS(K)=2 MIDSECTION	SP5	91
C	ITS(K)=3 AFTSECTION WHERE B/KG#1.0	SP5	92
C	ITS(K)=4 OTHER CASES	SP5	93
C		SP5	94
C		SP5	95
C	EUDY(K)=COEFFICIENT OF EUDY MAKING DAMPING FOR STATION K	SP5	96
C		SP5	97
C	ML=1 CALCULATE MOTIONS	SP5	98
C	ML=2 CALCULATE MOTIONS AND LOADS	SP5	99
C		SP5	100
C		SP5	101
C	SET STPR(K)=0.0 IF WE DO NOT WANT PRESSURE ON STATION K	SP5	102
C	SET STPR(K)=1.0 IF WE WANT PRESSURES ON STATION K	SP5	103
C	IT IS NOT POSSIBLE TO GET PRESSURES ON THE FIRST AND LAST STATION	SP5	104
C		SP5	105
C	VNY=VNY/SQRT(GRAV*ELL**3)	SP5	106
C	NUSHAL=NUS	SP5	107
C	SGL = SQRT(GRAV/ELL)	SP5	108
C	SLG = 1./SGL	SP5	109
C	NMF = NCH*.NCH*NWSTP	SP5	110
C	KTH=0	SP5	111
C		SP5	112
C	THIS IS WHERE THE LOOPS FOR THE CALCULATION OF MOTIONS AND LOADS BEGI	SP5	113
C	THE OUTER LOOP IS FOR HEADING AND FROUDE NUMBER AND THE INNER LOOP I	SP5	114
C	WAVELENGTH.	SP5	115
C		SP5	116
C	EPS = .017453293	SP5	117
C	FCT = .75	SP5	118
C	DO 999 MM=1,NOM	SP5	119
C	IF (SQG(MM)+1.) 4001,4002,4001	SP5	120
C	4001 CONTINUE	SP5	121
C	MDIG=ACOS(LOG(MM))*FACT	SP5	122
C	GO TO 4003	SP5	123
C	4002 CONTINUE	SP5	124
C	MDIG=160.	SP5	125
C	4003 CONTINUE	SP5	126
C	DO 999 JJ=1,NOS	SP5	127

VKNOTS = SQRT(ELL*GRAV)*FN(JJ)/1.689	SP5	128
DO 999 IHWSTP=1,NHWSTP	SP5	129
IF (IHWSTP(IHWSTP) .LE. 0) IHWSTP(IHWSTP) = 90	SP5	130
HWSTP = 1./FLOAT(IHWSTP(IHWSTP))	SP5	131
ASLCP = 190.*HWSTP	SP5	132
KTH=KTH+1	SP5	133
ITERAT = 0	SP5	134
IF (THMD(KTH) .GT. 0.) GO TO 1500	SP5	135
IF (HOG1(MM) .EQ. 190. .OR. HOG1(MM) .EQ. J.) THMD(KTH) = .00175	SP5	136
IF (HOG1(MM) .EQ. 90. .OR. HOG1(MM) .EQ. 270.) THMD(KTH) = .2	SP5	137
IF (THMD(KTH) .LE. 0.) THMD(KTH) = .2	SP5	138
1500 ITERAT = ITERAT + 1	SP5	139
THM=THMD(KTH)	SP5	140
C	SP5	141
C BY CALLING TANAKA THE EDDYMAKING COEFFICIENTS FOR THE STATIONS ARE	SP5	142
C CALCULATED	SP5	143
C	SP5	144
CALL TANAKA(THM,EDDY,RGB)	SP5	145
DO 612 LL=1,NUK	SP5	146
HOIG1 = 190.0 - HOIG	SP5	147
TOF=6.293185	SP5	148
GXI=ABS(SQRT(TOP/BAM(LL))+TOP*FN(JJ)*COG(MM)/BAM(LL))	SP5	149
C	SP5	150
C GXI IS THE NON-DIMENSIONALIZED FREQUENCY OF ENCOUNTER. IT IS	SP5	151
C DIMENSIONALIZED BY MULTIPLICATION WITH SQRT(G/L).	SP5	152
C	SP5	153
IF(GXI-0.05) 5002,5002,5003	SP5	154
C	SP5	155
C THE ABOVE TEST IS MADE TO EXCLUDE THE CASE OF GXI=0.0. THIS HAS	SP5	156
C IMPORTANCE FOR THE FOLLOWING SEA CASE.	SP5	157
C	SP5	158
5002 CONTINUE	SP5	159
GXI=0.05	SP5	160
5003 CONTINUE	SP5	161
WE(LL) = GXI*SGL	SP5	162
ZN(LL) = GXI	SP5	163
WVLNTH = BAM(LL)*ELL	SP5	164
WAVAMP(LL)=HWSTP*WVLNTH/2.	SP5	165
XLCHD(LL) = 1./BAM(LL)	SP5	166
UN=0.5*GXI**2	SP5	167
DO 200 L=1,6	SP5	168
DO 200 M=1,6	SP5	169
JA(L,M)=0.0	SP5	170
200 JB(L,M)=0.0	SP5	171
DO 1 N=2,NFR	SP5	172
ITEMP = N	SP5	173
DIFF=CMLEN(N)-GXI*SQRT(0.5)	SP5	174
IF(DIFF) 1,3,3	SP5	175
1 CONTINUE	SP5	176
3 CONTINUE	SP5	177
N = ITEMP	SP5	178
DELTA1=CMLEN(N)-OMEN(N-1)	SP5	179
NUM=NUT-1	SP5	180
NUM0=6*NUM	SP5	181
K1 = NUM3	SP5	182
K2 = 2*NUM0	SP5	183
K3 = 3*NUM0	SP5	184

NSKIP = 2*(N-2)*NUMB	SP5	185
NELEM = 2*NFR*NUMB	SP5	186
DELTO = GX1*SQRT(0.5) - OMEN(N-1)	SP5	187
TERM = DELT4/DELT1	SP5	188
C THE FOLLOWING PROCEDURE READS IN FROM DRUM STORAGE THE PRESSURES,	SP5	189
C CALCULATED IN SPRG2, NECESSARY TO CALCULATE THE PRESSURE AT THE GXI	SP5	190
C FREQUENCY. PRESSURE MEANS PRESSURE PER UNIT MOTION. PAA AND PAV A	SP5	191
C PRESSURES	SP5	192
C	SP5	193
DO 350 K=1,NOSHAL	SP5	194
READ (20) (A(I),I=1,NELEM)	SP5	195
DO 350 J=1,NCN	SP5	196
KM = (J-1)*6 + NSKIP	SP5	197
DO 350 M=1,6	SP5	198
KM = KM + 1	SP5	199
AR1 = A(KM)	SP5	200
AR2 = A(KM+K1)	SP5	201
AT1 = A(KM+K2)	SP5	202
AT2 = A(KM+K3)	SP5	203
DELT4 = AT1 - AR1	SP5	204
DELT5 = AT2 - AR2	SP5	205
PAA(K,J,M) = AR1 + DELT4*TERM	SP5	206
PAV(K,J,M) = AR2 + DELT5*TERM	SP5	207
350 CONTINUE	SP5	208
NCWIND 20	SP5	209
DO 202 L=1,10	SP5	210
DELT2=(ALFA(N,L)-ALFA(N-1,L))/DELT1	SP5	211
DELT3=(BETA(N,L)-BETA(N-1,L))/DELT1	SP5	212
DA1(L)=ALFA(N-1,L)+DELT2*(GX1*SQRT(0.5)-OMEN(N-1))	SP5	213
DB1(L)=BETA(N-1,L)+DELT3*(GX1*SQRT(0.5)-OMEN(N-1))	SP5	214
202 CONTINUE	SP5	215
C	SP5	216
C VISC IS CALLED TO CALCULATE SKIN FRICTION AND EDDYMAKING DAMPING.	SP5	217
C	SP5	218
CALL VISC(GX1,VU,TVD,THM,EDDY,RGB)	SP5	219
TBKD=0.0	SP5	220
DO 4 K=1,NUS	SP5	221
SBKD(K)=J.9	SP5	222
4 CONTINUE	SP5	223
IF(1816-1) 3003,3003,3004	SP5	224
3003 CONTINUE	FM00	127
C	SP5	226
C BILGEK IS CALLED TO CALCULATE ROLL DAMPING DUE TO BILGEKEELS.	SP5	227
C	SP5	228
CALL BILGEK(GX1,THM,SBKD,TBKD)	SP5	229
3004 CONTINUE	SP5	230
C	SP5	231
C DA ARE ADDED MASS COEFFICIENTS. DB ARE DAMPING COEFFICIENTS. BOTH	SP5	232
C ARE FOR THE WHOLE SHIP.	SP5	233
C	SP5	234
C	SP5	235
C	SP5	236
DA(1,1)=DA1(1)	SP5	237
DB(1,1)=DB1(1)	SP5	238
DA(2,2)=DA1(2)	SP5	239
DB(2,2)=DB1(2)	SP5	240
DA(3,3)=DA1(3)	SP5	241

DB(3,3)=JB1(3)	SP5	242
JA(2,4)=JA1(9)	SP5	243
DB(2,4)=DB1(9)	SP5	244
DA(2,6)=JA1(8)-FN(JJ)/GXI**2*DB1(2)	SP5	245
DB(2,6)=JB1(8)+FN(JJ)*CA1(2)	SP5	246
DA(3,5)=JA1(7)+FN(JJ)/GXI**2*DB1(3)	SP5	247
DB(3,5)=JB1(7)-FN(JJ)*CA1(3)	SP5	248
DA(4,4)=DA1(4)	SP5	249
DB(4,4)=DB1(4)	SP5	250
DB(4,4)=JB(4,4)+TVD+TBKD	SP5	251
DA(4,2)=DA(2,4)	SP5	252
JB(4,2)=DB(2,4)	SP5	253
DA(4,6)=DA1(10)-FN(JJ)/GXI**2*DB1(9)	SP5	254
DB(4,6)=DB1(10)+FN(JJ)*DA1(9)	SP5	255
DA(5,3)=DA1(7)-FN(JJ)/GXI**2*DB1(3)	SP5	256
DB(5,3)=DB1(7)+FN(JJ)*CA1(3)	SP5	257
DA(5,5)=DA1(5)+(FN(JJ)/GXI)**2*DA1(3)	SP5	258
DB(5,5)=DB1(5)+(FN(JJ)/GXI)**2*DB1(3)	SP5	259
DA(6,2)=DA1(8)+FN(JJ)/GXI**2*DB1(2)	SP5	260
DB(6,2)=DB1(8)-FN(JJ)*DA1(2)	SP5	261
DA(6,4)=DA1(10)+FN(JJ)/GXI**2*DB1(9)	SP5	262
JB(6,4)=JB1(10)-FN(JJ)*DA1(9)	SP5	263
DA(6,6)=JA1(6)+(FN(JJ)/GXI)**2*DA1(2)	SP5	264
DB(6,6)=JB1(6)+(FN(JJ)/GXI)**2*DB1(2)	SP5	265
IF(IEND-1) 3001,3001,3002	FM00	128
3001 CONTINUE	SP5	267
C	SP5	268
C ENOSEP CALCULATES THE ADDED-MASS AND DAMPING TERMS THAT ARISE FROM	SP5	269
C SEPAKATION OF THE FLOW ABOUT THE HULL.	SP5	270
C	SP5	271
C CALL ENOSEP(DA,DB,GXI,PAA,PAV,JJ)	SP5	272
3002 CONTINUE	SP5	273
C	SP5	274
C THE FOLLOWING PROCEDURE CREATES THE COEFFICIENT MATRICIES TOO AND T	SP5	275
C THESE MATRICIES ARE USED TO SOLVE THE TWO SETS OF COUPLED DIFFERENT	SP5	276
C EQUATIONS FOR THE MOTIONS. IN MATRIX FORM THEY ARE- TOO*X=800 A	SP5	277
C TEV*X=8EV. THE FIRST EQUATION IS FOR THE SURGE, HEAVE, AND PITCH.	SP5	278
C THE SECOND EQUATION IS FOR THE SWAY, ROLL AND YAW.	SP5	279
C	SP5	280
DO 109 I=1,3	SP5	281
DO 110 J=1,3	SP5	282
IEV=1+I	SP5	283
JEV=J+J	SP5	284
IOO=IEV-1	SP5	285
JOJ=JEV-1	SP5	286
TOO(I,J)=-GXI**2*(GMU(IOO,JOJ)+DA(IOO,JOJ))	SP5	287
TOO(I,J+3)=GXI*DB(IOO,JOJ)	SP5	288
TOO(I+3,J+3)=TOO(I,J)	SP5	289
TOO(I+3,J)=-TOO(I,J+3)	SP5	290
TEV(I,J)=-GXI**2*(GML(IEV,JEV)+DA(IEV,JEV))	SP5	291
TEV(I,J+3)=GXI*DB(IEV,JEV)	SP5	292
TEV(I+3,J+3)=TEV(I,J)	SP5	293
TEV(I+3,J)=-TEV(I,J+3)	SP5	294
110 CONTINUE	SP5	295
109 CONTINUE	SP5	296
TOU(2,2)=TOO(2,2)+C33	SP5	297
TOU(2,3)=TOO(2,3)+C35	SP5	298

TOD(3,2)=TOD(3,2)+C35	SP5	299
TOD(3,3)=TOD(3,3)+C55	SP5	300
TOD(5,5)=TOD(2,2)	SP5	301
TOD(5,6)=TOD(2,3)	SP5	302
TOD(6,5)=TOD(3,2)	SP5	303
TOD(6,6)=TOD(3,3)	SP5	304
TEV(2,2)=TEV(2,2)+C44	SP5	305
TEV(5,5)=TEV(2,2)	SP5	306
C * * * * *	FMCO	129
C FOR A HULLBONE HYDROFIL (IFCIL=2), SUBROUTINE -FOIL- CALCULATES	FMCO	130
C THE MOTION COEFFICIENTS AND THE EXCITATION FORCES AND MOMENTS DUE	FMCO	131
C TO THE FOILS. RETURNED ARE THE TERMS FOR THE TOD, BOD, TEV, AND	FMCO	132
C BEV MATRICIES	FMCO	133
C	FMCO	134
IF(IFOIL-1) 7200,7200,7100	FMCO	135
7100 CALL FOIL(TODF,TEVF,BODF,BEVF,VKNOTS,WAVAMP,HOG1,GXI,ELL,RHO,NF,CP	FMCO	136
2L,SPAN,CHORD,S,YF,ZF,OGAMMA,CLZ,ASP,THAS,T,LL)	FMCO	137
DO 7110 JA=1,6	FMCO	138
DO 7112 JB=1,6	FMCO	139
TODA(JA,JB)=TOD(JA,JB)	FMCO	140
TEVA(JA,JB)=TEV(JA,JB)	FMCO	141
TOD(JA,JB)=TOD(JA,JB)+TODF(JA,JB)	FMCO	142
TEV(JA,JB)=TEV(JA,JB)+TEVF(JA,JB)	FMCO	143
TODB(JA,JB)=TOD(JA,JB)	FMCO	144
TEVB(JA,JB)=TEV(JA,JB)	FMCO	145
7112 CONTINUE	FMCO	146
7110 CONTINUE	FMCO	147
7200 CONTINUE	FMCO	148
C * * * * *	FMCO	149
DO 1010 L=1,6	SP5	307
CFX(L)=(0.0,0.0)	SP5	308
1010 CONTINUE	SP5	309
INOS=0	SP5	310
C	SP5	311
C THE EXCITING FORCES AND MOMENTS FOR THE WHOLE SHIP (BOD AND BEV) A	SP5	312
C NOW CALCULATED. PEXR AND PEXI ARE THE FORCES AND MOMENTS FOR SECTI	SP5	313
C	SP5	314
DO 32 K=1,NUS	SP5	315
KO=K	SP5	316
WN=TCP/84M(LL)/2.	SP5	317
CP=WN*(ST(K)-TFST)*WDG(MM)	SP5	318
CP1=LCOS(CP)	SP5	319
CP2=SIN(CP)	SP5	320
CPET=(CP1+II*CP2)*OS(K)	SP5	321
UIF=ST(K)-TFST	SP5	322
DO 1643 I=1,NON	SP5	323
FR(I,1)=EN1(K,I)	SP5	324
FR(I,2)=-SHE(K,I)	SP5	325
FR(I,3)=CSE(K,I)	SP5	326
FR(I,4)=XX(K,I)*CSE(K,I)-YY(K,I)*FR(I,2)	SP5	327
FR(I,5)=-OIP*FR(I,3)	SP5	328
FR(I,6)=JIP*FR(I,2)	SP5	329
1643 CONTINUE	SP5	330
DO 1001 L=1,6	SP5	331
1001 USUM(L)=(0.0,0.0)	SP5	332
DO 610 L=1,6	SP5	333
DEF(L)=0.0	SP5	334

610 CONTINUE	SP5	335
DO 71 J=1,NON	SP5	336
PET=EXP(WN*YY(K,J))	SP5	337
ARG=WN*AX(K,J)*SOG(MM)	SP5	338
FC=COS(ARG)	SP5	339
FS=SIN(ARG)	SP5	340
CFAC(1)=FC*FR(J,1)	SP5	341
CFAC(3)=FC*FR(J,3)	SP5	342
CFAC(5)=FC*FR(J,5)	SP5	343
CFAC(2)=11*FS*FR(J,2)	SP5	344
CFAC(4)=11*FS*FR(J,4)	SP5	345
CFAC(6)=11*FS*FR(J,6)	SP5	346
PP=FR(J,3)	SP5	347
QQ=11*FR(J,2)*SOG(MM)	SP5	348
DDDD=(PP*FC+11*QQ*FS)*(GX1 *SQRT(0.5*WN)/UN)	SP5	349
DEVEN=(QQ*FC+11*PP*FS)*(GX1 *SQRT(0.5*WN)/UN)	SP5	350
DUM3=CFAC(3)	SP5	351
DUM2=CFAC(2)	SP5	352
CFAC(1)=CFAC(1)-DDDD*CMPLX(PAA(K,J,1),PAV(K,J,1))	SP5	353
CFAC(3)=CFAC(3)-DDDD*CMPLX(PAA(K,J,3),PAV(K,J,3))	SP5	354
CFAC(5)=CFAC(5)-DDDD*CMPLX(PAA(K,J,5),PAV(K,J,5))	SP5	355
CFAC(2)=CFAC(2)-DEVEN*CMPLX(PAA(K,J,2),PAV(K,J,2))	SP5	356
CFAC(4)=CFAC(4)-DEVEN*CMPLX(PAA(K,J,4),PAV(K,J,4))	SP5	357
CFAC(6)=CFAC(6)-DEVEN*CMPLX(PAA(K,J,6),PAV(K,J,6))	SP5	358
CFAC(5)=CFAC(5)+(2.*11*FN(JJ)/GX1)*(CFAC(3)-DUM3)	SP5	359
CFAC(6)=CFAC(6)-(2.*11*FN(JJ)/GX1)*(CFAC(2)-DUM2)	SP5	360
DO 1002 L=1,6	SP5	361
1002 CSUM(L)=CSUM(L)+PET*DEL(K,J)*CFAC(L)	SP5	362
DEF(3)=DEF(3)-DDDD*CMPLX(PAA(K,J,3),PAV(K,J,3))*PET*DEL(K,J)*4.	SP5	363
DEF(5)=DEF(5)-DDDD*CMPLX(PAA(K,J,5),PAV(K,J,5))*PET*DEL(K,J)*2.	SP5	364
DEF(2)=DEF(2)-DEVEN*CMPLX(PAA(K,J,2),PAV(K,J,2))*PET*DEL(K,J)*4.	SP5	365
DEF(4)=DEF(4)-DEVEN*CMPLX(PAA(K,J,4),PAV(K,J,4))*PET*DEL(K,J)*2.	SP5	366
DEF(6)=DEF(6)-DEVEN*CMPLX(PAA(K,J,6),PAV(K,J,6))*PET*DEL(K,J)*2.	SP5	367
71 CONTINUE	SP5	368
DO 10 L=1,6	SP5	369
PEXR(L,K0)=REAL(CSUM(L)*CPET)/TVOL	SP5	370
PLXI(L,K0)=AIMAG(CSUM(L)*CPET)/TVOL	SP5	371
10 CONTINUE	SP5	372
PEXR(1,K0)=4.0*PEXR(1,K0)	SP5	373
PEXR(2,K0)=4.0*PEXR(2,K0)	SP5	374
PEXR(3,K0)=4.0*PEXR(3,K0)	SP5	375
PEXR(4,K0)=2.0*PEXR(4,K0)	SP5	376
PEXR(5,K0)=2.0*PEXR(5,K0)	SP5	377
PEXR(6,K0)=2.0*PEXR(6,K0)	SP5	378
PLXI(6,K0)=2.0*PLXI(6,K0)	SP5	379
PEXI(5,K0)=2.0*PEXI(5,K0)	SP5	380
PEXI(4,K0)=2.0*PEXI(4,K0)	SP5	381
PEXI(3,K0)=4.0*PEXI(3,K0)	SP5	382
PEXI(2,K0)=4.0*PEXI(2,K0)	SP5	383
DO 611 L=1,6	SP5	384
PUFR(L,K)=REAL(DEF(L)*CPET*11)/TVOL/GX1/OS(K)*2.*FN(JJ)	SP5	385
PDFI(L,K)=AIMAG(DEF(L)*CPET*11)/TVOL/GX1/OS(K)*2.*FN(JJ)	SP5	386
611 CONTINUE	SP5	387
DO 1003 L=1,6	SP5	388
1003 CFX(L)=CFX(L)+CPET*CSUM(L)	SP5	389
32 CONTINUE	SP5	390
DO 103 L=1,3	SP5	391

LEV=L+L	SP5	392
L00=LEV-1	SP5	393
B00(L,1)=REAL(CFX(L00))/TVOL	SP5	394
B00(L+3,1)=AIMAG(CFX(L00))/TVOL	SP5	395
B00(L,1)=REAL(CFX(LEV))/TVOL	SP5	396
B00(L+3,1)=AIMAG(CFX(LEV))/TVOL	SP5	397
103 CONTINUE	SP5	398
B00(1,1)=4.0*B00(1,1)	SP5	399
B00(2,1)=4.0*B00(2,1)	SP5	400
B00(3,1)=2.0*B00(3,1)	SP5	401
B00(4,1)=4.0*B00(4,1)	SP5	402
B00(5,1)=4.0*B00(5,1)	SP5	403
B00(6,1)=2.0*B00(6,1)	SP5	404
B00(1,1)=4.0*B00(1,1)	SP5	405
B00(2,1)=2.0*B00(2,1)	SP5	406
B00(3,1)=2.0*B00(3,1)	SP5	407
B00(4,1)=4.0*B00(4,1)	SP5	408
B00(5,1)=2.0*B00(5,1)	SP5	409
B00(6,1)=2.0*B00(6,1)	SP5	410
C B00(1,1)=REAL PART(SURGE/H)	SP5	411
C B00(4,1)=IMAGINARY PART(SURGE/H)	SP5	412
C B00(1,1)=REAL PART(SWAY/H)	SP5	413
C B00(4,1)=IMAGINARY PART(SWAY/H)	SP5	414
C B00(2,1)=REAL PART(HEAVE/H)	SP5	415
C B00(5,1)=IMAGINARY PART(HEAVE/H)	SP5	416
C B00(2,1)=REAL PART(ROLL*L/H)	SP5	417
C B00(5,1)=IMAGINARY PART(ROLL*L/H)	SP5	418
C B00(3,1)=REAL PART(PITCH*L/H)	SP5	419
C B00(6,1)=IMAGINARY PART(PITCH*L/H)	SP5	420
C B00(3,1)=REAL PART(YAW*L/H)	SP5	421
C B00(6,1)=IMAGINARY PART(YAW*L/H)	SP5	422
C *	SP5	423
C IF(IFUJL-1) 7600,7600,7500	SP5	424
7500 DO 7510 JA=1,6	SP5	425
B00A(JA)=B00(JA,1)	SP5	426
B00V(JA)=B00(JA,2)	SP5	427
B00C(JA,1)=B00C(JA,1)+20CF(JA)	SP5	428
B00E(JA,1)=B00E(JA,1)+B00F(JA)	SP5	429
B00G(JA)=B00(JA,1)	SP5	430
B00H(JA)=B00(JA,2)	SP5	431
7510 CONTINUE	SP5	432
7600 CONTINUE	SP5	433
C *	SP5	434
C B00V(LL,1,1) = B00V(1,1)	SP5	435
C B00V(LL,1,2) = B00V(4,1)	SP5	436
C B00V(LL,2,1) = B00V(1,1)	SP5	437
C B00V(LL,2,2) = B00V(4,1)	SP5	438
C B00V(LL,3,1) = B00V(2,1)	SP5	439
C B00V(LL,3,2) = B00V(5,1)	SP5	440
C B00V(LL,4,1) = B00V(2,1)	SP5	441
C B00V(LL,4,2) = B00V(5,1)	SP5	442
C B00V(LL,5,1) = B00V(3,1)	SP5	443
C B00V(LL,5,2) = B00V(6,1)	SP5	444
C B00V(LL,6,1) = B00V(3,1)	SP5	445
C B00V(LL,6,2) = B00V(6,1)	SP5	446
C MATINS IS USED TO SOLVE THE EQUATIONS OF MOTION.	SP5	447
C CALL MATINS(T00,6,6,B00,1,1,ITEM,IO,INCEX)	SP5	448
DO 8201 IQ=1,6	SP5	449
B00C(IQ)=B00(IQ,1)	SP5	450

5286	FORMAT(73H)AMPLITUDE AND PHASE OF THE PRESSURE FOR THE SPECIFIED P	SP5	484
	JOINTS ON SECTION I2)	SP5	485
	WRITE(6,5207)	SP5	486
5287	FORMAT(25X,13H Y-COORDINATE,9X,13H Z-COORDINATE,7X,10H AMPLITUDE,1	SP5	487
	12X,6H PHASE)	SP5	488
	DO 5288 JS=1,2	SP5	489
	IF(JS-1) 6222,6222,6223	FMCD	175
6222	CONTINUE	SP5	491
	CSP=1.0	SP5	492
	WRITE(6,6224)	SP5	493
6224	FORMAT(16H STARBOARD SIDE)	SP5	494
	GO TO 6225	SP5	495
6223	CONTINUE	SP5	496
	CSP=-1.0	SP5	497
	WRITE(6,6226)	SP5	498
6226	FORMAT(11H PORT SIDE)	SP5	499
6225	CONTINUE	SP5	500
	DO 5209 J=1,NON	SP5	501
	JM=J+NON*(JS-1)	SP5	502
	YPRES=XX(K,J)*EL*CSP	SP5	503
	ZPRES=YY(K,J)*EL	SP5	504
	AV=SQR(1+PREM(KPA,JM)**2+PREIM(KPA,JM)**2)	SP5	505
	IF(PREM(KPA,JM)) 751,752,751	SP5	506
752	IF(PREM(KPA,JM)) 751,753,751	SP5	507
753	PH=0.0	SP5	508
	GO TO 754	SP5	509
751	PH=ATAN2(PREM(KPA,JM),PRERE(KPA,JM))*FACT	SP5	510
754	CONTINUE	SP5	511
	WRITE(6,5210) YPRES,ZPRES,AV,PH	SP5	512
5210	FORMAT(25X,F10.4,10X,F10.4,10X,F10.4,10X,F10.4)	SP5	513
5209	CONTINUE	SP5	514
5203	CONTINUE	SP5	515
5204	CONTINUE	SP5	516
5203	CONTINUE	SP5	517
	IF (ML.EQ. 2) CALL LCADS	SP5	518
612	CONTINUE	SP5	519
C-----	TEST FOR CONVERGENCE OF ROLL ANGLE-----	SP5	520
	RHMD(KTH)=3MAX(NOK,THCAL)	SP5	521
	THDIFF = THMD(KTH) - RHMD(KTH)	SP5	522
	THORAU = ABS(THDIFF)	SP5	523
	IMMD(KTH) = ITERAT	SP5	524
	HMD(ITERAT,KTH,1) = THMD(KTH)	SP5	525
	HML(ITERAT,KTH,2) = PHMD(KTH)	SP5	526
	IF (THORAU .LE. EPS) GO TO 1505	SP5	527
	IF (ITERAT .EQ. 5) GO TO 1505	SP5	528
	THMD(KTH) = THMD(KTH) - SIGN(1.,THDIFF)*FCT*THORAU	SP5	529
	GO TO 1500	SP5	530
1505	IF (IF01L-1) 2401,2401,2402	FMCD	176
2402	WRITE(6,2199)	FMCD	177
	DO 5614 JM=1,2	FMCD	178
	IF(JM.EQ. 1) H=1	FMCD	179
	IF(JM.EQ. 2) H=6	FMCD	180
	IF(H.EQ. 6 .AND. PRNTOP.EQ. MIN) GO TO 5614	FMCD	181
	WRITE(H,2199) TITU,HDIG1,VKNOTS,FN(JJ)	FMCD	182
5614	CONTINUE	FMCD	183
	WRITE(6,2200)	FMCD	184
	WRITE(6,2201)	FMCD	185

DO 2300 LX=1,NOK	FM00	186
LWEINC=NOK-LX+1	FM00	187
2300 WRITE(6,2202) ZN(LWEINC),(T(LWEINC,KX),KX=1,10)	FM00	188
WRITE(6,2204)	FM00	189
WRITE(6,2205)	FM00	190
DO 2301 LX=1,NOK	FM00	191
LWEINC=NOK-LX+1	FM00	192
WRITE(6,2202) ZN(LWEINC),(T(LWEINC,KX),KX=11,20)	FM00	193
2301 WRITE(6,2203) (T(LWEINC,KX),KX=21,30)	FM00	194
WRITE(6,2206)	FM00	195
WRITE(6,2207)	FM00	196
DO 2302 LX=1,NOK	FM00	197
LWEINC=NOK-LX+1	FM00	198
WRITE(6,2202) ZN(LWEINC),(T(LWEINC,KX),KX=31,40)	FM00	199
2302 WRITE(6,2203) (T(LWEINC,KX),KX=41,50)	FM00	200
WRITE(6,2208)	FM00	201
WRITE(6,2209)	FM00	202
DO 2303 LX=1,NOK	FM00	203
LWEINC=NOK-LX+1	FM00	204
WRITE(6,2210) ZN(LWEINC),(T(LWEINC,KX),KX=51,56)	FM00	205
2303 WRITE(6,2211) (T(LWEINC,KX),KX=57,62)	FM00	206
IF (IFRINT) 2401,2401,8000	FM00	207
8000 WRITE(6,8001)	FM00	208
DO 8101 IQ=1,3	FM00	209
JQ=IQ+IQ-1	FM00	210
8101 WRITE(6,8021) (TODA(IQ,KQ),KQ=1,6),JQ,800A(IQ)	FM00	211
DO 8102 IQ=4,6	FM00	212
JQ=IQ+IQ-7	FM00	213
8102 WRITE(6,8022) (TODA(IQ,KQ),KQ=1,6),JQ,800A(IQ)	FM00	214
WRITE(6,8002)	FM00	215
DO 8103 IQ=1,3	FM00	216
JQ=IQ+IQ-1	FM00	217
8103 WRITE(6,8021) (TODF(IQ,KQ),KQ=1,6),JQ,800F(IQ)	FM00	218
DO 8104 IQ=4,6	FM00	219
JQ=IQ+IQ-7	FM00	220
8104 WRITE(6,8022) (TODF(IQ,KQ),KQ=1,6),JQ,800F(IQ)	FM00	221
WRITE(6,8003)	FM00	222
DO 8105 IQ=1,3	FM00	223
JQ=IQ+IQ-1	FM00	224
8105 WRITE(6,8021) (TODJ(IQ,KQ),KQ=1,6),JQ,800J(IQ)	FM00	225
DO 8106 IQ=4,6	FM00	226
JQ=IQ+IQ-7	FM00	227
8106 WRITE(6,8022) (TODJ(IQ,KQ),KQ=1,6),JQ,800J(IQ)	FM00	228
WRITE(6,8004)	FM00	229
DO 8107 IQ=1,6	FM00	230
8107 WRITE(6,8023) 800C(IQ),(TODC(IQ,KQ),KQ=1,6),800B(IQ)	FM00	231
WRITE(6,8011)	FM00	232
DO 8108 IQ=1,3	FM00	233
JQ=IQ+IQ	FM00	234
8108 WRITE(6,8021) (TEVA(IQ,KQ),KQ=1,6),JQ,8EVA(IQ)	FM00	235
DO 8109 IQ=4,6	FM00	236
JQ=IQ+IQ-6	FM00	237
8109 WRITE(6,8022) (TEVA(IQ,KQ),KQ=1,6),JQ,8EVA(IQ)	FM00	238
WRITE(6,8012)	FM00	239
DO 8110 IQ=1,3	FM00	240
JQ=IQ+IQ	FM00	241
8110 WRITE(6,8021) (TEVF(IQ,KQ),KQ=1,6),JQ,8EVF(IQ)	FM00	242

DO 8111 IQ=4,6	FMOD	243
JQ=IQ+IQ-6	FMOD	244
8111 WRITE(6,8022) (TEVF(IQ,KQ),KQ=1,6),JQ,SEVF(IQ)	FMOD	245
WRITE(6,8013)	FMOD	246
DO 8112 IQ=1,3	FMOD	247
JQ=IQ+IQ	FMOD	248
8112 WRITE(6,8021) (TEVB(IQ,KQ),KQ=1,6),JQ,SEVB(IQ)	FMOD	249
DO 8113 IQ=4,6	FMOD	250
JQ=IQ+IQ-6	FMOD	251
8113 WRITE(6,8022) (TEVB(IQ,KQ),KQ=1,6),JQ,SEVB(IQ)	FMOD	252
WRITE(6,8014)	FMOD	253
DO 8114 IQ=1,6	FMOD	254
8114 WRITE(6,8023) SEVC(IQ),(TEVC(IQ,KQ),KQ=1,6),SEVB(IQ)	FMOD	255
2401 IF (IHSIP .EQ. 1) CALL EXCFM	FMOD	256
CALL MCTOUT	SP5	532
IF (ML .EQ. 1) GO TO 781	SP5	533
ITEMP = PRNTOP	SP5	534
NOSM1 = NUS - 1	SP5	535
DO 780 ISTAT=1,NOSM1	SP5	536
PRNTOP = MIN	SP5	537
IF (STLO(ISTAT) .GT. 0.) PRNTOP = ITEMP	SP5	538
CALL LCDOUT(ISTAT)	SP5	539
780 CONTINUE	SP5	540
PRNTOP = ITEMP	SP5	541
781 CONTINUE	SP5	542
998 CONTINUE	SP5	543
999 CONTINUE	SP5	544
CALL KCTA3L	SP5	545
RETURN	SP5	546
END	SP5	547

1	SUBROUTINE FOIL(TUDF,TEVF,BUDF,BEVF,VKNOTS,WAMPL,HUG1,GXI,ELL,RHO,	FOIL	2
	2NF,01,02,03,04,05,06,07,08,09,IMAS,T,NFREQ)	FOIL	3
	COMMON /FOIL/ GA(6,6)	FOIL	4
	DIMENSION TODF(6,6),TEVF(6,6),BUDF(6),BEVF(6)	FOIL	5
5	DIMENSION Q1(10),Q2(10),Q3(10),Q4(10),Q5(10),Q6(10),Q7(10),Q8(10),	FOIL	6
	209(10)	FOIL	7
	DIMENSION GB(6,6),GC(6,6),GF(6),T(32,62),GAA(6,6)	FOIL	8
	COMPLEX CK,H2,C2,P1B33,P1C33,P2H35,P1C35,P2C35,P1B22,P1B24,P1C24,P	FOIL	9
	12B26,P1C26,P1B44,P2H44,P1C44,P2B46,P1C46,P1B53,P1C53,P3B55,P1C55,P	FOIL	10
0	22C55,P1B62,P1B64,P1C64,P2B66,P1C66	FOIL	11
	COMPLEX C,EXL,EXM,AA,APG,HSIN,HCOS,V1,V2,W1,W2,PL1,PF2,PF3,PL2,PF4	FOIL	12
	2,PH1,PF5,PF6,BB,W3	FOIL	13
	COMPLEX GB,GC,GF	FOIL	14
5	P1A33=P1A35=P1B35=P1A22=P1A24=P1A26=P1B26=P1A44=P2A44=P1A46=P1B46=	FOIL	15
	1P1A55=P1B55=P2B55=P1A66=P1B66=P3B66=0.	FOIL	16
	P1B33=P1C33=P2H35=P1C35=P2C35=P1B22=P1B24=P1C24=P2B26=P1C26=P1B44=	FOIL	17
	2P2B44=P1C44=P2B46=P1C46=P1B53=P3B55=P1C55=P2C55=P1B62=P1B64=P1C64=	FOIL	18
	3P2B66=P1C66=(0.,0.)	FOIL	19
	PF2=PF3=PF4=PF5=PF6=(0.,0.)	FOIL	20
	DO 200 I=1,6	FOIL	21
	GF(I)=(0.,0.)	FOIL	22
	DO 201 J=1,6	FOIL	23
	IF(NFREQ.EQ.1) GA(I,J)=0.	FOIL	24
	GB(I,J)=(0.,0.)	FOIL	25
5	201 GC(I,J)=(0.,0.)	FOIL	26
	200 CONTINUE	FOIL	27
C		FOIL	28
C	MULTIPLICATION FACTORS FOR NON-DIM. ARE	FOIL	29
C	ACCEL FORCES (1./MASS)	FOIL	30
C	VEL. FORCES (1./MASS)*SQRT(LPP/GRAV)	FOIL	31
C	DISPL. FORCES (1./MASS)*(LPP/GRAV)	FOIL	32
C	SUBSCRIPTS 11,13,31,33,22	FOIL	33
C		FOIL	34
C	INERTIA MOMENTS (1./MASS)/LPP**2	FOIL	35
C	ANGULAR VEL. MOMENTS (1./MASS)*SQRT(LPP/GRAV)/LPP**2	FOIL	36
C	ANGULAR DISPL. MOMENTS (1./MASS)*(LPP/GRAV)/LPP**2	FOIL	37
C	SUBSCRIPTS 55,44,46,64,66	FOIL	38
C		FOIL	39
C	CROSS INERTIA (1./MASS)/LPP	FOIL	40
C	CROSS VEL. (1./MASS)*SQRT(LPP/GRAV)/LPP	FOIL	41
C	CROSS DISPL. (1./MASS)*(LPP/GRAV)/LPP	FOIL	42
C	SUBSCRIPTS 15,35,51,53,24,26,42,62	FOIL	43
C		FOIL	44
C	EXCIT. FORCES/WAVE AMPL. LPP/(MASS*GRAV*WAMPL)	FOIL	45
C	SUBSCRIPTS 1,2,3	FOIL	46
C		FOIL	47
C	EXCIT. MOM./WAVE AMPL. 1./(MASS*GRAV*WAMPL)	FOIL	48
C	SUBSCRIPTS 4,5,6	FOIL	49
C		FOIL	50
	GRAV=32.2	FOIL	51
	RMASS=1./IMAS	FOIL	52
	ZLDIVG=ELL/GRAV	FOIL	53
	ELLSQ=ELL*ELL	FOIL	54
	FA1=RMASS	FOIL	55
	FB1=RMASS*SQRT(ZLDIVG)	FOIL	56
	FC1=RMASS*ZLDIVG	FOIL	57
	FA2=FA1/ELLSQ	FOIL	58

	FB2=FB1/ELLS0	FOIL	59
	FC2=FC1/ELLS0	FOIL	60
	FA3=FA1/ELL	FOIL	61
	FB3=FB1/ELL	FOIL	62
	FC3=FC1/ELL	FOIL	63
	FD1=ELL/(TMAS*GRAV*WAMPL)	FOIL	64
	FO2=FD1/ELL	FOIL	65
5	C	FOIL	66
	PI=3.14159	FOIL	67
	XMU=(180.0-HQ01)/57.2957795	FOIL	68
	U=VKNOTS*1.689	FOIL	69
	SINMU=SIN(XMU)	FOIL	70
0	COSMU=COS(XMU)	FOIL	71
	OMEGAE=GXI*SQRT(GRAV/ELL)	FOIL	72
	GDIVU=GRAV/(2.*U)	FOIL	73
	OMEGA=-GDIVU*SQRT((GDIVU*GDIVU)+(2.*GDIVU*OMEGAE))	FOIL	74
5	A1=PI*RHO	FOIL	75
	A3=A1*U	FOIL	76
	B1=0.5*RHO*U	FOIL	77
	C1=B1*U	FOIL	78
	BB=CMPLX(0.,1.)	FOIL	79
0	C-----	FOIL	80
	C SUMMATIONS FOR FOIL COEFFICIENTS AND EXCITATION FORCES / MOMENTS	FOIL	81
	C-----	FOIL	82
	C	FOIL	83
	DO 100 I=1,NF	FOIL	84
	CPL=Q1(I)	FOIL	85
5	SPAN=Q2(I)	FOIL	86
	CHORD=Q3(I)	FOIL	87
	S=Q4(I)	FOIL	88
	Y=Q5(I)	FOIL	89
	Z=Q6(I)	FOIL	90
0	DGAMMA=Q7(I)	FOIL	91
	CLZ=Q8(I)	FOIL	92
	ASP=Q9(I)	FOIL	93
	NCPL=CPL	FOIL	94
5	AREA=SPAN*CHORD	FOIL	95
	ASPRAT=SPAN/CHORD	FOIL	96
	ASPCOR=ASPRAT/(ASPRAT+ASP)	FOIL	97
	CPL=CPL*ASPCOR	FOIL	98
	GAMMA=DGAMMA/57.2957795	FOIL	99
0	SING=SIN(GAMMA)	FOIL	100
	SINGSO=SING*SING	FOIL	101
	COSG=COS(GAMMA)	FOIL	102
	COSGSO=COSG*COSG	FOIL	103
	CLALPH=2.*PI	FOIL	104
5	XK1=0.5*OMEGAE*CHORD/U	FOIL	105
	XK2=(OMEGA*OMEGA)/GRAV	FOIL	106
	XK3=0.5*(OMEGAE*OMEGA)*CHORD*COSMU/GRAV	FOIL	107
	CALL THEO(XK1,XK)	FOIL	108
	A2=0.25*AREA*CHORD*CPL	FOIL	109
0	B2=AREA*CLALPH*CK*CPL	FOIL	110
	C2=CLZ*AREA*CK*CPL	FOIL	111
	C * * * * *	FOIL	112
	IF(NFREQ.GT.1) GO TO 308	FOIL	113
	P1A33=P1A33+(A2*CUSGSO)	FOIL	114
	P1A35=P1A35+(A2*S*CUSGSO)	FOIL	115

5	P1A55=P1A55*(A2*CUSG50*(CHORD*CHORD/32.*S*S))	FOIL	116
	P1A22=P1A22*(A2*SING50)	FOIL	117
	P1A24=P1A24*((A2*Z*SING50)+(A2*Y*SING*COSG))	FOIL	118
	P1A26=P1A26*(A2*S*SING50)	FOIL	119
	P1A44=P1A44*(A2*EA*AEA*SPAN/48.)*CPL	FOIL	120
)	P2A44=P2A44*(A2*((Z*SING+Y*COSG)**2))	FOIL	121
	P1A46=P1A46*((A2*Z*S*SING50)+(A2*Y*S*SING*COSG))	FOIL	122
	P1A66=P1A66*(A2*SING50*(CHORD*CHORD/32.*S*S))	FOIL	123
308	P1B33=P1B33*(B2*CUSG50)	FOIL	124
	P1B35=P1B35*(A2*CUSG50)	FOIL	125
5	P2B35=P2B35*(B2*CUSG50*(S*(CHORD/4.)))	FOIL	126
	P1B53=P1B53*(B2*(S-(CHORD/4.))*COSG50)	FOIL	127
	P1B55=P1B55*(A2*S*CUSG50)	FOIL	128
	P2B55=P2B55*((CHORD**3)*SPAN*COSG50/16.)*CPL	FOIL	129
	P3B55=P3B55*(B2*(S*(CHORD/4.))*(S-(CHORD/4.))*CUSG50)	FOIL	130
)	P1B22=P1B22*(B2*SING50)	FOIL	131
	P1B24=P1B24*((B2*Z*SING50)+(B2*Y*SING*COSG))	FOIL	132
	P1B26=P1B26*(A2*SING50)	FOIL	133
	P2B26=P2B26*(B2*(S*(CHORD/4.))*SING50)	FOIL	134
	P1B44=P1B44*(B2*SPAN*SPAN/12.)*CPL	FOIL	135
5	P2B44=P2B44*(B2*((Z*SING+Y*COSG)**2))	FOIL	136
	P1B46=P1B46*((A2*Z*SING50)+(A2*Y*SING*COSG))	FOIL	137
	P2B46=P2B46*(B2*(S*(CHORD/4.))*((Z*SING50)+(Y*SING*COSG)))	FOIL	138
	P1B62=P1B62*(B2*(S-(CHORD/4.))*SING50)	FOIL	139
	P1B64=P1B64*(B2*(S-(CHORD/4.))*((Z*SING50)+(Y*SING*COSG)))	FOIL	140
)	P1B66=P1B66*(A2*S*SING50)	FOIL	141
	P2B66=P2B66*(B2*(S*(CHORD/4.))*(S-(CHORD/4.))*SING50)	FOIL	142
	P3B66=P3B66*((CHORD**3)*SPAN*SING50/16.)*CPL	FOIL	143
	P1C33=P1C33*(C2*CUSG50)	FOIL	144
	P1C35=P1C35*(B2*CUSG50)	FOIL	145
;	P2C35=P2C35*(C2*(S-(CHORD/4.))*COSG50)	FOIL	146
	P1C53=P2C35	FOIL	147
	P1C55=P1C55*(B2*(S-(CHORD/4.))*COSG50)	FOIL	148
	P2C55=P2C55*(C2*(S*(CHORD/4.))*(S-(CHORD/4.))*COSG50)	FOIL	149
	P1C24=P1C24*(C2*Y*SING50)	FOIL	150
)	P1C26=P1C26*(B2*SING50)	FOIL	151
	P1C64=P1C64*(C2*(S-(CHORD/4.))*Y*SING50)	FOIL	152
	P1C66=P1C66*(B2*(S-(CHORD/4.))*SING50)	FOIL	153
	P1C44=P1C44*(C2*Y*((Y*CUSG50)+(Z*SING50)))	FOIL	154
	P1C46=P1C46*((B2*Z*SING50)+(B2*Y*SING*COSG))	FOIL	155
;	C * * * * *	FOIL	156
	CALL EXCIT(XK3,XK1,CK,EXL,EXM)	FOIL	157
25	C=CMPLX(CUSG,SINMUG)	FOIL	158
	XREAL=XK2*SING	FOIL	159
	XIMAG=XK2*SINMU*CUSG	FOIL	160
)	AA=CMPLX(XREAL,XIMAG)	FOIL	161
	ARG=0.5*AA*SPAN	FOIL	162
	HSIN=0.5*(CEXP(ARG)-CEXP(-ARG))	FOIL	163
	HCOS=0.5*(CEXP(ARG)+CEXP(-ARG))	FOIL	164
	V1=(2./AA)*HSIN	FOIL	165
;	V2=(1./(AA*AA))*(AA*SPAN*HCOS-2.*HSIN)	FOIL	166
	XREAL=XK2*Z	FOIL	167
	XIMAG=-XK2*Y*SINMU	FOIL	168
	AA=CMPLX(XREAL,XIMAG)	FOIL	169
	AA=WAMPL*OMEGA*CEXP(AA)*C	FOIL	170
)	W1=AA*V1*JB	FOIL	171
	W2=AA*V2*JB	FOIL	172

	W3=AA*88	FOIL	173
	IF (NCPL-1) S1,S1,S0	FOIL	174
50	W1=2.*W1	FOIL	175
5	W2=2.*W2	FOIL	176
	W3=2.*W3	FOIL	177
51	XIMAG=-XK2*5*COSMU	FOIL	178
	AA=CEXP(C*PLX(0.,XIMAG))	FOIL	179
	C=CHORD*EXL*AA	FOIL	180
	PL1=C*AIMAG(W1)*88	FOIL	181
	PF3=PF3+(PL1*COSG*ASPCOR)	FOIL	182
	PL1=C*REAL(W1)	FOIL	183
	PL2=CHORD*W2*EXL	FOIL	184
	PM1=0.25*CHORD*CHORD*EXM*AA	FOIL	185
5	PF5=PF5-(((S*PL1)-PM1*88*AIMAG(W3))*COSG)*ASPCOR	FOIL	186
	MD=MDG1	FOIL	187
	IF (MD .GT. 180.) MD=MD-180.	FOIL	188
	IF (MD .GT. 172.) GO TO 100	FOIL	189
	IF (MD .LT. 8.) GO TO 100	FOIL	190
	PF2=PF2-(PL1*SING*ASPCOR)	FOIL	191
	PF4=PF4+(PL2+PL1*(Y*COSG+Z*SING))*ASPCOR	FOIL	192
	PF6=PF6+(((S*PL1)+PM1*REAL(W3))*SING)*ASPCOR	FOIL	193
100	CONTINUE	FOIL	194
C		FOIL	195
5	C-----	FOIL	196
C	FOIL COEFFICIENTS (NON-DIM.)	FOIL	197
C	C-----	FOIL	198
	IF (NFREQ .GT. 1) GO TO 310	FOIL	199
	GA(3,3)=FA1*(+A1*P1A33)	FOIL	200
	GA(3,5)=FA3*(-A1*P1A35)	FOIL	201
	GA(5,3)=GA(3,5)	FOIL	202
	GA(5,5)=FA2*(+A1*P1A55)	FOIL	203
	GA(2,2)=FA1*(+A1*P1A22)	FOIL	204
	GA(2,4)=FA3*(-A1*P1A24)	FOIL	205
5	GA(2,6)=FA3*(+A1*P1A26)	FOIL	206
	GA(4,2)=GA(2,4)	FOIL	207
	GA(4,4)=FA2*(+A1*(P1A44+P2A44))	FOIL	208
	GA(4,6)=FA2*(-A1*P1A46)	FOIL	209
	GA(6,2)=GA(2,6)	FOIL	210
	GA(6,4)=GA(4,6)	FOIL	211
	GA(6,6)=FA2*(+A1*P1A66)	FOIL	212
310	GB(3,3)=F41*(+B1*P1B33)	FOIL	213
	GB(3,5)=F43*(-A3*P1B35-B1*P2B35)	FOIL	214
	GB(5,3)=F43*(-B1*P1B53)	FOIL	215
5	GB(5,5)=F42*(+A3*P1B55+A3*P2B55+B1*P3B55)	FOIL	216
	GB(2,2)=F41*(+B1*P1B22)	FOIL	217
	GB(2,4)=F43*(-B1*P1B24)	FOIL	218
	GB(2,6)=F43*(+A3*P1B26+B1*P2B26)	FOIL	219
	GB(4,2)=GB(2,4)	FOIL	220
	GB(4,4)=F42*(+B1*(P1B44+P2B44))	FOIL	221
	GB(4,6)=F42*(-A3*P1B46-B1*P2B46)	FOIL	222
	GB(6,2)=F43*(+B1*P1B62)	FOIL	223
	GB(6,4)=F42*(-B1*P1B64)	FOIL	224
	GB(6,6)=F42*(+A3*P1B66+B1*P2B66+A3*P3B66)	FOIL	225
	GC(3,3)=FC1*(+C1*P1C33)	FOIL	226
	GC(3,5)=FC3*(-C1*(P1C35+P2C35))	FOIL	227
	GC(5,3)=FC3*(-C1*P1C53)	FOIL	228
	GC(5,5)=FC2*(+C1*(P1C55+P2C55))	FOIL	229

GC(2,4)=FC3*(-C1*P1C24)	FOIL	230
GC(2,6)=FC3*(+C1*P1C26)	FOIL	231
GC(4,4)=FC2*(+C1*P1C44)	FOIL	232
GC(4,6)=FC2*(-C1*P1C46)	FOIL	233
GC(6,4)=FC2*(-C1*P1C64)	FOIL	234
GC(6,6)=FC2*(+C1*P1C66)	FOIL	235
DO 400 K=1,6	FOIL	236
T(NFREQ,K)=GA(K,K)	FOIL	237
T(NFREQ,K+10)=REAL(G8(K,K))	FOIL	238
T(NFREQ,K+20)=AIMAG(G8(K,K))	FOIL	239
T(NFREQ,K+30)=REAL(GC(K,K))	FOIL	240
400 T(NFREQ,K+40)=AIMAG(GC(K,K))	FOIL	241
T(NFREQ,7)=GA(3,5)	FOIL	242
T(NFREQ,8)=GA(2,6)	FOIL	243
T(NFREQ,9)=GA(2,4)	FOIL	244
T(NFREQ,10)=GA(4,6)	FOIL	245
T(NFREQ,17)= REAL(G8(3,5))	FOIL	246
T(NFREQ,27)=AIMAG(G8(3,5))	FOIL	247
T(NFREQ,18)= REAL(G8(2,6))	FOIL	248
T(NFREQ,28)=AIMAG(G8(2,6))	FOIL	249
T(NFREQ,19)= REAL(G8(2,4))	FOIL	250
T(NFREQ,29)=AIMAG(G8(2,4))	FOIL	251
T(NFREQ,20)= REAL(G8(4,6))	FOIL	252
T(NFREQ,30)=AIMAG(G8(4,6))	FOIL	253
T(NFREQ,37)= REAL(GC(3,5))	FOIL	254
T(NFREQ,47)=AIMAG(GC(3,5))	FOIL	255
T(NFREQ,38)= REAL(GC(2,6))	FOIL	256
T(NFREQ,48)=AIMAG(GC(2,6))	FOIL	257
T(NFREQ,39)= REAL(GC(2,4))	FOIL	258
T(NFREQ,49)=AIMAG(GC(2,4))	FOIL	259
T(NFREQ,40)= REAL(GC(4,6))	FOIL	260
T(NFREQ,50)=AIMAG(GC(4,6))	FOIL	261
C	FOIL	262
C MULTIPLICATION OF ACCELERATION TERMS BY -GX1*GX1	FOIL	263
C MULTIPLICATION OF VELOCITY TERMS BY +GX1	FOIL	264
C	FOIL	265
A=-GX1*GX1	FOIL	266
B=GX1	FOIL	267
DO 202 I=1,6	FOIL	268
DO 203 J=1,6	FOIL	269
GAA(I,J)=A*GA(I,J)	FOIL	270
203 G8(I,J)=B*GB(I,J)	FOIL	271
202 CONTINUE	FOIL	272
C	FOIL	273
C FOIL COMPONENTS FOR MATRICIES -TOD AND TEV-	FOIL	274
C	FOIL	275
DO 205 I=1,3	FOIL	276
DO 206 J=1,3	FOIL	277
IEV=I+I	FOIL	278
JEV=J+J	FOIL	279
IOD=IEV-1	FOIL	280
JOD=JEV-1	FOIL	281
TODF(I,J)=GAA(IOD,JOD)-AIMAG(G8(IOD,JOD))*REAL(GC(IOD,JOD))	FOIL	282
TODF(I,J+3)=+REAL(G8(IOD,JOD))*AIMAG(GC(IOD,JOD))	FOIL	283
TODF(I+3,J+3)=TODF(I,J)	FOIL	284
TODF(I+3,J)=-TODF(I,J+3)	FOIL	285
TEVF(I,J)=GAA(IEV,JEV)-AIMAG(G8(IEV,JEV))*REAL(GC(IEV,JEV))	FOIL	286

TEVF(I,J+3)=+REAL(GB(IEV,JEV))+AIMAG(GC(IEV,JEV))	FOIL	287
TEVF(I+3,J+3)=TEVF(I,J)	FOIL	288
TEVF(I+3,J)=-TEVF(I,J+3)	FOIL	289
206 CONTINUE	FOIL	290
205 CONTINUE	FOIL	291

C EXCITATION FORCES AND MOMENTS (NUN-DIM.)	FOIL	292
C	FOIL	293
C	FOIL	294
C	FOIL	295
GF(2)=FD1*(+A3*PF2)	FOIL	296
GF(3)=FD1*(+A3*PF3)	FOIL	297
GF(4)=FD2*(+A3*PF4)	FOIL	298
GF(5)=FD2*(+A3*PF5)	FOIL	299
GF(6)=FD2*(+A3*PF6)	FOIL	300
DU 402 K=1,6	FOIL	301
T(NFREQ,K+50)= REAL(GF(K))	FOIL	302
402 T(NFREQ,K+56)=AIMAG(GF(K))	FOIL	303
C	FOIL	304
C FOIL COMPONENTS FOR MATRICIES -B00 AND BEV-	FOIL	305
C	FOIL	306
B00F(1)=0.0	FOIL	307
B00F(2)=+REAL(GF(3))	FOIL	308
B00F(3)=+REAL(GF(5))	FOIL	309
B00F(4)=0.0	FOIL	310
B00F(5)=-AIMAG(GF(3))	FOIL	311
B00F(6)=-AIMAG(GF(5))	FOIL	312
BEVF(1)=+REAL(GF(2))	FOIL	313
BEVF(2)=+REAL(GF(4))	FOIL	314
BEVF(3)=+REAL(GF(6))	FOIL	315
BEVF(4)=-AIMAG(GF(2))	FOIL	316
BEVF(5)=-AIMAG(GF(4))	FOIL	317
BEVF(6)=-AIMAG(GF(6))	FOIL	318
RETURN	FOIL	319
999 END	FOIL	320

```

SUBROUTINE THEO(XK1,CK)
  COMPLEX CK
1001 FORMAT(*      J0   IER=*,I2)
1002 FORMAT(*      J1   IER=*,I2)
1003 FORMAT(*      Y0   IER=*,I2)
1004 FORMAT(*      Y1   IER=*,I2)
  CALL IBSJ(XK1,0,XJ0,1.E-6,IER)
  IF(IEK.GE.3) GO TO 77
  CALL IBSJ(XK1,1,XJ1,1.E-6,IER)
  IF(IEK.GE.3) GO TO 78
  CALL IBESY(XK1,0,Y0,IER)
  IF(IEK.EQ.3) GO TO 79
  CALL IBESY(XK1,1,Y1,IER)
  IF(IEK.EQ.3) GO TO 80
  T1=XJ1+Y0
  T2=Y1-XJ1
  X=XJ1*T1+Y1*T2
  Y=-Y1*Y0-XJ1*XJ0
  CK=CMPLX(X,Y)
  X=T1*T1+T2*T2
  CK=CK/X
  GO TO 81
77 WRITE(6,1001) IER
  GO TO 81
78 WRITE(6,1002) IER
  GO TO 81
79 WRITE(6,1003) IER
  GO TO 81
80 WRITE(6,1004) IER
81 RETURN
END

```

THEO	2
THEO	3
THEO	4
THEO	5
THEO	6
THEO	7
THEO	8
THEO	9
THEO	10
THEO	11
THEO	12
THEO	13
THEO	14
THEO	15
THEO	16
THEO	17
THEO	18
THEO	19
THEO	20
THEO	21
THEO	22
THEO	23
THEO	24
THEO	25
THEO	26
THEO	27
THEO	28
THEO	29
THEO	30
THEO	31
THEO	32

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SUBROUTINE EXCIT(XK3,XK1,CK,EXL,EXH)
COMPLEX CK,T1,T2,T3,T4,EXL,EXH,V
1001 FORMAT(* J0 IER=*,I2)
1002 FORMAT(* J1 IER=*,I2)
1003 FORMAT(* J2 IER=*,I2)
1004 FORMAT(* J3 IER=*,I2)
IF(XK3) 2,3,3
2 ISIGN=0
GO TO 4
3 ISIGN=1
4 XK3=ABS(XK3)
CALL IDESJ(XK3,0,XJ0,1.E-4,IER)
IF(IER.GE.3) GO TO 77
CALL IDESJ(XK3,1,XJ1,1.E-6,IER)
IF(IER.GE.3) GO TO 78
CALL IDESJ(XK3,2,XJ2,1.E-6,IER)
IF(IER.GE.3) GO TO 79
CALL IDESJ(XK3,3,XJ3,1.E-6,IER)
IF(IER.GE.3) GO TO 80
IF(ISIGN) 5,5,6
5 XJ1=-XJ1
XJ3=-XJ3
XK3=-XK3
6 T1=CMPLX(XJ0,-XJ1)
T2=T1*CK
R1=0.5*XK1*(XJ0+XJ2)
T3=CMPLX(R1,0.)
EXL=T2+T3
T1=XJ0*CK
T2=XJ1*(1.-CK)
V=CMPLX(0.,1.)
T2=V*T2
R1=(XJ1+XJ3)*(XK1/4.)
T3=CMPLX(R1,0.)
T4=CMPLX(XJ2,0.)
EXH=T1+T2-T3+T4
GO TO 81
77 WRITE(6,1001) IER
GO TO 81
78 WRITE(6,1002) IER
GO TO 81
79 WRITE(6,1003) IER
GO TO 81
80 WRITE(6,1004) IER
81 RETURN
END

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EXCIT 2
EXCIT 3
EXCIT 4
EXCIT 5
EXCIT 6
EXCIT 7
EXCIT 8
EXCIT 9
EXCIT 10
EXCIT 11
EXCIT 12
EXCIT 13
EXCIT 14
EXCIT 15
EXCIT 16
EXCIT 17
EXCIT 18
EXCIT 19
EXCIT 20
EXCIT 21
EXCIT 22
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EXCIT 37
EXCIT 38
EXCIT 39
EXCIT 40
EXCIT 41
EXCIT 42
EXCIT 43
EXCIT 44
EXCIT 45
EXCIT 46
EXCIT 47

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C
C-----VERSION 4 - CDC 6700 - L O A D S - JUNE, 1972-----
C
SUBROUTINE LOADS
COMMON AM(27),NUT,NMAS,NOS,ST(25),DS(25),EL,ELL,X(25,8),Y(25,8),PMLD
1AS(27),XMAS(27),ZMAS(27),RRG(27),XG,ZG,TMAS,EI44,EI55,EI66,EI46,TPLD
2ST,RF33,RM35,RM55,DGM,DIP,K,N,TVOL,ALFA(40,11),BETA(40,11),HDG(10)LOD
3,FN(5),BAM(30),CDG(10),SDG(10),OMAX,OMIN,NFR,NOK,NOB,NOH,OMEN(40),LOD
4FR(7,6),XX(25,7),YY(25,7),DEL(25,7),SNE(25,7),CSE(25,7),ENI(25,7),LOD
5SUN,OMEGA,IO,TITO(12),WORD,NON,IXAST,HDG1(10),IT,CBV,CMC,PRNTOP LOD
6COMMON ST1(27),YMAS(27),BEAM,DRAFT,DMAX,IRR,M,IENG,I8ILGE,IPRES. LOD
72VNY,GRAV,AMODL,MOD,AKEELL,BEAMKL,ITS(25),RD(25),RFI(25),DELTAD(25)LOD
82,RKD(25),SD(25),COSPHD(25),PHID(25),STPR(25),IHMD(50) LOD
9COMMON NWSTP,INWSTP(12) LOD
10COMMON /TEMP/ PDFR(6,25),PDFI(6,25),RMO(6,30),AIMO(6,30), LOD
112 DA1(11),DB1(11),PEXR(6,25),PEXI(6,25),DADS(10,25),DDDS(10,26), LOD
122 TOA(6,6),TOB(6,6),SRF33(27),SRM35(27),SRM55(27),SC44(27), LOD
132 PAV(25,7,6),PAA(25,7,6),DA(6,6),DB(6,6),TEV(6,6),REV(6,1), LOD
142 TOD(6,6),BOD(6,1),INDEX(6,3),ARI(42),AR2(42),AT1(42),AT2(42), LOD
152 VD(25),SBKD(27),EDDY(27),RGB(27),PRERE(8,14),PREIM(8,14), LOD
162 FZRS(25),BVRSG(25),RVISG(25),FZISG(25),FYRS(25),FYISG(25), LOD
172 TMRSG(25),TMISG(25),BLRSG(25),BLISG(25),RHMD(50),WE(30),ZN(30), LOD
182 XL1LMD(30),IHMD(50),WAVAMP(30),DUM4(76) LOD
19COMMON /TMP1/ FACT,JJ,DM1(5),LL,GXI LOD
20COMMON /TMP3/ RLO(5,30,25),AILO(5,30,25),STATN(24) LOD
21
C
C AFTER FIRST CALCULATING THE ADDED-MASS AND DAMPING FOR EACH SECTIONLOD
C THE SHEARING FORCES AND BENDING AND TORSIONAL MOMENTS ARE DETERMINELOD
C
DO 16 K=1,NOS
DIP=ST(K)-TPST
DO 54 I=1,NON
FR(I,1)=ENI(K,I)
FR(I,2)=-SNE(K,I)
FR(I,3)=CSE(K,I)
FR(I,4)=XX(K,I)*CSE(K,I)-YY(K,I)*FR(I,2)
FR(I,5)=-DIP*FR(I,3)
FR(I,6)=DIP*FR(I,2)
54 CONTINUE
DO 55 LK=1,10
GO TO(613,613,613,613,613,613,614,615,616,617),LK
613 CONTINUE
L=LK
M=LK
GO TO 618
614 CONTINUE
L=5
M=3
GO TO 618
615 CONTINUE
L=2
M=6
GO TO 618
616 CONTINUE
L=2
M=4
GO TO 618
617 CONTINUE
L=6
M=4
618 CONTINUE
DADS(LK,K)=0.0
DDDS(LK,K)=0.0
DO 619 J=1,NON
DADS(LK,K)=DADS(LK,K)+DEL(K,J)*FR(J,L)*PAA(K,J,M)
DDDS(LK,K)=DDDS(LK,K)+DEL(K,J)*FR(J,L)*PAV(K,J,M)

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619	CONTINUE	L00	68
	DADS(LK,K)=2.0*DADS(LK,K)*DS(K)	L00	69
	DDDS(LK,K)=2.0*DDDS(LK,K)*DS(K)	L00	70
55	CONTINUE	L00	71
	DO 620 L=1,10	L00	72
	DADS(L,K)=DADS(L,K)/TVOL/UN	L00	73
	DDDS(L,K)=DDDS(L,K)/TVOL/SQRT(UN)*SQRT(2.)	L00	74
620	CONTINUE	L00	75
	DO 621 L=4,10	L00	76
	DADS(L,K)=DADS(L,K)*0.5*0.5	L00	77
	DDDS(L,K)=DDDS(L,K)*0.5*0.5	L00	78
621	CONTINUE	L00	79
	DO 622 L=7,9	L00	80
	DADS(L,K)=DADS(L,K)*2.	L00	81
	DDDS(L,K)=DDDS(L,K)*2.	L00	82
622	CONTINUE	L00	83
16	CONTINUE	L00	84
C		L00	85
C	THE POSSIBILITY THAT THERE MAY BE MASS FORWARD OF THE F.P. IS NOW	L00	86
C	ACCOUNTED FOR.	L00	87
C		L00	88
	NOS1=NOS+1	L00	89
	DA(2,2)=PMAS(NOS1)/TMAS*(-GX1**2)	L00	90
	DA(2,4)=-ZMAS(NOS1)/ELL*PMAS(NOS1)/TMAS*(-GX1**2)	L00	91
	DA(2,6)=XMAS(NOS1)*DA(2,2)/ELL	L00	92
	DA(3,3)=DA(2,2)	L00	93
	DA(3,5)=-DA(2,6)	L00	94
	DA(4,2)=DA(2,4)	L00	95
	ZD2=ZMAS(NOS1)**2	L00	96
	DA(4,4)=PMAS(NOS1)/TMAS*(ZD2+RRG(NOS1)**2)/ELL/ELL*(-GX1**2)	L00	97
	DA(4,6)=XMAS(NOS1)/ELL*DA(4,2)	L00	98
	DA(6,2)=DA(2,6)	L00	99
	DA(6,4)=DA(4,6)	L00	100
	DA(6,6)=(PMAS(NOS1)/TMAS*(XMAS(NOS1)/ELL)**2)*(-GX1**2)	L00	101
	DA(6,6)=DA(6,6)+PMAS(NOS1)/TMAS*(YMAS(NOS1)/ELL)**2*(-GX1**2)	L00	102
	DA(5,3)=DA(3,5)	L00	103
	DA(5,5)=PMAS(NOS1)/TMAS*(ZD2+XMAS(NOS1)**2)/ELL/ELL*(-GX1**2)	L00	104
	FYR=-DA(2,2)*BEV(1,1)-DA(2,4)*BEV(2,1)-DA(2,6)*BEV(3,1)	L00	105
	FYI=-DA(2,2)*BEV(4,1)-DA(2,4)*BEV(5,1)-DA(2,6)*BEV(6,1)	L00	106
	FZR=-DA(3,3)*BOD(2,1)-DA(3,5)*BOD(3,1)	L00	107
	FZI=-DA(3,3)*BOD(5,1)-DA(3,5)*BOD(6,1)	L00	108
	BLR=-DA(6,2)*BEV(1,1)-DA(6,4)*BEV(2,1)-DA(6,6)*BEV(3,1)	L00	109
	BLI=-DA(6,2)*BEV(4,1)-DA(6,4)*BEV(5,1)-DA(6,6)*BEV(6,1)	L00	110
	DA(5,1)=(ZMAS(NOS1)/ELL*PMAS(NOS1)/TMAS)*(-GX1**2)	L00	111
	RVYR=-DA(5,3)*BOD(2,1)-DA(5,5)*BOD(3,1)-DA(5,1)*BOD(1,1)	L00	112
	RVYI=-DA(5,3)*BOD(5,1)-DA(5,5)*BOD(6,1)-DA(5,1)*BOD(4,1)	L00	113
	TMR=-DA(4,2)*BEV(1,1)-DA(4,4)*BEV(2,1)-DA(4,6)*BEV(3,1)	L00	114
	TMI=-DA(4,2)*BEV(4,1)-DA(4,4)*BEV(5,1)-DA(4,6)*BEV(6,1)	L00	115
	NOSM1=NOS-1	L00	116
	NOS2=NOS+2	L00	117
	DO 53 K=1,NOSM1	L00	118
	PRF33=SRF33(K)	L00	119
	PRM35=SRM35(K)	L00	120
	PRM55=SRM55(K)	L00	121
	PC44=SC44(K)	L00	122
	DA(2,2)=(DADS(2,K)+PMAS(K)/TMAS)*(-GX1**2)	L00	123
	DB(2,2)=DDDS(2,K)*GX1	L00	124
	DA(2,4)=(-ZMAS(K)/ELL*PMAS(K)/TMAS+DADS(9,K))*(-GX1**2)	L00	125
	DB(2,4)=DDDS(9,K)*GX1	L00	126
	DA(2,6)=(DADS(8,K)+XMAS(K)/ELL*PMAS(K)/TMAS-FN(JJ)/GX1**2*DDDS(2,K,LOD	L00	127
	1))*(-GX1**2)	L00	128
	DB(2,6)=(DDDS(8,K)+FN(JJ)*DADS(2,K))*GX1	L00	129
	DA(3,3)=(DADS(3,K)+PMAS(K)/TMAS)*(-GX1**2)	L00	130
	DB(3,3)=DDDS(3,K)*GX1	L00	131
	DA(3,5)=(DADS(7,K)-XMAS(K)/ELL*PMAS(K)/TMAS+FN(JJ)/GX1**2*DDDS(3,K,LOD	L00	132
	1))*(-GX1**2)	L00	133

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DB(3,5)=(DDDS(7,K)-FN(JJ)*DADS(3,K))*GXI LOD 134
DA(4,2)=(-ZMAS(K)/ELL*PHAS(K)/THAS*DADS(9,K))*(-GX1**2) LOD 135
DB(4,2)=DDDS(9,K)*GXI LOD 136
ZD2=ZMAS(K)**2 LOD 137
DA(4,4)=(PHAS(K)/THAS*(ZD2+RR0(K)**2)/ELL/ELL*DADS(4,K))*(-GX1**2) LOD 138
DB(4,4)=DDDS(4,K)*GXI LOD 139
DB(4,4)=DB(4,4)+VD(K)*GXI+SBKD(K)*GXI LOD 140
DA(4,6)=(-PHAS(K)/THAS*ZMAS(K)/ELL*XMAS(K)/ELL*DADS(10,K)-FN(JJ)/GL0D 141
1XI**2*DDDS(9,K))*(-GX1**2) LOD 142
DB(4,6)=(DDDS(10,K)+FN(JJ)*DADS(9,K))*GXI LOD 143
DA(4,4)=DA(4,4)+PHAS(K)/THAS*(-ZMAS(K)/ELL) LOD 144
DA(6,2)=(XMAS(K)/ELL*PHAS(K)/THAS*DADS(8,K)+FN(JJ)/GX1**2*DDDS(2,K)LOD 145
1))*(-GX1**2) LOD 146
DB(6,2)=(DDDS(8,K)-FN(JJ)*DADS(2,K))*GXI LOD 147
DA(6,4)=(-PHAS(K)/THAS*ZMAS(K)/ELL*XMAS(K)/ELL*DADS(10,K)+FN(JJ)/GL0D 148
1XI**2*DDDS(9,K))*(-GX1**2) LOD 149
DB(6,4)=(DDDS(10,K)-FN(JJ)*DADS(9,K))*GXI LOD 150
DA(6,6)=(PHAS(K)/THAS*(XMAS(K)/ELL)**2*DADS(6,K)+(FN(JJ)/GX1)**2*DL0D 151
1ADS(2,K))*(-GX1**2) LOD 152
DB(6,6)=DA(6,6)+PHAS(K)/THAS*(YMAS(K)/ELL)**2*(-GX1**2) LOD 153
DB(6,6)=(DDDS(6,K)+(FN(JJ)/GX1)**2*DDDS(2,K))*GXI LOD 154
DA(5,1)=(ZMAS(K)/ELL*PHAS(K)/THAS)*(-GX1**2) LOD 155
DA(5,3)=(DADS(7,K)-XMAS(K)/ELL*PHAS(K)/THAS-FN(JJ)/GX1**2*DDDS(3,K)LOD 156
1))*(-GX1**2) LOD 157
DB(5,3)=(DDDS(7,K)+FN(JJ)*DADS(3,K))*GXI LOD 158
DA(5,5)=(PHAS(K)/THAS*(ZD2+XMAS(K)**2)/ELL/ELL*DADS(5,K)+(FN(JJ)/GL0D 159
1XI)**2*DADS(3,K))*(-GX1**2) LOD 160
DB(5,5)=(DDDS(5,K)+(FN(JJ)/GX1)**2*DDDS(3,K))*GXI LOD 161
TDA(2,2)=(-FN(JJ)/GX1**2/DS(K)*(DDDS(2,K)+DDDS(2,K+1)))*(-GX1**2) LOD 162
TDB(2,2)=(FN(JJ)/DS(K)*(DADS(2,K)+DADS(2,K+1)))*GXI LOD 163
TDA(2,4)=(-FN(JJ)/GX1**2/DS(K)*(DDDS(9,K)+DDDS(9,K+1)))*(-GX1**2) LOD 164
TDB(2,4)=(FN(JJ)/DS(K)*(DADS(9,K)+DADS(9,K+1)))*GXI LOD 165
TDA(2,6)=(-FN(JJ)/GX1**2/DS(K)*(DDDS(8,K)+DDDS(8,K+1))-(FN(JJ)/GX1)LOD 166
1)**2/DS(K)*(DADS(2,K)+DADS(2,K+1)))*(-GX1**2) LOD 167
TDB(2,6)=(FN(JJ)/DS(K)*(DADS(8,K)+DADS(8,K+1))-(FN(JJ)/GX1)**2/DS(LOD 168
1K)*(DDDS(2,K)+DDDS(2,K+1)))*GXI LOD 169
TDA(4,2)=TDA(2,4) LOD 170
TDB(4,2)=TDB(2,4) LOD 171
TDA(4,4)=(-FN(JJ)/GX1**2/DS(K)*(DDDS(4,K)+DDDS(4,K+1)))*(-GX1**2) LOD 172
TDB(4,4)=(FN(JJ)/DS(K)*(DADS(4,K)+DADS(4,K+1)))*GXI LOD 173
TDA(4,6)=(-FN(JJ)/GX1**2/DS(K)*(DDDS(10,K)+DDDS(10,K+1))-(FN(JJ)/GL0D 174
1XI)**2/DS(K)*(DADS(9,K)+DADS(9,K+1)))*(-GX1**2) LOD 175
TDB(4,6)=(FN(JJ)/DS(K)*(DADS(10,K)+DADS(10,K+1))-(FN(JJ)/GX1)**2/DL0D 176
1S(K)*(DDDS(9,K)+DDDS(9,K+1)))*GXI LOD 177
TDA(6,2)=(-FN(JJ)/GX1**2/DS(K)*(DDDS(8,K)+DDDS(8,K+1)))*(-GX1**2) LOD 178
TDB(6,2)=(FN(JJ)/DS(K)*(DADS(8,K)+DADS(8,K+1)))*GXI LOD 179
TDA(6,4)=(-FN(JJ)/GX1**2/DS(K)*(DDDS(10,K)+DDDS(10,K+1)))*(-GX1**2)LOD 180
1) LOD 181
TDB(6,4)=(FN(JJ)/DS(K)*(DADS(10,K)+DADS(10,K+1)))*GXI LOD 182
TDA(6,6)=(-FN(JJ)/GX1**2/DS(K)*(DDDS(6,K)+DDDS(6,K+1))-(FN(JJ)/GX1)LOD 183
1)**2/DS(K)*(DADS(8,K)+DADS(8,K+1)))*(-GX1**2) LOD 184
TDB(6,6)=(FN(JJ)/DS(K)*(DADS(6,K)+DADS(6,K+1))-(FN(JJ)/GX1)**2/DS(LOD 185
1K)*(DDDS(8,K)+DDDS(8,K+1)))*GXI LOD 186
TDA(3,3)=(-FN(JJ)/GX1**2/DS(K)*(DDDS(3,K)+DDDS(3,K+1)))*(-GX1**2) LOD 187
TDB(3,3)=(FN(JJ)/DS(K)*(DADS(3,K)+DADS(3,K+1)))*GXI LOD 188
TDA(5,3)=(-FN(JJ)/GX1**2/DS(K)*(DDDS(7,K)+DDDS(7,K+1)))*(-GX1**2) LOD 189
TDB(5,3)=(FN(JJ)/DS(K)*(DADS(7,K)+DADS(7,K+1)))*GXI LOD 190
TDA(3,5)=TDA(5,3)+(FN(JJ)/GX1)**2/DS(K)*(DADS(3,K)+DADS(3,K+1))*(-LOD 191
1GX1**2) LOD 192
TDB(3,5)=TDB(5,3)+(FN(JJ)/GX1)**2/DS(K)*(DDDS(3,K)+DDDS(3,K+1))*GXLOD 193
1I LOD 194
TDA(5,5)=(-FN(JJ)/GX1**2/DS(K)*(DDDS(5,K)+DDDS(5,K+1))+(FN(JJ)/GX1)LOD 195
1)**2/DS(K)*(DADS(7,K)+DADS(7,K+1)))*(-GX1**2) LOD 196
TDB(5,5)=(FN(JJ)/DS(K)*(DADS(5,K)+DADS(5,K+1))+(FN(JJ)/GX1)**2/DS(LOD 197
1K)*(DDDS(7,K)+DDDS(7,K+1)))*GXI LOD 198
PVH=PEXP(5,K)-DA(5,1)*BOD(1,1)-DA(5,3)*BOD(2,1)-DA(5,5)*BOD(3,1)-DL0D 199

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1R(5,3)*BOD(5,1)-DR(5,5)*BOD(6,1)                                LOD 200
AIVM=PEXI(5,K)*DR(5,3)*BOD(2,1)*DR(5,5)*BOD(3,1)-DA(5,1)*BOD(4,1)-LOD 201
1DA(5,3)*BOD(5,1)-DA(5,5)*BOD(6,1)                                LOD 202
RTM=PEXR(4,K)-DA(4,2)*BEV(1,1)-DA(4,4)*BEV(2,1)-DA(4,6)*BEV(3,1)-DL00 203
1R(4,2)*BEV(4,1)-DR(4,4)*BEV(5,1)-DR(4,6)*BEV(6,1)              LOD 204
AITM=PEXI(4,K)*DR(4,2)*BEV(1,1)*DR(4,4)*BEV(2,1)*DR(4,6)*BEV(3,1)-LOD 205
1DA(4,2)*BEV(4,1)-DA(4,4)*BEV(5,1)-DA(4,6)*BEV(6,1)              LOD 206
RLM=PEXR(6,K)-DA(6,2)*BEV(1,1)-DA(6,4)*BEV(2,1)-DA(6,6)*BEV(3,1)-DL00 207
1R(6,2)*BEV(4,1)-DR(6,4)*BEV(5,1)-DR(6,6)*BEV(6,1)              LOD 208
AILM=PEXI(6,K)*DR(6,2)*BEV(1,1)*DR(6,4)*BEV(2,1)*DR(6,6)*BEV(3,1)-LOD 209
1DA(6,2)*BEV(4,1)-DA(6,4)*BEV(5,1)-DA(6,6)*BEV(6,1)              LOD 210
RFY=PEXR(2,K)-DA(2,2)*BEV(1,1)-DA(2,4)*BEV(2,1)-DA(2,6)*BEV(3,1)-DL00 211
1R(2,2)*BEV(4,1)-DR(2,4)*BEV(5,1)-DR(2,6)*BEV(6,1)              LOD 212
AIFY=PEXI(2,K)*DR(2,2)*BEV(1,1)*DR(2,4)*BEV(2,1)*DR(2,6)*BEV(3,1)-LOD 213
1DA(2,2)*BEV(4,1)-DA(2,4)*BEV(5,1)-DA(2,6)*BEV(6,1)              LOD 214
RFZ=PEXR(3,K)-DA(3,3)*BOD(2,1)-DA(3,5)*BOD(3,1)-DR(3,3)*BOD(5,1)-DL00 215
1R(3,5)*BOD(6,1)                                                  LOD 216
AIFZ=PEXI(3,K)*DR(3,3)*BOD(2,1)*DR(3,5)*BOD(3,1)-DA(3,3)*BOD(5,1)-LOD 217
1DA(3,5)*BOD(6,1)                                                  LOD 218
FYR=FYR+RFY                                                        LOD 219
YI=FYI+AIFY                                                        LOD 220
FZR=FZR+RFZ                                                        LOD 221
FZI=FZI+AIFZ                                                        LOD 222
BLR=BLR+RLM                                                        LOD 223
BLI=BLI+AILM                                                        LOD 224
BVR=BVR+RVM                                                        LOD 225
BVI=BVI+AIVM                                                        LOD 226
TMR=TMR+RTM                                                        LOD 227
TMI=TMI+AITM                                                        LOD 228
EVR=(PDFR(5,K)+PDFR(5,K+1))/2.-TDA(5,3)*BOD(2,1)-TDA(5,5)*BOD(3,1)LOD 229
1)-TOR(5,3)*BOD(5,1)-TOR(5,5)*BOD(6,1)                          LOD 230
EVI=(PDFI(5,K)+PDFI(5,K+1))/2.+TOR(5,3)*BOD(2,1)+TOR(5,5)*BOD(3,1)LOD 231
1-TDA(5,3)*BOD(5,1)-TDA(5,5)*BOD(6,1)                          LOD 232
ETR=(PDFR(4,K)+PDFR(4,K+1))/2.-TDA(4,2)*BEV(1,1)-TDA(4,4)*BEV(2,1)LOD 233
1-TDA(4,6)*BEV(3,1)-TOR(4,2)*BEV(4,1)-TOR(4,4)*BEV(5,1)-TOR(4,6)*BELOD 234
2V(6,1)                                                            LOD 235
ETI=(PDFI(4,K)+PDFI(4,K+1))/2.+TOR(4,2)*BEV(1,1)+TOR(4,4)*BEV(2,1)LOD 236
1+TOR(4,6)*BEV(3,1)-TDA(4,2)*BEV(4,1)-TDA(4,4)*BEV(5,1)-TDA(4,6)*BELOD 237
2V(6,1)                                                            LOD 238
ELR=(PDFR(6,K)+PDFR(6,K+1))/2.-TDA(6,2)*BEV(1,1)-TDA(6,4)*BEV(2,1)LOD 239
1-TDA(6,6)*BEV(3,1)-TOR(6,2)*BEV(4,1)-TOR(6,4)*BEV(5,1)-TOR(6,6)*BELOD 240
2V(6,1)                                                            LOD 241
ELI=(PDFI(6,K)+PDFI(6,K+1))/2.+TOR(6,2)*BEV(1,1)+TOR(6,4)*BEV(2,1)LOD 242
1+TOR(6,6)*BEV(3,1)-TDA(6,2)*BEV(4,1)-TDA(6,4)*BEV(5,1)-TDA(6,6)*BELOD 243
2V(6,1)                                                            LOD 244
EYR=(PDFR(2,K)+PDFR(2,K+1))/2.-TDA(2,2)*BEV(1,1)-TDA(2,4)*BEV(2,1)LOD 245
1-TDA(2,6)*BEV(3,1)-TOR(2,2)*BEV(4,1)-TOR(2,4)*BEV(5,1)-TOR(2,6)*BELOD 246
2V(6,1)                                                            LOD 247
EYI=(PDFI(2,K)+PDFI(2,K+1))/2.+TOR(2,2)*BEV(1,1)+TOR(2,4)*BEV(2,1)LOD 248
1+TOR(2,6)*BEV(3,1)-TDA(2,2)*BEV(4,1)-TDA(2,4)*BEV(5,1)-TDA(2,6)*BELOD 249
2V(6,1)                                                            LOD 250
EZR=(PDFR(3,K)+PDFR(3,K+1))/2.-TDA(3,3)*BOD(2,1)-TDA(3,5)*BOD(3,1)LOD 251
1-TOR(3,3)*BOD(5,1)-TOR(3,5)*BOD(6,1)                          LOD 252
EZI=(PDFI(3,K)+PDFI(3,K+1))/2.+TOR(3,3)*BOD(2,1)+TOR(3,5)*BOD(3,1)LOD 253
1-TDA(3,3)*BOD(5,1)-TDA(3,5)*BOD(6,1)                          LOD 254
FYRS=FYR+EYR                                                        LOD 255
FYIS=FYI+EYI                                                        LOD 256
FZRS=FZR+EZR-PRF33*BOD(2,1)-PRM35*BOD(3,1)                      LOD 257
FZIS=FZI+EZI-PRF33*BOD(5,1)-PRM35*BOD(6,1)                      LOD 258
TMRs=TMR+ETR                                                        LOD 259
TMIs=TMI+ETI                                                        LOD 260
TMRs=TMRs-PC44*BEV(2,1)                                           LOD 261
TMIs=TMIs-PC44*BEV(5,1)                                           LOD 262
BLRS=BLR+FLR-(ST(K)-TPST*0.5*DS(K))*0.5*FYRS                    LOD 263
BLIS=BLI+ELI-(ST(K)-TPST*0.5*DS(K))*0.5*FYIS                    LOD 264
BVRs=BVR+EVR-(ST(K)-TPST*0.5*DS(K))*0.5*FZRS                    LOD 265

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BVIS=BVI*EVI+(ST(K)-TPST*0.5*DS(K))*0.5*FZIS	LOD	266
BVRS=BVRS-PRM35*BOD(2,1)-PRM55*BOD(3,1)	LOD	267
BVIS=BVIS-PRM35*BOD(5,1)-PRM55*BOD(6,1)	LOD	268
FAC=TVOL/8.*ELL/BEAM	LOD	269
FYRS=FYRS*FAC	LOD	270
FYIS=FYIS*FAC	LOD	271
FZRS=FZRS*FAC	LOD	272
FZIS=FZIS*FAC	LOD	273
TMRS=TMRS*FAC	LOD	274
TMIS=TMIS*FAC	LOD	275
BLRS=BLRS*FAC	LOD	276
BLIS=BLIS*FAC	LOD	277
BVRS=BVRS*FAC	LOD	278
BVIS=BVIS*FAC	LOD	279
FYRSG(K)=FYRS	LOD	280
FYISG(K)=FYIS	LOD	281
TMRS(K)=TMRS	LOD	282
TMISG(K)=TMIS	LOD	283
BLRSG(K)=BLRS	LOD	284
BLISG(K)=BLIS	LOD	285
FZRSG(K)=FZRS	LOD	286
FZISG(K)=FZIS	LOD	287
BVRSG(K)=BVRS	LOD	288
BVISG(K)=BVIS	LOD	289
RLO(1,LL,K)=FYRS	LOD	290
AILO(1,LL,K)=FYIS	LOD	291
RLO(2,LL,K)=FZRS	LOD	292
AILO(2,LL,K)=FZIS	LOD	293
RLO(3,LL,K)=TMRS	LOD	294
AILO(3,LL,K)=TMIS	LOD	295
RLO(4,LL,K)=BVRS	LOD	296
AILO(4,LL,K)=BVIS	LOD	297
RLO(5,LL,K)=BLRS	LOD	298
AILO(5,LL,K)=BLIS	LOD	299
STATN(K)=ST1(K+1)+0.5*DS(K+1)*10.	LOD	300
53 CONTINUE	LOD	301
RETURN	LOD	302
END	LOD	303
C	EFM	2
C-----VERSION 4 - CDC 6700 - E X C F M - JUNE, 1972-----	EFM	3
C	EFM	4
SUBROUTINE EXCFM	EFM	5
COMMON DM1(1496),FN(5),BAM(30),DM3(23),NOK,DM4(1137),TITO(12),	EFM	6
2 DM5(16),PRNTOP,DM6(356)	EFM	7
INTEGER PRNTOP,H	EFM	8
COMMON /TEMP/ DM7(4784),ZN(30),DM8(186)	EFM	9
COMMON /TMP1/ FACT,JJ,HDIG1,VKNOTS,DM9(5)	EFM	10
COMMON /TMP5/ BDV(30,6,2)	EFM	11
DATA MIN /3HMIN/	EFM	12
BACKSPACE 1	EFM	13
CALL SEPART (1)	EFM	14
L = 0	EFM	15
N = 1	EFM	16
IF (BAM(1) .LE. BAM(NOK)) L = NOK + 1	EFM	17
IF (BAM(1) .LE. BAM(NOK)) N = - 1	EFM	18
DO 5614 JH=1,2	EFM	19
IF (JH .EQ. 1) H = 1	EFM	20
IF (JH .EQ. 2) H = 6	EFM	21
IF (H .EQ. 6 .AND. PRNTOP .EQ. MIN) GO TO 5614	EFM	22
WRITE (H,5608) TITO,HDIG1,VKNOTS,FN(JJ)	EFM	23
5608 FORMAT(4H1 EXCITING FORCES AND MOMENTS *** ,12A6,15X,3H***EFM	EFM	24
2///17X,9HFAIDING =,F5.0,4H DEG,7X,12HSHIP SPEED =,F6.2,6H KNOTS/	EFM	25
2 18X,15H(HEAD SEAS=180),9X,15HFROUDE NUMBER =,F7.4)	EFM	26
C-----PRINT EXCITING FORCES AND MOMENTS-----	EFM	27
WRITE (H,5610)	EFM	28
5610 FORMAT (//47X,33HNONDIMENSIONAL TRANSFER FUNCTIONS//	EFM	29

2 16X,13HSURGE FORCE /,8X,12HSWAY FORCE /,7X,13HHEAVE FORCE /,7X,	EFM	30
2 13HROLL MOMENT /,6X,14HPITCH MOMENT /,8X,12HYAW MOMENT /,7X,	EFM	31
2 3(13X,7HM*G*R/L),3(13X,5HM*G*R,2X),/5X,6HWE(MD),	EFM	32
2 6(20H AMPL. RATIO PHASE)/11X,6(16X,4HDEG /)	EFM	33
K = L	EFM	34
DO 5612 LL=1,NOK	EFM	35
K = K * N	EFM	36
IF (JH .EQ. 2) GO TO 5604	EFM	37
C-----COMPUTE AMPLITUDE AND PHASE-----	EFM	38
DO 5600 I=1,6	EFM	39
RL = BDV(K,I,1)	EFM	40
AI = BDV(K,I,2)	EFM	41
BDV(K,I,1) = SQRT(RL**2 + AI**2)	EFM	42
BDV(K,I,2) = ATAN2D(AI,RL)	EFM	43
5604 CONTINUE	EFM	44
WRITE (H,5611) ZN(K),((BDV(K,I,J),J=1,2),I=1,6)	EFM	45
5611 FORMAT (4X,F7.3,6(1PE13.4,0PF7.1))	EFM	46
5612 CONTINUE	EFM	47
5614 CONTINUE	EFM	48
CALL SEPART (2)	EFM	49
RETURN	EFM	50
END	EFM	51
C	MTD	2
C-----VERSION 4 - CDC 6700 - M O T O U T - JUNE, 1972-----	MTD	3
C	MTD	4
SUBROUTINE MOTOUT	MTD	5
C-----MOTION OUTPUT SUBROUTINE-----	MTD	6
C-----MOTIONS ARE SURGE (X1), SWAY (X2), HEAVE (X2), ROLL (X4),-----	MTD	7
C-----PITCH (X5), YAW (X6)-----	MTD	8
INTEGER PRNTOF,H	MTD	9
COMMON DM1(R1),ELL,DM2(1414),FN(5),BAM(30),DM3(23),NOK,DM4(1137),	MTD	10
2 TITO(12),WORD,DM5(15),PRNTOF,DM6(344),INWSTP(12)	MTD	11
COMMON /TEMP/ DM7(300),RMO(6,30),AIMO(6,30),DM8(4094),WE(30),	MTD	12
2 ZN(30),XL1LMD(30),DM9(50),WAVAMP(30),DM0(76)	MTD	13
COMMON /TMP1/ FACT,JJ,HDIG1,VKNOTS,WSLOPE,WSTP,IWSTP,DMA(2)	MTD	14
COMMON /TMP2/ SHM(30,6,2)	MTD	15
DATA MIN /3HMIN/	MTD	16
DO 10 I=1,NOK	MTD	17
WVLNTH = BAM(I)*ELL	MTD	18
C-----TERM1 SCALES NONDIMENSIONAL DISPLACEMENTS BY-	MTD	19
C	MTD	20
WAVAMP	MTD	21
TERM1 = WAVAMP(I)	MTD	22
C-----TERM2 SCALES NONDIMENSIONAL ANGLES BY-	MTD	23
C	MTD	24
WAVAMP * 57.3 / WVLNTH	MTD	25
TERM2 = TERM1*FACT/WVLNTH	MTD	26
DO 10 J=1,6	MTD	27
C-----COMPUTE SINGLE AMPLITUDES-----	MTD	28
TERM = TERM1	MTD	29
IF (J .GT. 3) TERM = TERM2	MTD	30
SHM(I,J,1) = TERM*SQRT(RMO(J,I)**2 + AIMO(J,I)**2)	MTD	31
C-----COMPUTE PHASES-----	MTD	32
SHM(I,J,2) = ATAN2D(AIMO(J,I),RMO(J,I))	MTD	33
10 CONTINUE	MTD	34
L = 0	MTD	35
N = 1	MTD	36
IF (BAM(1) .LE. BAM(NOK)) L = NOK + 1	MTD	37
IF (BAM(1) .LE. BAM(NOK)) N = - 1	MTD	38
BACKSPACE 1	MTD	39
CALL SEPART (1)	MTD	40
DO 35 JH=1,2	MTD	41
IF (JH .EQ. 1) H = 1	MTD	42
IF (JH .EQ. 2) H = 6	MTD	43
IF (H .EQ. 6 .AND. PRNTOF .EQ. MIN) GO TO 35	MTD	44
WRITE (H,1000) TITO,HDIG1,VKNOTS,WSLOPE,FN(JJ),INWSTP(IWSTP)	MTD	45
C-----PRINT SINGLE AMPLITUDES-----	MTD	46
WRITE (H,1010) (WORD,I=1,4)	MTD	47

K = L	MT0	46
DO 15 LL=1,NOK	MT0	47
K = K + N	MT0	48
WRITE (H,1020) WE(K),XL1LMD(K),BAM(K),ZN(K),WAVAMP(K),	MT0	49
2(SHM(K,I,1),I=1,6)	MT0	50
15 CONTINUE	MT0	51
IF (H.EQ. 6) GO TO 35	MT0	52
WRITE (1,1030)	MT0	53
K = L	MT0	54
DO 30 LL=1,NOK	MT0	55
K = K + N	MT0	56
WRITE (1,1040) WE(K),(SHM(K,I,2),I=1,6)	MT0	57
30 CONTINUE	MT0	58
35 CONTINUE	MT0	59
CALL SEPART (2)	MT0	60
IF (PRNTOP.EQ. MIN) GO TO 80	MT0	61
C-----PRINT RESPONSE AMPLITUDE OPERATORS-----	MT0	62
WRITE (6,1050)	MT0	63
K = L	MT0	64
DO 50 LL=1,NOK	MT0	65
K = K + N	MT0	66
DO 40 I=1,6	MT0	67
SHM(K,I,1) = SHM(K,I,1)/WAVAMP(K)	MT0	68
40 SHM(K,I,1) = SHM(K,I,1)**2	MT0	69
WRITE (6,1060) WE(K),((SHM(K,I,J),J=1,2),I=1,6)	MT0	70
50 CONTINUE	MT0	71
C-----PRINT NONDIMENSIONAL TRANSFER FUNCTIONS-----	MT0	72
WRITE (6,1070)	MT0	73
K = L	MT0	74
WCON = ELL/360.	MT0	75
DO 70 LL=1,NOK	MT0	76
K = K + N	MT0	77
DO 60 I=1,6	MT0	78
SHM(K,I,1) = SORT(SHM(K,I,1))	MT0	79
IF (I.GT. 3) SHM(K,I,1) = WCON*SHM(K,I,1)/XL1LMD(K)	MT0	80
60 CONTINUE	MT0	81
WRITE (6,1060) XL1LMD(K),((SHM(K,I,J),J=1,2),I=1,6)	MT0	82
70 CONTINUE	MT0	83
80 CONTINUE	MT0	84
RETURN	MT0	85
1000 FORMAT(41HSHIP MOTIONS IN REGULAR WAVES *** ,12A6,15X,3H***MT0	86	
2///17X,HEADING =*,F5.0,* DEG*,7X,SHIP SPEED =*,F6.2,* KNOTS*,5X,MT0	87	
2*WAVE SLOPE (360*,1H*,*R/LAMBDA), K*,1H*,*R, =*,F5.2,* DEG*/18X, MT0	88	
2*(HEAD SEAS=180)*,9X,*FROUDE NUMBER =*,F7.4,7X,*WAVE STEEPNESS (2*MT0	89	
21H*,*R/LAMBDA) = 1 /*I3)	MT0	90
1010 FORMAT(//58X,17HSINGLE AMPLITUDES,	MT0	91
2//6X,* WE L/LAM LAM/L WE(ND) *	MT0	92
2 *WAVE AMPL.(R) SURGE(X1) SWAY(X2) HEAVE(X3)*	MT0	93
2 * ROLL(X4) PITCH(X5) YAW(X6)*,	MT0	94
2 /7X,3HRPS,18X,4(7X,A6),10X,3HDEG,9X,3HDEG,11X,3HDEG/)	MT0	95
1020 FORMAT(5X,2F6.3,F6.2,F7.3,2X,1P7E13.4)	MT0	96
1030 FORMAT (//6X,*WE FS*,24X,*PHASES IN DEGREES*//)	MT0	97
1040 FORMAT (4X,F7.3,6F10.3)	MT0	98
1050 FORMAT (//50X,*RESPONSE AMPLITUDE OPERATORS*//	MT0	99
2 15X,14H(SURGE / R)**2,7X,13H(SWAY / R)**2,6X,14H(HEAVE / R)**2,	MT0	100
2 7X,13H(ROLL / R)**2,6X,14H(PITCH / R)**2,7X,12H(YAW / R)**2/	MT0	101
26X,* WE *,	MT0	102
26(20H AMPL. RATIO PHASE)/7X,4HRPS ,6(20H SQUARED DEG)//)	MT0	103
1060 FORMAT(4X,F7.3,6(1PE13.4,0PF7.1))	MT0	104
1070 FOPMAT (//47X,*NONDIMENSIONAL TRANSFER FUNCTIONS*//	MT0	105
2 17X,9HSURGE / R,12X,8HSWAY / R,11X,9HHEAVE / R,11X,	MT0	106
2 10HROLL / K*R,10X,11HPITCH / K*R,10X,9HYAW / K*R,	MT0	107
2 /6X,*L/LAM*,6(20H AMPL. RATIO PHASE)/11X,6(16X,4HDEG)//	MT0	108
END	MT0	109
C	LDO	2
C-----VERSION 4 - CDC 6700 - L O D O U T - JUNE, 1972-----	LDO	3

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C                                     L00 4
SUBROUTINE LODOUT (ISTAT)                                     L00 5
C-----LOAD OUTPUT SUBROUTINE-----L00 6
C-----LOADS ARE HORIZONTAL SHEAR FORCE (V2), VERTICAL SHEAR FORCE (V3),-L00 7
C-----TORSIONAL MOMENT (V4), VERTICAL BENDING MOMENT (V5), HORIZONTAL---L00 8
C-----BENDING MOMENT (V6)-----L00 9
      INTEGER PRNTOP,H                                         L00 10
      COMMON DM1(80),EL,ELL,DM2(510),TMAS,DM3(12),TVOL,DM4(890),FN(5), L00 11
      2 BAM(30),DM5(23),NOK,DM6(1137),TITO(12),WORD,DM7(15),PRNTOP, L00 12
      2 DM8(54),BEAM,DM9(8),GRAV,DM90(280),INWSTP(12)          L00 13
      COMMON /TFMP/ DM0(4754),WE(30),ZN(30),XL1LMD(30),DMA(50), L00 14
      2 WAVAMP(30),DMR(76)                                     L00 15
      COMMON /TMP1/ FACT,JJ,MDIG1,VKNOTS,WSLOPE,WSTP,IWSTP,DMC(2) L00 16
      COMMON /TMP2/ SLD(30,6,2)                                L00 17
      COMMON /TMP3/ RLO(5,30,25),A1LO(5,30,25),STATN(24)      L00 18
      COMMON /LODPRN/ DM10(24),WORD2,WORD3,DM11(263)          L00 19
      DATA MIN /3HMIN/                                       L00 20
      K = ISTAT                                                L00 21
C-----RO EQUALS SHIP MASS DIVIDED BY DISPLACED VOLUME-----L00 22
      RO = TMAS/(TVOL*EL**3)                                   L00 23
      CON = 20*GRAV*BEAM*ELL                                  L00 24
      DO 10 I=1,NOK                                           L00 25
C-----TERM1 SCALES NONDIMENSIONAL FORCES BY-                L00 26
      RO = GRAV * BEAM * ELL * WAVAMP                         L00 27
      TERM1 = WAVAMP(I)*CON                                    L00 28
C-----TERM2 SCALES NONDIMENSIONAL MOMENTS BY-               L00 29
      RO = GRAV * BEAM * ELL * ELL * WAVAMP                   L00 30
      TEPM2 = TERM1*ELL                                        L00 31
      DO 10 J=1,5                                              L00 32
C-----COMPUTE SINGLE AMPLITUDES FOR A PARTICULAR STATION---L00 33
      TERM = TERM1                                             L00 34
      IF (J .GT. 2) TERM = TERM2                               L00 35
      SLD(I,J,1) = TERM*SORT(RLO(J,I,K)**2 + A1LO(J,I,K)**2) L00 36
C-----COMPUTE PHASES-----L00 37
      SLD(I,J,2) = ATAN2D(A1LO(J,I,K),RLO(J,I,K))            L00 38
      10 CONTINUE                                             L00 39
      L = 0                                                    L00 40
      N = 1                                                    L00 41
      IF (BAM(1) .LE. BAM(NOK)) I = NOK + 1                  L00 42
      IF (BAM(1) .LE. BAM(NOK)) N = - 1                       L00 43
      BACKSPACE 1                                              L00 44
      CALL SEPART (1)                                          L00 45
      DO 35 JH=1,2                                             L00 46
      IF (JH .EQ. 1) H = 1                                     L00 47
      IF (JH .EQ. 2) H = 6                                     L00 48
      IF (H .EQ. 6 .AND. PRNTOP .EQ. MIN) GO TO 35           L00 49
      WRITE (H,1000) TITO,MDIG1,VKNOTS,WSLOPE,FN(JJ),INWSTP(IWSTP) L00 50
C-----PRINT SINGLE AMPLITUDES-----L00 51
      WRITE (H,1010) STATN(ISTAT),WORD,(WORD2,I=1,2),(WORD3,I=1,3) L00 52
      K = L                                                    L00 53
      DO 15 LL=1,NOK                                           L00 54
      K = K + N                                                 L00 55
      WRITE (H,1020) WE(K),XL1LMD(K),BAM(K),ZN(K),WAVAMP(K), L00 56
      2(SLD(K,I,1),I=1,5)                                       L00 57
      15 CONTINUE                                             L00 58
      IF (H .EQ. 6) GO TO 35                                   L00 59
      WRITE (1,1030)                                           L00 60
      K = L                                                    L00 61
      DO 30 LL=1,NOK                                           L00 62
      K = K + N                                                 L00 63
      WRITE (1,1040) WE(K),(SLD(K,I,2),I=1,5)                 L00 64
      30 CONTINUE                                             L00 65
      35 CONTINUE                                             L00 66
      CALL SEPART (2)                                          L00 67
      IF (PRNTOP .EQ. MIN) GO TO 80                           L00 68
C-----PRINT RESPONSE AMPLITUDE OPERATORS-----L00 69

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WRITE (6,1050)
K = L
DO 50 LL=1,NOK
K = K + N
DO 40 I=1,5
SLD(K,I,1) = SLD(K,I,1)/WAVAMP(K)
40 SLD(K,I,1) = SLD(K,I,1)**2
WRITE (6,1060) WE(K),((SLD(K,I,J),J=1,2),I=1,5)
50 CONTINUE
C-----PRINT NONDIMENSIONAL TRANSFER FUNCTIONS-----
WRITE (6,1070)
K = L
DO 70 LL=1,NOK
K = K + N
DO 60 I=1,5
SLD(K,I,1) = SQRT(SLD(K,I,1))/CON
IF (I .GT. 2) SLD(K,I,1) = SLD(K,I,1)/ELL
60 CONTINUE
WRITE (6,1060) XL1LMD(K),((SLD(K,I,J),J=1,2),I=1,5)
70 CONTINUE
80 CONTINUE
RETURN
1000 FORMAT(41H1 SEA LOADS IN REGULAR WAVES *** ,12A6,15X,3H***
2///17X,*HEADING **,F5.0,* DEG*,7X,*SHIP SPEED **,F6.2,* KNOTS*,5X,
2*WAVE SLOPE (360*,1H*,*R/LAMBDA), K*,1H*,*R, **,F5.2,* DEG*/18X,
2*(HEAD SEAS=180)*,9X,*FROUDE NUMBER **,F7.4,7X,*WAVE STEEPNESS (2*
21H*,*R/LAMBDA) = 1 /*13)
1010 FORMAT(/49X,*SINGLE AMPLITUDES (STATION*,F6.2,1H),
2//6X,* WE L/LAM LAM/L WE(ND) *
2 *WAVE AMPL.(R) H.SHEAR(V2) V.SHEAR(V3) T.MOM.(V4)*
2 * V.MOM.(V5) H.MOM.(V6)*//7X,3HRPS,25X,A6,2(7X,A6),4X,
2 3(3X,A8,2X)/)
1020 FORMAT(5X,2F6.3,F6.2,F7.3,2X,1P7E13.4)
1030 FORMAT (/6X,*WE FS*,24X,*PHASES IN DEGREES*//)
1040 FORMAT (4X,F7.3,6F10.3)
1050 FORMAT(/50X,28HRESPONSE AMPLITUDE OPERATORS//
214X,*(H.SHEAR / R)*,2H*,*2 (V.SHEAR / R)*,2H*,*2 (T.MOM.*LDO
2 * / R)*,2H*,*2 (V.MOM. / R)*,2H*,*2 (H.MOM. / R)*,3H*,*2/LDO
26X,* WE *,
25(20H AMPL. RATIO PHASE)/7X,4HRPS ,5(20H SQUARED DEG //)
1060 FORMAT(4X,F7.3,6(1PE13.4,0PF7.1))
1070 FORMAT(/47X,33HNONDIMENSIONAL TRANSFER FUNCTIONS//
214X,*H.SHEAR / V.SHEAR / T.MOM. /
2 * V.MOM. / H.MOM. /*//15X,2(2X,10HRO*G*B*L*R,8X),
23(12HRO*G*B*L*R,8X)/6X,*L/LAM*
25(20H AMPL. RATIO PHASE)/11X,5(16X,4HDEG //)
END
C
C-----VERSION 4 - CDC 6700 - R C T A B L - JUNE, 1972
C
SUBROUTINE RCTABL
COMMON DM1(81),ELL,DM2(1414),FN(5),BAM(30),DM3(24),NOB,NOH,
2 DM4(1150),HOG1(10),DM5(67),GRAV,DM6(229),THMD(50),NWSTP,
2 INWSTP(12)
COMMON /TEMP/ DM7(4844),IHMD(50),DM8(106)
COMMON /TMP1/ FACT,DMP(8)
COMMON /TMP4/ HMD(5,50,2),NHF,EPS
WRITE (6,5500)
5500 FORMAT (1H1,18X,32HROLL AMPLITUDE CONVERGENCE TABLE)
KTH = 0
DO 5340 I=1,NOH
HOG1 = HOG1(I)
DO 5340 J=1,NOB
VKNOTS = SQRT(ELL*GRAV)*FN(J)/1.689
DO 5340 N=1,NWSTP
KTH = KTH + 1

```

WSTP = 1./FLOAT(INWSTP(N))	RCT	21
WSLOPE = 180.*WSTP	RCT	22
WRITE (6,5503) HDIG1,VKNOTS,FN(J),WSLOPE,INWSTP(N)	RCT	23
5503 FORMAT (//,OH HEADING =,F5.0,	RCT	24
220H DEG SHIP SPEED =,F6.2,25H KNOTS FROUDE NUMBER =,F7.4,	RCT	25
216H WAVE SLOPE =,F5.2,4H DEG,24H WAVE STEEPNESS = 1 /,I3)	RCT	26
ITERAT = IHMD(KTH)	RCT	27
DO 5335 L=1,ITERAT	RCT	28
K = L - 1	RCT	29
THRAD = HMD(L,KTH,1)	RCT	30
THCRAD = HMD(L,KTH,2)	RCT	31
THEDEG = THRAD*FACT	RCT	32
THCDEG = THCRAD*FACT	RCT	33
THDRAD = ABS(THRAD - THCRAD)	RCT	34
THDDEG = THDRAD*FACT	RCT	35
5335 WRITE (6,5505) K,THRAD,THEDEG,THCRAD,THCDEG,THDRAD,THDDEG	RCT	36
5505 FORMAT (12H0 ITERATION,I3,4X,17HROLL AMPL. EST. =,F7.4,	RCT	37
26H RAD (,F5.2,5H DEG)/19X,17HROLL AMPL. CAL. =,F7.4,6H RAD (,F5.2,	RCT	38
25H DEG)/19X,17H DIFFERENCE =,F7.4,6H RAD (,F5.2,5H DEG))	RCT	39
5340 IF (ITERAT.EQ. 5 .AND. THDRAD.GT. EPS) WRITE (6,5510)	RCT	40
5510 FORMAT (78H0JUST CAN NOT GET ROLL AMPLITUDE TO CONVERGE. FIVE ATTERCT	RCT	41
2MPTS AND FIVE FAILURES./45H C-EST LA VIE. WILL TRY OTHER CONDITIONR	RCT	42
25 NOW.)	RCT	43
WRITE (6,5513)	RCT	44
5513 FORMAT (//33H ROLL AMPLITUDE ESTIMATES (RAD) =)	RCT	45
WRITE (6,5515) (THMD(I),I=1,NHF)	RCT	46
5515 FORMAT (8F10.4)	RCT	47
RETURN	RCT	48
END	RCT	49
C	TAN	2
C-----VERSION 4 - CDC 6700 - T A N A K A - JUNE, 1972-----	TAN	3
C	TAN	4
C SUBROUTINE TANAKA(THM,EDDY,RGB)	TAN	5
C	TAN	6
C PROGRAMMER- O. FALTINSEN,DNV	TAN	7
C	TAN	8
COMMON AM(27),NUT,NMAS,NOS,ST(25),DS(25),EL,ELL,X(25,8),Y(25,8),PMTAN	TAN	9
1AS(27),XMAS(27),ZMAS(27),RRG(27),XG,ZG,TMAS,EI44,EI55,EI66,EI46,TPTAN	TAN	10
2ST,RF33,RM35,RM55,DGM,DIP,K,N,TVOL,ALFA(40,11),BETA(40,11),HDG(10),TAN	TAN	11
3,FN(5),BAM(30),CNG(10),SDG(10),OMAX,OMIN,NFR,NOK,NOB,NOH,OMEN(40),TAN	TAN	12
4F(7,6),XX(25,7),YY(25,7),DEL(25,7),SNE(25,7),CSE(25,7),EN1(25,7),TAN	TAN	13
5UN,OMEGA,IP,TITO(12),WORD,NON,IXAST,HDG1(10),IT,CBV,CMC,PRNTOP	TAN	14
COMMON ST1(27),TMAS(27),BEAM,DRAFT,DMAX,IRR,ML,IEND,IBILGE,IPRES,TAN	TAN	15
2VNY,GRAV,AMODL,MOD,AKEELL,BEAMKL,ITS(25),RO(25),RFD(25),DELTAD(25),TAN	TAN	16
2,RKD(25),SD(25),COSPHD(25),PHID(25),STPR(25),THMD(50)	TAN	17
COMMON NWSTP,INWSTP(12)	TAN	18
DIMENSION EDDY(27),RGB(27),F1(15),BDKG(15),GKDB(6),RFORE(6	TAN	19
1),BAFT(5),CAFT(5),XI(8),YI(8)	TAN	20
DIMENSION ALF2(5),F2(5)	TAN	21
ALF2(1)=0.0	TAN	22
ALF2(2)=0.0873	TAN	23
ALF2(3)=0.1745	TAN	24
ALF2(4)=0.3491	TAN	25
ALF2(5)=0.5235	TAN	26
F2(1)=1.	TAN	27
DO 1 I=1,5	TAN	28
BDKG(I)=1./(60.-I*10.)	TAN	29
1 CONTINUE	TAN	30
BDKG(6)=1./5.	TAN	31
DO 2 I=7,13	TAN	32
BDKG(I)=0.5*0.5*(I-7)	TAN	33
2 CONTINUE	TAN	34
IF(THM-0.1745) 3,3,4	TAN	35
3 CONTINUE	TAN	36
F1(1)=0.455	TAN	37
F1(2)=0.52	TAN	38

F1(3)=0.42	TAN	39
F1(4)=0.35	TAN	40
F1(5)=0.52	TAN	41
GO TO 5	TAN	42
4 CONTINUE	TAN	43
IF (THM-0.2618) 6,6,7	TAN	44
6 CONTINUE	TAN	45
FAC=(THM-0.1745)/(0.2618-0.1745)	TAN	46
F1(1)=(0.32-0.455)*FAC+0.455	TAN	47
F1(2)=(0.34-0.52)*FAC+0.52	TAN	48
F1(3)=(0.29-0.42)*FAC+0.42	TAN	49
F1(4)=(0.31-0.35)*FAC+0.35	TAN	50
F1(5)=(0.48-0.52)*FAC+0.52	TAN	51
GO TO 5	TAN	52
7 CONTINUE	TAN	53
IF (THM-0.3491) 8,9,9	TAN	54
8 CONTINUE	TAN	55
FAC=(THM-0.2618)/(0.3491-0.2618)	TAN	56
F1(1)=(0.25-0.32)*FAC+0.32	TAN	57
F1(2)=(0.25-0.34)*FAC+0.34	TAN	58
F1(3)=(0.22-0.29)*FAC+0.29	TAN	59
F1(4)=(0.28-0.31)*FAC+0.31	TAN	60
F1(5)=(0.45-0.48)*FAC+0.48	TAN	61
GO TO 5	TAN	62
9 CONTINUE	TAN	63
F1(1)=0.25	TAN	64
F1(2)=0.25	TAN	65
F1(3)=0.22	TAN	66
F1(4)=0.28	TAN	67
F1(5)=0.45	TAN	68
5 CONTINUE	TAN	69
F1(6)=0.63	TAN	70
F1(7)=0.63	TAN	71
F1(8)=0.59	TAN	72
F1(9)=0.53	TAN	73
F1(10)=0.4	TAN	74
F1(11)=0.35	TAN	75
F1(12)=0.32	TAN	76
F1(13)=0.3	TAN	77
IF (THM-0.0873) 10,10,11	TAN	78
10 CONTINUE	TAN	79
AEX=10.6	TAN	80
GO TO 12	TAN	81
11 CONTINUE	TAN	82
IF (THM-0.1745) 13,13,14	TAN	83
13 CONTINUE	TAN	84
AEX=(7.66-10.6)/(0.1745-0.0873)*(THM-0.0873)+10.6	TAN	85
GO TO 12	TAN	86
14 CONTINUE	TAN	87
IF (THM-0.2618) 15,15,16	TAN	88
15 CONTINUE	TAN	89
AEX=(6.34-7.66)/(0.2618-0.1745)*(THM-0.1745)+7.66	TAN	90
GO TO 12	TAN	91
16 CONTINUE	TAN	92
AEX=(5.28-6.34)/(0.3491-0.2618)*(THM-0.2618)+6.34	TAN	93
12 CONTINUE	TAN	94
GKDB(1)=1.2	TAN	95
GKDB(2)=1.4	TAN	96
GKDB(3)=1.6	TAN	97
GKDB(4)=1.8	TAN	98
GKDB(5)=2.0	TAN	99
GKDB(6)=2.05	TAN	100
RFORE(1)=1.0	TAN	101
RFORE(2)=0.6	TAN	102
RFORE(3)=0.34	TAN	103
RFORE(4)=0.15	TAN	104

RFORE(5)=0.04	TAN	105
RFORE(6)=0.0	TAN	106
BAFT(1)=1.0	TAN	107
BAFT(2)=1.25	TAN	108
BAFT(3)=1.5	TAN	109
BAFT(4)=2.0	TAN	110
BAFT(5)=2.25	TAN	111
CAFT(1)=0.22	TAN	112
CAFT(2)=0.24	TAN	113
CAFT(3)=0.3	TAN	114
CAFT(4)=0.5	TAN	115
CAFT(5)=0.63	TAN	116
DO 17 K=1,NOS	TAN	117
ITSU=ITS(K)	TAN	118
GO TO(18,19,20,21),ITSU	TAN	119
18 CONTINUE	TAN	120
RGB(K)=ABS(Y(K,NUT)*EL-ZG)	TAN	121
IF(X(K,1)) 60,60,61	TAN	122
60 CONTINUE	TAN	123
EDDY(K)=0.63	TAN	124
GO TO 29	TAN	125
61 CONTINUE	TAN	126
GDB=RGB(K)/2./X(K,1)/EL	TAN	127
IF(GDB-2.05) 22,23,23	TAN	128
23 CONTINUE	TAN	129
RBIL=0.0	TAN	130
GO TO 24	TAN	131
22 CONTINUE	TAN	132
DO 25 J=2,6	TAN	133
ITEMP = J	TAN	134
IF(GDB-GKDB(J)) 26,26,25	TAN	135
25 CONTINUE	TAN	136
26 CONTINUE	TAN	137
J = ITEMP	TAN	138
RBIL=(RFORE(J)-RFORE(J-1))/(GKDB(J)-GKDB(J-1))*(GDB-GKDB(J-1))*RFO	TAN	139
RE(J-1)	TAN	140
RBIL=RBIL*X(K,1)*EL	TAN	141
24 CONTINUE	TAN	142
BDG=1./GDB	TAN	143
DO 27 J=2,13	TAN	144
ITEMP = J	TAN	145
IF(BDG-BDKG(J)) 28,28,27	TAN	146
27 CONTINUE	TAN	147
28 CONTINUE	TAN	148
J = ITEMP	TAN	149
FONE=(F1(J)-F1(J-1))/(BDKG(J)-BDKG(J-1))*(BDG-BDKG(J-1))*F1(J-1)	TAN	150
F2ALF=1.	TAN	151
EDDY(K)=F2ALF*FONE*EXP(-AEX*RBIL/ABS(Y(K,NUT))/EL)	TAN	152
GO TO 29	TAN	153
19 CONTINUE	TAN	154
DO 30 J=1,NUT	TAN	155
XI(J)=X(K,J)*EL	TAN	156
YI(J)=Y(K,J)*EL	TAN	157
30 CONTINUE	TAN	158
RBIL=RD(K)	TAN	159
RGB(K)=SQRT((YI(NUT)-ZG)**2+XI(1)**2)-RBIL*(SQRT(2.)-1.)	TAN	160
BDG=2.*XI(1)/ABS(YI(NUT)-ZG)	TAN	161
DO 31 J=2,13	TAN	162
ITEMP = J	TAN	163
IF(BDG-BDKG(J)) 32,32,31	TAN	164
31 CONTINUE	TAN	165
32 CONTINUE	TAN	166
J = ITEMP	TAN	167
FONE=(F1(J)-F1(J-1))/(BDKG(J)-BDKG(J-1))*(BDG-BDKG(J-1))*F1(J-1)	TAN	168
EDDY(K)=FONE*EXP(-AEX*RBIL/ABS(YI(NUT)))	TAN	169
GO TO 29	TAN	170

20	CONTINUE	TAN	171
	RGB(K)=ABS(Y(K,NUT)*EL-Z0)	TAN	172
	BDO=2.*X(K,1)*EL/RGB(K)	TAN	173
	DO 33 J=2,5	TAN	174
	ITEMP = J	TAN	175
	IF(BDG-BAFT(J)) 34,34,33	TAN	176
33	CONTINUE	TAN	177
34	CONTINUE	TAN	178
	J = ITEMP	TAN	179
	EDDY(K)=(CAFT(J)-CAFT(J-1))/(BAFT(J)-BAFT(J-1))*(BDG-BAFT(J-1))+CATAN	TAN	180
	1FT(J-1)	TAN	181
	GO TO 29	TAN	182
21	CONTINUE	TAN	183
	RGB(K)=0.0	TAN	184
	EDDY(K)=0.0	TAN	185
29	CONTINUE	TAN	186
	GO TO(40,40,43,43),ITSU	TAN	187
40	CONTINUE	TAN	188
	IF(X(K,2)-X(K,1)) 42,43,43	TAN	189
42	CONTINUE	TAN	190
	BR=(X(K,1)-X(K,2))/(-Y(K,2))	TAN	191
	ALF=ATAN(BR)	TAN	192
	RDD=RBIL/ABS(Y(K,NUT))/EL	TAN	193
	IF(RDD) 44,44,45	TAN	194
44	CONTINUE	TAN	195
	F2(2)=0.855	TAN	196
	F2(3)=0.765	TAN	197
	F2(4)=0.682	TAN	198
	F2(5)=0.646	TAN	199
	GO TO 46	TAN	200
45	CONTINUE	TAN	201
	IF(RDD-0.0571) 47,47,48	TAN	202
47	CONTINUE	TAN	203
	F2(2)=(0.745-0.855)/0.0571*RDD+0.855	TAN	204
	F2(3)=(0.670-0.765)/0.0571*RDD+0.765	TAN	205
	F2(4)=(0.745-0.682)/0.0571*RDD+0.682	TAN	206
	F2(5)=(0.915-0.646)/0.0571*RDD+0.646	TAN	207
	GO TO 46	TAN	208
48	CONTINUE	TAN	209
	IF(RDD-0.1142) 49,49,50	TAN	210
49	CONTINUE	TAN	211
	F2(2)=0.74	TAN	212
	F2(3)=(0.72-0.670)/(0.1142-0.0571)*(RDD-0.0571)+0.67	TAN	213
	F2(4)=(0.89-0.745)/(0.1142-0.0571)*(RDD-0.0571)+0.745	TAN	214
	F2(5)=(1.34-0.915)/(0.1142-0.0571)*(RDD-0.0571)+0.915	TAN	215
	GO TO 46	TAN	216
50	CONTINUE	TAN	217
	IF(RDD-0.1713) 51,51,52	TAN	218
51	CONTINUE	TAN	219
	F2(2)=(0.70-0.74)/(0.1713-0.1142)*(RDD-0.1142)+0.74	TAN	220
	F2(3)=0.72	TAN	221
	F2(4)=(1.20-0.89)/(0.1713-0.1142)*(RDD-0.1142)+0.89	TAN	222
	F2(5)=(1.94-1.34)/(0.1713-0.1142)*(RDD-0.1142)+1.34	TAN	223
	GO TO 46	TAN	224
52	CONTINUE	TAN	225
	F2(2)=0.7	TAN	226
	F2(3)=0.72	TAN	227
	F2(4)=1.2	TAN	228
	F2(5)=1.94	TAN	229
46	CONTINUE	TAN	230
	DO 53 J=2,5	TAN	231
	ITEMP = J	TAN	232
	IF(ALF-ALF2(J)) 54,54,53	TAN	233
53	CONTINUE	TAN	234
54	CONTINUE	TAN	235
	J = ITEMP	TAN	236

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      F2ALF=(F2(J)-F2(J-1))/(ALF2(J)-ALF2(J-1))*(ALF-ALF2(J-1))+F2(J-1) TAN 237
      EDDY(K)=EDDY(K)*F2ALF TAN 238
43  CONTINUE TAN 239
17  CONTINUE TAN 240
      RETURN TAN 241
      END TAN 242
C
C-----VERSION 4 - CDC 6700 - R I L G E K - JUNE, 1972-----BIL 2
C BIL 3
C SUBROUTINE BILGEK(GXI,THM,SRKD,TBKD) BIL 4
C BIL 5
C PROGRAMMER- F.E. DE NOOIJ,DNV BIL 6
C BIL 7
C BIL 8
      COMMON AM(27),NUT,NMAS,NOS,ST(25),DS(25),EL,ELL,X(25,8),Y(25,8),PMBIL 9
      1AS(27),XMAS(27),ZMAS(27),RRG(27),XG,ZG,TMAS,EI44,EI55,EI66,EI46,TPBIL 10
      2ST,RF33,RM35,RM55,OGM,OIP,K,N,TVOL,ALFA(40,11),BETA(40,11),HOG(10)BIL 11
      3,FN(5),BAM(30),COG(10),SDG(10),OMAX,OMIN,NFR,NOK,NOB,NOH,OMEN(40),BIL 12
      4FR(7,6),XX(25,7),YY(25,7),DEL(25,7),SNE(25,7),CSE(25,7),ENI(25,7),BIL 13
      5UN,OMEGA,IO,TITO(12),WORD,NON,IXAST,HOG1(10),IT,CBV,CMC,PRNTOP BIL 14
      COMMON ST1(27),YMAS(27),BEAM,DRAFT,OMAX,IRR,ML,IEND,IBILGE,IPRES, BIL 15
      2VNY,GRAV,AMODL,MOD,AKEELL,BEAMKL,ITS(25),RD(25),RFD(25),DELTAD(25)BIL 16
      2,RKD(25),SD(25),COSPHD(25),PHID(25),STPR(25),THMD(50) BIL 17
      COMMON NWSTP,INWSTP(12) BIL 18
C BIL 19
C THIS CALCULATION METHOD IS A MODIFICATION OF KATOS METHOD BIL 20
C R=RADIUS OF RILGE CIRCLE AT STATION K BIL 21
C RF=RISE OF FLOOR AT STATION K BIL 22
C DELTA=LENGTH OF THAT PART OF THE BILGEKEEL WHICH IS AT STATION K BIL 23
C RK=DISTANCE OF MIDDLE OF BILGEKEEL FROM THE MOMENTAXIS IN WATERPLABIL 24
C S=LENGTH OF GIRTH FROM THE ROOT OF BILGEKEEL TO THE WATERSURFACE BIL 25
C AT STATION K BIL 26
C COSPHI=COSINUS TO THE ANGLE MADE BY THE PLANE OF BILGEKEEL WITH RK BIL 27
C PHI=ANGLE BETWEEN RK AND WATERPLANE BIL 28
C BEAMKL=BREADTH OF BILGE KEEL BIL 29
C AKEEL=LENGTH OF BILGEKEEL BIL 30
C BIL 31
      DIMENSION SRKD(27) BIL 32
      DO 703 K=1,NOS BIL 33
      R=RD(K) BIL 34
      RF=RFD(K) BIL 35
      DELTA=DELTAD(K) BIL 36
      IF (DELTA.LE. 0.) GO TO 703 BIL 37
      RK=RKD(K) BIL 38
      S=SD(K) BIL 39
      COSPHI=COSPHD(K) BIL 40
      PHI=PHID(K) BIL 41
      SHBEAM=2.*X(K,1)*EL BIL 42
      GK=ABS(Y(K,NUT))*EL BIL 43
      T=6.283185*SQRT(ELL/GRAV)/GXI BIL 44
      DRAUGT=GK BIL 45
      TETAM=THM BIL 46
      AKAPPA = R*(1.+RF/SHBEAM)**2./SQRT(0.5*SHBEAM*GK) BIL 47
      CK =1.+3.5*EXP(-9.*AKAPPA) BIL 48
      CO =1000.*(1.440+03.8*PHI**3.) BIL 49
      ALABDA = R/(DRAUGT-(RF/SHBEAM)*(SHBEAM-2.*R)) BIL 50
      FUNLAB = 1.34* SIN(3.1416*ALABDA/3.6)/(1.+0.162* SIN(3.1416*(ALABDBIL 51
      1DA-0.9)/1.8)) BIL 52
      EPSIL=ATAN(2.*RF/SHBEAM) BIL 53
      Q =(0.5*SHBEAM * TAN(3.1416/4. -EPSIL/2.)*RF-GK)*SIN(3.1416/4.*EPBIL 54
      1SIL/2.) BIL 55
      PO = GK - DRAUGT/3. - 2.* RF/3. BIL 56
      PONE=0.88*(GK-DRAUGT-0.54*(SHBEAM/2.-(DRAUGT-RF)*TAN(3.1416/4.*EPSBIL 57
      1IL/2.))) BIL 58
      BCIRC = COSPHI + S*(Q+PO-(PO-PONE)*FUNLAB)/2./BEAMKL/RK BIL 59
      ZETA = BEAMKL/(RK*PHI**.75) BIL 60
      AN = 1.4 +2.03*EXP(-25.*ZETA) BIL 61

```

ALPHA = 2.-AN	BIL	62
REYN=8.*BEAMKL*RK*THM*GXI/ELL/ELL/VNY/6.2832*(AMODL/ELL)**2	BIL	63
IF (REYN-10.**3) 10,10,11	BIL	64
10 CA=1.95-0.25*ALOG(REYN)/ALOG(10.)*0.2*SIN(3.1416*(ALOG(REYN)/ALOG(110.)-2.19)/0.54)	BIL	65
GO TO 7	BIL	66
11 CA=1.	BIL	67
7 CONTINUE	BIL	68
F = RK*TETAM * PHI**1.70/(T * SORT(BEAMKL))	BIL	69
FALFA= F**ALPHA	BIL	70
CN = 1.98* EXP(-11.*BEAMKL/AKEELL)	BIL	71
CS=CO/2.68/1000./FALFA	BIL	72
SBKD(K)=GXI*2.*(RK/EL)**3*THM*2.*DELTAL*BEAMKL/ELL/ELL/3./3.14159381L	BIL	73
1*CS*CA*CK*CN*BCIRC/TVOL	BIL	74
SBKD(K)=2.*SBKD(K)	BIL	75
TBKD=TBKD*SBKD(K)	BIL	76
410 FORMAT(12E10.4)	BIL	77
703 CONTINUE	BIL	78
RETURN	BIL	79
END	BIL	80
C	END	81
C-----VERSION 4 - CDC 6700 - E N D S E P - JUNE, 1972-----	END	2
C	END	3
C SUBROUTINE ENDSEP(DA,DB,GXI,PAA,PAV,JJ)	END	4
C	END	5
C PROGRAMMER- O. FALTINSEN,DNV	END	6
C	END	7
C	END	8
COMMON AM(27),NUT,NMAS,NOS,ST(25),DS(25),EL,ELL,X(25,8),Y(25,8),PMEND	END	9
1AS(27),XMAS(27),ZMAS(27),RRG(27),XG,ZG,TMAS,EI44,EI55,EI66,EI66,TPEND	END	10
2ST,RF33,RM35,RM55,DGM,DIP,K,N,TVOL,ALFA(40,11),BETA(40,11),HOG(10)END	END	11
3,FN(5),BAM(30),CDG(10),SDG(10),OMAX,OMIN,NFR,NOK,NOR,OMEN(40),END	END	12
4FR(7,6),XX(25,7),YY(25,7),DEL(25,7),SNE(25,7),CSE(25,7),EN1(25,7),END	END	13
5UN,OMEGA,10,TITO(12),WORD,NON,IXAST,HOG1(10),IT,CBV,CMC,PRNTOP	END	14
COMMON ST1(27),YMAS(27),BEAM,DRAFT,DMAX,IRR,ML,IEND,IBILGE,IPRES,END	END	15
2VNY,GRAV,AMODL,MOD,AKEELL,BEAMKL,ITS(25),RD(25),RFD(25),DELTA0(25)END	END	16
2,RKD(25),SD(25),COSPHD(25),PHID(25),STPR(25),THMD(50)	END	17
COMMON NWSTP,INWSTP(12)	END	18
DIMENSION DA(6,6),DB(6,6),PAA(25,7,6),PAV(25,7,6),DAOS(10),DDDS(10)END	END	19
1)	END	20
C	END	21
C NOS IS TEMPORARILY CHANGED TO IXAST IN THIS ROUTINE	END	22
C	END	23
NOSH=NOS	END	24
NOS=IXAST	END	25
DIP=ST(NOS)-TPST	END	26
DO 54 I=1,NON	END	27
FR(I,1)=EN1(NOS,I)	END	28
FR(I,2)=-SNE(NOS,I)	END	29
FR(I,3)=CSE(NOS,I)	END	30
FR(I,4)=XX(NOS,I)*CSE(NOS,I)-YY(NOS,I)*FR(I,2)	END	31
FR(I,5)=-DIP*FR(I,3)	END	32
FR(I,6)=DIP*FR(I,2)	END	33
54 CONTINUE	END	34
DO 55 LK=1,10	END	35
GO TO(613,613,613,613,613,613,614,615,616,617),LK	END	36
613 CONTINUE	END	37
L=LK	END	38
M=LK	END	39
GO TO 618	END	40
614 CONTINUE	END	41
L=5	END	42
M=3	END	43
GO TO 618	END	44
615 CONTINUE	END	45
L=2	END	46
M=6	END	47

GO TO 618	END	48
616 CONTINUE	END	49
L=2	END	50
M=4	END	51
GO TO 618	END	52
617 CONTINUE	END	53
L=6	END	54
M=4	END	55
618 CONTINUE	END	56
DAOS(LK)=0.0	END	57
DDDS(LK)=0.0	END	58
DO 619 J=1,NON	END	59
DAOS(LK)=DAOS(LK)*DEL(NOS,J)*FR(J,L)*PAA(NOS,J,M)	END	60
DDDS(LK)=DDDS(LK)*DEL(NOS,J)*FR(J,L)*PAV(NOS,J,M)	END	61
619 CONTINUE	END	62
DAOS(LK)=2.0*DAOS(LK)*DS(NOS)	END	63
DDDS(LK)=2.0*DDDS(LK)*DS(NOS)	END	64
55 CONTINUE	END	65
DO 620 L=1,10	END	66
DAOS(L)=DAOS(L)/TVOL/UN	END	67
DDDS(L)=DDDS(L)/TVOL/SQRT(UN)*SQRT(2.)	END	68
620 CONTINUE	END	69
DO 621 L=4,10	END	70
DAOS(L)=DAOS(L)*0.5*0.5	END	71
DDDS(L)=DDDS(L)*0.5*0.5	END	72
621 CONTINUE	END	73
DO 622 L=7,9	END	74
DAOS(L)=DAOS(L)*2.	END	75
DDDS(L)=DDDS(L)*2.	END	76
622 CONTINUE	END	77
DA(2,2)=DA(2,2)-FN(JJ)/GX1**2/DS(NOS)*2.*DDDS(2)	END	78
DB(2,2)=DB(2,2)+FN(JJ)/DS(NOS)*2.*DAOS(2)	END	79
DA(2,4)=DA(2,4)-FN(JJ)/GX1**2/DS(NOS)*2.*DDDS(9)	END	80
DB(2,4)=DB(2,4)+FN(JJ)/DS(NOS)*2.*DAOS(9)	END	81
DA(2,6)=DA(2,6)-FN(JJ)/GX1**2/DS(NOS)*2.*DDDS(8)-(FN(JJ)/GX1)**2/DEND	END	82
1S(NOS)*2.*DAOS(2)	END	83
DB(2,6)=DB(2,6)+FN(JJ)/DS(NOS)*2.*DAOS(8)-(FN(JJ)/GX1)**2/DS(NOS)*	END	84
12.*DDDS(2)	END	85
DA(4,2)=DA(2,4)	END	86
DB(4,2)=DB(2,4)	END	87
DA(4,4)=DA(4,4)-FN(JJ)/GX1**2/DS(NOS)*DDDS(4)*2.	END	88
DB(4,4)=DB(4,4)+FN(JJ)/DS(NOS)*2.*DAOS(4)	END	89
DA(4,6)=DA(4,6)-FN(JJ)/GX1**2/DS(NOS)*2.*DDDS(10)-(FN(JJ)/GX1)**2/DEND	END	90
1DS(NOS)*2.*DAOS(9)	END	91
DB(4,6)=DB(4,6)+FN(JJ)/DS(NOS)*2.*DAOS(10)-(FN(JJ)/GX1)**2/DS(NOS)	END	92
1*2.*DDDS(9)	END	93
DA(6,2)=DA(6,2)-FN(JJ)/GX1**2/DS(NOS)*2.*DDDS(8)	END	94
DB(6,2)=DB(6,2)+FN(JJ)/DS(NOS)*2.*DAOS(8)	END	95
DA(6,4)=DA(6,4)-FN(JJ)/GX1**2/DS(NOS)*2.*DDDS(10)	END	96
DB(6,4)=DB(6,4)+FN(JJ)/DS(NOS)*DAOS(10)*2.	END	97
DA(6,6)=DA(6,6)-FN(JJ)/GX1**2/DS(NOS)*2.*DDDS(6)-(FN(JJ)/GX1)**2/DEND	END	98
1S(NOS)*2.*DAOS(8)	END	99
DB(6,6)=DB(6,6)+FN(JJ)/DS(NOS)*2.*DAOS(6)-(FN(JJ)/GX1)**2/DS(NOS)*	END	100
12.*DDDS(8)	END	101
DA(3,3)=DA(3,3)-FN(JJ)/GX1**2/DS(NOS)*2.*DDDS(3)	END	102
DB(3,3)=DB(3,3)+FN(JJ)/DS(NOS)*2.*DAOS(3)	END	103
DA(5,3)=DA(5,3)-FN(JJ)/GX1**2/DS(NOS)*2.*DDDS(7)	END	104
DB(5,3)=DB(5,3)+FN(JJ)/DS(NOS)*2.*DAOS(7)	END	105
DA(3,5)=DA(3,5)+(FN(JJ)/GX1)**2/DS(NOS)*2.*DAOS(3)-FN(JJ)/GX1**2/DEND	END	106
1S(NOS)*2.*DDDS(7)	END	107
DB(3,5)=DB(3,5)+(FN(JJ)/GX1)**2/DS(NOS)*2.*DDDS(3)+FN(JJ)/DS(NOS)*	END	108
12.*DAOS(7)	END	109
DA(5,5)=DA(5,5)-FN(JJ)/GX1**2/DS(NOS)*2.*DDDS(5)+(FN(JJ)/GX1)**2/DEND	END	110
1S(NOS)*2.*DAOS(7)	END	111
DB(5,5)=DB(5,5)+FN(JJ)/DS(NOS)*2.*DAOS(5)+(FN(JJ)/GX1)**2/DS(NOS)*	END	112
12.*DDDS(7)	END	113

NOS=NOSH	END	114
RETURN	END	115
END	END	116
C	HYD	2
C-----VERSION 4 - CDC 6700 - H Y D P R E - JUNE, 1972-----	HYD	3
C	HYD	4
SUBROUTINE HYDPRE(WN,BOD,BEV,PAA,PAV,GXI,PRERE,PREIM,JJ,MM)	HYD	5
C	HYD	6
C PROGRAMMER- O. FALTINSEN,DNV	HYD	7
C	HYD	8
COMMON AM(27),NUT,NMAS,NOS,ST(25),DS(25),EL,ELL,X(25,8),Y(25,8),PMHYD	HYD	9
1AS(27),XMAS(27),ZMAS(27),RRG(27),XG,ZG,TMAS,EI44,EI55,EI66,EI46,TPHYD	HYD	10
2ST,RF33,RM35,RM55,DGM,DIP,K,N,TVOL,ALFA(40,11),BETA(40,11),HDG(10)	HYD	11
3,FN(5),BAM(30),CDG(10),SDG(10),OMAX,OMIN,NFR,NOK,NOB,NOH,OMEN(40),HYD	HYD	12
4FR(7,6),XX(25,7),YY(25,7),DEL(25,7),SNE(25,7),CSE(25,7),EN1(25,7),HYD	HYD	13
SUN,OMEGA,ID,TITO(12),WORD,NON,IXAST,HDG1(10),IT,CBV,CMC,PRNTOP	HYD	14
COMMON ST1(27),YMAS(27),BEAM,DRAFT,DMAX,IRR,ML,IEND,IBILGE,IPRES,	HYD	15
2VNY,GRAV,AMODL,MOD,AKEELL,BEAMKL,ITS(25),RD(25),RFD(25),DELTAD(25)	HYD	16
2,RKD(25),SD(25),COSPHD(25),PHID(25),STPR(25),THMD(50)	HYD	17
COMMON NWSTP,INWSTP(12)	HYD	18
DIMENSION BOD(6,1),BEV(6,1),PAA(25,7,6),PAV(25,7,6),REP(1	HYD	19
14,3),AIP(14,3),PRERE(8,14),PREIM(8,14)	HYD	20
COMPLEX PDIFR,CPET,II	HYD	21
COMPLEX PP,QQ,DODD,DEVEN	HYD	22
II=(0.0,1.0)	HYD	23
KPA=0	HYD	24
DO 1 K1=1,NOS	HYD	25
IF(STPR(K1)) 2,1,2	HYD	26
2 CONTINUE	HYD	27
KM=K1-1	HYD	28
KP=K1+1	HYD	29
KPA=KPA+1	HYD	30
DO 3 K=KM,KP	HYD	31
CP=WN*(ST(K)-TPST)*CDG(MM)	HYD	32
CP1=COS(CP)	HYD	33
CP2=SIN(CP)	HYD	34
CPET=(CP1+II*CP2)	HYD	35
DIP=ST(K)-TPST	HYD	36
DO 4 JS=1,2	HYD	37
GO TO(5,6),JS	HYD	38
5 CONTINUE	HYD	39
CSP=1.0	HYD	40
GO TO 7	HYD	41
6 CONTINUE	HYD	42
CSP=-1.0	HYD	43
7 CONTINUE	HYD	44
DO 8 J=1,NON	HYD	45
FR(J,1)=EN1(K,J)	HYD	46
FR(J,2)=-SNE(K,J)*CSP	HYD	47
FR(J,3)=CSE(K,J)	HYD	48
FR(J,4)=XX(K,J)*CSE(K,J)*CSP-YY(K,J)*FR(J,2)	HYD	49
FR(J,5)=-DIP*FR(J,3)	HYD	50
FR(J,6)=DIP*FR(J,2)	HYD	51
PET=EXP(WN*YY(K,J))	HYD	52
ARG=WN*XX(K,J)*CSP*SDG(MM)	HYD	53
FC=COS(ARG)	HYD	54
FS=SIN(ARG)	HYD	55
PP=FR(J,3)	HYD	56
PP=PP+II*FR(J,1)*CDG(MM)	HYD	57
QQ=II*FR(J,2)*SDG(MM)	HYD	58
DODD=(PP*FC+II*QQ*FS)*(GXI*SQRT(0.5*WN)/UN)	HYD	59
DEVEN=(QQ*FC+II*PP*FS)*(GXI*SQRT(0.5*WN)/UN)	HYD	60
PDIFR=-(DEVEN*CMPLX(PAA(K,J,2),PAV(K,J,2))*CSP*FR(J,2)+DODD*CMPLX	HYD	61
1PAA(K,J,3),PAV(K,J,3))*FR(J,3))*PET*CPET	HYD	62
PDIFR=PDIFR-DODD*CMPLX(PAA(K,J,1),PAV(K,J,1))*FR(J,1)*PET*CPET	HYD	63
RPDIF=REAL(PDIFR)	HYD	64

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AIPDF=AIMAG(PDIFR)
REPMO=PAA(K,J,1)*BOD(1,1)+CSP*PAA(K,J,2)*BEV(1,1)+PAA(K,J,3)*BOD(2,1)+
1,1)*0.5*(CSP*PAA(K,J,4)*BEV(2,1)+PAA(K,J,5)*BOD(3,1)+CSP*PAA(K,J,6)*
2)*BEV(3,1))-PAV(K,J,1)*BOD(4,1)-CSP*PAV(K,J,2)*BEV(4,1)-PAV(K,J,3)*
3)*BOD(5,1)-0.5*(CSP*PAV(K,J,4)*BEV(5,1)+PAV(K,J,5)*BOD(6,1)+CSP*PAV(K,J,6)*
4(K,J,6)*BEV(6,1))
AIPMO=PAV(K,J,1)*BOD(1,1)+CSP*PAV(K,J,2)*BEV(1,1)+PAV(K,J,3)*BOD(2,1)+
1,1)*0.5*(CSP*PAV(K,J,4)*BEV(2,1)+PAV(K,J,5)*BOD(3,1)+CSP*PAV(K,J,6)*
2)*BEV(3,1))+PAA(K,J,1)*BOD(4,1)+CSP*PAA(K,J,2)*BEV(4,1)+PAA(K,J,3)*
3)*BOD(5,1)+0.5*(CSP*PAA(K,J,4)*BEV(5,1)+PAA(K,J,5)*BOD(6,1)+CSP*PAA(K,J,6)*
4(K,J,6)*BEV(6,1))
JM=J+NON*(JS-1)
KKM=K-KM+1
REP(JM,KKM)=RPDIF*REPMO
AIP(JM,KKM)=AIPDF+AIPMO
8 CONTINUE
4 CONTINUE
3 CONTINUE
DO 9 JS=1,2
GO TO(10,11),JS
10 CONTINUE
CSP=1.0
GO TO 12
11 CONTINUE
CSP=-1.0
12 CONTINUE
K=K+1
DO 13 J=1,NON
JM=J*(JS-1)+NON
M=MM
PRERE(KPA,JM)=REP(JM,2)*FN(JJ)/GX1/DS(K1)*(AIP(JM,3)-AIP(JM,1))+
1*EXP(WN*YY(K,J))*COS(WN*(ST(K)-TPST)*CDG(MM)+CSP*WN*XX(K,J)*SDG(M))
2)-(BOD(2,1)+CSP*XX(K,J)/2.*BEV(2,1)-0.5*(ST(K)-TPST)*BOD(3,1))
PREIM(KPA,JM)=AIP(JM,2)*FN(JJ)/GX1/DS(K1)*(REP(JM,3)-REP(JM,1))+
1*EXP(WN*YY(K,J))*SIN(WN*(ST(K)-TPST)*CDG(MM)+CSP*WN*XX(K,J)*SDG(M))
2)-(BOD(5,1)+CSP*XX(K,J)/2.*BEV(5,1)-0.5*(ST(K)-TPST)*BOD(6,1))
13 CONTINUE
9 CONTINUE
1 CONTINUE
RETURN
END
C
C-----VERSION 4 - CDC 6700 - P R E S T - JUNE, 1972-----
C
SUBROUTINE PREST(PRF33,PRM35,PRM55,PC44)
C
C PROGRAMMER- O. FALTINSEN,DNV
C
COMMON AM(27),NUT,NMAS,NOS,ST(25),DS(25),EL,ELL,X(25,8),Y(25,8),PMPRS
1AS(27),XMAS(27),ZMAS(27),RRG(27),XG,ZG,TMAS,EI44,EI55,EI66,EI46,TPPRS
2ST,RF33,RM35,RM55,DGM,DIP,K,N,TVOL,ALFA(40,11),BETA(40,11),HOG(10)
3,FN(5),BAM(30),CDG(10),SDG(10),OMAX,OMIN,NFR,NOK,NOB,NOM,OMEN(40),
4FR(7,6),XX(25,7),YY(25,7),DEL(25,7),SNE(25,7),CSE(25,7),EN1(25,7),
5UN,OMEGA,IO,TITO(12),WORD,NON,IXAST,HOG1(10),IT,CBV,CMC,PRNTOP
COMMON ST1(27),YMAS(27),BEAM,DRAFT,DMAX,IRR,ML,IEND,IBILGE,IPRES,
2VNY,GRAY,AMODL,MOD,AKEELL,BEAMKL,ITS(25),RD(25),RFD(25),DELTAO(25)
2,RKD(25),SD(25),COSPHD(25),PHID(25),STPR(25),THMD(50)
COMMON NWSTP,INWSTP(12)
DIMENSION SS(27),HBM(27),SHR(27),HSB(27)
DIMENSION HB3(27)
NMAD=K+1
NMUD=K+2
HB3(1)=0.0
SS(1)=ST1(1)/10.
SS(NMUD)=ST(K)*0.5*DS(K)
HBM(1)=0.0

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IF(K-NOS) 2,3,3	PRS	27
2 CONTINUE	PRS	28
HB3(NMUD)=2.*X(K,1)**3	PRS	29
HBM(NMUD)=X(K,1)	PRS	30
GO TO 4	PRS	31
3 CONTINUE	PRS	32
HBM(NMUD)=0.0	PRS	33
HB3(NMUD)=0.0	PRS	34
4 CONTINUE	PRS	35
DO 1 J=2,NMAD	PRS	36
IP1=J-1	PRS	37
SS(J)=ST(IP1)	PRS	38
HBM(J)=X(IP1,1)	PRS	39
HB3(J)=2.*X(IP1,1)**3	PRS	40
1 CONTINUE	PRS	41
DO 5 J=1,NMUD	PRS	42
SPD=SS(J)-TPST	PRS	43
SHB(J)=SPD*HBM(J)	PRS	44
HSB(J)=SPD*SHB(J)	PRS	45
5 CONTINUE	PRS	46
FPCM=SIMPUN(SS,HB3,NMUD)	PRS	47
PCBV=0.5*SIMPUN(SS,AM,NMUD)/TVOL	PRS	48
PC44=PCBV*PPCM/3.0/TVOL*0.5	PRS	49
PRF33=4.0*SIMPUN(SS,HBM,NMUD)/TVOL	PRS	50
PRM35=-2.0*SIMPUN(SS,SHB,NMUD)/TVOL	PRS	51
PRM55=SIMPUN(SS,HSB,NMUD)/TVOL	PRS	52
RETURN	PRS	53
END	PRS	54
C	VIS	2
C-----VERSION 4 - CDC 6700 - V I S C - JUNE, 1972-----	VIS	3
C	VIS	4
SUBROUTINE VISC(GXI,VD,TVD,THM,EDDY,RGB)	VIS	5
C	VIS	6
C PROGRAMMER- O. FALTINSEN,DNV	VIS	7
C	VIS	8
COMMON AM(27),NUT,NMAS,NOS,ST(25),DS(25),EL,ELL,X(25,8),Y(25,8),PI,VIS	VIS	9
1AS(27),XMAS(27),ZMAS(27),RRG(27),XG,ZG,TMAS,EI44,EI55,EI66,EI46,TPVIS	VIS	10
2ST,RF33,RM35,RM55,DGM,DIP,K,N,TVOL,ALFA(40,11),BETA(40,11),HOG(10)VIS	VIS	11
3,FN(5),BAM(30),CDG(10),SDG(10),OMAX,OMIN,NFR,NOK,NOB,NOH,OMEN(40),VIS	VIS	12
4FR(7,6),XX(25,7),YY(25,7),DEL(25,7),SNE(25,7),CSE(25,7),EN1(25,7),VIS	VIS	13
5UN,OMEGA,IO,TIU(12),WORD,NON,IXAST,HOG1(10),IT,CBV,CMC,PRNTOP	VIS	14
COMMON ST1(27),YMAS(27),BEAM,DRAFT,OMAX,IRR,ML,IEND,IBILGE,IPRES,	VIS	15
2VNY,GRAV,AMODL,MOD,AKEELL,BEAMKL,ITS(25),RD(25),RFD(25),DELTA(25)VIS	VIS	16
2,RKD(25),SD(25),COSPHD(25),PHID(25),STPR(25),THMD(50)	VIS	17
COMMON NWSTP,INWSTP(12)	VIS	18
DIMENSION VD(27)	VIS	19
DIMENSION EDDY(27)	VIS	20
DIMENSION RGB(27)	VIS	21
DIMENSION XI(8),YI(8)	VIS	22
C	VIS	23
C THIS SUBROUTINE CALCULATES SKIN-FRICTIONAL AND EDDYMAKING ROLL-DAMPVIS	VIS	24
C	VIS	25
PI=3.141593	VIS	26
TVD=0.0	VIS	27
DO 2 K=1,NOS	VIS	28
RG=RGB(K)/EL	VIS	29
PSUR=0.0	VIS	30
DO 3 J=1,NON	VIS	31
PSUR=PSUR+DEL(K,J)	VIS	32
3 CONTINUE	VIS	33
PSUR=PSUR*DS(K)*2.	VIS	34
DO 11 J=1,NUT	VIS	35
XI(J)=X(K,J)	VIS	36
YI(J)=Y(K,J)	VIS	37
11 CONTINUE	VIS	38
SQAR=2.*ABS(SIMPUN(YI,XI,NUT))	VIS	39

DK=ABS(Y(K,NUT))	VIS	40
BMK=2.*BMAX(NUT,XI)	VIS	41
CA=SQAR/BMK/DK	VIS	42
RS=1./PI*((0.887+0.145*CA)*(1.7*DK+CA*BMK)+2.*ZG/EL)	VIS	43
PHOAR=RS**3*PSIJR	VIS	44
PARM=RS**2	VIS	45
RN=3.22/8./PI*GX1*PARM*THM**2/VNY*(AMODL/ELL)**2	VIS	46
VA2=0.0	VIS	47
GO TO(4,5),MOD	VIS	48
5 CONTINUE	VIS	49
VA2=0.014*RN**(-0.114)	VIS	50
4 CONTINUE	VIS	51
VA=1.328*RN**(-0.5)+VA2	VIS	52
VD(K)=1./6./PI*PHOAR*THM*GX1/TVOL*VA	VIS	53
VD(K)=VD(K)+1./6./PI*PSUR*RG**3*THM*GX1/TVOL*EDDY(K)	VIS	54
VD(K)=2.*VD(K)	VIS	55
TVD=TVD+VD(K)	VIS	56
2 CONTINUE	VIS	57
RETURN	VIS	58
END	VIS	59
C	ATD	2
C-----VERSION 4 - CDC 6700 - A T A N 2 D - JUNE, 1972-----	ATD	3
C	ATD	4
FUNCTION ATAN2D (B,A)	ATD	5
C	ATD	6
C PROGRAMMER- W. MEYERS,NSRDC	ATD	7
C	ATD	8
C-----ARCTANGENT FUNCTION TO COMPUTE ANGLES (IN DEGREES) IN ANY-----	ATD	9
C-----QUADRANT. THE B ARGUMENT IS THE IMAGINARY VECTOR. THE A-----	ATD	10
C-----ARGUMENT IS THE REAL VECTOR.-----	ATD	11
C	ATD	12
DATA EPS /1.E-10/	ATD	13
IF (B .EQ. 0.) ATAN2D = 0.	ATD	14
IF (B .GT. 0.) ATAN2D = 90.	ATD	15
IF (B .LT. 0.) ATAN2D =-90.	ATD	16
IF (ABS(A) .GT. EPS) ATAN2D = ATAN2(B,A)*57.295779	ATD	17
RETURN	ATD	18
END	ATD	19
C	BMX	2
C-----VERSION 4 - CDC 6700 - B M A X - JUNE, 1972-----	BMX	3
C	BMX	4
FUNCTION BMAX(NUT,XI)	BMX	5
DIMENSION XI(1)	BMX	6
A=XI(1)	BMX	7
IF (NUT .EQ. 1) GO TO 20	BMX	8
DO 10 I=2,NUT	BMX	9
IF(XI(I).GT.A) A=XI(I)	BMX	10
10 CONTINUE	BMX	11
20 BMAX=A	BMX	12
RETURN	BMX	13
END	BMX	14

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